

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART
and

(description of the party along with address), hereinafter referred to as "The Bidder / Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for

PACKAGE A:

Handling of Materials at BHEL/ Client's Stores/ Storage Yard and transportation to site of Erection, Erection, Testing & Assistance for commissioning and Trial Operation and application of insulation, refractory including supply & application of final Painting etc. of Boiler & auxiliaries, Air Pre Heaters, Ducts & Dampers, Boiler Integral Piping, ESP, Gates, Duct support structures, structure for bunker, fans, bowl mills, Rotation Equipment's, Fuel Oil System auxiliaries, Auxiliary boiler & Auxiliaries and their insulation, etc. and Detailed Engineering, Fabrication, Erection of Bunker including initial and final painting along with supply & installation of items as per BOQ of Unit 1 of 2x660 MW Udangudi STPP, Tuticorin District, Tamil Nadu

PACKAGE B:

Handling of Materials at BHEL / Client's Stores / Storage Yard and transportation to site of Erection, Erection, Testing & Assistance for commissioning and Trial Operation and application of insulation, refractory including supply & application of final Painting etc. of Boiler & auxiliaries, Air Pre Heaters, Ducts & Dampers, Boiler Integral Piping, ESP, Gates, Duct support structures, Structure for bunker, Fans, Bowl mills, Rotation Equipment's, Fuel Oil System auxiliaries, and their insulation, etc. and Detailed Engineering, Fabrication, Erection of Bunker including initial and final painting along with supply & installation of items as per BOQ of Unit 2 of 2x660 MW Udangudi STPP, Tuticorin District, Tamil Nadu

The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1- Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-

- 1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
- 1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.
- 1.1.3 The Principal will exclude from the process all known prejudiced persons.
- 1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2- Commitments of the Bidder(s) / Contractor(s)

- 2.1 The Bidder(s) / Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
 - 2.1.1 The Bidder(s) / Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.
 - 2.1.2 The Bidder(s) / Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.
 - 2.1.3 The Bidder(s) / Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s) / Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal

as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

- 2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s) / Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
- 2.2 The Bidder(s) / Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.
- 2.3 The Bidder(s) / Contractor(s) shall not approach the Courts while representing the matters to IEMs and will await their decision in the matter.

Section 3- Disqualification from tender process and exclusion from future contracts

If the Bidder(s) / Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s) / Contractor(s) from the tender process or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers / Contractors", framed by the Principal.

Section 4 - Compensation for Damages

- 4.1 If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent Earnest Money Deposit/ Bid Security.
- 4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit / Performance Bank Guarantee, whichever is higher.

Section 5 - Previous Transgression

- 5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- 5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.
- 

Section 6 - Equal treatment of all Bidders/ Contractors / Sub-contractors

- 6.1 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors. In case of sub-contracting, the Principal contractor shall be responsible for the adoption of IP by his sub-contractors and shall continue to remain responsible for any default by his sub-contractors.
- 6.2 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7- Criminal Charges against violating Bidders / Contractors / Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 - Independent External Monitor(s)

- 8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
- 8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.
- 8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s) / Contractor(s). The Bidder(s) / Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s) / Contractor(s) / Sub-contractor(s) with confidentiality in line with Non- disclosure agreement.
- 8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.
- 8.5 The role of IEMs is advisory, would not be legally binding and it is restricted to resolving issues raised by an intending bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.
- 8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process, the matter should be examined by the full panel of IEMs jointly as far as possible, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management. 

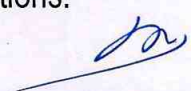
- 8.7 The IEMs would examine all complaints received by them and give their recommendations / views to CMD, BHEL, at the earliest. They may also send their report directly to the CVO and the Commission, in case of suspicion of serious irregularities requiring legal/ administrative action. IEMs will tender their advice on the complaints within 10 days as far as possible.
- 8.8 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.
- 8.9 IEM should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the organization should be looked into by the CVO of the concerned organisation.
- 8.10 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code/ Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.
- 8.11 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.
- 8.12 The word 'Monitor' would include both singular and plural.

Section 9 - Pact Duration

- 9.1 This Pact shall be operative from the date IP is signed by both the parties till the final completion of contract for successful bidder and for all other bidders 6 months after the contract has been awarded. Issues like warranty / guarantee etc. should be outside the purview of IEMs.
- 9.2 If any claim is made / lodged during currency of IP, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

- 10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.
- 10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
- 10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
- 10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.



- 10.5 Only those bidders / contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.



