

TENDER SPECIFICATION

BHEL:PS:SR:SAS:SCT:GK1115-078/T.No.20/ 2008-09

FOR

**TRANSPORTATION FROM STROES TO
SITE, HANDLING OF EQUIPMENTS AT SITE,
ERECTION, TESTING & COMMISSIONING OF
ELECTRICAL AND C & I SYSTEMS FOR
5X3 0MW CAPACITY PUMP SETS**

at

KALWAKURTHY LIFT IRRIGATION SCHEME STAGE I

**MAHABOOB NAGAR DISTRICT
ANDHRA PRADESH**

PART – I TECHNICAL BID

BOOK NO: 1



BHARAT HEAVY ELECTRICALS LIMITED
(A Government of Indian Undertaking)
Power Sector, Southern Region,
Service After Sales - 39, Ek Tara Building,
Sarojini Devi Road, Secunderabad 500 003, A.P



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TENDER SPECIFICATION NO: BHEL:PS:SR:SAS:SCT:GK1115-078/T.No.20/08-09

Messrs

Date:

Dear Sir

Sub: Transportation from stores to site, Handling of equipments at Site, Erection, Testing and Commissioning of Electrical and C&I systems for 5 x 30 MW capacity pump sets sets at Kalwakurthy Lift irrigation Pump Hydro Electric Project, Mahaboob Nagar District Andhra Pradesh.

Please find enclosed one set of non-transferable tender documents containing 102 pages along with general conditions of contract Booklet for the above work.

You are requested to go through the tender documents, GCC Booklet and offer your most competitive rate and submit the tender documents duly filled in as per procedure indicated in the tender specification along with requisite EMD of Rs. 2,00,000/- (Rupees Two Lakhs only) either in the form of Cash or by Demand Draft. Bids with Deviations from the tender conditions will be rejected.

A SEPARATE LETTER SHALL BE FURNISHED INDICATING THAT THERE ARE NO DEVIATIONS FROM THE TENDER CONDITIONS

The completed quotations shall reach the office of the under signed on or before **11.00 Hrs. on 14.10.2008** and tenders will be opened on the same day **at 11.30 Hrs.** You are requested to depute your authorized representative at the time of opening

Kindly acknowledge the receipt of the tender documents and confirm your participation

In case you are not participating in this you may return the document immediately or send the regretted letter.

Kindly note that BHEL reserves the right to reject any or all tenders without assigning any reason.

Thanking you.

Yours faithfully
For and on behalf of
BHARAT HEAVY ELECTRICALS LIMITED

Senior Deputy General Manager Contracts

Date :

Encl : One set of Tender documents along with GCC Booklet and drawings

BHARAT HEAVY ELECTRICALS LIMITED
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SECIAL INSTRUCTIONS TO BIDDERS

The Bidder must submit their bids as requested in sealed cover prominently superscribed the Tender Specification number, due date and time of submission as mentioned in the TENDER NOTICE.

The following information shall be furnished by the Bidder along with their offer (Technical Bid cover)

- 01 Details of Previous experience during the last five years indicating contract value, duration completion period and present engagement as per G.C.C.
- 02 Organization structure of the Company as per GCC.
- 03 Financial status of the firm enclosing balance sheet and profit and loss account for the past 3 years and certificate from the Company Banker as per G.C.C.
- 04 Turnover of the Company in last 3 Financial years in construction works only.
- 05 Latest Income Tax clearance certificate.
- 06 BIO DATA of key personnel presently in the Roles of the company and proposed site organization for carrying our the work including deployment of Engineers and Supervisors.
- 07 Declaration sheets as per Appendix of Tender Specification.
- 08 Checklist and Schedule of General particulars as per Appendix in GCC.
- 09 T & P owned/deployment details as per G.C.C.
- 10 Technical manpower deployment details as per G.C.C.
- 11 Other relevant details as per GCC and checklist.
- 12 A DECLARATION SHEET INDICATING THAT THERE IS NO DEVIATION IN TENDER DOCUMENT(AS IN PAGE 3) TENDERS MAY FURTHER NOTE THAT THIS DECLARATION IS A PREREQUISITTE FOR BHEL TO CONSIDER THEIR BIDS. BIDS SUBMITTED WITHOUT "NO DEVIATION DECLARATION WILL BE REJECTED BY BHEL.
- 13 SAFTY PLAN

Bidder may further note that the submission of safety plan is prerequisite for BHEL to consider their bids.

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PROCEDURE FOR SUBMISSION OF SEALED BIDS

The Tenders must submit their bids as required in two parts in separate sealed covers prominently superscribed as Part-I "Technical Bid and Part-II "Price Bid and also indicating on each of the covers the tender specification number and due date time as mentioned in the Tender Notice.

Part-I (Technical Bid) Cover-I

Excepting Rate Schedule, all other schedules, data sheets and details called for in the specification shall be enclosed, in part I Technical Bid only.

Part II (Price Bid) Cover II

All indications of price shall be given in this part II Price Bid.

These two separate cover I & II (Part I and Part II) shall together be enclosed in a third envelope (Cover III) along with requisite EMD as indicated and this sealed cover shall be superscribed and submitted to Senior Deputy General Manager/ Contracts at the above mentioned address before the due date as indicated. The Tenders will be intimated separately in case any clarifications are required.

SENIOR DEPUTY GENERAL MANAGER/CONTRACTS.

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(A Government of Indian Undertaking)
Power Sector, Southern Region,
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TENDER NOTICE

Sealed Tenders are invited from reputed contractors with sufficient previous experience in the under mentioned similar nature of work.

Tender Specification No. BHEL:PS:SR:SAS:SCT:GK1115-078/T.No.20/ 2008-09

Description	EMD
Transportation, Handling of equipments at Site Erection, Testing Commissioning of Electrical and C&I systems for 5 x 30 MW capacity sets at Kalwakurthy lift irrigation pump Hydro Electric Project, Mahaboob nagar District, Andhra Pradesh.	Rs.2,00,000/- (Rupees Two Lakhs only)

Cost of Tender Documents (Including all Taxes)	:	Rs.1,700/-
Sale Starts on	:	23.09.2008
Sale close on	:	14.10.2008
Due date and Time for Submission	:	14.10.2008 at 11.00 Hrs.
Date and time for opening Of Technical Bids	:	14.10.2008 at 11.30 Hrs.

Interested parties can get the Tender documents from the office of the Senior Deputy General Manager/ Contracts on all working days by remitting the cost of tender documents either by Cash or A/C Payee Demand Draft drawn in favour of M/s Bharat Heavy Electricals Limited, Secunderabad – 500 003. Money order, Cheques and Postal Orders will not be accepted.

The Bharat Heavy Electricals Limited takes no responsibility for any delay, loss or non-receipt of tender documents sent by post and also reserves the right to reject any or all the tenders without assigning any reason therefore. TENDERS NOT ACCOMPANIED BY THE PRESCRIBED EARNEST MONEY DEPOSIT ARE LIABLE TO BE SUMMARILY REJECTED,

SENIOR DEPUTY GENERAL MANAGER/CONTRACTS

CERTIFICATE FOR NO DEVIATION

I, _____ OF
M/s. _____ hereby certify
that there is no deviation from the Tender conditions either technical or
commercial and I am agreeing to all the terms and conditions mentioned
in the Tender Specification.

SIGNATURE OF THE TENDERER

OFFER OF CONTRACTOR

The Senior Deputy General Manager/Contracts

BHARAT HEAVY ELECTRICALS LIMITED

(A Government of Indian Undertaking)

Power Sector, Southern Region,

Service After Sales - 39, Ek Tara Building,

Sarojini Devi Road, Secunderabad 500 003, A.P

Sir,

I/We hereby offer to carry out the work detailed in Tender Specification No. BHEL:PS:SR:SAS:SCT:GK1115-078/T.No.20/ 2008-09 issued by Bharat Heavy Electricals Limited, Power Sector:Southern Region, in accordance with the terms and conditions thereof.

I/We have carefully perused the following documents connected with the above work and agreed to abide by the same.

1. Instructions to Tenderer
2. General Conditions of Contract
3. Special conditions of Contract

Other Section, Appendices and Schedules

I/We have deposited/forwarded herewith the Earnest Money Deposit/the Bank Guarantee in the format prescribed and as stipulated towards the Earnest Money Deposit a sum of Rs. _____ (Rupees _____ only) vide BHEL'S Cash Receipt No. _____ Dt. _____ which shall be refunded _____ should our offer not be accepted. Should our offer be accepted. I/We Security Deposit for the work as provided or in the Tender Specification within the stipulated time as may be indicated by BHEL, Power Sector : Southern Region, SAS, Secunderabad-3.

I/We further agree to execute all the works referred to in the said documents upon the terms and conditions continued or referred to therein and as detailed in the appendices annexed thereto.

DATE:

CONTRACTOR:

PLACE:

ADDRESS:

Witness with their address

Signature

Name

Address

PROJECT INFORMATION

PROJECT : Kalwakurthy Lift irrigation Scheme stage 1

CUSTOMER : M/S Patel Engineering Ltd

LOCATION OF PROJECT : Kalwakurthy Lift irrigation Pump 5X 30 MW
LIS, Yellur village, Kollapur, Mahaboob
Nagar District Andhra Pradesh.

Other particulars

1. Latitude :
2. Longitude :
3. Seismic Forces :
4. Rainfall :
5. Highest Temperature :
6. Topo Sheet No. :

SECTION III

COMMON CONDITIONS OF CONTRACT

3.1 SCOPE OF CONTRACT

- 3.1.1 The Intent of this specification is to provide erection and commissioning services for execution of projects according to most modern and proven techniques and codes. The omission of specific reference to any method and equipment of material necessary for the proper and efficient services towards installation of the Plant shall not relieve the contractor of the responsibility of providing such services, facilities to complete the project or portion of project awarded to him. The quoted rate shall deem to be inclusive of all such contingencies.
- 3.1.2 The contractor shall carry out the work in accordance with Instructions/drawings/specification/standard practices supplied by BHEL from time to time.
- 3.1.3 Provision of all types of labour, Supervisors, Engineers watch and ward as required tools and tackles as required, consumables as required under various clauses of tender specification for handling transportation, erection, testing and commissioning.
- 3.1.4 Proper out-turn as per BHEL plan and commitment.
- 3.1.5 Completion of work in time.
- 3.1.6 Good quality and accurate workmanship for proper performance of equipment / systems.
- 3.1.7 Preservation of all components at all stages of pre-assembly/erection/testing and commissioning till unit is handed over.

3.2 FACILITIES TO BE PROVIDED BY BHEL:

3.2.1 OPEN SPACE

Open space for building of temporary office shed and contractor's stores shed(s) will be provided Contractor has to build the same at his cost

Open space for building labour colony shall be provided in specified area as allotted by M/S PEL. Contractor has to build his labour colony at his cost, including fencing around labour colony, for their safety.

3.2.2 ELECTRICITY :

For construction purpose and for contractor's office and stroe sheds electricity will be provided at one single point as provided by customer to BHEL. Further distribution shall be arranged by the contractor at his own cost including supply of energy meter with calibration certificate

3.2.3 WATER

For construction purpose water will be provided at one single point. The contractor at his own cost shall arrange further distribution. For labour colony water has to be arranged by the contractor at his cost.

3.2.4 TOOLS & TACKLES :

All the Tools, Plants, Instruments required for the complete erection of components shall be arranged by the contractor, BHEL shall not provide any T & P for this work. However only MAXI – TERMI tool will be provided by BHEL, if supplied from unit.

3.2.5 CONSUMABLES :

All Consumables and electrodes including Oxygen / acetylene, Argon Gases, Paints etc. shall be arranged by the Contractor at their own cost.

3.3 FACILITIES TO BE PROVIDED AND DEVELOPED BY THE TENDERER AT HIS COST

3.3.1 CIVIL CONSTRUCTION :

It shall be the responsibility of the contractor to construct his own office shed stores shed, with all facilities like electricity, water, supply, sanitary arrangements in the area allotted to him for the purpose.

3.3.2 WATER DISTRIBUTION :

Distribution of water for construction purpose and as well as drinking purpose from the single point provided by BHEL to various work-fronts shall be contractor's responsibility and at his cost.

3.3.3 ELECTRICITY DISTRIBUTION :

Provision of distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cable 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/ there customer with the appropriate statutory requirements shall be the responsibility of the tenderer/contractor.

POSSESSION OF GENERATORS :

As there are bound to be interruptions in regular power supply, power cut / load shedding in any construction sites, due to inherent power shortage in Stage on this account, suitable extension of time, if found necessary only be given and contractor is not entitled for any compensation. It shall be the responsibility of the tenderer/ contractor to provide, maintain the complete installation on the load side of the supply with due regard to safety requirements at site.

3.3.4 LIGHTING FACILITY :

Adequate lighting facilities such as flood lamps low volt hand lamps and area lighting shall be arranged by the contractor at the site of construction, contractor's material storage area etc. at his cost.

3.3.5 POWER DISTRIBUTION :

For the purpose of planning contractor shall furnish along with tender the estimated requirement of power (month wise) for execution of work in terms of maximum KW demand.

3.3.6 CONTRACTOR'S OBLIGATION ON COMPLETION :

On completion of work all the temporary buildings, structures, pipelines, cables etc. shall be dismantled and leveled and debris shall be removed as per instruction of BHEL by the Contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from Contractor. The decision of BHEL Engineer in this regard is final.

3.4 GASES

3.4.1 All required gases like Oxygen/acetylene/LPG/argon/Nitrogen required for construction purpose shall be supplied by the Contractor at his cost. It shall be the responsibility of the contractor to plan the activities and store sufficient quantity of those gases. Non-availability of gases cannot be considered as reasons for not attaining the required progress of erection.

3.4.2 BHEL reserves the right to reject the use of any gas in case required purity is not maintained.

3.4.3 The contractor shall submit weekly / fortnightly / monthly statement report regarding consumption of all consumables for cost analysis purposes.

3.4.4 The contractor shall ensure safe keeping of the inflammable cylinder at a separate place away from normal habit with proper security etc

3.4.5 The contractor shall arrange air / gas manifold ensuring proper distribution and reduction of handling time.

3.4 ELECTRODES

3.5.1 All required electrodes shall be arranged by contractor, at his cost. It shall be the responsibility of the contractor to obtain prior approval of BHEL, before procurement regarding suppliers, type of electrodes on receipt of the electrodes at site it shall be subject to inspection and approval by BHEL. The contractor shall inform BHEL details regarding type of electrodes, batch No., and date of expiry etc.

3.5.2 Storage of electrodes shall be done in an air conditioned/controlled humidity room as per requirement, at his own cost by the contractor.

3.5.3 All Low electrodes shall be baked / dried in the electrode drying oven (range 375 deg.C – 425 deg.C) to the temperature and period specified by the BHEL Engineer before they are used in erection work and each Welder should be provided with one portable electrode drying oven at the work spot. Electrode drying oven and portable drying ovens shall be provided by the contractor at his cost.

- 3.5.4 In case of improper arrangement of procurement of above electrodes BHEL reserve the right to procure the same from any source and recover the cost from the contractor's first subsequent bill at market value plus departmental charges of BHEL Postponement of such recovery is not permissible.
- 3.5.5 BHEL reserves the right to reject the use of any electrodes at any stage if found defective because of bad quality, improper storage, date of expiry, unapproved type of electrodes etc. It shall be the responsibility of the contractor to replace at this cost without loss of time.

3.6 TOOL & TACKLES

- 3.6.1 All T & P required for the satisfactory execution of work shall be arranged by contractor at his cost.
- 3.6.2 All the T & P arranged by contractor including electrical connections wherein required shall be reliable/proven/tested and necessary test certificate.
- 3.6.3 All instruments, measuring tools etc, are to be calibrated periodically as per the requirement of BHEL and necessary calibration certificates are to be submitted to BHEL before use.
- 3.6.4 All the T&P lifting tackles including wire ropes, slings shackles and electrically operated equipment shall be got approved by BHEL Engineer before they are actually put on use. Test certificates should be submitted before their usage .
- 3.6.5 For the movement of cranes etc. It may become necessary to lay sleeper bed for obtaining leveled safe approach for usage of equipment. It shall be the contractor's responsibility to lay necessary sleepers. The required sleepers are to be arranged by the contractor at their cost. BHEL will not provide any sleeper for the above work.

3.7 SUPERVISORY STAFF AND WORKMEN

- 3.7.1 The Contractor shall deploy experienced Engineers, Supervisors all the skilled workmen like High Pressure Welders (gas, TIG and arc) Carbon, alloy steel welders, Gas cutters, electricians, Riggers, Sarongs, Erectors, Carpenters, fitters etc. in addition to other skilled, semi-skilled and unskilled workmen required for all the work of handling and transportation from site storage to erection site, transportation, erection, testing and commissioning contemplated under this specification. Only fully trained and competent men with previous experience of job shall be employed.. They shall hold valid certificates wherever necessary.

BHEL reserves the right to decide on the suitability of the workers and other personnel who will be employed by the contractor, BHEL reserves right to insist on removal of any employee of the contractor at any time, if they find them unsuitable and the contractor shall forthwith remove him.

- 3.7.2 Contractor shall be qualified Engineer (Graduates in engineering and supervisors Diploma Holders) and experienced in the area of work. They shall ensure proper out-turn of work and discipline on the part of labour put on the job by the contractor and in general see that the works are carried out in safe and proper manner and in coordination with other labour and staff employed directly by BHEL or other contractors of BHEL's client.

- 3.7.3 The Contractor shall also furnish Daily & Monthly report showing the number of employees engaged in various categories of work and a progress report of work as required by BHEL Engineer.
- 3.7.4 The work shall be executed under the usual condition existing in major power plant construction and in conjunction with numerous other operations at site. The bidder and his personnel shall co-operate with other personnel contractor coordinating his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.
- 3.7.5 The contractor's supervisory staff shall execute the work in the most substantial and workman like manner in stipulated time. Accuracy of work, good workmanship and aesthetic finish are essential part of this contract. The contractor shall be responsible to ensure that assembly and workmanship conform to the dimensions and tolerances given in he drawings/instructions given by BHEL Engineers from time to time.
- 3.7.6 The contractor shall employ the necessary number of qualified and approved full time electricians at his cost to maintain his temporary electrical installation till the completion of work.
- 3.7.7 It is the responsibility of the bidder to carryout the work for achieving the target set by BHEL and also during erection, commissioning and testing period. The contractor's quoted rate shall include all these contingencies.
- 3.8.0 If the contractor or his workmen or employees shall break, deface, injure or destroy any part of a building, road, kerb, fence, enclosure, water pipes, cables, drains, electric or telephone posts or wires, trees or any other property or to ay part of erected components etc. The contractor shall make the same good at his own expense or in default BHEL may cause the same to be good by other workmen or by other means and deduct to expenses (of which BHEL's decision is final) from any money due to the contractor.

3.9 SCOPE OF MATERIAL HANDLING AND SITE STORAGE AND OTHER RESPONSIBILITIES :

- 3.9.1 While BHEL will endeavour to store/stack/identify materials properly in their open/closed storage yard/shed it shall be contractor's responsibility to assist BHEL in identifying material well in time for erection, taking delivery of the same in time following the procedure indicated by BHEL and transport the material safely to pre-assembly yard/erection site in time according to programme.
- 3.9.2 The contractor shall identify necessary supervisor/labour for the above work in sufficient quality as may be needed by BHEL for areas covering their scope.
- 3.9.3 It shall be contractor's responsibility to arrange necessary cranes/tractors, trailer or trucks/slings/tools and tackles/labour including operators and on to transport equipment, move it to erection site/pre-assembly yard and unload the same at pre-assembly yard/erection site and the quoted rate shall include the same.
- 3.9.4 All equipments so used by Contractor shll be of proven quality and safe in operation as approved by the statutory authorities as per the law in force.

- 3.9.5 Any loss/damage to materials issued to contractor shall be made good by him or BHEL, will arrange for replacement at cost recovery basis and decision of BHEL, shall be final. Any loss/damage must be intimated to TG in-charge of BHEL in writing within 24 hours of the occurrence.
- 3.9.6 All the surplus damaged, unused materials, package materials/ containers/ special transporting frames, gunny bags etc. supplied by BHEL shall be returned to the BHEL Stores by the contractor immediately.
- 3.9.7 The contractor shall take delivery of the components and equipment and special consumable from the storage area after getting the approval of the BHEL Engineer on standard indent from to be specified by BHEL. At periodic/interval of work, complete and detailed account of the equipment so erected and electrodes used shall be submitted to the BHEL Engineer.
- 3.9.8 The contractor shall submit monthly plan for erection and the same will be mutually agreed upon after discussion. The contractor shall arrange for Engineers, Supervisors and labour force and tools and plants and consumables to suit the above plan and execute the work accordingly.
- 3.9.9 The contractor shall have total responsibility for all equipment and materials in his custody, stores, loose, semi-assembled, assembled or erected by him at site.
- 3.9.10 The contractor shall make suitable security arrangement including employment of security personnel to ensure the protection of all materials/equipments and works from theft, fire pilferage and any other damage and loss.
- 3.9.11 The contractor shall ensure that the packing materials and protection devices used for the various equipments during transit and storage are removed before these equipments are installed.
- 3.9.12 All equipments shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings etc. shall be used for unloading and / or handling of the equipments without the specific written permission of the Engineer. The equipments from the storage yard shall be moved to the actual site of erection / location at the appropriate time as per the direction of BHEL Engineer so as to avoid damage for such equipments at site.
- 3.9.13 The work covered under this specification is of highly sophisticated nature requiring best quality/proven workmanship, engineering and construction management. He should also ensure successful and timely commercial operation of equipment installed. The contractor must have adequate quantity of precision tools, construction aids in possession. Contractor must also have adequate trained, qualified and experienced supervisory staff and skilled personnel.
- 3.9.14 All the necessary certificates and licenses required to carry out this scope of work are to arranged by the contractor then and there at no extra cost.
- 3.9.15 The Contractor shall take all reasonable care to protect the materials and work till such time the erected equipment has been taken over by BHEL/their

client. Necessary suitable temporary fencing and lighting shall be provided by the contractor as a safety measure against accident and damage of property of BHEL. Suitable caution notices shall be displayed where access to any part may be deemed to be unsafe and hazardous.

- 3.9.16 The contractor shall be responsible for taking all safety precautions during the construction and leaving the site safe at all items. When the work is temporarily suspended he shall be protect all construction materials, equipments and facilities from causing damage to existing property interfering with the operation of the station when it goes into service. The contractor shall comply with all applicable provisions of the safety regulations clean-up programme and other precautionary measures which the BHEL has in effect at the site.
- 3.9.17 All lifting tackles including wire ropes, slings, shackles etc, used by the contractor shall be got approved by BHEL Engineer at site before they are actually put on the work. It will be the responsibility of the contractor to ensure safe lifting of the equipment taking due precautions to avoid any accidents and damage to other equipments and personnel. All piping shall be adequately supported and protected to prevent damage during handling and erection. The history cards for major equipments to be maintained by the contractor.
- 3.9.18 The contractor shall take delivery of equipment from storageyard/ stores / sheds. He shall also make arrangements for verification of equipment maintain records and keep safe custody watch and ward of equipment after it has been handed over to him till these are fully erected, tested and commissioned and taken over by BHEL's client. The stolen / lose / damaged goods shall have to be made good by the contractor at his own cost.
- 3.9.19 Some times it may become necessary for the contractor to handle certain unrequired components in order to take out the required materials. The contractor has to take this contingency also into account. No extra payment is payable for such contingencies.

3.10.0 PRESERVATION OF COMPONENTS :

- 3.10.1 It shall be the responsibility of the contractor to apply preservative painting on all equipments before erection. It shall be contractor's responsibility to arrange for required labour, brush and other consumables like cotton waste, cloth etc., for carrying out preservative painting. The quoted rates shall be inclusive of above work. The required paint (red oxide) and thinner shall be arranged by BHEL at free of cost.
- 3.10.2 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.
- 3.10.3 Any failure on the part of contractor to carry out work according to above clauses will entail BHEL to carry out the job from any other party and recover the cost from contractor.

3.10.4 Due to atmospheric conditions erected materials are likely to get rusted. It is the responsibility of the contractor to preserve the erection materials drawn from stores for erection till these are commissioned and handed over to customer. All the consumables like paint, thinner, painting brush emery paper, cotton waste, cloth etc., have to be procured by the contractor at his cost. The contractor should ensure that the materials are not rusted on any account till they are handed over to customer. The decision of the BHEL Engineer is final with regard to frequency of application of paint.

3.11.0 DRAWINGS AND DOCUMENTS

3.11.1 The detailed drawing specification available with BHEL Engineers will form part of this tender specification. These documents will be made available to the contractor during execution of work at site.

3.11.2 One set of necessary drawings to carry out the erection work will be furnished to the contractor by BHEL, on loan which shall be returned to BHEL Engineer at site after completion of work. Contractor's personnel shall take care of these documents given to them.

3.11.3 The data furnished in various appendices and the drawings enclosed with this Tender Specifications are only for the guidance purpose and describes the equipment to be installed tested and commissioned under this specifications. However, the changes in the design and in the quantity may be expected to occur as is usual in any such large scales of work.

3.11.4 Should any error or ambiguity be discovered in the specification or information the contractor shall forthwith bring the same to the notice of BHEL, before commencement of work. BHEL's interpretation in such cases shall be final and binding on the contractor.

3.11.5 Deviation from design dimensions should not exceed permissible limit. The contractor shall not correct or alter any dimensions/details without specific approval of BHEL.

3.12.0 SITE CLEANLINESS AND SAFETY REQUIREMENTS

3.12.1 Contractor shall strictly follow all safety requirements/conditions as per clause 2.15.0 and its sub-clauses of General Conditions of contract booklet enclosed with this tender.

3.12.2 Non-conformity of safety rules and safety appliances will be viewed seriously and the BHEL has right to impose fines on the contractors as under BHEL Engineers decision is final and binding in this regard.

SL. NO.	Safety	Fine (Rs.)
01	Not wearing safety helmet	50/-
02	Not wearing safety belt	100/-
03	Grinding without goggles	50/-
04	Not using 24 V supply for internal work	500/-
05	Electrical plugs not used for hand machines	100/-
06	Not slinging properly	200/-
07	Using damaged sling	200/-
08	Lifting cylinder without cage	500/-
09	Not using proper welding cable with lot of joints and not insulated properly	200/-
10	Not removing small scrap from platforms	200/-
11	Gas cutting without taking proper precaution	

	or not using sheet below gas cutting	200/-
12	Not maintaining elec. winches which are being operated dangerously	500/-
13	Improper earthing of electrical T & Ps	500/-

3.12.3 The contractor should exclusively deploy one Safety Engineer along with a safety supervisor for effective implementation and co-ordination of safe working conditions.

3.13 PROGRESS OF WORK

3.13.1 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 etc. employed are not sufficient, BHEL will induct required additional workmen to improve the progress or take over a part of the job and get it done on risk and cost of the contractor and recover from Contractor's bill, all charges incurred on this account including all expenses together with BHEL overheads.

3.13.2 The contractor shall submit daily, weekly and monthly progress reports manpower reports, material reports, consumables report and other reports considered necessary by the BHEL Engineer.

The manpower reports shall clearly indicate the manpower deployed category wise daily specifying also the activities in which they are engaged.

3.13.3 The progress reports shall indicate that progress achieved against planned with reasons indicating delays if any and shall give remedial action which the contractor intends to take to make good the slippage or lost time so that further works can proceed as per the original programme and the slippage do not accumulate and affect the overall programme, in a format designed and approved by BHEL site engineer.

3.13.4 The contractor shall arrange for weekly progress review meeting with the "Engineers" at site during which actual progress during the week vis-à-vis scheduled programme shall be discussed for action to be taken for achieving targets. The programme for subsequent work shall also be presented by contractor for discussion. The contractor shall constantly update/revise his work programme to meet the overall requirements and suit the material availability.

3.13.5 The contractor shall arrange for submitting three sets of progress photographs every month at BHEL office the areas to be photographed will be as per the instruction of BHEL Engineer. The quoted rate shall include this contingency.

3.13.6 The contractor must obtain the signature and permission of the security personnel of the customer for bringing any of their materials inside the site premises, without the entry gate pass these materials will not be allowed to be taken outside.

3.13.7 The contractor shall maintain a record in the form as prescribed by BHEL for all operations carried out on each weld and maintain a record indicating the number of welds, the name of welders who welded the same, date and time of start and completion, preheat temperature, radiographic results, rejections, if any, percentage of rejection, etc. and submit copies of the same to BHEL Engineer, as required.

3.14.0 SPECIFIC REQUIREMENTS FOR ISO 9002 :

IMPORTANT NOTE

Contractors shall ensure that all their Staff/Employees are exposed to periodical training programmes conducted by agencies/personnel on ISO 9002 Standards.

Contractors shall ensure that the Quality is maintained in all the works connected with this contract at all stages of the requirement of BHEL.

Contractor shall ensure that all Inspection, Measuring and Testing equipments that are used, whether owned by the contractors or used on loan, are calibrated by the authorised agencies and the valid calibration certificate will be available with them for verification by BHEL. A list of such instruments possessed by contractor at site with its calibration status is to be submitted to BHEL Engineer for control.

Contractors shall arrange for the inspection of the works at various stages as required by BHEL, Immediate corrective action shall be taken by the contractors for the non-conformances if any, observed and pointed out by BHEL.

3.15.0 INSPECTION / QUALITY ASSURANCE / QUALITY CONTROL /STATUTORY INSPECTION :

Various Inspection/quality control/quality assurance procedures/methods at various stages of erection and commissioning will be as per BHEL /Customer quality control procedures / codes / and other statutory provisions and as per BHEL Engineer's instructions.

Preparation of quality assurance log sheets and protocols with customer's Engineers. Welding logs and other quality control and quality assurance documentation as per BHEL Engineer's instructions, is within the scope of work /specification.

The protocols between contractor and customer/BHEL shall be made prior to installation for correctness of foundations, materials, procedures, at each stage of Installation, generally as per the requirement of Customer/BHEL. This is necessary to ensure elimination of errors or keeping them within tolerable limits and to avoid accumulation and multiplication of errors.

A Daily log Book should be maintained by every supervisor/Engineer of Contractor on the job Duplicate (One for BHEL and one for Contractor) for detailing and incorporating Alignment/clearance/centering/Levelling Readings and Inspection details of various Electrical and C&I works.

All the Electrical/Technical Measuring and Testing Instruments/Gauges, Feeler Guages, Height Guages, Dial Guages, Micrometers, Levels, Spirit Levels, Surface Plates, Straight Edges, Vernier Calipers and all measuring instruments shall be provided by the contractor for checking Levellings, instruments shall be provided by the contractor for checking Levelling, Alignment, centering etc. of Erected Equipments at various stages. The Instruments/Gauges/Tools etc. provided should be of Brand. Quality and Accuracy specified by BHEL Engineer and should have necessary calibration and other certificate as per the Requirements of BHEL Engineer.

Total Quality is the Watch Ward of the work and standards, procedures laid down by BHEL. We shall follow all the Instructions as per BHEL Drawings and Quality / Standards. Contractor shall provide for the services of quality Assurance Engineer.

STAGE INSPECTION BY FES / QA ENGINEERS

Apart from Day-to-Day Inspection by BHEL Engineers Stationed at site and also by Customer's Engineers. Stage inspection and Equipment under Erection and Commissioning at various stages of Erection and commissioning by TEAMS of Engineers from Field Engineering Services of BHEL's manufacturing units and Quality Assurance Teams from Field Quality Assurance Unit/Factory Quality Assurance and Commissioning Engineers Contractor shall arrange all labour, Tools and Tackles, etc. for such stage inspections free of cost.

Any modifications suggested by FES and QA Engineers Team shall be carried out. Claims of Contractor, if any shall be dealt as applicable.

Any minor rectifications or minor repairs of defective work found out during stage Inspection shall be rectified free of cost, by the contractor.

Any major rectification or major repairs of defective work found out during stage inspection verification / checking but not attributable to contractor shall also be carried out. Claims of contractor, if any, shall be dealt as applicable.

SECTION VI

ELECTRICAL PACKAGE

SCOPE OF WORK AND SPECIAL CONDITIONS

6.0 SCOPE OF WORK : GENERAL

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

- 6.0.1 Identification of equipments at BHEL storage yard and stores located 1 km from pump house and transporting all the equipments / items listed in the Bill of Material from store and yard, providing technical assistance for checking and making the shortage / damage reports, taking delivery at storage yard and pre-assembly of equipment whether required erecting the equipment signing fastening supporting cleaning checking and carrying out statutory tests as required that operation, pre-commissioning, commissioning and post-commissioning activities upto the time of completion of commissioning activities and commercial operation of the unit along with the supply of all consumables, tools and tackles and testing instruments.
- 6.0.2 It is not the intent to specify herein all details of equipment and material. Any item of work not covered by this but necessary to complete the system will be deemed to have been include in the scope of the job. The major items of works are described hereinafter under the head "Erection". However, the contractor shall perform all the necessary works to complete the installation for satisfactory handling over to the ultimate customer.
- 6.0.3 Site testing shall be required for all electrical equipment installed by the contractor to ensure proper installation, setting connection and functioning in accordance with drawings, specifications and manufacturer's recommendations.
- 6.0.4 The contractor shall take full responsibility 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 shall make the necessary minor wiring changes or cable connection to obtain the intended operation. Testing shall also include any additional tests which the engineer feels necessary because of site conditions customer requirement to determine that equipment material and system meets requirement of the specification.
- 6.0.5 Scope of works covered under this specification is of highly sophisticated nature, requiring the best quality of workmanship, engineering and construction management. The contractor should ensure timely completion of work. The contractor must have adequate quantity of tools, measuring instruments, calibrating equipment etc., in his possession. He must also have on his rolls adequate trained, qualified and experienced engineers supervisory staff and skilled personnel. The manpower deployment identified by contractor should match the requirement of sophistication involving equipments to be erected and should possess electrical contractor licence to carry out the scope / job mentioned in the BOM.