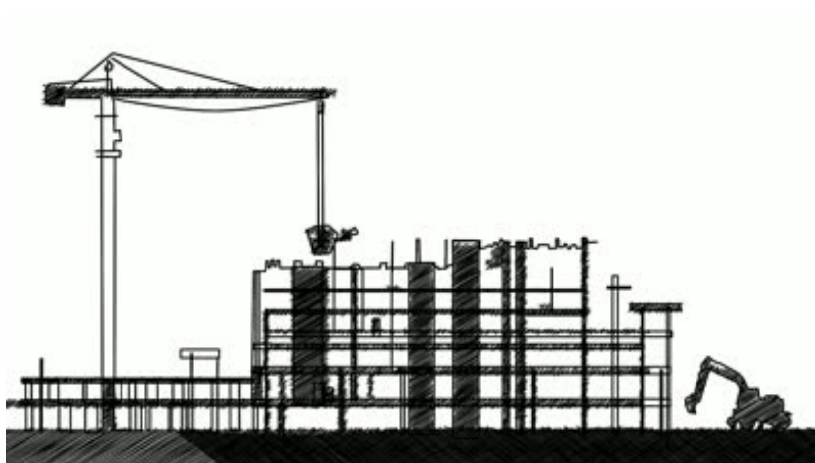
For & On behalf of the Principal
(Office Seal)
Place: Chennai
Date: June 03, 2019
एस. पि. सेतुरामन / S.P. SETHURAMAN
वरिष्ठ प्रबन्धक - उप संचिदा / Sr. Manager / Sub-Contracts
BHEL - P.S.S.R.
690, Anna Salai, Nandanam, Chennai - 600 035.

Witness: 

(Name & Address) -----
Shailendra Kumar
BHEL PSSR

For & On behalf of the Bidder / Contractor
(Office Seal)
Place: -----
Date: -----

Witness: -----
(Name & Address) -----



HEALTH, SAFETY and ENVIRONMENT PLAN

for

**SITE
OPERATIONS**

by

**SUB-
CONTRACTORS**

POWER SECTOR



HEALTH, SAFETY AND ENVIRONMENT
PLAN FOR
SITE OPERATION by SUBCONTRACTORS

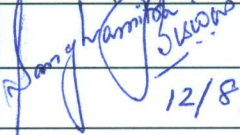
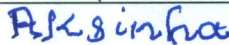
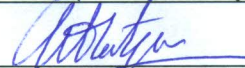
POWER SECTOR

Doc no.: HSEP: 14

REV: 00

Date: 12.08.2014

DOCUMENT ISSUE SHEET

	Prepared	Reviewed	Approved
Name	Sanghamitra B. Jayant	A.K. Sinha	Anuj Bhatnagar
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Signature			
Date	12/8/14	12/8/14	12/8/14

HSE PLAN FOR SITE OPERATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START	SIGNING OF MOU	
	Agree to comply to HSE requirement- Statutory and BHEL's	
PLAN	HSE ORGANISATION	
	Manpower 1 (one) safety officer for every 500 workers or part thereof 1(one) safety-steward/ supervisor for every 100 workers Qualification As per Cl. 7.1	HSE Roles and responsibilities - Site In-charge- As per clause 7.2.1 - Safety officer- As per clause 7.2.2
PROVIDE	HSE Planning	
	for Man , Machinery/Equipment/Tools & Tackles	
	HSE INFRASTRUCTURE	
	- PPEs - Drinking Water - Washing Facilities - Latrines and Urinals - Provision of shelter for rest - Medical facilities	- Canteen facilities - Labour Colony - Emergency Vehicle - Pest Control - Scrapyard - Illumination
TRAIN	HSE TRAINING , AWARENESS & PROMOTION	
	Training - Induction training - Height work and other critical areas - Tool Box talk & Pep Talk	Awareness & Promotion - Signage - Poster - Banner - Competition - Awards
COMMUNICATE	HSE COMMUNICATION	
	Incident Reporting - Accident- Fatal & Major - Property damage - Near Miss	Event Reporting - Celebrations - Training - Medical camp

EXECUTE SAFELY

OPERATIONAL CONTROL PROCEDURES

PERMIT TO WORK

Height work (above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, excavation(More than 4 metres)

SAFETY DURING WORK EXECUTION

- | | |
|--|---|
| <ul style="list-style-type: none"> • Welding • Rigging • Cylinder- storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works | <ul style="list-style-type: none"> • Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance |
|--|---|

HOUSE KEEPING

WASTE MANGEMENT

TRAFFIC MANAGEMENT

ENVIRONMENTAL CONTROL

EMERGENCY PREPAREDNESS AND RESPONSE PLAN

CHECKS

HSE AUDITS & INSPECTION

- | | |
|---|---|
| <ul style="list-style-type: none"> • Daily Checks • Inspection of PPEs • Inspection of T& Ps • Inspection of Cranes & Winches | <ul style="list-style-type: none"> • Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc |
|---|---|

HSE PERFORMANCE EVALUATION PARAMETERS

NON CONFORMANCE

PENALTY for NON CONFORMANCE

Refer Clause 16

Incremental penalty

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.



**HEALTH, SAFETY AND ENVIRONMENT
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1.0 PURPOSE

- 1.1 The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.
- 1.2 This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.
- 1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.
- 1.4 In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.