- 6.0.6 The work shall be executed under the usual conditions affecting major power plant construction and in conjunction with numerous other operations 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.
- 6.0.7 All the work shall be carried out as per the 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.
- 6.0.8 The contractor shall at his cost perform any services, tests etc. although not specified but nevertheless required for the completion of work.
- 6.0.9 Contractor shall calibrate, erect & commission all the equipments, cabling etc. as per sequence prescribed by BHEL at site. The sequence of erection/commissioning methodology will be dedecided by the BHEL engineers depending upon the availability of materials/work fronts etc. no claims for extra payment from the contractor will be enterained on the grounds of deviation from the methods of erection/ commissioning adopted in erection/commissioning of similar job or for any reasons whatsoever.
- 6.0.10 All the necessary certificates and licenses required to carryout this work are to be arranged by the contractor expeditiously at his cost.
- 6.0.11 During the course of erection, testing and commissioning of electrical/ C & I works certain rework/ modification / rectification / repairs / fabrication etc. will be necessary on accout of feed back from various Hydro electric power stations or units already commissioned and / or units under erection and commissioned and also on account of design discrepancies and manufacturing defects and site opetation / maintenance requirements Contractor shall carryout such rework / modification / rectification / fabrication / repairs etc. Promptly and expeditiously. Daily log sheets ondicating the details of work carried out, manhours, consumables used etc. shall be maintained by the contractor and got signed by BHEL engineer every day. Claims of contractor, if an, for such works, will be dealt as per appropriate clause referred elsewhere.
- 6.0.12 The scope of work is divided as **Electrical & Instrumentation**

Electrical : This part covers the details of equipments scope of erection testing & commissioning details etc.

Instrumentation : This part covers the details of controls and instruments scope of erection, testing & commissioning details etc.

6.1 Electrical: The scope is sub-divided into following heads :

6.1.1 Power Transformers

6.1.1.1 SFC

Transformers	10 MVA	5	ONAN
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6.1.1.2 Excitation

Transformers		5	Dry type
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DETAILS OF TRANSFORMERS :

All transformers will be oil immersed except dry type and suitable for indoor & outdoor installation at 53.3 & 58.3 MT level of Power house building.

6.1.1.4 STATIC FREQUENCY CONVERTER SYSTEM TRANSFORMER :

Transformer Specification :

10 MVA, ONAN type transformer

- a. Overall Dimensions : 6300x4600x3600 mm
- b. Approximate Weight
Core and Coil – 15750 Kg
Oil Wt.
Oil quantity – 5900 Litres
Total Wt – 19500 kg

6.1.1.5. EXCITATION TRANSFORMERS

Dry type transformer

Approx.weight : 2500 KG

6.1.1.6 SCOPE OF WORK FOR TRANSFORMERS

1. Receipt & Unloading of all accessories & spares including oil in drums at site store, inspection, storage, maintain of N2 gas pressure in transformer tank, handling of accessories between stores & transformer location, erection of all the accessories cabling from transformer accessories to marshalling KIOSK & OLTC panel, oil filling, Oil pressure testing dryout, precommissioning test, commissioning of equipment and final painting and handing over.

Note : Refer Section VII for general technical requirement for erection testing and commissioning.

2. The contractor will load transport, unload the Transformers on rails from storage area, turn the wheels/rollers if necessary for changing over at right angles on rails, roll the transformers to their respective locations and put them on the foundation. The necessary sleepers winches, jacks etc. required for this operation will be arranged by the contractor at his cost.
3. The components of all the transformers except dry Type transformers will be sent to site in several packages which will have to be erected assembled at site. However, excitation and unit auxiliary transformers may be sent to site in assembled conditions.
4. Samples from each and every oil drum will have to be tested for required strength is found inadequate, the oil in the drums should be filtered. The entire arrangement for testing oil samples, filtering whenever required to achieve the desired strength and moisture content within shortest time shall be made by the contractor. The job has to be taken up in consultation with BHEL Engineers at site at the cost of the contractor.
5. Required Nos. of High Vac filter machines with adequate capacity, vacuum pumps and 5 KV motorized megger, suitable oil tank will be arranged by the contractor at his cost. The transformers may have to be suitably lagged/covered during the drying out operation by the contractor at no extra cost.
6. The contractor will engage his men on three shift operation during drying out the transformers.

7. The auxiliary transformers will be bolted to the adopted panel/bus duct on both the sides and the busbars will be connected together. Any modification required in the bus connectors for matching the PCC Busbar with the transformers LT side shall be carried out by the contractor at no extra cost.
8. The auxiliaries components of the above transformers are to be cleaned and checked before the assembly as instructed by BHEL Engineer.
9. The contractor has to carry out all pre-commissioning works for the transformer using their own testing equipments under the supervision of BHEL Engineer.
10. Die Electric strength/PPM of the transformer oil has to be improved and brought to the BHEL recommended value using their own filtering machines and other testing equipments.
11. All the transformers protective system such as Buchholz relay explosion vent. Oil and winding temperature detectors etc., healthiness are to be checked under the guidance of BHEL Engineer.
12. Transformer protective relays are to be checked prior to the commissioning of the transformer.
13. 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.
14. 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.
15. The Scope final painting involves supply of paints, thinner and other consumables at the cost of the contractor.

6.1.2 **STATION AUXILIARY PANELS COMMON FOR ALL UNITS**

These panel mentioned below will be located at 5 MT level from turbine floor.

- a) HP air compressor starter panel
- b) Dewatering pump starter panel
- c) Drainage pump starter panel

6.1.3 **Static excitation system**

This consists of following panels and these shall be installed in the control room at 43.5 MT from turbine floor.

- a) Regulation cubicle
- b) Thyristor cubicle
- c) Field flashing/ field breaker cubicles
- d) Auxiliary excitation cubicle
- e) Transformer cubicle

6.1.4 **Unit Auxiliary starter panels**

- a) Cooling water pump starter panel
- b) Brake dust collector panel
- c) HS Lub oil pump, starter panel
- d) Generator stator heater pump starter panel
- e) Top cover drainage pump starter panel
- f) Cooling water strainer pump starter panel
- g) Oil pressure pump unit starter panel

6.1.5 Instrumentation Panels and Controls :

The scope of work of Instrumentation panels / Controls / Instruments covers collection, transportation from stores/yards, the installation, testing and commissioning of the equipments, hardwares along with accessories as detailed in Bill of Material. The broad scope of control panel are listed below.

- a) Auto sequence control panels
- b) Alarm annunciator panels
- c) Temperature measurement/Gauge panels
- d) SFC Control Panels
- e) Sequence of event recording and diagnostic system panel etc.
- f) Control, metering and monitoring panels.
- g) Common control line & transducer panels etc.

The above panels are installed in the control room at 48.5 MT and 53.5 MT from turbine floor adjacent to the machine and will have to be wired upto the respective units and lines.

6.2.0 Bus Ducts

6.2.1 11 KV/415V, Segregated Phase-Bus Ducts

The 11 KV SP busduct is connected to the low voltage side of Generator transformer. The rating is 1500 Amps. The material is aluminium Alloy and joints are bolted type using anti oxidation compound and high tension bolts. The shape is rectangular and have 6 nos of breathers. The Bus duct comprises of CTs, PTs, NGR, NGT, Insulator etc.

6.2.1 Scope of erection work for busducts

The contractor is responsible for receipt and unloading of all the busduct materials and accessories and equipments as indicated the BOM such as NG cubicle. LAVT cubicle, PTs, CTs etc and drawing inspection erection installation of all the materials, testing, commissioning of equipments / panel painting and handing over.

1. If any modification required in the supported structures due to site conditions, the same will be carried out without any extra cost. Pockets will be provided during casting in which anchor bolts will be grouted for supporting the structures.
2. All bolts in the joints and flanges will be tightened by torque wrench to approved pressure Antioxidation compound will be used for joints.
3. The alignment of the busduct will start from generator side. The generator terminal enclosure shall be placed and aligned first.
4. Only a few holes on the generator terminal box flange will be drilled at works. The balance numbers of holes shall be drilled at site to facilitate matching of busduct cover flange with generator flange easily at site.

5. A ground bus shall be provided running the entire length of the busduct, solidly grounding all parts of supporting structures and one end of each enclosure.
6. The contractor has to carry out final painting as per the standard color codes recommended by BHEL. The paints, thinner and other consumables required for this job shall be arranged by the contractor at his cost.
7. Following work also to be carried out by the contractor
 - a) Transport of busduct equipments from BHEL Stores to erection site.
 - b) Cleaning of enclosure and conductors, insulators and other panels before assembly and erection.
 - c) Placement of embedments and erection and alignment of steel support structures.
 - d) Assembly and checking of busduct at ground level if necessary.
 - e) Erection and commissioning of NG cubicle with all its accessories.
 - f) Fixing of neutral side flexible connection to generator and position of neutral CTs after testing.
 - g) Assembly, erection and commissioning of VT, LAVT cubicles with its equipments such as lighting arrestors, voltage transformers, fuses, etc.
 - h) Fixing of wall bushings.
 - i) Erection and alignment of TEE OFF busducts for unit auxiliary transformers.
 - j) Fixing of current transformers in busbuds including wiring from CT terminal to marshalling box, taking through conduct pipe.
 - k) Conducting air tightness and water tightness test and it should satisfy the requirement of BHEL / Customer Standards in case of any leakage contractor has to rectify and bring to the required level of air tightness and water tightness and water tightness without any extra changes.
 - l) Providing earthing connections as per site conditions.
 - m) Minor civil work such as chipping and drilling holes on concrete if necessary and grouting of busduct support structures.
 - n) Carrying out short-circuit test before commissioning of the generator as per the instructions of BHEL engineer.
 - o) Carrying out required level of cleaning inside as well as outside of the busduct for the purpose of conducting high voltage test before commissioning of the unit.
 - p) Erection and commissioning of above busduct include extension of embedments and erection of required supports structures as detailed in the drawing.
 - q) The required earthing as detailed in the relevant drawings for the busduct are to be carried out by the contractor.
 - r) High voltage test of the busduct is to be carried out by the contractor as per instruction of BHEL engineer after making necessary cleaning inside as well as outside of the busduct.
 - s) The contractor has to carry out final painting as per the standard color codes recommended by BHEL paints will be supplied by contractor as part of erection which includes thinner and other consumables etc.

- 6.3.0 11KV Switchgears
- 6.3.1 11 KV Switchboard is of BHEL make, floor mounting, sheet steel drawout truck type suitable for indoor installation. The switchboard is comprising of vacuum break circuit breakers and are suitable for operation on 11 KV, 3 Phase, 50Hz system. The tentative details are as under.
- 6.3.2 415V – Power motor control centres (PNCC) / MCC
Motor control centres are Double Front drawout type consisting of circuit breakers unit contractors / starter fuse switch units. MCB etc. arranged in multi-tier construction. These PCC & MCCs are mainly supplied to cater the requirement of Turbine drives, valves, battery charger etc.
- 6.3.3 DC Distribution Board
DCDB is single front non-drawout type, consisting of circuit breaker contractors, starter, fuse unit, MCB etc. arranged in multi-tier construction shall be located in MCC room.
- 6.3.4 Scope work for HT & LT Switch Board and DCDB
The scope of work covers receipt of all the materials from stores, transportation to the respective location, erection, testing, commissioning and handing over.
- 1a 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 by the contractor. The opening left on the floor during the time of casting where the base channels will have to be grouted. All necessary concrete chipping and finishing works are deemed to be included in the scope of the job. For fabrication / erection of frame (if required) no separate rate shall be paid. This is applicable for local start/stop push button box also.
- 1b For the panels 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 by the contractor.
2. The contractor shall set each piece of equipment on its foundation or supporting structures. The contractor shall assemble equipment as required. All equipments shall be installed with parallel, horizontal and vertical alignment by skilled craftsmen arranged by the contractor.
3. All the boards will be delivered in sections necessary interconnection of bus bar. bolting of panels. Left out panel/inter panel wiring, etc. 'will have to be done by the contractor.
4. Normally the panels will be complete with Instrument mounting and wiring. However, if necessary, dismantling of the existing components, making modifications in wiring to suit operating conditions, mounting and rewiring of new components will be carried out without any extra cost Mounting and wiring of any instruments, meters, relays etc. if supplied loose for safety In transit, will also be Included In the scope of the job.

5. The commissioning of MCCs, PMCCs, HT switchgear, DCDBs will also involve the trial runs and commissioning of all connected equipment like motors, valves, and finally the spinning of the turbine. 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/actuators as per BOM).
- 6 The contractor has to do touch up painting of switchgear panels wherever necessary. This Includes supply of paint also.

6.3.5 AVR I GENERATOR & TRANSFORMER PROTECTION INSTRUMENTATION CONTROL PANELS PANELS

The above panels shall be installed In Control rooms. Microprocessor based control and protection panels shall be supplied with loose items like PC. Monitor. Computer furniture Inter connecting cables etc

6.3.6. SCOPE OF WORK FOR AVR I GENERATOR & TRANSFORMER PROTECTION PANELS I INSTRUMENTATION CONTROL PANELS

The scope of work will be in line with clause 6.3.4. However any special Instruments/testing equipments like secondary injection kits. CRO. frequency counter etc, are required for calibrator. and testing of Relays, Recorders Indicators etc.. same shall be arranged by the contractor.

6.5.0. CABLES

- 6.5.1. BHEL will supply all the cables which covers HT Power and L T Control, Power and signal cables etc, with all the accessories, The scope of work involves Transportation of all the cables from Storage area to the respective place laying, termination, checking and proper dressing, The scope also covers supply of dressing materials viz, Aluminium strips, PVC ties, Ferrules, Tag plates, Lugs upto 2.5 sq.mm,

6.5.2 Scope of work for cable laying

Scope of work for cable laying / termination laying of cables shall include drilling of holes in the. panels JB and fixing of glands and termination on either end as per BHEL specification and BHEL engineer's Instructions, This work includes dressing of the cables, fixing of the ferrules, tagging the cables with necessary numbering.

- 6.5.3 Rates quoted for the cabling under the scope of contractor, shall include supply of dressing/clamping materials, ferrules, tag plates, and lug upto 2.5 sqmm. The material quality shall be as per BHEL's requirement as detailed in Section VII Maximetermi pins will be supplied by BHEL free of cost.
- 6.5.4. Unit rates based on length in metres will be paid for laying of power cables (L T/HT) , control cables. special cables. signal cables. compensating cables etc. which cover required type of termination of either end of panel / instruments / JB

etc. by providing suitable cable glands, jugs, end connectors etc. as per BHEL drawings and specification.

- 6.5.5 For flexible conduit laying work, drilling of the holes in the plates, fixing of the end connectors providing suitable supports and fixing tag marks wherever specified and required by BHEL has to be carried out by the contractor.
- 6.5.6 In the case of flexible conduit laying and fixing end (connectors, no separate payment will be made for end connectors.
- 6.5.7. Unit rate of cable laying shall include laying/pulling of cables in horizontal/vertical runs In trays, ducts, conduits'; supply and. erection of clamps cable tags and markers lugs upto 2.5 sqmm etc. and terminations of various sizes of cables. Unit rates shall also include drilling of gland plates, fixing of glands, ferrules and lugs and connection to the equipment. Separate shall be paid for termination of HT cables alone. However termination of L T/control special cables shall be pat of cable laying rate.
- 6.5.8. Unit rates of laying of cables directly buried in ground shall be applicable for lengths of cables laid and shall be measured between the two points of cables entering into the ground. Following shall be the break-up of prices for directly buried cables:
- a. Unit rate of laying shall be same as that for the cables of same size laid in cable tray.
 - b. Unit rate of earth work in excavation and backfilling shall be quoted separately for the buried cables, earth work shall be measured in cubic metre of earth specifically excavated for the purpose of buried cables.
 - c. Unit rate of supply and filling of sand shall be applicable for the quantity of sand in cubic metres.
 - d. Unit rate of supply and erection of protective covering shall be applicable for the area of protective covering and shall be measured in terms of per square metre of protective cover.
- 6.5.9 Unit rate of installation of conduits and pipes (all types) shall be applicable for the length of the various sizes of conduits Installed as below:
- a. Upto 25 mm
 - b. Above 25 mm upto 50 mm
 - c. Above 50 mm upto 75 mm
 - d. Above 75 mm upto 100 mm
 - e. Above 100 mm upto 150 mm

6.5.10 MEASUREMENTS & WASTAGES

Quantity measurement and return of surplus quantity.

- a. For all payment purposes, measurement shall be made on the basis of the execution of drawings / physical measurements. Physical measurements shall be made by the contractor in the presence of the Engineer.
- b. The measurement for cable laying shall be made on the basis of length actually laid from lug to lug including that of loops provided and paid accordingly.
- c. All the surplus, scrap & serviceable cables cut out of the cables quantity i.e. issued to the contractor shall be returned by the contractor to BHEL in good condition and as directed by the engineer.
- d. All cables being returned to stores should carry" an aluminium tag indicating the size and type of cable. Cable of more than 5 meters length termed as serviceable material and shall be returned size wise and category wise to the owner's stores/yard. Cable of serviceable length being returned to the stores in drums shall have their free ends sealed and the balance lengths on the drum(s) shall be noted and certified by (he Engineer-in-charge. This shall be applicable only for the purpose of accounting the cables issued for Installation.

6.5.11. While carrying out material appropriation with contractor, all the above points will be taken into account. All serviceable material returned by the contractor shall be deducted from the quantities issued for the respective sizes and categories and the balance quantity(ies) will be taken as the net quantity(ies) Issued to the contractor. material appropriation shall then be done and allowable scrap quantity calculated as per wastage allowance percentage specified above. Any scrap/wastages generated by the contractor in excess of the allowable percentage shall be charged at the rates decided by the Engineer whose decision shall be final and binding on the contractor.

For steel material supplied to the contractor, all scrap shall be returned to . BHEL stores with due accounting.

6.5.12. Cutting & Wastage Allowance

- a. Contractor shall carefully plan the cutting schedule of each cable drum in consultation with Engineer such that wastages are minimized and any resultant short lengths can be used where appropriate route lengths are available.
- b. The wastage allowances as permissible for various items are indicated in Data Sheet A in Section VII.
- c. Cutting and wastage allowance shall be computed on the lengths of cables and weight of steel actually used, measured and accepted.

6.5.13. Cable Installation shall be properly co-ordinated at site with other services and wherever necessary suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures. equipment, utilities and services any such adjustment shall be done with the approval of Engineer.

6.5.14. The below listed jobs shall also be considered as normal Jobs and shall be carried out by the contractor at no extra cost to and to the satisfaction of engineer.

- a. Modification such as rotating the terminal box through 90 deg. or 180 deg as required.
- b. Enlargement of cable entry holes, if necessary: by chipping and finishing the same properly.
- c. Drilling of gland plates of equipment of not done already.
- d. Reasonable amount of drilling, cutting reaming and reallocating 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. Supply of all cement, sand etc. required for grouting, necessary supports for cable trays, conduits etc.
- f. Sealing of all openings between conduits/pipes and the encasing wall/floor
- g. All supporting and clamping arrangement.
- h. In case any existing structure is affected/damaged due to Installation work of cables the contractor shall repair the same to the satisfaction of Engineer.
- i. Changes in line and grade or addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement.
- j. Small modifications in the cable tray routings.
- k. Cleaning and minor chipping work, dewatering of trenches if necessary minor civil works and other associated works. Securing the supports on walls, ceilings, floor or trenches by suitable anchoring may also have to be done: if required.
- l. All excavations shall be back filled to the original level with good consolidation
- m. Any wrong erection shall be removed and re-erected promptly to comply with the design requirements to the satisfaction of Engineer.
- n. Leaping of cores/wires at terminals as per interconnection. diagrams.

6.5.15. While testing and commissioning if the system to which the cabling is connected is observed to be not functioning, it shall be the responsibility of the contractor to check, establish and demonstrate in close coordination with the commissioning agencies that there is no defect in the cabling. The contractor shall put his supervisor and workmen along the commissioning agencies to check the interconnecting cables.

6.6.16. Complete cabling work shall be carried out as per following drawings /documents furnished by BHEL to the successful contractor and the instructions of engineer.

- a. Cable trench layout drawings.
- b. Cable tray layout drawings
- c. Cable schedules (covering details like from, to, route, cable details etc.)
- d. Cable interconnection diagrams
- e. Relevant civil drawings
- f. Equipment layout drawings

6.5.17 Termination of Cables

- a. At cable termination points, where the conductor and the cable insulation will be terminated, termination shall be made in a neat manner.
- b. The contractor shall include connections to terminal of various equipments Installed by others. The contractor shall work in co-operation with other agencies in obtaining correct direction of rotation and commissioning of the equipments.
- c. Wherever the equipment installed by other are not provided with cable accessories such as cable gland, holes etc. contractor shall co-operate to get the same done.
- d. The Insulating sleeves shall be of fire resistant and be long enough to over pass conductor insulation and shall be properly sized.
- e. Termination of all the cables Installed by the tenderer is included in his scope. The work of testing and reconnecting, changing of connectors. Rearrangements of leads if required shall be carried out by the tenderer without additional cost.
- f. Tools/ equipments required for the connections and termination of cable except: maxi term I tools shall be provided by the contractor wherever necessary.

6.6.0 INSTRUMENTATION

The scope of work for various instruments (Remote/Local) covers collection and transportation from stores, calibration, erection, testing and commissioning as enumerated in the Bill of Material. The scope of work includes the following:

- 6.6.1. Erection of racks, gauge boards, fixing of transmitters at respective places.
- 6.6.2. Impulse piping for local Instruments from the corresponding tapping points
- 6.6.3. Providing supports for capillary type gauges and switches
- 6.6.4. Prior to installation, all the instruments (local & remote) are to be bench calibrated and limit switches: relays: timers: thermocouples and RTDS etc.. shall be checked for proper operation
- 6.6.5. During commissioning. any calibration or replacement of instruments and rechecking of cable termination if necessary the same shall be done by the

contractor within the quoted rate and no extra payment will be made. For fixing of racks or any supports, no extra payment shall be made for minor chipping and grouting. Contractor shall arrange painting for all the steel work like supports, racks: frames, canopy, impulse pipe etc. erected by him. The scope of painting include apart from supply of paints and primer, painting of two quotes of red oxide primer and final painting of approved colour by BHEL Engineer to achieve the thickness of 3-5 Micron. Contractor shall arrange the paints from reputed standard supplier in consultation with BHEL engineers at site. Contractor shall also arrange necessary painting consumables like brushes emery sheets, thinners etc. at his cost. No separate rate shall be payable for painting. The contractor should accommodate the cost of painting in the erection rate itself. Instruments Log Nos and JB Nos. shall be painted on the equipments and instruments wherever required. Contractor has to do touch up painting for the panels erected by him wherever necessary and this includes supply of paints also.

- 6.6.7 All the necessary tools and tackles, welding sets required for the execution of the works, and the instruments/equipments required for calibration purpose will have to be provided by the contractor.
- 6.6.8 The erection of pressure/differential pressure gauges. switches etc. includes fixing instruments on the racks/supports along with the manifolds, drain valves associated fittings, clamps etc. and no separate rate shall be paid for each item. However, for fabrication of racks and supports rates shall be paid on tonnage basis and Impulse lines on metre basis.
- 6.6.9 Laying of impulse piping shall include erection, welding of unions, connector heads, nut and tail pieces, sockets, nipples, equals Tees, couplings, Root valves etc., and supporting with suitable fixtures and U clamps. The impulse piping supplied shall be carbon steel, alloy steel and stainless steel. The unit rates as applicable will be paid which includes local site routing, cold bending, tigwelding.
- 6.6.10. For fabrication and erection materials like angles, channels, plates, flats, etc., the bidder shall quote on tonnage basis. No separate rate shall be paid for erection of fabricated item at site. The rate quoted for steel materials include, fabrication and installation
- 6.6.11. Contractor shall supply and fix all necessary U clamps: fasteners etc., wherever required for supports of all impulse pipes. The cost for these items are to be accommodated in the respective: pipes erection rates.
- 6.6.12. No separate payment shall be made for any instruments/cards/components which are to be mounted and commissioned inside the panel/boxes. Even if the instrument/card or any components supplied as loose items which are to be mounted inside the panel/box the same shall be carried out as free of cost. In general the scope of erection of any panels/deck/box included all the above-mentioned works. However, any major modification involved inside the panels the same be carried out at extra cost.
- 6.6.13. The scope of installation of Thermowell includes seal welding of the same wherever required.

- 6.6.14. Contractor shall arrange all the welding Electrodes and filler wire. However, necessary approval shall be obtained for the electrodes filler wire from BHEL welding engineers.
- 6.6.15. Wherever the equipments installed by others are not provided with cable accessories such as cable gland, holes etc., contractor shall co-operate to get the same done.
- 6.6.16. During commissioning, commissioning, post commissioning and trial operation stages of various systems, certain category of manpower with T&P and consumables will have to be provided for BHEL commissioning engineers for their assistance.
- 6.6.17. The rates quoted for various calibration and erection of instruments in the scope of work covers after installation the same are required to be put in service and performance to be checked as per optional and system requirement. The activity is to be coordinated by contractor separately. The required manpower shall not be taken from commissioning assistance.
- 6.6.18. The mounting frames instruments mounting may come either fabricated or loose. In the case of fabricated frames, erection has to be carried out at site either by fixing on the ground or on a suitable structure and the fittings to be properly fixed by grouting or by welding.
- 6.6.19. Where the frames have to be fabricated at site, the same has to be carried out as per the drawings and sketches provided by BHEL. On all the mounted frames necessary drilling shall be done for mounting junction boxes to be provided.
- 6.6.20. The contractor has to fix the indicators, recorders in the cut outs provided in the control room panel, field panel and any other panels. In case enlarging is required grinding to be carried out to suit the mounting as free of cost.
- 6.6.21. After erection of various C&I equipment prior to commissioning and after commissioning, protocols have to be made with Shell's Customer. The proforma and formats will be given by SHEL and have to be printed by the contractor in adequate numbers.
- 6.6.22. Laying of copper, tubing shall include fixing, union, tees, etc., and supporting with suitable clamps and fixtures. The connectors and tees will be of different sizes as per the site requirement. No separate payment will be made for erection of above fittings including clamping and dressing. Dressing materials required for clamping shall be supplied free of cost by the contractor.
- 6.6.23. Unit rates on length basis will be applicable for laying of copper SS tubing which includes site routing, bending, providing supports, end ferrules and connecting to the instrument air line on one end and the instrument on the other end.
- 6.6.24. The erection and commissioning of temperature switches temperature gauges etc.. shall include fixing of thermowells wherever required as per SHEL specification and instructions of site engineers.
- 6.6.25. If any drilling and tapping required for mounting of instruments, shall be carried out at site as part of instruments erection and commissioning work as per SHEL

specification and site engineer's instructions. No separate payment shall be made for drilling and tapping.

6.6.26. Wherever frames, supports and other attachments have to be fabricated at site for which steel will be given free of cost by SHEL, the unit rates for fabrication and erection will be paid as per rate schedule. Whenever fabricated frames, supports are sent from the units: payment will be made as per the rate schedule on tonnage basis.

6.6.27. Control valves, trip valves, flow meters, solenoids, actuators erected by mechanical contractor have to be calibrated and commissioned as per the site requirement. Payment will be made as per the rate schedule as per commissioning assistance requirement.

6.6.28. For panels erected by other agencies, commissioning/calibrating work and trouble shooting work has to be carried out by the contractor as commissioning assistance.

6.6.29 For fixing racks and any supports, chipping of foundation and grouting of equipment, fixing of racks and supports is included in; the scope of this specification

6.6.30. Rates have been asked item-wise for instruments, gauges, switches, Indicators, recorders etc., as indicated in different systems. The rates quoted by the contractor should be uniform as far as possible for the similar items of work appearing in different systems of the rate schedule.

6.6.31. Instruments are generally classified in rate schedule, whether these are to be mounted on UCB, instrument panels or in field. However, there may be few instruments, not classified but requires to be erected/mounted on UCB or panel. Unit rates quoted against such instrument will only be applicable.

6.6.32 In certain cases, instrument/devices are supplied mounted on equipment or drawn by; other agency as a part of mechanical package. The same are to be received or to be collected from other agency for keeping in safe custody to avoid damages. The same are to be erected back after calibration/testing for which unit rate will be paid for erection/calibration. Proper record is to be maintained under intimation to BHEL engineer.

6.6.33. Normally, mechanical contractor will terminate his work with root valves wherever connections are to be given for low switches, etc., further work for mounting of the switches have to be done by the contractor.

GENERAL TECHNICAL REQUIREMENT FOR INSTRUMENTS AND CONTROLS

6.6.34 The routing of pipes shall include sufficient flexibility near the tapping.

6.6.35 The pipe shall be cold (dbent) using hydraulic bending machinery only

6.6.36 Horizontal impulse line shall be laid with proper slope towards the tapping point.

6.6.37 Support for the piping and tubing shall be adequate and in no case less than

the limit shown below:

a) ¼" / 6mm / 3/8" 00 copper tube - continuous

b) ½" NB pipe / tube - 5'

- 6.6.38. Minimum number of fitting shall be used on all impulse line wherever possible
- 6.6.39. On completion of pipelines. installation, the pipeline shall be hydraulic tested. The contractor shall arrange for hydraulic pumps and standard gauges and conduct test satisfactorily.
- 6.6.40. Impulse pipe shall be isolated from the instruments and tested at two times of the maximum of the working pressure The fall in pressure shall not be less than 1 Kg/cm or 1 % of the working pressure whichever is less in 30 minutes and there shall not be any leak at the joints when Isolated from source of pressure.
- 6.6.41. All field mounted instruments are to be located in such a way as not to obstruct walkways or planned equipments access and shall be easily accessible for maintenance.
- 6.6.42. Hand drill shall not be used for mounting the instruments.
- 6.6.43. All the temperature gauges even if it is mounted on the control panel and dispatched to the same shall be removed from the panel and calibrated at site. Adequate care shall be taken for routing the capillary of the gauges.
- 6.6.44. All the electronic instruments viz. Recorder. Indicator, Controller etc., shall be calibrated before commissioning the instruments. Even if the instruments are dispatched along with the panel, to the same shall be removed, recalibrated and re-fixed at site.
- 6.6.45. The contractor shall provide: adequate number of adequately experienced, qualified Supervisors, Technicians, Instrument mechanics, helpers etc., for commissioning the system till handing over to Customer.

SCOPE OF WORK FOR FABRICATION OF MATERIALS & STRUCTURAL STEEL:

- 6.6.46 The scope of fabrication generally includes supports for cable tray, instruments, impulse pipes, GI pipes, mounting frames for JB, control box, panel, canopy for local instruments wherever required.
- 6.6.48 The unit rate shall be paid on tonnage basis and no rate shall be paid for the erection of fabricated items i.e., the rate quoted for the steel material includes fabrication and installation. However for earthing materials the rate shall be paid on metre basis.
- 6.6.49 Fabrication shall be carried out as per schemes in consultation with site engineers

6.6.50 For fixing of frames or racks if any minor grouting is required the same shall be carried out at free of cost. After installation of frames, supports, panels minor chipping and grouting wherever required is in the scope of the contractor

SCOPE OF WORK FOR DCS PACKAGE WITH RELATED INSTRUMENTATION AND DATA ACQUISITION SYSTEM

6.6.51 The scope includes erection of Digital control system panels (DCS) marshalling panels, interposing relay panels in the control room.

6.6.52 As these are microprocessor based system panels, experienced personnel shall be deployed in erection and commissioning of these panels

6.6.53 The scope also includes erection of sophisticated systems like Data Acquisition System (DAS) which comprises of computer workstations, operator workstations CRTs, server based computer system panels: printers, with respective Interconnecting cables etc.

6.6.54 Laying and termination of Intra-Plant Bus (IPB) cable I.e. Data Highway between DCS and DAS systems shall be carried out by the contractor by suitably deploying skilled personnel.

6.6.55. Laying of multi-core cables suitable for maxi-termi connections shall be carried out between Marshalling panels and DAS panels and maxi-termi tool shall be provided by BHEL to carry out terminations in the above panels and wherever required it is to be done by the contractor.

6.6.56 Necessary care shall be taken by the contractor while executing the work in the above panels, modules etc.

6.6.57. 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.

6.6.58. The complete details of panels of DCS package with Instruments, control deck, DAS system details shall be furnished in the BOM so as to enable the contractor to carry out erection as per scope.

6.7.0. SCOPE OF PRECOMMISSIONING / COMMISSIONING AND POST COMMISSIONING ACTIVITIES

6.7.1. The work is also inclusive of various commissioning activities of the power station as follows

- i) Trial run of various equipments. including checking of SFC system
- ii) Spinning of Turbine / Pump
- iii) Synchronisation of Turbine/Pump
- iv). Trial operation.