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HSE TARGETS

EXPLOSION	ZERO
FATALITY	ZERO
LOST TIME INJURY	ZERO
FIRE	ZERO
VEHICLE INCIDENTS	ZERO
ENVIRONMENTAL INCIDENTS	ZERO

4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY

Power Sector HSE Policy

We, at BHEL Power Sector, reaffirm our belief that the Health and Safety of our stakeholders and conservation of Environment is of utmost importance and takes precedence in all our business decisions. In pursuit of this belief and commitment, we strive to:

- ✓ Ensure total compliance with applicable legislation, regulations and other requirements concerning Occupational Health, Safety and Environment.
- ✓ Ensure continual improvement in the Occupational Health, Safety and Environment Management System performance.
- ✓ Enhance Occupational Health, Safety and Environment awareness amongst employees, customers and suppliers by proactive communication and training.
- ✓ Review periodically and improve Occupational Health, Safety and Environment Management System to ensure its continuing suitability, adequacy and effectiveness in a continuously changing business environment.
- ✓ Develop a culture of safety through active leadership and provide appropriate training at all levels to enable employees to fulfill their Health, Safety and Environmental obligations.
- ✓ Incorporate appropriate Occupational Health, Safety and Environmental criteria into business decisions for selection of plant, technology and services as well as appointment of key personnel.
- ✓ Ensure availability at all times of appropriate resources to fully implement the Occupational Health, Safety and Environmental policy of the company.

This policy will be communicated to all employees and made available to interested parties.

Sd/-

Date: 01.05.2013

Director (Power)

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5.0 MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector _____ Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s _____ do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/s _____ shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to all workers and supervisors for compliance.

In addition to this, M/S _____ shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s _____ shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

Signed by authorized representative of M/s -----

Name :

Place & Date:



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6.0 TERMS AND DEFINITIONS

6.1 DEFINITIONS

6.1.1 INCIDENT

Work- related or natural event(s) in which an injury , or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

6.1.2 NEAR MISS

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

6.1.3 MAN-HOUR WORKED

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labours. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

6.1.4 FIRST AID CASES

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

6.1.5 LOST TIME INJURY

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6.1.6 MEDICAL CASES

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

Non-Reportable Cases:

An incident, where the injured person is given medical help and discharged for work without counting any lost time.



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Reportable Cases:

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

Injury Cases:

These are covered under the heading of non-reportable cases. In these cases the incident caused injury to the person, but he still continues his duty.

6.1.8 TOTAL REPORTABLE FREQUENCY RATE

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\frac{\text{Number of Reportable LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

6.1.9 SEVERITY RATE

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI} \times 1,000,000}{\text{Total Man Hours Worked}}$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI} \times 1000}{\text{Average number of manpower deployed}}$$

7.0 HSE ORGANISATION

Number of safety officers:

The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

Deployment: The subcontractor should deploy sufficient safety officers and safety-steward/Safety-supervisor, as per requirement given above, since initial stage and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty of Rs.30,000/- per man month for the delayed period.

7.1 QUALIFICATION FOR HSE PERSONNEL

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries

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2	Safety-Steward/ Supervisor	Safety- Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years
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7.2 RESPONSIBILITIES

7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR

- Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the site management.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents(Fatal/Major/Minor/Near Miss)to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mockdrill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HQ/External /Customer HSE audits.



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- Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the work site.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site and labour colony.
- Shall ensure adequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available.

7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HQ on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Apprise PS– Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters

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8.0 PLANNING BY SUBCONTRACTOR

8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable.
- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:
 - o Mobile cranes.
 - o Side Booms.
 - o Forklifts.
 - o Grinding machine.
 - o Drilling machine.
 - o Air compressors.
 - o Welding machine.
 - o Generator sets.
 - o Dump Trucks.
 - o Excavators.
 - o Dozers
 - o Grit Blasting Equipment.
 - o Hand tools.
- Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.

8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.



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8.3 PROVISION OF PPEs

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

Relevant is-codes for personal protection

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 6994 – 1973 (Part-I)	Industrial Safety Gloves (Leather & Cotton Gloves).
IS: 1989 – 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 6519 – 1971	Code of practice for selections care and repair of Safety footwear.
IS: 11226 – 1985	Leather Safety footwear having direct molding sole.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 – 1983	Industrial Safety Belts and Harness
IS: 8519 -1977	Guide for selection of industrial Safety equipment for body protection
IS: 9473-2002, 14166-1994, 14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.



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- Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public
- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmet and any other PPEs as deemed appropriate for the area of work.

Colour scheme for Helmets:

1. Workmen: Yellow
 2. Safety staff: Green or white with green band
 3. Electrician: Red
 4. Others including visitors: White
- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced.
 - The issuing agency shall maintain register for issue and receipt of PPEs.
 - The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
 - The body harnesses shall be serial numbered.

8.4 ARRANGEMENT OF INFRASTRUCTURE

8.4.1 DRINKING WATER

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as " Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next due date.
- Potability of water should be tested as per IS10500 at least once in a year.

8.4.2 WASHING FACILITIES

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

8.4.3 LATRINES AND URINALS

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- Separate facilities shall be provided for the use of male and female worker if any.