- 6.7.2 The above activities, tests, trial runs may have to be repeated till satisfactory results are obtained and also to satisfy the requirements of customer / consultant! statutory authorities like electrical inspector etc.
- 6.7.3 The precommissioning activities will start prior to spinning of turbine and various trials, commissioning operations shall continue till the units are handed over to customer. Simultaneous commissioning activities will be in progress in various areas, checking of equipments erected, making ready for trial runs, etc. All these works need specialized personnel including electricians/instrument mechanics in each area to render assistance to BHEL commissioning staff. Contractor shall earmark separate manpower for various commissioning activities. The manpower shall not be disturbed or diverted.
- 6.7.4 The mobilisation 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. If at any time the requisite manpower consumables, T & P are not arranged then BHEL shall make alternate arrangements and necessary recoveries with overhead cost will be made from the bills of the contractor.
- 6.7.5 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
- 6.7.6 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 is rework is rectification fabrication modification due to (improvement is 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.
- 6.7.7 During commissioning activities and carrying out various tests if any, instrument required temporarily, same shall be erected and commissioned to suit the commissioning activities. After completion of activities the temporary systems have to be removed and no extra rate shall be paid for this.
- 6.7.8 The contractor shall take the full responsibility of testing, pre-commissioning and commissioning of the equipment being installed by him under the overall supervision of BHEL. 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 these will be witnessed by BHEL Engineers and reports signed jointly. The contractor shall submit a check list of BHEL prior to taking up testing and commissioning activities by BHEL and the activities shall be carried out in accordance with the check list.
- 6.7.9 The post-commissioning activities will include tile trial run of all the connected equipment/system which will continue upto the handing over of the unit. The contractor shall arrange for sufficient number of manpower along with Engineer

and supervisors for carrying out the activities under his own responsibility in coordination with various other agencies.

6.7.10. In case, any rework IS required because of contractor's faulty erection which IS noticed during commissioning, the same has to be rectified by the contractor at his cost.

6.8.0 TIME SCHEDULE

6.8.1 The contractor has to mobilise in all respects within two weeks from the date of issue of Telegraphic I Tele-fax letter of Indent. The contractor has to mobilise his resources and work force in such a manner that the entire work is completed as per the events mentioned below:

Events to be achieved (Unit I)	Period in month from start of work
Erection completion	05
Spinning of turbine	06
Synchronisation	07
Trial operation & Handing over	08

Balance 4 units shall be started within a phase shift of 3 months and all the 5 units are to be completed within 20 months, from the start of work.

6.8.2 BHEL, owing to its commitment to their customer, may ask contractor to compress the total completion schedule. Contractor shall plan his activities and mobilise additional resources accordingly to the satisfaction of BHEL engineer within the quoted rates.

6.8.3 The contractor should reach site and establish his site office and mobilise to commence the work as per directions of BHEL engineer. The date of starting of the work at site shall be fixed in consultation with BHEL's engineer and the same will be recorded in measurement book while entering the first RA bill.

6.8.4. Subject to availability of materials and other inputs, it is the responsibility of the contractor to carry out work to achieve the monthly progress and keep up the schedules.

6.8.5. Contractor shall draw the monthly erection programme along with BHEL engineer indicating the work to be achieved and event to be completed as per enclosed bar chart. Once the programme is drawn, he shall adhere to the same. Contractor shall plan and erect the materials as it is received at site. The monthly planned percentage shall take into consideration the material available at site before the start of the month and also any material received during the month. Contractor shall mobilise his resources required to achieve the monthly programmes.

6.8.6. The entire scope of erection, testing and commissioning for all the five units is expected to be completed by 20 months from the date of commencement of work.

6.8.7. The work under this scope of contract is deemed to be completed in all respects only when all the components/equipments are erected and trial runs testing and

commissioning of the equipments are completed. The decision of BHEL in this respect shall be final and binding with the contractor.

6.8.8. During the tenure of contract, if BHEL is not satisfied with the progress of work, BHEL have the right to withdraw any portion of work I balance work and get the same done either directly employing their own men or through other agency at Contractors risk and cost. Contractor shall not be entitled for any compensation whatsoever in this refund.

6.9.0 PROGRESS AND MONITORING OF WORK

6.9.1. The responsibility of the contractor to provide all the relevant information on a regular basis regarding erection progress, welding progress, labour availability, equipment deployment, consumption of electrodes, gases, etc.

6.9.2. The contractor shall submit daily, weekly and monthly progress reports, manpower reports, material reports, equipment reports etc. as per formats specified by BHEL. The progress reports shall indicate the progress achieved against planned with reasons indicating the delays, if any. The report shall also give the remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original programme and the slippage do not accumulate and affect the overall programme.

6.10.0 EXTRA CHARGES FOR MODIFICATION ANI) RECTIFICATION WORK

- a. BHEL may consider payment for extra works on man day basis for such of those works which require major revamping / rework/ratification/modification which is totally unusual to normal erection or commissioning work which are not due to contractor's faulty erection.
 - b. The decision of BHEL in this regard shall be final and binding on the contractor. The contractor may submit his work claim bills (Specifically agreed by BHEL Engineer) along with the labour sheet duly certified by BHEL Engineer at site. But BHEL also got the option to get these work done through other agencies if they so desire.
- 6.10.1. All extra work, if any, carried out should be done by a separate gang which should be identified prior to start of work for certification, of man hours. Daily labour sheets should be maintained and should be signed by contractor's representative and BHEL Engineer. Signing of the labour sheets does not necessarily mean the acceptance of extra works. Only those works which are identified as not usual to normal erection and certified so by the Project Manager, and accepted by designer/supplier or competent authority only will be considered for payment.
- 6.10.2. The decision of BHEL in this regard shall be final and binding on the contractor.
- 6.10.3. The following man hour rates will be applicable for modification/rectification work.
- 6.10.4. Average single man hour rate including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals, including consumables for carrying out any rework, re-vamping as may arise during the course of erection RS.25/- man hour.

6.10.5. Average single man hour rate including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals excluding consumables for carrying out any rework/revamping as may arise during the course of erection RS.16/- per man hour.

6.10.6. EXTRA WORK DOES NOT INCLUDE

Nominal dressing of foundations, holes, bases, nuts and bolts, in case of abnormal conditions, this can be mutually discussed before starting of such work.

Extra works are broadly defined as below:

Design changes which will be intimated to the contractor after the start of erection and same refers to dismantling of erected components rectification of components which have been received in damaged conditions during transit, rectification of components wrongly manufactured at work, any other works which do not fall in the scope of this contract.

The decision of BHEL in this regard shall be final and binding on the contractor.

6.12.0 TAXES

6.12.1 Notwithstanding the fact that this is only an erection service contract not involving any transfer of materials whatsoever and not attracting any sales tax liability, being labour oriented job work, for the purpose of Sales Tax 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., interalia indicating the name of the supplier, address and ST Registration No. and ST paid and should furnish to BHEL at the year end.

6.12.2 The contractor has to register under local Sales Tax-Law and get assessed. The contractor has to give a certificate each year that the returns and submitted regularly and the turnover on this contract is included in his sales tax return. The sales tax registration number and certificate is to be furnished at site soon after the award of contract. The ST registration number is required to be given to BHEL site office immediately after the award of contract.

6.12.3. The final bill amount would be paid only after assessment orders covering this turnover are produced. The ST deduction at source will be made from running bills, unless necessary exemption is produced.

6.13 IMPORTANT CONDITIONS FOR PAYMENT

6.13.1. It may be noted that the first running bill will be released only on production of the following.

- i. ST Regn. No.
- ii. PF Regn. No.
- iii. Labour Licence No.
- iv. Workmen Insurance Policy No.

6.14.0. PROVIDENT FUND & MINIMUM WAGES

You are required to extend the benefit of Provident Fund to the labour employed by you in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, you are hereby required to get yourself registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to you by the Provident Fund authorities within one month from the date of issue of this letter of intent. In case you are exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of your failure to comply with the provisions of said Act, if recoveries therefore are enforced from payments due to us by the customer or paid to statutory authorities by us, such amount will be recovered from payments due to you.

The contractor shall ensure the payments of minimum labour wages to the workmen under him as per the rules applicable from time to time in the state. The final bill amount would be released only on production of clearance certificate from PF/ESI and labour authorities as applicable.

6.15.0 GUARANTEE

- 6.15.1. The materials to be supplied of reputed make. All supplies are to be guaranteed for 12 months from taking over of the work. The contractor shall be responsible for the quality of workmanship, shall guarantee the work done, shall rectify/replace at free of cost all defects due to faulty supply / erection / commissioning during the guarantee period.
- 6.15.2. In the event of contractor failing to replace/repair the defective supplies/works within the time required BHEL may proceed to undertake replacement/repairs at the contractor's risk and cost without prejudice to any other points/rights.

6.16.0 OVER RUN CHARGES

In case due to reasons not attribute to the contractor, the work gets delayed and completion time gets extended beyond Twenty (20) months from the date of commencement of the work the contractor shall not be entitled for any over run compensation (ORC) for a period of first Four (4) months after the expiry of 20 months. In case of ORC arise the same will apply at Rs.20,000/- (Rupees Twenty thousand only) per month for extension to the completion period beyond 24(20+4) months as stated above duly taking into account the balance work at the end of that period.

- 6.16.1. The exact period of overrun will have to be ascertained before the commencement of grace period.
- 6.16.2. During the period of over run targets will be fixed on month to month basis, which have to be adhered. In case of any shortfall due to the reasons attributable to the contractor, ORC amount will be proportionately reduced.
- 6.6.13. The payment of over run charges for extended stay for reasons not attributable to contractor will be subject to achieving the monthly programme of work as mutually agreed upon during the extended stay.

6.19.0. Materials/Consumables are to be arranged by the contractor for erection and commissioning as part of the scope.

- a. Welding electrodes for welding and other accessories
- b. Provision for Temporary Scaffoldings.
- c. Round Aluminium Tags
- d. Teflon tape and Insulation tape.
- e. Hole tight/Bitumen tape for GI pipe coupling.
- f. Paints required for primer coating and final coating and for protective coating, Steel structures fabricated at site and other erected items as per the special conditions stipulated.
- g. Solder wire (Lead) -(60/40)
- h. Protocol/Calibration report sheets as per 8HEL Format.
- i. Panel/JB Sealing compound material (for cable entry from bottom Top of Panel).
- J. PVC cable tie, Aluminium strip and hardware for clamping of cables.
- K. Ferrules
- l. Lugs

6.20.0. DETAILS TO BE FURNISHED BY THE TENDERERS:

6.20.1. Apart from other details called for in the tender document under the various other provisions, the following details shall be submitted by the tenderers along with their offers. Please also refer the check list.

6.20.2. Tenderers shall furnish the names of approved high pressure welders on tig welding and ARC welding; technicians, electricians should have relevant certificates to carry out the work as per requirement of statutory authorities.

6.20.3. Tenderers shall go through very carefully all the provisions under section 6 and shall submit list of T&P and instruments that are available with him for mobilisation for the work specified in the tender. Tenderers shall indicate the present location and submit a schedule of tools and plants for this site to meet the schedules of erection and commissioning, in the event of the above work being awarded to the tenderer (This should be submitted as per Appendix VI B similarly, manpower deployment plan as per appendix VI A shall be submitted by the contractor along with his offer.

6.20.4 Contractor shall also submit his organisation chart as called for in the check list.

6.20.5. Contractor should submit tentative monthwise erection plan to match with BHEL schedule.

6.20.6 Contractor should furnish the proof of owning major tools and plants.

6.20.7 Contractor should furnish the names of engineers, supervisors, HP welders; instrument technician and other technicians and other specialised staff working with him for more than two years.

6.20.8 The Information as called for in the tender specification shall be submitted in proper and orderly manner serially as per the check list duly filled in a file/folder with appropriate headings.

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

- a) Final Field Quality Plan
- b) Final Quality Plan
- c) Bar chart covering planned activities at site
- d) Billing schedule

6.21.1 The following information shall be furnished after testing and inspection.
Test certificates of various tests conducted at site.

6.21.2 As built drawings:

After successful completion, testing and commissioning of installation work, the above listed Purchasers 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.

6.22.0 EQUIPMENTS FOR TESTING & COMMISSIONING

6.22.1 The following testing equipments IT&P shall be brought to site by contractor in sufficient number to carryout the Job imultaneously in more than one area.

a) Insulation tester:

- i) Motonsed megger - 0 - 1000 - 2000 - 5000V, 0 - 25000 M ohms
- ii) Hand operated megger - 0.5 KV/1 0 KV/2.5 KV, 200 - 100 M ohm

Earth resistance tester 0 to 1, 10, 100 ohms

c) Transformer oil test kit

d) Torque wrench

e) Voltmeter ac 0 - 125 - 250 - 625 V AC

f) Ammeter ac 0 - 2A - 10A AC.

g) Wattmeter - AC/DC - 0 - 125 - 250 V 0-5-10A.

h) Multimeter - analogue: ACV 2.5V - 2500V, AC A - 100 mA - 10 A
DC V 25.V - 2500V, DC A - 50mA -10A

Resistance - =: - 200 M ohms

digital: voltages ac & dc - 1 00mv - 1000 V

current 10-mA - 10A Resistance - 0-20 M ohms

i) High vacuum stream line oil filter of 1000 GPH for transformer dry out.

- j) Variac - 1 phase - 5A, 15A 3 phase - 10A, 20A.
- k) Primary injection kit - 0-5000 A
- l) Secondary injection kit - 0-5A
- m) HV Test kit - 50 KV AC 400kV A
- n) Wheat stone bridge - 0.05 m ohm - 100 ohm
- o) Oscilloscope.
- p) 5A DC powersource-
- q) Air compressor.
- r) M IG/TIG welding machines.
- s) Vacuum pump
- t) Phase sequence meter - 11 OV - 450V - 25 to 65Hz.
- u) Frequency meter - 0 - 115 - 230 - 4500 - 45 - 601/s.
- v) Tong tester - 0 - 5A - 10A, 30A, 60A, 150A - 600A
- w) Tachometer etc.
- x) SF6 filling and evacuatng equipment.
- aa) Dead weight tester rated 400KG/CM2
With weights and test gauges facility make 1 No.
- bb) Oil temperature bath suitable to calilbrate.
The instruments range - 0 300 deg C 1 No.
- cc) Furnace - 600 deg. C 1 No.
- dd) Standard gauges
 - 1. 0- 1 Kg/CM2 Pressure gauge 1 No.
 - 2. 0 - 5/6 Kg/CM2 Pressure gauge 1 No.
 - 3. 0 - 10 Kg/CM2 Pressure gauge 1 No.
 - 4 0 - 60 Kg/CM2 Pressure gauge 1 No.
 - 5. 0 - 100 Kg/CM2 Pressure gauge 1 No.
 - 6. 0 - 25 Kg/CM2 Pressure gauge 1 No.
 - 7.0 - 200 Deg.C Temp. gauge 1 No.
 - 8.0- 100 Deg C Temp. gauge 1 No.
 - 9. -1 to +3 Kg/CM2 Compound gauge 1 No.
- ee) Manometers 0 - 1 000 ~nvf Hg \water column

With hand bulb for lab and small manometer For field purpose each	1 No.
ff) Soldering iron "Soldron" make 25 wan/GO watt	1 each
gg) Mercury wlanometer	1 No.
hh) Glass thermometer 0-120 Deg C, 0 - 200 Deg C 0 each	1 No.

6.22.2 Note for Contractors instruments

- a. The contractor shall arrange all the above. T&P, equipments and instruments as indicated.
- b. The contractor at his cost shall arrange all cranes and truck/tractor, trailers required for material handling purpose and also cranes required for erection. If contractor require any cranes of heavy lift same can be hired from BHEL on chargeable basis 5L.0ject to availability.
- c. Any other tools and plants instruments and equipments required in addition to the above for the successful completion of this job will have to be arranged by the contractor at their cost.
- d. Necessary accessories for the above shall also be provided by the contractor
- e. The above instruments/equipments will be sent for testing and calibration wherever from time to time and maintained by contractor as required by BHEL.
- f. All testing instruments shall have calibration certificate issued by recognised/accredited agencies.
- g. List of such agencies and periodicity of calibration required for different instruments will be furnished by BHEL at site.
- h. Contractor shall maintain calibration records as per the format CP:FE:FOZ enclosed in the Tender Specification and produced whenever called for by BHEL Engineers.
- 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.

6.22.3 CALIBRATION RECORDS

Contractor has to calibrate all the instruments and maintain the calibration records for all the instruments erected by the Contractor wherever required.

ELECTRICAL INSPECTORATE'S APPROVAL/STATUTORY INSPECTION

- a. All electrical installation covered in contractors scope which also includes equipment covered in commissioning assistance are to be inspected/approved by the electrical inspector/statutory authority. For getting electrical inspectorate's approval contractor shall arrange the following:

Completion certificate for all the equipment covered in the contract

Copy of test results conducted at site for all the equipment.

All other documents as required by statutory authority.

Contractor shall arrange for the above inspection and also carry out the modifications/rectification, if any, as suggested by the authority at his cost. However, this is not applicable for materials erected by Mechanical Contractor.