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8.4.4 PROVISION OF SHELTER DURING REST

Proper Shed & Shelter shall be provided for rest during break

8.4.5 MEDICAL FACILITIES

8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. The medical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste –Management and Handling Rules, 1998)

8.4.5.2 FIRST AIDER

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)

- The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:13-F01
- The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)

The persons engaged at the site shall undergo health checkup as per the format no. HSEP:13-F02 before induction. The persons engaged in the following works shall undergo health checkup at least once in a year:

- a. Height workers
- b. Drivers/crane operators/riggers



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- c. Confined space workers
- d. Shot/sand blaster
- e. Welding and NDE personnel

8.4.6 PROVISION OF CANTEEN FACILITY

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

8.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY

- The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labour colony.
- Regular housekeeping of the labour colony shall be ensured.
- Proper sanitation and hygienic conditions to be maintained.
- Drinking water and electricity to be provided at the labour colony.
- Bathing/ washing bay
- Room ventilation and electrification.

8.4.8 PROVISION OF EMERGENCY VEHICLE

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle any emergency

8.4.9 PEST CONTROL

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

8.4.10 SCRAPYARD

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

8.4.11 ILLUMINATION

- The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II). Some recommended values are given below:



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S. No.	Location	Illumination (Lux)
A. Construction Area		
1.	Outdoor areas like store yards, entrance and exit roads	20
2.	Platforms	50
3.	Entrances, corridors and stairs	100
4.	General illumination of work area	150
5.	Rough work like fabrication, assembly of major items	150
6.	Medium work like assembly of small machined parts	300
	rough measurements etc.	
7.	Fine work like precision assembly, precision	700
	measurements etc.	
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
B. Office		
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

9.0 HSE TRAINING& AWARENESS

9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules.
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)



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- Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:13-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work. The agenda shall consist of the followings:
 - o Details of the job being intended for immediate execution.
 - o The relevant hazards and risks involved in executing the job and their control and mitigating measures.
 - o Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
 - o Recent non-compliances observed.
 - o Appreciation of good work done by any person.
 - o Any doubt clearing session at the end.
- Record of Tool box talk shall be maintained as per format no. HSEP:13-F04
- Tool box talk to be conducted at least once a week for the specific work.

9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:
 - o Hazards identification and risk analysis (HIRA)
 - o Work Permit System
 - o Incident investigation and reporting
 - o Fire fighting
 - o First aid
 - o Fire-warden training
 - o EMS and OHSMS
 - o T & Ps fitness and operation

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- o Electrical safety
- o Welding, NDE & Radiological safety
- o Storage, preservation & material handling.
- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC

9.5.1 Display of HSE posters and banners

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

9.5.2 Display of HSE signage

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

9.5.3 Competition on HSE and award

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

9.5.4 HSE awareness programme

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

10.0 HSE COMMUNICATION

10.1 INCIDENT REPORTING

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. (Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

10.2 HSE EVENT REPORTING

- Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.



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11.0 OPERATIONAL CONTROL

All applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCPs is given below. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCPs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Power Sector Regional HQ, or available in downloadable format in the website, which may be referred by subcontractor, if they so desire.

LIST OF OCPs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DG set	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hotwell / deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronisation		

11.1 HSE ACTIVITIES

HSE activities shall be conducted at site based on the HSEMSM developed by Power Sector and issued to site by Regions.

While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

- 1) HSE Procedure for Register of OHS Hazards and Risks
- 2) HSE Procedure for Register of Environmental Aspects and Impacts
- 3) HSE Procedure for Register of Regulations

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- 4) Operational Control Procedures
- 5) HSE Procedure for Emergency Preparedness and Response Plan
- 6) Contract documents

11.2 WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System
 - a. Height working above 2 metres
 - b. Hot working at height
 - c. Confined space
 - d. Radiography
 - e. Excavation more than 4 meter depth
 - f. Heavy lifting above 50 ton
 Refer Annexure 05 for Work permit formats.
- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

11.3.2 RIGGING

Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.

11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP

Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.

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When cylinders are transported by powered vehicle they shall be secured in a vertical position.

11.3.4 DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
- All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

11.3.5 T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL..Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

11.3.6 CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.



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- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist" and the report is to be submitted to BHEL safety officer
- Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

11.3.8 FIRE SAFETY

- Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- Emergency contacts nos must be displayed at prominent locations
- Tarpaulin being inflammable should not be used (instead, only non infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.

11.3.9 SCAFFOLDING

- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders.
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than $\frac{1}{4}$ horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the out side and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from savor, from swaying, from the building or structure.

11.3.10 WORK AT HEIGHT:

- Guardrails and toe-board/barricades and sound platform conforming to IS:4912-1978 should be provided.



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- Wherever necessary, life-line(pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should be provided.
- Safety Net as per IS:11057:1984 should be used extensively for prevention/ arrest of men and materials falling from height. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
- Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.
- Monkey Ladder should be properly made and fitted with cages.
- Jhoola should be made with angles and flats and tested like any lifting tools before use.
- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.
- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- Empty drums must not be used.
- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure alongwith separate fall arrestor. Rope ladder should be discouraged.

11.3.11 WORKING PLATFORM

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least ¼" for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

11.3.14 LIFTING SAFETY

- It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.



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- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractor by engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

11.3.15 HOISTING APPLIANCE

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

11.4 ENVIRONMENTAL CONTROL

Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.

Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).

In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique

All subcontractors shall be responsible for the cleanliness of their own areas.

The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable & practicable precautions can be taken to protect other persons who may be affected.

It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.

The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

11.5 HOUSEKEEPING

- Keeping the work area clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings has to be done by



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subcontractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. Sufficient waste bins shall be provided at
- Different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

11.6 WASTE MANAGEMENT

Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.

11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.

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11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

11.7 TRAFFIC MANAGEMENT SYSTEM

11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.
- Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- Speed limits shall be clearly displayed. Speed ramps preceded by a warning signs or marker are necessary.
- The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse



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- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

11.7.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- o A high level of stability.
- o A safe means of access/egress.
- o Suitable and effective service and parking brakes.
- o Windscreens with wipers and external mirrors giving optimum all round visibility.
- o Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- o Provision of seat belts.
- o Guards on dangerous parts.
- o Driver protection - to prevent injury from overturning and from falling objects/materials.
- o Driver protection from adverse weather.
- o No vehicle shall be parked below HT/LT power lines.
- o Valid Pollution Under Control certification for all vehicles

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11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
 - Brakes.
 - Tires.
 - Steering.
 - Mirrors.
 - Windscreen waters.
 - Wipers.
 - Warning signals.
 - Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

11.7.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
 - Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
 - All overhangs shall be made clearly visible and restricted to acceptable limits
 - Load shall be checked before moving off and after traveling a suitable distance.
 - On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.
 - Warning signs shall be displayed during transportation of material.
- All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

11.7.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

11.8 EMERGENCY PREPAREDNESS AND RESPONSE

- Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HQ
- Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- Assembly point shall be earmarked and access to the same from different location shall be shown
- Fire exit shall be identified and pathway shall be clear for emergency escape.



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- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- First aid center shall be developed at site with trained medical personnel and ambulance
- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- Tie up with fire brigade shall be done in case customer is not having fire station.
- Tie up with hospital shall be done in case customer is not having hospital.
- Disaster Management group shall be formed at site
- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats
- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test etc as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- Personal Safety wears & gear compliance.
- Complying with site safety rules and permit-to-work (PTW).
- Positions and postures of workers.
- Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:13-F06 for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.

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12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:13-F07 for its healthiness and maintenance.
- The T&Ps which require third party inspection shall be checked for its validity during inspection. The third party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:13-F08

12.4 INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:13-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the I-card.
- The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
 - o Fall arrestor
 - o Lifelines
 - o Safety nets
 - o Fencing and barricading
 - o Warning signage
 - o Covering of opening
 - o Proper scaffolding with access and egress.
 - o Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.



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- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

12.8 INSPECTION OF ELEVATOR

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.

13.0 HSE PERFORMANCE

HSE performance of the subcontractor shall be monitored as per the following parameters:

Sl. No.	Parameters of measurement
1	Timely deployment of qualified safety officer and cumulative number of days in a month the required no. of qualified safety officer is available
2	Shortfall in number of meetings in the month conducted or attended by the safety officer
3	Level of compliance wrt decisions taken in previous meetings/audit/inspection/as reported.
4	Delay in submission of monthly report on safety in the prescribed format
5	Delay in reporting any incident including near-miss to BHEL /Customer/statutory authority(if required)
6	Degree of PPE non-compliance
7	Non- conducting of health check-up as per BOCW equirements
8	Non availability of proper first-aid facility , ambulance, adequate labour welfare initiatives
9	Non conductance of induction training and tool box meeting
10	Total number of instances in the month, House keeping NOT attended inspite of instructions by BHEL i.e. removal/disposal of surplus earth/ debris/scrap/unused/surplus cable drums/other electrical items/surplus steel items/packing material

- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen.
- To decide HSE reward performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job.

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14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non- compliance on HSE requirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.
- If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHEL shall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.



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- BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

16. NON COMPLIANCE

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01.	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03.	Not wearing safety shoe	200/-*
04.	Not keeping gas cylinders vertically	200/-
05.	Not using flash back arrestors	100/-
06.	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18.	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

- Legend:-

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.



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17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- HSE checklist(**Annexure 02**) shall be used for carrying out audit/inspection and report shall be submitted to BHEL sitemanagement
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed off by site in a time bound manner and reported back the implementation status
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HQs shall be implemented by site and reported to Site management.

18.0 MONTHLY HSE REVIEW MEETING

- Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE performance. It will also discuss the incidents occurred since previous meeting, its root cause and Corrective action and Preventive action. The agenda is given below:
 - o Implementation of earlier MOM
 - o HSE performance
 - o HSE inspection
 - o HSE audit and CAPA
 - o HSE training
 - o Health check-up camp
 - o HSE planning for the erection and commissioning and installation activities in the coming month
 - o HSE reward and promotional activities
- The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS, Site Incharge of Subcontractors and HSE officer of Subcontractors.
- MOM on the discussion will be circulated to the concerned for implementation.