- b. Contractor shall also have valid electrical installation license on his company as well as individual acceptable to respective state electrical inspectorate requirement.
- c. The scope includes getting the approvals from the statutory authorities (Like electrical inspector and labour officers). This includes arranging for inspection visits of inspector periodically as per BHEL Engineer's Instructions, submitting documents, etc. And following up the matter with them.
- d. All fees connected with the contractors for testing his electricians, technicians, etc. and testing, inspection, calibrating of his instruments and equipment, shall be paid by the contractor. It shall be contractor's responsibility to obtain approval of statutory authorities, wherever applicable, for the conducting of any work which comes under the purview of these authorities. Any cost arising from this shall be the contractor's account. However, BHEL shall pay all other fees (FEES FOR VISITS, INSPECTION FEES, REGISTRATION FEES, ETC.) In case these inspections have to be repeated due to default / fault of the contractor and fees have to be paid again, the contractor shall have to bear the charges. These would be deducted from his bills.

6.23.0.TERMS OF PAYMENT

6.23.1 For transformers:

- | | | |
|----|--|-----|
| a. | Receipt, transport to the placement of erection | 10% |
| b. | Placement, assembly, alignment, grouting mounting and wiring loose parts | 40% |
| c. | Oil filling (gas filling) filtration, mechanical operation checking | 20% |
| d. | Pre commissioning checks, tests, calibration and energisation and commissioning. | 20% |

e.	Trial run and on submission of final bills	5%
f.	After guarantee period	5%
6.23.2. For HT/L T Switchgear / DCDB / All types of control and protection panels / battery charger		
a.	Receipt transport to erection site	10%
b.	Placement, assembly fixing and clamping	40%
c.	Adjustment, Alignment grouting and electronic interconnections	20%
d.	Precommissioning, tests, checks, calibration and making ready for energisation	20%
e.	Trial run and on submission of final bills	5%
f.	After guarantee period	5%

6.23.3 For busducts with associated equipments

a.	Receipt, transport to the place of erection and checking	10%
b.	Erection of supporting structures	10%
c.	Placement, Assembly, grouting, mounting and wiring of loose components	30%
d.	Final connection	20%
e.	Precommissioning tests, checks, calibration and making ready for energisation	20%
f.	Trial run and on submission of final bills	5%
g.	After guarantee period	5%

6.23.5 For HT cable laying

a.	Cable laying clamping tagging & termination	70%
b.	High pot testing	20%
c.	Trial run and on submission of final bills	5%
d.	After guarantee period	5%

6.23.6 For L T cable (all types)

a.	Laying and tagging	70%
b.	Termination and dressing	10%
c.	Clamping	5%
d.	Trial run and on submission of final bill	5%
e.	After guarantee period	5%

6.23.7 Commissioning Assistance:

- | | |
|---|-----|
| a. Satisfactory commissioning of individual equipment | 50% |
| b. Satisfactory commissioning with the system | 40% |
| c. Trial run and on submission of final bills | 05% |
| d. After Guarantee period | 05% |

6.23.8 For all other equipments which are not covered in the above the following terms of payment will be applicable.

- 75% of the accepted rate for respective item of work on prorata basis on satisfactory completion of work.
- 10% of the accepted rate on commissioning of the Individual equipment/panel/instrument.
- 5% of the accepted rate on completion of the commissioning of the systems.
- 2% of the accepted rate for final dressing and painting of impulse pipes and fabricated steel structures and supports.
- 3% on submission and passing of final bill.
- 5% after guarantee period.

6.24.0. The commissioning assistance provided by the contractor includes the following activities also in all electrical drives erected by mechanic/ contractors and connected HT/L T switchgear DCDB, erected by the contractor.

- IR value of electrical equipments, measurement of winding resistance etc.
- Dryout all the motors if required to improve IR value.
- Changing lubrication of gear boxes and greasing at appropriate locations, if any without dismantling.
- Checking direction of rotation of motor and testing and commissioning of equipments under scope for full operation from local as well as remote.
- Attending to any defects till the handing over of the unit to customer by BHEL.
- Calibration of all field instruments.
- Servicing of removing/ replacement of defective components if necessary.
- Functional checks in Switchboards and control panels, cleaning of bus bars modules etc. and ensuring tightness of all busbar links etc.

6.25.0 STORAGE

6.25.1 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.

6.25.2 The wooden pallet provided for packing itself can be retained for raised platform to protect equipment from ground damp, sinking into around and to circulate air under storage equipment.

- 6.25.3 This will also help in lifting the packing with front lift truck.
- 6.25.4 Periodic inspection of silicagel placed inside the equipment is necessary. It has to be replaced when decolorisation takes place or regenerated.
- 6.25.5 Due care should be taken to ensure that the equipment is not expose to fumes gases etc. which can affect electrical contacts of relays and terminal boards. .
- 6.25.6 The storage room and the equipments 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.
- 6.25.7 All the equipments, materials and goods kept in the store room should be identified all registered in a book. Inspection report should be recorded. Any discrepancy observed should be communicated to site.
- 6.25.8 Packing material shall be retained if the cubicle to be repacked after inspection.

6.26.0 SUB-ASSEMBLIES

- a) All sub-assemblies should be kept in a separate place where it is easily accessible.
- b) Sub-assemblies should have a protective cover in case it is stored without wooden packing/case to prevent accumulation of dust. Silicagel packets should also be kept along with it.
- c) Sub-assemblies should not be stacked one above the other.

6.27.0 LOOSE ITEMS (Wherever applicable)

- 6.27.1. The loose items supplied for the main equipment falls into various categories like tools, cables and cable ducts, frames etc. are to be categorised and stored separately.

MONTHWISE MAN POWER DEPLOYMENT (NUMBER TO BE INDICATED CATEGORYWISE IN EACH MONTH) BY THE CONTRACTOR

Sl. No.	Category	Months							
		1	2	3	4	5	6	7	8 and so on....
1.	Resident Manager								
2.	Engineers								
3.	Supervisors								
	a. Mechanical								
	b. Electrical								
	c. Industrial Relations/ Safety								
4.	Riggers								
5.	Fitters								
6.	HP Welders								
7.	Structure Welders								
8.	TIG welders								
9.	Electricians								
10.	Store Keeper								
11.	Semi skilled and unskilled workers								
12.	Watchman/Security								

NOTE

1. Minimum Number of persons to be indicated monthwise.
2. Above deployment plan will be discussed with BREL Site Engineer and necessary changes will have to be made by the contractor as per disillusion. If required, any additional deployment during execution of the work will have to be arranged by the contractor for meeting various schedules/targets set by BHEL without any additional compensation.
3. Resident Engineer should have a minimum qualification of Engineering Degree or Diploma in Engineering with 15 years of experience in Thermal /Hydro/Industrial Power Station.
4. Supervisor should have a minimum qualification of Diploma in Engineering or a graduate with 10 to 15 years of experience in Thermal/Hydro/Industrial Power Station.

5. Lab Technicians should have experience in Thermal Hydro/Industrial Power Stations. .
6. Contractor should have one Store Keeper and one Transport Supervisor for the safe transportation of materials.

**DEPLOYMENT PLAN FOR MAJOR TOOLS AND PLANTS I INSTRUMENTS
(MONTH WISE QUANTITY) BE INDICATED CATEGORYWISE BY THE
CONTRACTOR**

Sl. No.	Category	Months						
		Present	1	2	3	4	5	6 & So on
	Location							
1.	Welding Transformer							
2.	Welding Generators							
3.	TIG Welding sets : (air cooled)							
4.	Insulation Tester							
	a. Motorised Megger 1000 & 5000 V Grade							
	b. Hand operated Megger . 500 & 1000 V Grade							
5.	Earth resistance Megger							
6	Transformer oil testing kit							
7.	Torque wrench							
8.	Volt Meter Ammeter/ Avometer/other instrument							
9.	Multimeter Test lamps Field telephone sets different gauges							
10.	High value steam line filter of 1000 GPH for transformer dryout							

APPENDLX - VI B

**DEPLOYMENT PLAN' FOR MAJOR TOOLS AND PLANTS INSTRUMENTS
(MONTH WISE QUANTITY TO BE INDICATED CATEGORYWISE BY THE
CONTRACTOR**

Sl. No.	Category	Months							Location
		Present	1	2	3	4	5	6 & So on	
1.	3 phase/Single phase Variac 15 Amps								
2.	Primary and Secondary Inject On testing kits.								
3.	HV test kit								
4.	Resistance measurement unit								
5.	Oscilloscope								
6.	5 Amps DC Power Supply: unit								
7.	Crimping Tools with various sizes of dyes.								

NOTE

1. The list of Tools and other plants to be deployed for this project (1Y be indicated by the tenders separated) .
2. Above deployment plan will be discussed with the site engineer and necessary changes will have to be made by the contractor as per discussions. If required, an additional deployment during execution of work will have to be made by the contractor for meeting various schedules/targets set by BHEL without any additional compensation.

**ELECTRICAL PACKAGE
GENERAL TECHNICAL REQUIREMENTS AND GUIDELINES FOR INSTALLATION,
TESTING AND COMMISSIONING**

TESTING & INSPECTION IN GENERAL

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

1. Completion

- 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.
- Drying of equipment as required and testing of oil. for di-electric strength.
- Continuity check of cables etc.

INSPECTION AND TESTING

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.

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 Electrical Inspector system/equipment 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 functioning of the system as a whole and each equipment as part of title system.

TESTS FOR AC MOTORS:

1. I R 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.
12. Check for tipping 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 contact of slip ring brush and measure brush pressure (150-200 gm/sq. cm)
20. For CVV drive check cooling water and system/piping, availability of pressure, cleaning and pressure testing of pipelines etc.
21. Check for polarisation index of stator winding, R 1 O/R 1 by motorised megger (The value should not be less than 2.0) R60/10 absorption coefficient shall not be less than 1.5.
22. Dielectric test (only for HT motors).
23. Measurement of open circuit rotor winding voltage for slip ring motor.
24. For actuator drives following shall be checked/tested
 - Visual and dimensional
 - Hydraulic pressure for valves
 - I R and operation of limit switches
 - Winding resistance

TESTS FOR 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.
12. Measurement of RPM.

TRANSFORMER

1.1 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 know the various working operations very well.

1.2 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.

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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 indicates that the tank and the transformer components respectively are tight, and that the active part including the insulation materials is dry.

If there is no positive gas-pressure, transformer should be immediately filled with dry ;8. 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

...

1.3 UNLOADING:

Whenever rollers trolleys are supplied with transformer, movement of transformer at site is earned 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.

1.4 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.

1.5 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 lif1ing angles, minimum height to crane hook and transformer weight, appear from the OGA drawings. Check at lifting have compete 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.

1.6 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
6. Core check that it has not moved in transit
7. Core-ground; this is checked with the megger after removing earth connection.
8. CT s, 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 shaft, moisture
12. 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:

- i. Fire-fighting equipment shall be available at the oil-treatment equipment as well as at work on and adjacent to the transformer.
- ii. 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.
- iii. Smoking on or near the transformer shall not be allowed.
- iv. Transformer tank, control cabinet etc, as well as assembling and oil-treatment equipment shall be connected with the permanent earthing system of the station
- v. Check that there is no overpressure in the transformer when blank mg plates or connection lids are to be opened.
- vi. All loose objects, tools, screws, nuts etc.. shall be removed from the transformer cover before opening the connection and blanking lids
- vii. All loose objects (tools, pencils, spectacles etc..) shall be removed from the boiler-suit pockets etc. before starting the work through man holes
- viii. 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.
- ix. Tools with loose sleeves and tools with catches must not be used at work inside the transformer.

- x. Greatest possible cleanliness shall be observed at work inside the transformer, and at handling of part to be mounted inside the transformer.
- xi. Fibrous cleaning materials should not be used as it can deteriorate oil when mixed with it.
- xii. All components despatched separately should be cleaned inside and outside before being fitted.
- xiii. A Transformer is best protected from damp hazard by circulating warm, dry, deaerated oil through it until its temperature is 5 C to 10 C above ambient. This should be done before allowing external access to the interior of the tank. The warm oil should be circulated all the time transformer is open to atmosphere.
- xiv. Oil pump & all joints in the oil pipe work should be air tight to avoid entrance of air through leakage joints.
- xv. 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.
- xvi. Objects which-despite all precaution are dropped inside transformer/reactor, must absolutely be brought up from the equipment.
- xvii. Check that the oxygen content inside the transformer tank is minimum 20% if a person is to enter the tank

1.7 ASSEMBLY

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

1.8 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 Buchholz level as per instructions given elsewhere.
- (ii) After filling the oil in transformer and breaking the vacuum, oil can be filled in the conservator either through reactor or 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 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 main reactor/drain valve. Temporarily stop filling operation when oil starts coming from opening after ensuring that no air bubbles come out through 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 degC level.
- (viii) Remove 011 pump and connect air cell to breather from point also remove pressure gauge and put plug.
- (ix) The system is now properly filled. Air release plugs operation are fitted ill normal

1.9 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 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. Valves, fitting, gaskets etc.
- viii. Dry nitrogen cylinders.

1.10 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.

COMMISSIONIGN CHECKS

SI NO 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.
8. Cooling accessories (Pump motors, Fan motors etc.) for direction and OIL 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. I R of core to earth.
18. Die electric strength of oil PPM & Chemical analysis test
19. I R 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. Tap changing at 415v 3 50 Hz supply in all three phases
25. TAN-DELTA test if quality check list calls for.

INSULATION RESISTANCE TEST

Sl.No	Description	Date	Time in Hrs	Megger	(not. I R Value Temp Remarks less than 500 V).
1.	Control wiring				

2. Tap Changer
 - a) Motor
 - b) Control
3. Cooling system
 - a) Motor Fan
 - b) Motor pump
 - c) Control Wiring
4. Main Winding:
 - a) HV/E+V Not less than -1 000 V
 - b) LV/E+HV+LV
 - c) HV/IV (megger)
 - d) IV/L V
 - e) HV IL

Note 1. While checking these values no external, lighting arrestors etc should be 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. It should satisfy 18:1666.

1. Tank Top Sample Bottom Sample
2. Cooling system Top Sample Bottom Sample
3. OL TC Divertor (each phase)

Tests on CT

1. Ratio
2. Polarity
3. Magnetising current
4. I R Value

Potential Transformer Tests

1. I R test of primary winding by HV megger between windings
2. I R 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 I R 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			

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 property.

2) For More details Please refer Respective Manuals. .

BUSDUCTS

2.0 HANDLING AND STORAGE

2.1 Inspection at Site:

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

- a. Completeness and correctness of the consignment (Compare with delivery documents)

- b. Physical damage if any during transit

Handling During Erection:

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

- a). While lifting enclosure assemblies manila ropes are passed round the bus duct 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.

On completion of 2.3 items must be returned to original packing cases unless required for immediate erection.

2.3 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.
- 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

2.4 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.

2.5 A. During unpacking, handling and storage:

DO's

- 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.

DON'T s

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

2.6 During Erection & Commissioning:

DO's

1. Carry out pre-lay survey to verify the position of various equipments to be connected, levels of floors and positions of outputs.
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 CT s and seal-off bushings before final tightening of hardware.
6. Make the busbar joints as per the instructions.
7. Ensure aluminium welding by qualified welder only.
8. Take care for proper sealing while jointing the enclosure.

9. Ensure proper earthing of enclosure and structure as specified.
10. Check wiring as per relevant wiring diagram.
11. Ensure that CT secondaries are shorted and grounded before HV test on busduct.

DON'T s

1. Don't allow accumulation of dirt or foreign material inside the enclosure during erection.
2. Don't overtight the bolts.
3. Don't hammer the bolts etc. while joining the busbars if holes are not matching.
4. Don't forget any foreign material inside the enclosure.
5. Don't allow aluminium welding by unqualified welder.
6. Don't subject IAS, capacitors, and PTs to HT test as these are pretested and test at site is not required.
7. Don't subject NG transformers to over voltage as these are pretested.
8. Don't apply rated voltage unless pre commissioning checks are completed.

2.7 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, hardwares, flexibles, and other miscellaneous items are packed separately.

B. Marking:

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

- a. Project name and unit number
- b. Item no of main BOM this is encircled
- c. Phase marking R, Y or B
- d. Work order number

- e. Drawing number and item/variant number
- f. Arrow indicating direction towards transformers end. Direction of arrow shall be decided from layout.

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

2.8 Pre Layout Survey

Before starting the erection work the centre lines of the complete busduct installation, location of connected equipments such as main transformer, unit auxiliary transformer, station auxiliary transformers, LAVT, 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.

2.9 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.

2.10 Sequence of erection:

Normally the following sequence of erection is recommended

A. Erection of steel work:

All the structures are to be installed, levelled and foundation bolts grouted.

Place longitudinal cross channels in position, adjust level & bolted them.

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

B. Erection of Enclosures:

Before installation of enclosures in position each assembly and conductor complete with insulator supports to be checked for correctness and cleaned.

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.

C. Handling of Busducts :

For handling of busducts specified instructions should be followed.