19.0 FORMATS USED (Details available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:13-F01	00
02	Health Check Up	HSEP:13-F02	00
03	HSE Induction Training	HSEP:13-F03	00
04	Tool Box Talk	HSEP:13-F04	00
05	Monthly Site HSE Report	HSEP:13-F05	00
06	Inspection of PPE	HSEP:13-F06	00



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07	Inspection of T&Ps	HSEP:13-F07	00
08	Status of T&Ps	HSEP:13-F08	00
09	Inspection of Cranes and Winches	HSEP:13-F09	00
10	Inspection on Height Working	HSEP:13-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:13-F11	00
12	Inspection on Electrical Installation	HSEP:13-F12	00
13	Inspection on Elevator	HSEP:13-F13	00
14	HSE Penalty	HSEP:13-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:13-F15	00



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20.0 ANNEXURES

ANNEXURE 01

As per Contract Labour (Regulation & Abolition Act), Central Rules, 1971,

- (1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

(a) For establishments in which the number of contract labour employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labour exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.



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(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

(2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.



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ANNEXURE 02

HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT

PROJECT: _____

SUBCONTRACTOR: _____

DATE : _____

OWNER : _____

INSPECTION BY: _____

Note : write 'NA' wherever the items is not applicable

Item	Y e s	N o	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNEL PROTECTIVE EQUIPMENTS				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landing				
Properly secured				



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Angle + 70° from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
Others				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				



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Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				
Provision of crèches for children.				



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ANNEXURE 03

REFERENCES

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
(1)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	IS:2925 – 1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	IS:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) – 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	IS:3696 (Part I) – 1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002)	Scaffolds and Ladders-Code of Safety
(9)	IS:3786 – 1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	IS:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves – Electricals purposes-Specification
(11)	IS:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	IS: 5983 – 1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	IS:6519 – 1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	IS:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Part I)-1973 (Re affirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	IS:8519 – 1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 : 2011	Flash Back(Flame Arrestor) Specification



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(18)	IS:8520 – 1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	IS:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	IS:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	IS:11057 – 1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	IS:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 2003)	Safe Use of Cranes-Code of Practice
(24)	IS:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	IS:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored Pressure)-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing



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**ANNEXURE 04 : SAFETY FORMATS
&
ANNEXURE 05 : WORK PERMIT FORMATS**

**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:13-F01

REV NO.: 00

PAGE NO. 01 OF 02

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Number of employees on the site:- _____

Sl.No.	Item	No. Available	Remarks
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

**POWER SECTOR****INSPECTION OF FIRST AID BOX**

FORMAT NO: HSEP:13-F01

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Sl.No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmX1 meter) available		
19	No of rolls of adhesive plaster (2 cmX1 meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti septic solution available		

Signature of Subcontractor's Site I/C::

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:13-F02

REV NO.: 00

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Name of Site :	
Name of Sub-Contractor :	
Name of Employee :	

NAME:

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness

Personal History

EXAMINATION	OBSERVATION
<u>General Physical Examination</u>	
Height :	
Weight :	
BMI :	
Built And nourishment :	
Pallor :	
Temperature :	
Chest Expansion :	Inspiration Expansion
Lymph Node Enlargement :	
<u>Ear, Nose, Throat</u> :	
Ear :	
Nose :	
Throat :	

**POWER SECTOR****HEALTH CHECK UP**

FORMAT NO: HSEP:13-F02

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EXAMINATION	OBSERVATION
<u>Cardiovascular System Examination :</u>	
Inspection :	
Palpation :	Pulse BP
Auscultation (Heart Sounds) :	
<u>Respiratory System :</u>	
Inspection :	Respiratory Rate
Palpation:	
Percussion :	
Auscultation (Breath Sounds) :	
<u>Examination of Abdomen :</u>	
Inspection :	
Palpation :	
Auscultation (Bowel Sounds) :	
Any Other :	
Clinical Impression	

Signature of the examining doctor

**POWER SECTOR****HSE INDUCTION TRAINING**

FORMAT NO: HSEP:13-F03

REV NO.: 00

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Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training Co-ordinator	

Sl No.	Name	Designation	Organisation	Signature

Signature of Training co-ordinator :

**POWER SECTOR****TOOL-BOX TALK**

FORMAT NO: HSEP:13-F04

REV NO.: 00

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Name of Site :	
Sub-Contractors Name :	
Date :	

Topic	Name of person delivered Tool Box Talk	No. of Participants attended	Remarks

Signature of Site I/C of Subcontractor :

**POWER SECTOR****PERSONAL PROTECTIVE EQUIPMENTS**

FORMAT NO: HSEP:13-F06

REV NO.: 00

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Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Item	Issued this Month	Nos. Issued up to the Month	Percentage of usage at site
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor :

**POWER SECTOR****INSPECTION OF T&Ps**

FORMAT NO: HSEP:13-F07

REV NO.: 00

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Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

Sl.No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs / overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Site Safety Officer (BHEL)

Signature-Subcontractor/ Subcontractor's
Safety Officer

**POWER SECTOR****STATUS OF T&Ps**

FORMAT NO: HSEP:13-F08

REV NO.: 00

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Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	Nos. Deployed	Identification No.	Nos. Tested by competent person	Validity of Test Certificate
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:13-F09

REV NO.: 00

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Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Crane Reg. No (Make/Model)

Name of Driver/Operator

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers fully extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		



POWER SECTOR

INSPECTION OF CRANES AND WINCHES

FORMAT NO: HSEP:13-F09

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Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone other than the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured that the guard does not constitute a hazard by itself?				
8	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

**POWER SECTOR****INSPECTION OF CRANES AND WINCHES**

FORMAT NO: HSEP:13-F09

REV NO.: 00

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Sl. No.	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:13-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained to the workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	ACCESS/EGRESS		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding or falling?		
6	Do side rails extend 36" above top landing?		
7	Are built up ladders constructed of sound materials?		

**POWER SECTOR****INSPECTION OF HEIGHT WORKING**

FORMAT NO: HSEP:13-F10

REV NO.: 00

PAGE NO. 02 OF 02

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
8	Are rugs and cleats not over 12" on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	Housekeeping		
1	Walkways, aisles & all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	PPE And Safety Devices		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF WELDING AND GAS
CUTTING**

FORMAT NO: HSEP:13-F11

REV NO.: 00

PAGE NO. 01 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
Sl.no.	Description	Y e s	N o	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly & insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Is the physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Is the electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

**POWER SECTOR****INSPECTION OF WELDING AND GAS
CUTTING**FORMAT NO: HSEP:13-F11
REV NO.: 00
PAGE NO. 02 OF 02

Gas Cutting				
Sl. no	Description	Yes	No	Remarks
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for O2 and LPG cylinder?			
8	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	% Compliance			

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:13-F12 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF ELECTRICAL INSTALLATION	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	Contents	Yes/No	Remarks
A	Cable		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	DBs/SDBs		
1.	Is earth conductor continued upto DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
C	ELCB		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

**POWER SECTOR****INSPECTION OF ELECTRICAL INSTALLATION**

FORMAT NO: HSEP:13-F12

REV NO.: 00

PAGE NO. 02 OF 02

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
D	Grounding		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	Electrically operated Machines or Accessories.		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of Site I/C of subcontractor :

**POWER SECTOR****INSPECTION OF ELEVATOR**

FORMAT NO: HSEP:13-F13

REV NO.: 00

PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Sr. No.	Description	Remarks
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs/overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Subcontractor/ Subcontractor's
Safety Officer

Signature-Site Safety Officer (BHEL)

**POWER SECTOR****HSE PENALTY**

FORMAT NO: HSEP:13-F14

REV NO.: 00

PAGE NO. 01 OF 02

Sub: MEMO for Penalty for non compliances in Safety

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

Safety Area

SN	Violation of Safety Norms	Fine (in Rs)
01.	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03.	Not wearing safety shoe	200/-*
04.	Not keeping gas cylinders vertically	200/-
05.	Not using flash back arrestors	100/-
06.	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slings properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18.	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

Legend:-

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

1 Copy to Site Construction Manager(BHEL)

	POWER SECTOR- HQ	FORMAT NO: HSEP:13-F15 REV NO.: 00 PAGE NO. 01 OF 01
	Incident Report (To be submitted within 24 hours of time of incident)	

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	NAME OF SITE		3	ACTIVITY AREA	
2	SCOPE OF WORK		4	NAME OF CONTRACTOR	
			5	NAME & DESIGNATION OF BHEL ACTIVITY I/C	
6	DATE & TIME OF ACCIDENT		7	DATE RESUMED	
8	NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)				
9	NO. OF MANHOURS LOST BY OTHERS				
10	PERSONAL DETAILS OF INJURED AND / OR DETAILS OF MATERIALS / EQUIPMENT / PROPERTY DAMAGED				
NAME			NAME OF MATERIAL / EQUIPMENT / PROPERTY		
PERIOD OF EMPLOYMENT					
AGE	YRS	SEX	MALE/ FEMALE	ESTIMATED COST	ACTUAL COST
MARITAL STATUS		SINGLE / MARRIED			
OCCUPATION		NATURE OF DAMAGE			
PART OF BODY INJURED					
NATURE OF INJURY					
AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE					
12	PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) CAUSING ACCIDENT INJURY / DAMAGE				
13	DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED)				
ANALYSIS					
14	WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT				
15	WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND / OR CONDITION ?				
16	WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE ?				
	DATE :		SIGNATURE OF SITE HSE COORDINATOR		
17	COMMENTS OF HEAD / SOX				
	DATE:		SIGNATURE OF HEAD/SOX		