D. Sequence of erection-enclosure assemblies:

For above the following sequence is recommended:

E. Indoor Assemblies:

(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) alongwith 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.GT, N.G.R and complete the terminal connections.

Note. Before fixing top chamber I bottom chamber, care should be taken that shunts are welded on line side busduct as shown in layout 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.

F. Outdoor Portion:

Position the wall frame at the power house wall, place the wall duct and inset the rubber sealing ring over the enclosure. Complete the wall frame assembly.

Place the remaining enclosures on the structure starting from the wall duct and complete the main run to generator transformer. From main run tap-off enclosures are to be connected to unit auxiliary transformers, accommodating current transformers, flexible connection, disconnecting link and rubber bellows.

The alignment and exact locations of ducts may be verified before proceeding for making the assemblies of make-up piece rubber bellows, wall frame and bolted if needed joints of conductor and enclosures.

G. 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.

H. 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

**GENERAL TECHNICAL REQUIREMENT AND GUIDELINES FOR ERECTION,
TESTING & COMMISSIONING**

7.0 GUIDELINE FOR INSTALLATION OF C & I EQUIPMENTS

- 7.1.1. 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.
- 7.1.2 Maintenance platforms & approach facilities shall be provided for all sensing & primary devices wherever possible.
- 7.1.3 Instruments shall be located in weather proof enclosures and wherever required suitable canopy shall be provided.
- 7.1.4 High & Low pressure impulse lines shall not be grouped and run together. Also impulse lines for explosive & inert gases shall not run together.
- 7.1.5 Impulse lines of high pressure steam, harmful gases, etc. shall not be brought into the control room, as far as possible.
- 7.1.6 Intrinsically safe circuits shall be used for explosion hazardous areas.
- 7.1.7 Separate cable routing shall be followed for high and low voltage lines.
- 7.1.8 All electrical equipments shall meet the requirements of Indian Electricity Rules.
- 7.1.9 Wherever severe vibrations are expected, shock absorbers shall be provided.
- 7.1.10. Before and after regulating/control valves. straight pipe lengths of 10mm dia on either side must be ensured
- 7.1.11 Installation of instruments with radio-active isotopes, mercury and other toxic substances shall be as per statutory regulations provided by authorities.
- 7.1.12. Compensating cables should be connected directly to instruments, i.e. no junction boxes shall be used.
- 7.1.13 Orifice plates or flow nozzles must be provided with atleast 100 upstream and 50 downstream straight length of pipe from bends tees, branch pipes & control valves.
- 7.1.14 Control valves shall be installed after orifice plates.
- 7.1.15 Pressure gauges shall be provided with snubbers, syphons (for more than 100°C), 3 way valve manifolds wherever applicable.
- 7.1.16. 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.

- 7.1.17. Correct level (height) between detecting element and tapping point and transmitter shall be maintained.
- 7.1.18. The equipment shall maintain its normal posture (level, perpendicular, front and back).
- 7.1.19. Connection between detecting element tapping point and transmitter shall be maintained at short distances wherever practicable to avoid any time lag.
- 7.1.20. 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.
- 7.1.21. For details of installing each measuring instruments, instruction manual issued by the respective manufacture of instruments may be referred to, wherever necessary.
- 7.1.22. The drain pipes shall be terminated in a common closed header and finally the common header shall be connected to plant open drain.
- 7.1.23. 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.

7.2.0 GUIDE LINE FOR ERECTION OF IMPULSE LINES

- 7.2.1 All impulse lines burrs and air lines shall be thoroughly cleaned and any foreign matter by cleaning with compressed air shall done before installation.
- 7.2.2 The routing of pipe lines shall include sufficient flexibility near tappings to allow for thermal expansion of the process equipment. Typical routing of impuse pipes and installation of various instruments shall be as per. drawings enclosed with this tender.
- 7.2.3 The pipes shall be cold bent using hydraulic bending machines only.
- 7.2.4 The horizontal impulse lines shall be laid with proper slopes towards the tapping point.
- 7.2.5 Supports for piping and tubing shall be adequate and in no case exceed limits shown below:

a) 1/4" 001318" 00 Copper	Continuous
b) 1r2" NB Pipe/Tube	5'
c) 3/4" NB Pipe/Tube	5'
d) 1 II NB Pipe/Tube	8'

- 7.2.6 All impulse line welding shall be done through welding generator/rectifier and only structural welding could be done through welding transformer.
- 7.2.7 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.
- 7.2.8 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.
- 7.2.9 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.
- 7.2.10 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.
- 7.2.11 Alternatively hose assembly - S.S. flexible may be used for connection between tapping point and impulse pipe.
- 7.2.12 The expansion bends are to be avoided as far as possible, as these act as air/sedimentation traps hampering the system performance.
- 7.2.13 Impulse piping shall be arranged as short as possible with a minimum of bends.
- 7.2.14 Horizontal piping shall be avoided and 1/10 slope shall be maintained.
- 7.2.15 Pipes shall not be laid parallel to high temperature process piping.
- 7.2.16 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.
- 7.2.17 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 atleast of 300 mm before a change of direction is made.
- 7.2.18 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.
- 7.2.19 In order to take care of tile boiler expansion, suitable flexible connecting pipes can be arranged either at the tapping point end or at the instrument end as shown in the figure.

7.2.20 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 minimum as possible. A suitable condensing chamber as shown in the figure can be arranged which will eliminate the condensate or any blocking in the impulse pipe.

7.2.21 Impulse Piping for Steam and Water System

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

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

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

7.2.24 In case 2 way manifold used and connected with nipple and coupling, it is necessary to provide tee with plug for purging or venting, as shown in the figure. 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.

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

7.2.26 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.

7.2.27 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.

7.2.28 Bending:

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

7.2.29 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.

7.2.30 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.

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

7.2.32 Cutting:

- Pipe cutter or wheel grinder shall be used for pipe cutting.
- Gas cutting shall be avoided.
- Burn inside the cut end shall be removed.
- The cutting surface shall be as perpendicular to the axis as possible.

7.2.33 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 Joint~ 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 as shown in the figure.

7.2.34 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 press.

7.3.0 GUIDELINES FOR INSTALLATION OF PNEUMATIC LINE

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

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

7.3.3 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.

7.3.4 Multi-core copper tubing shall not to be bend less than 10 deg and 0 is the 00 if the multi-core copper.

7.3.5 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.

- 7.3.6 The joints shall be screwed with teflon tapping wherever the pipes are frequently to be removed for cleaning and other purposes and suitable uniform fittings shall be used. .
- 7.3.7 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.
- 7.3.8 Instrument airline should not be routed where severe vibration, high temperature exists and adequate space should be available for maintenance.
- 7.3.9 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.
- 7.3.10 While using the pipe cutter, care shall be taken to remove burr from the cutting side.
- 7.3.11 The location 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.
- 7.3.12 While fixing the copper tube fittings only teflon tapes should be used. However, 110 tape shall be used while tightening the ferrules.

7.3.13 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 ps1 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 ps1, and checked with soap solution for leak.

7.4.0. 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).

- 7.4.1 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).
- 7.4.2 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.

- 7.4.3 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.
- 7.4.4 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.
- 7.4.5 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.
- 7.4.6 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.

7.5.0 GENERAL NOTES ON INSTALLATION OF LOCAL INSTRUMENT RACK AND JB FRAME

- 7.5.1 In cases where the local instrument stands are to be installed on a concrete foundation. It shall be fixed by anchor bolts.
- 7.5.2 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 as shown in the figure. However, in cases where there is a probability for removal of stand is likely to arise, it shall be fixed by bolts, as shown in the figure.
- 7.5.3 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.
- 7.5.4 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/J Bs shall be supported by welded on to any of the working equipments, or even hand grided or floor grided, as per safety norms.
- 7.5.5 Proper care should be taken to ensure that welding of the stand on any structure or Beam is fully welded.

7.6.0 GENERAL GUIDELINE ON FLOW INSTRUMENTS INSTALLATION

- 7.6.1 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.

- 7.6.2 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.
- 7.6.3 Care shall be taken while welding the impulse pipe. Improper management 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. .
- 7.6.4 Always 3/4" to 1" pipe is recommended for free flow condensate. Gate valve shall be used for the tapping and pipe should be insulated upto condensing pot.
- 7.6.5 The Measuring instrument shall be located close to the flow sensing element. The speed of response is reduced if there is a long run,
- 7.6.6 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.
- 7.6.7 Location of Flow element should have clear straight run of 100 in upstream and 50 in downstream.
- 7.6.8 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.
- 7.6.9 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 and facility shall be provided for checking the '0' calibration.
- 7.6.10 If the flow of any dry gases are to be measured, the location of instrument can be kept above or below the tapping points?
- 7.6.11 For air flow measurement it is always preferable to install the instruments above the pipeline, In case, if the instrument must be installed below the duct pipeline, suitable Dust Collection Chamber can be installed as shown in the figure.
- 7.6.12 The condenser Pot should be located nearer to the tapping point and both condenser chamber should be at the level of upper tapping,
- 7.6.13 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.
- 7.6.14 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 '0' 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.

- 7.6.15 In an installation where the instruments must be located above the tapping points and the condensing chamber should be equally located above the instruments as shown in the figure, the pipeline upto the condensing pot should be insulated.
- 7.6.16 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.
- 7.6.17 The commonly used sealing liquid includes water, light oil, glycerol, ethylene glycol and mixtures of the last two with water.
- 7.6.18 The sealing chambers, in each pressure pipe, should be installed at the same level and as close as possible to the pressure tapings.
- 7.6.19 The general arrangement for pressure tapings from the Sealing Chamber to the instrument is shown in the sketch.
- 7.6.20 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.

7.7.0 GENERAL GUIDELINE ON INSTALLATION OF VALVES

- 7.7.1 Primary isolating valves (root valves) must be located at the tapping which can be of globe valves.
- 7.7.2 These valves shall be installed where access is possible.
- 7.7.3 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.
- 7.7.4 For pressure more than exceeding 40 kg, 2 isolating valves shall be provided.
- 7.7.5 In the case of heavy duty isolating valves, suitable support shall be provided to avoid any loading on the stubs.
- 7.7.6 In viscous fluids, suitable steam tracing shall be provided.
- 7.7.7 These valves are always located as nearer to the measuring device as possible.
- 7.7.8 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 gun metal '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.

7.7.9 Painting:

All the supporting steelworks impulse pipe shall have protective painting. The surface shall be free from rust, foreign adhering matters, grease etc. Two coats of rust preventing red-oxide primer and final painting of two coats as per the colour DECIDED by the site engineer. (More details please refer Section VI scope of works). After cleaning the surface is painted with one coat of Red oxide zinc chromate primer confirming to IS 2074 and allowed to dry completely. The primer coated surface is painted with two coat of final painting of desired colour which shall be selected from 1\$-5.

7.8.0 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

7.9.0.GUIDELINES FOR LANDING AND STORAGE OF ELECTRONIC CUBICLES /SUB-ASSEMBLISES/LOOSE ITEMS.

7.9.1. 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 sided 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.

7.9.2 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.

7.9.3 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, sulphurdioxide etc.

7.9.4 After opening the case, all supports provided for transport are to be removed with due care.

7.9.5 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 not be 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 this tender.

J. 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 it should be ensured that proper sealing is achieved.

2.11 Busbar Bolted Joints

A. Aluminium to Aluminium Joints (Un plated):

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 breaching 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 under 2.11A above 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.

C. Aluminum to Copper Joints using bimetallic strip:

For cleaning of aluminum and copper surfaces follow instructions given under 2.11 A&B above. Apply jointing compound to aluminum 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 aluminum surfaces. Care should be taken that copper faces copper surface and aluminum faces aluminum surface.

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.

2.12 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)
M12 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 (20-1 00 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.

2.13 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 now into the enclosure).

2.14 Earthing of busduct (continuous type) 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.

2.15 Site tests:

The tests to be carried out on the equipment at precommissioning stage shall include following but not limited to the following.

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, all, grease, swaft and any 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 clutch. 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. Netural grounding transformer HV terminal
- e. Lightening arresters

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. HV. Circuit breakers on system side are kept in the open position.

D. Test Voltage:

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

For A.C. voltage duration atleast 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	
12	28	
24	44	
36	60	

E. Meggar-Checks:

Before the application of high voltage, check the insulation of each bus, conductors by means of 2.5 KV meggar. 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 T able-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 hus including tap-off must withstand the above test voltage.

G. TESTS FOR GENERATOR:

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
5. Temperature rise'- at rated voltage, current, power factor and frequency
6. Overspeed test:
7. Calculation of efficiency
8. Phase sequencel voltage balance/current balance checks.
9. Insulation of bearing pedestal housing
10. Determination of reactance's and time constants.
11. Instantaneous short circuit test (Optional).
12. Noise measurement test.
13. Response of voltage and frequency with sudden shedding of 25%, 50%,75% and 100% of rated load respectively.
14. Response of voltage and frequency with sudden application of 25%, 50%, 75% and 100% rated load respectively
15. Temperature detector test
16. Measurement of DC resistance of winding
17. Pressure test on heat exchangers (cooling system)
18. Inter turn insulation test of stator winding with. induced voltage 130% of rated value for 5 minutes (if applicable).
19. Measurement of shaft voltage.
20. String test as per data sheet.

HT SWITCHGEAR

1. IR test
2. HV one minute P.F. test checking of all level
3. Checking of oil level
4. Measurement of BDV of oil for MOCB
5. Measurement of contact resistance for HT breakers
6. Test to prove inter changeability of similar parts (including breaker module)
7. Testing of relays as per supplier's commissioning manual
8. Testing and calibration of all meters.
9. Operation of all relays by secondary injection method
10. Testing of CT polarities and CT ratio by primary injection test.
11. Measurement of knee point voltage and secondary resistance for CT s used for differential protection.'
12. I R and voltage ratio test for PT s
13. Functional test of all circuit components for each panel! feeder.
14. Test to prove closing tripping operation at minimum and maximum specified voltage in test and service position.
15. Check for drawout test and service position of breakers for all feeders.
16. Check for covering of all openings in the panel - check for continuity and operation of aux. contacts of breaker.
17. HV test on vacuum interrupters (for VCBs)
18. Check for pressure of SF6 gas and air (for SF6).

HT ISOLATOR

1. I R test before and after HV test
2. HV test (by 15 kV meggar)
3. Operational test
4. Checking of interlocking with earth switch
5. Checking of operation of earth switch
6. Checking for tightness of earth connection

7 Check for continuity of aux. contacts.

L T - SWITCHGEAR I CONTROL PANEL

3.0 The following points shall be checked up during erection.

3.1 Layout of foundation channels.

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

3.3 Location and serial no. of panels.

3.4 Positioning of panels.

3.5 Verticality of switchgear panels within the limit specified.

3.6 Checking of modules and its manual operation.

3.7 Earthing of panels and breaker truck to station earth.

3.8 Lugs for termination of L T cables.

3.9 Mounting and fixing arrangements of Bus bars.

3.10 Tightening of Busbar jointing bolts as specified

3.11 Clearance between:

i. Phase to Phase

ii. Phase to earth

3.12 Minimum clearance for:

i. Breaker and modules withdrawal

ii. Distance required for maintenance work

3.13. Check the operation of :

i. Remote control

ii. Various required - closing / tripping / alarm / indications / interlocks

3.14 Installation position of insts and relays

Operation of relays and meters by secondary injection.

3.15. AC/DC supplies for panel

Final relay settings as per customer requirements.

- 3.16. Tightness of terminal connections L T connections.
- 3.17. Opening operation of breaker, manually and electrically.
- 3.18. Working of ammeters and voltmeters for their entire range and other panel mounted insts like recorder, indicator etc.
- 3.19. Tests for L T Switchgear I ACDB/DCDB ETC...
 - 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 DC voltage.
 - f. Checking of interlocks provided and tripping of breaker through relays.
 - g. Space heater operation check.
 - h. Opening and closing time check
 - J. Checking of interlocks provided and tripping of breaker through relay
 - k. Control and metering circuit checks.
 - l. Thermal overload relay testing and checking.
 - m. Calibration of all instruments and meters
 - n. Phase rotation checks.
- 3.20 Test for generator and transformer control panel
 - a. For generator relay panel:
 - i. Functional checks on relays like pickup and drop of voltage by doing secondary injection and Loop checking of the relays.
 - ii. Checking of interlock and protection by Primary injection and Checking of synchronising circuits as per schemes.
 - b. For transformer control panel:
 - i. Checking of control circuits and Calibration of the panel meters.
 - ii. Checking of the total annunciator / indication system.

4.0 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 nad first aid.
4. Check polarity of connections between battery and charger
5. Visual inspection test for level and leakages.
6. Checking of layout as per approved drawing.
7. Checking of I R 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. I R 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
11. Check AC ripple in boost and float mode after charging.
12. Check polarity of cables connected to battery.

Apart from above following tests also to be carried out:

- a. Insulation resistance and earth resistance checks.
- b. Primary and secondary injection test.
- c. Calibration of all instruments
- d. 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.
- e. Battery capacity test

5.0 LAYING OF CABLES AND TRAYS - TERMINATION AND TESTING:

- 5.1 In the plant building, substations, switches rooms, control rooms atc power and control cables shall generally be laid on cable trays installed in concrete trenches, tunnels) cable besements, cable vaults, cable shafts or along building and structures as the case may be.
- 5.2 In case of multicore cables are taken diameter upto 30mm where not more then 3 cables are taken directly along structures, walk ways, platforms, galleries, walls, ceiling rtc. by proper clamping at regular intervals of more than 300mm.
- 5.3 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. GI conduits shall also be used for flameproof installations, wherever required, with sealing at both ends.

- 5.4 In corrosive atmospheres, where 11 OOV grade cables are required to be taken in pipes, rigid heavy duty PVC pipes shall be provided.
- 5.5 Entry of cables through trenches/tunnels into buildings shall be by means of one method indicated in drawing as applicable for different buildings.

Cables laid exposed in racks/trays and routed 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 basements.

- 5.6 All cables routed along walls or in equipment rooms shall be protected by means of laying them through G.I. pipes or by protected sheet metal covers up to a height of 2000 mm from the working floor levels and platforms, for protection against mechanical damage. All vertical risers shall be of enclosed type.
- 5.7 Sheet metal 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 dust/atmospheric conditions etc.
- 5.8 Cable trays shall be supported on ISA 50x50x6 mm MS / GI brackets. Brackets shall be welded to steel plate inserts in the trenches/tunnels or supporting channel angle inserts in the areas.
- 5.9 Where direct heat radiation exists, heat isolating barriers (subject to customer approval), for cabling systems shall be adopted.
- 5.10 For 415 V power wiring in ancillary buildings, offices and laboratories, cables shall be taken through embedded/exposed GI conduits or rigid PVC pipes as applicable.
- 5.11 If required, a few number of cables in exceptional areas may be directly buried into the earth.
- 5.12 Wherever cables are to be laid below roads and railway tracks, the same shall be taken through ducts buried at a suitable depth to be decided by Engineers at that time.
- 5.13 At certain places, where hazardous fumes/gases may cause fire to the cables, cable trenches after installation of cables may be sand filled.
- 5.14 In corrosive atmosphere, PVC conduits shall be used for cables. Single core cables, when pulled individually shall be taken through PVC pipes only.
- 5.1 Erection of cable trays, supports and accessories: (If applicable only)
 - a. Cable tray/racks, fittings, (such as elbows, reducers, tees, etc.) end tray support structure shall be erected by the contractor.

- b. Constructional details and supporting arrangement for the cable trays shall be as shown in the drawing which will be handed over to the successful bidder. All cable trays, vertical raceways and supporting steel work shall be handed over to the successful bidder. All cable trays, vertical raceways and supporting steel work shall be installed along the routes and indicated in the drawings and as per the "instructions of the Engineer-in-charge. The contractor has to fabricate and install complete tray supporting structures as per the drawing/site requirement.
- c. Wherever specified or directed by Engineer, the contractor shall install galvanised MS sheet 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.
- d. 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.
- e. 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.
- f. 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.
- g. Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way or maintenance of adjacent equipments.
- h. For installation of cables in GI conduits the conduit shall be installed first without cables but having suitable pull wires laid in conduits.
- i. 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.
- j. GI conduits shall run without moisture or water traps and shall be made drawing arrangement towards the end
- k. 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.
- l. Bends of GI pipes/conduits shall be made without causing damage to the pipes/conduits.
- m. Occupancy of conduits shall not be greater than 40%
- n. The adopter for coupling rigid GI Pipe/conduits and flexible conduit shall be of aluminium or galvanised steel.

5.17 Transportation & Storage of cable drums:

- a. Transportation and storage of cable drums shall generally conform to the requirements of IS:1255.

All the cables shall be supplied to the contractor free of cost from BHEUCustomer's store/storage area. Transportation of cables from storage area to the work site shall be carried by suitable material Handling equipments.

- b. The cable drums shall be transported on wheels to the place of work
- c. Empty cable drums shall be return to the BHEL/Customer store by the contractor.

5.18. Laying of cable in trays, conduits & Along the structure

- a. Laying and installation of power, control and special cables shall generally conform to IS:12545.

B The cables shall be paid-out in proper direction from the cable drums (opposite to the normal direction of rotation for transportation).

- c. In case of higher size cables, the paid 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.
- d. Suitable extra length of cables shall be provided for all feeders for any future contingency, in consultation with Engineer.
- e. Cable runs shall be uniformly spaced, properly supported and protected and in an approved manner. All bends in runs shall be well defined and made with due consideration to avoid sharp bending kinking of cable. The bending radius of various types of cables shall not be less than those Specified in Is:1255.
- f. 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 25mm spacing for straight runs or as specified by engineer for easy identification of cable.
- g. When a cable passes through a wall, cable number tags shall be fixed on both sides of the wall.
- h. Single core cables for A.C. circuits shall from a complete circuit in trefoil formation supported by means trefoil clamps of non-magnetic material.
- i. 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 of bigger diameter cable.

- j. All 11 00 v grade multicore power cable and single core DC cables shall be placed in single layer, touching each other and clamped by means of single or multiple galvanized MS saddles/aluminium strips/nylon cable ties as specified in data sheet-A or as agreed for the contract. Cables above 35mm diameter shall be clamped individually.
- k. 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.
- l. Segregation of the cables on the basis of their types and their functions shall be as under for horizontal formations:
 - i). HT cables shall be laid in the top tier (s)
 - ii). LT power cables to be laid in the tray (s) below the HT cable trays.
 - iii). LT control cables to be laid in the tray (s) next below to the LT power cable (trays)
 - iv). Special control cables including screened control cables to be laid in the bottom most tray (s).

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 to top trays, the order convenient for linking the horizontal and vertical formations shall be followed.

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.

In hierarchical order:

- i) Control cables are mixed up with the special control cables with clear minimum gap of 100mm between them.
- ii) LT power cables are mixed up with control cables with clear minimum gap of 150 mm between them.
- iii) LT power cables are mixed up with HT power cables with clear minimum gap of 200 mm between them.
- iv) LT power cables are mixed up with special control cables with clear minimum gap of 200 mm between them.

However, under no circumstances HT power cables can be mixed up with control cables of any type.

- o) It shall bring it to the notice of Engineer if the routes indicated in the cable schedules supplied by the purchaser defy the criteria mentioned in above (cause for general arrangement of various types of cables in different trays).
- p) 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
- q) 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 galvanized.

- r) 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 wall using raw plus and MS flat spacers of minimum 6mm thickness.
- s) 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.
- t) No single core cable shall pass through a GI conduit or duct singly except DC single core cables. AC single core cables shall pass through GI conduits/pipes in trefoil formation only.
- u) In case of 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.
- v) 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 watertight 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 shall be by cold setting compound. Any alternative sealing arrangement may be suggested with the offer for consideration by BHEL.

Wherever specific cable routes are not shown in cable schedules cables be laid as directed by Engineer.

Tests to be conducted for Earthing:

1. Check tightness of all earth connections.
2. Check earthing of all metallic equipments, cable trays, busbar supporting structures, yard fencing steel structures of yard, rails, gates, building column (if steel) all elect equipments, gas/oil/water pipe lines etc. as per the drawing/specification.
3. Measurement of earth resistance for each electrode.
4. Measurement of total earth resistance.
5. Measurement of earth loop resistance for E/F path of biggest L T drive.

5.19 Support Spacings & Clampings

Support spacing and clamping shall be as per data sheet A.

5.20 Laying of cables Directly buried in ground

- a. Laying and installation of directly buried cables in ground shall conform to the requirements of IS 1255.
- b. The part of cable which is not buried shall comply with the requirements of clause 6.2.9 above, as applicable.

5.21 Cable termination and jointing

- a. Contractor shall carry out cable terminations shall be carried out at various electrical and electronic equipment terminals.
- b. When the equipments are provided with undrilled, gland plates for cable/conduct entry into the equipment, the contractor shall performs all drilling and cutting on the gland plate and any minor modification work required to complete the job at no extra cost The contractor shall prepare a drawing showing the holes for cable entry in the gland plate and take Engineer's approval before drilling holes. Gas cutting shall not be allowed.
- c. Termination of cable 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.
- d. All cable entries in the equipment shall be sealed by cable glands
- e. Adequate length of cables shall be pulled inside the switch boards, control panels, terminal boxes etc. So as to permit neat termination of each core/conductor.
- f. 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.
- g. Control cable cores entering switchboard or control panels shall be nearly 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. I spare terminals are not available, spare cores shall be neatly dressed and suitably taped at both ends.
- h. Screened control cables of 0.5 sq.mm cross-sectional area shall be terminated by means of Maxi-termi termination system. Contractor shall ensure the availability of all tools, tackles and accessories required for the termination of 0.5 sq.mm screened control cables by this method, such as Maxi-termi guns, clips etc.
- i. Individual cores of control cables shall be ferrules for identification. Ferrule numbers shall be provided as per the control schemes and other' related documents supplied.
- j. End sealing termination of RT cables shall be done by mean specified in the specification for terminations. The 'system shall be suitable for types of cables specified and complete. with stress relief system
- k. Termination and jointing of aluminium/copper conductor power cables shall be done by means of compression method using compression type aluminium lined copper lugs as indicated in Data Sheet A.
- l. 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.

- m. 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 at joint
- n. Junction boxes shall be used, wherever required, for jointing of control cables.
- o. Termination and jointing shall generally conform to the requirements of IS:1255 and shall strictly conform to the recommendations of termination and jointing kit supplier.

5.22 Earthing of cable system:

- a. All the conduits, trays and support structure on which the cables have been installed shall be bonded to the main earthing system. All electrical continuity and permanent connection to earth. Gaslater or other pipes shall not be used as earth medium.
- b. Armour earthing:

While the armour of the cable is not earthed through gland plate.

- i) Armour of the HT cable shall be earthed only at one end of cable.
- ii) Armour of other cables shall be earthed at both ends of cable.

- c. Screen Earthing:

- i) Screen of HT power cables shall be earthed at one end only.
- ii) Screen of control cables shall be earthed at one end if the same is not earthed through cable gland,
- iii) Screen of electronic earthing system cables shall be earthed as per the requirement stipulated elsewhere,

5.23 Codes and Standards:

Installation of cabling work shall comply with the following Indian standards (latest editions):

- IS 1255 code of practice for installation and maintenance of power cables upto and including 33 KV rating.
- IS 732 [Technical wiring Installation (system voltage not exceeding 650V)
- 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 coating of cadmium on iron and steel.
- IS 2629 Code of practice for hot dip galvanizing 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.

- i) Indian Electricity Act and Rules framed there under
- ii) Fire insurance regulations
- iii) Regulations laid down by the Chief Electrical Inspector of state
- iv) Regulations laid down by the Factory Inspector of State
- v) Any other regulations laid down by the authorities.
- vi) In case any clause of contradictory nature arises between standards and this specification, the latter shall prevail.

5.24 Design Requirements (Applicable if only supply covered in contractor scope):

A. Strip Cable clamps:

- i) Strip clamp shall be of aluminium alloy or cast steel or M.S. and shall be used to fasten the group of multi-core cables on the tray.
- ii) Clamps shall be of simple construction, made of 4 mm thick, 25mm wide strip to cover the entire width upto 300 wide tray and part of the tray for more than 300 wide trays. Strips shall have two right angle bends for fixing on the rung with two bolts.
- iii) Clamps shall be two 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.
- iv) Steel clamps shall be not dip galvanised.

B. Self locking clamps:

- i) Clamps shall be of nylon material/fibre glass.
- ii) Clamps shall have self locking feature when the cord is looped.

- iii) Clamps shall be provided with manual lock release.
- iv) Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- v) Type test certificates to ascertain the strength of clamps shall be submitted for purchaser's approval.
- vi) Nylon self locking clamps shall be of BHEL approved made only.

C. Ferrules:

- i) Ferrules shall be required for individual core of cable hence they shall be suitable for the insulated conductor diameter.
- ii) Ferrules shall be of plastic material.
- iii) 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
- iv) 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.
- v) If customer prefers, continuous embossed (printed) ferrules in some areas if shall be supplied in c customer with BHEL/customer.

D. Tags:

- i) Cables shall be provided with cable number tags for identification.
- ii) Cable tags shall be of durable fibre, aluminium or stainless steel sheets.
- iii) Cable number shall be engraved type in case of aluminium or stainless steel tags, and printed type in case of fibre sheet.
- iv) Tags shall be durable quality of size 60mm x 12mm with holes at both ends.
- v) Samples of tags shall be approved by BHEL Engineer before delivery.
- vi) Tags shall be provided. with non-corrosive wire of sufficient strength for taggings.

All cable crimping type lugs for various size of power and control cables as per IS.

EPVC Tapes, Special Tapes and supporting arrangements.

5.25 Testing for Cabling:

A The contractor shall take full responsibility of testing, Precommissioning and commissioning of the cabling system installed by him under the overall supervision of the Engineer. It shall be the overall responsibility to the contractor to arrange and complete all activities in complete coordination with equipment commissioning agency keeping in view the overall commissioning programme. The contractor shall submit to the Engineer a checklist for testing and commissioning and the activities shall be carried out in accordance with the check list

B. Testing and electrical measurement of cable installations shall conform to 18:1255

C. Prior to installation, cables shall be tested for:

- i) Continuity of conductors
- ii) Insulation resistance between conductors & earth
- iii) Insulation resistance between conductors

D. After Installation cables shall be tested for:

- i) Insulation resistance between conductors & iron
- ii) Insulation resistance between conductors & Earth
- iii) Conductor resistance(DC)
- iv) Capacitance between conductors (for cables above 11 KV grade)
- v) Capacitance between conductor & earth (for cables above 11 KV grade»)
- vi) DC High voltage test (for HT cables/L T power cables of higher sizes interconnecting PMCCs & MCC)
- vii) Absence of cross phasing
- viii) Fitness of terminations

E. The Checks and commissioning tests shall be carried out as part of the installation work and the contractor shall not be paid any extra amount for the same.

F. If any additional tests are necessary to determine that the works comply with the specification, manufacturer's instruction or the applicable IS code of installation, same shall be conducted.

G. All test shall be performed to ensure that materials supplied and workmanship conform to the relevant standards and that such tests are adequate to demonstrate that the equipment will comply with the requirements of this specification.

H. All testing equipment & instruments shall be arranged insufficient numbers to carry out the job simultaneously in more than one area. All instruments shall be calibrated to the satisfaction for the Engineer before actual testing and tests shall be conducted by qualified and experienced personnel as detailed in section VI.

I. All documents/records regarding test data and all other measured values shall be submitted to Engineer for approval and subsequent record and reference. All cables shall be energised only after certification form commissioning personal. The results of all tests shall conform tot he specification requirements as well as any specific performance data guaranteed during finalization of contract.

Note: The test specified above for all the electrical equipments are not exhaustive. Any other pre-commissioning and field tests not included in the above list but necessary as per relevant standards, Electricity rules, 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.

**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/Fiber/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 between adjacent trefoils : Double the diameter of larger cable or 150 mm Whichever is less

Other Clamps:

A. Power Cables:

Above 35mm Ø D

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

ii) Vertical runs Individually clamped at 3000 mm Interval (max)
Upto 35mm ØD

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:

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
Pin type, maxi-termi type 0
- c. Special cables

7. Wastage Allowance:

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

SITE FACILITIES

1.1.0. ESTABLISHMENT.'

1.1.1 For construction purposes:

- | | |
|---|-----|
| a) Open space for office | Yes |
| b) Open space for storage | Yes |
| c) Bidders Office and Stores building | |
| - Supply of all material required | Yes |
| - services for construction | Yes |
| d) All office equipments offices stores consumables | Yes |
| e) Canteen facilities | Yes |
| f) Fire fighting system buckets, extinguishers etc. | Yes |
| f) Fencing of storage area of the bidder | Yes |

1.1.2 For living purposes

- | | |
|-------------------------|-----|
| a) Open space | Yes |
| b) Living Accommodation | Yes |

1.2.0 ELECTRICITY

- | | |
|---|-----|
| a) Single point source | Yes |
| b) Further Distribution required for the scope of work | Yes |
| - Supply of material | Yes |
| - Execution of work | Yes |
| 2. Supply, installation and connection of energy material operation and maintenance | Yes |
| Duties and Deposits for toe above | Yes |

Sl. No.	Description BHEL Bidder	Remarks
3.	Living facilities for office use	Yes

including charges

4. Demolations Yes

1.2.3 For living accommodation Yes

1.3.0 Water supply

1.3.1 For construction purposes :

1. Availability at a single point source Yes

2. Further distribution as per work requirement Yes

- Supply of materials required Yes

- Execution of work Yes

1.3.2 For office & stores

1. Distribution from single source as per need Yes

- Supply of materials required Yes

- Execution of work Yes