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

BURNING/WELDING /HOT WORK PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____

Name of Work Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site

Second Copy – BHEL SAFETY

Third Copy : Contractor



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

LIFTING ACTIVITY PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____

Name of Work Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Unwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorised/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked and in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site**Second Copy – BHEL SAFETY****Third Copy : Contractor**



SAFETY WORK CLEARANCE

Permit no. _____

Project: _____

Emergency Contact Nos: _____

Subcontractor: _____

WORKING AT HEIGHT PERMIT

Area : _____ Date: _____ Time: _____

Name of Site Engineer (Permit Requesting Authority): _____ Sign: _____

Name of Work Performing Contractor: _____

Name of Package In charge: _____ Sign: _____ Date: _____

Description of Work: _____

Work Execution Date: _____ Time Valid from: _____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer: _____ Sign: _____ Date: _____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name: _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Safety Representative: _____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority: _____ **Sign:** _____ **Date:** _____ **Time:** _____**Permit Cancellation:**

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority: _____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): _____ Sign: _____ Date: _____ Time: _____

Name of BHEL Site Engr. (Permit Issuing Authority): _____ Sign: _____ Date: _____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site**Second Copy – BHEL SAFETY****Third Copy : Contractor**



BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR(FINANCE)- HEAD QUARTERS
ASIAD, NEW DELHI

From : Kalyan Coari
AGM-Finance

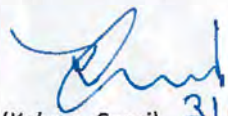
For : As Per Distribution List

No. PW:FM:FAX:T&P Hire :2019-21
Dated : 31st May, 2019

Subject : Revision of Hire Charges on Issue of Capital Tools & Plants

The rates of hire charges for capital Tools and Plants and Operator's charges circulated vide letter No. PWR:FM:T&P Hire 2017-19 dated 01st June,2017 were valid upto 31.5.2019. The Revised Rates effective from 01.06.2019 are enclosed as detailed below :

- (i) Annexure C1 & T1 : Rates of hire charges applicable to contractors working for BHEL
- (ii) Annexure C2 & T2 : Rates of hire charges applicable to outside agencies other than Contractors working for BHEL.
2. The Crane Operator's charges will be as follows :
 - A. **If BHEL operator is utilised Rs. 7200/- (Rupees Seven thousand two hundred only) per day of 8 hours.** For services less than 4 hours, half of per day rate will be charged. For services for 4 hours or more but up to 8 hours, full day rate will be charged. Overtime Allowance (OTA) will be charged at double the rate on hourly basis.
 - B. **If vendor sourced operator is provided, the rates shall be the actual cost to BHEL with 30% overheads.**
3. The hire charges of Capital Tools & Plants are exclusive of operating expenses e.g. fuel & consumables. **All Operating expenses are chargeable to User's account.**
4. All other terms and conditions / aspects governing the issue of T&P on Hire "will remain the same as already circulated vide our letter of even number dated 22.1.1992 (copy enclosed).
5. **The revised rates will be effective from 01.06.2019 and will remain valid upto 31.5.2021.** This will be subject to revision thereafter.
6. For any additional item, the rates of hire charges will be worked out jointly by PS-MSX & Finance (PS-Hqrs) on specific request. All necessary details will be provided by the concerned Region.


(Kalyan Coari) 31/05/19
AGM (Fin)

Encl : As above



REF: PWR:FAX:HIRE CHARGES
DT : 22.1.92.

SUBJECT : ISSUE OF TOOLS AND PLANTS
TO SUB-CONTRACTORS AND RECOVERY
OF HIRE CHARGES THEREOF - - - -

The rates of hire charges for capital tools and plants last circulated vide Sr. Manager/Finance's letter reference PWA:SMQ:FAX:24.02 dated 20.5.88 have been revised. The revised rates have been worked out based upon the recommendations of the study team set up vide office order No. PW:SMQ:FAX:11.36 Dt. 1.10.88. The study team's/committee's recommendations relating to issue of T&P to sub contractors A e enclose rates of hire charges have been worked out and are enclosed as follows :-

- i) Annexures 1.1, 1.2, 1.3, & 1.4
Rates for hire charges as applicable to contractors working for BHEL.
- ii) Annexures 2.1 & 2.2
Rates of hire charges as applicable to outside agencies other than contractors working for BHEL.
- iii) Annexure - III
Crane operators charges.

The important conditions/aspects governing the issue of T&P on hire are as follows :-

- i) The tender documents shall specify :-
 - a) List of T&P to be provided by BHEL free of hire charges
 - b) List of T&P which may be given on hire, if available at site and the rate of hire charges recoverable for the same. For items and rates specified in the N.I.T. these charges shall not change during the currency of that contract. For items/rates not specified in N.I.T. the current rates shall be charged.
- ii) The rates given in Annexure 1.1, 1.2, & 2.1 are on hourly basis. The unit of recovery is an hour and for fraction of an hour, the chargeable unit will be an hour only. The rates given in Annexure 1.3, 1.4 & 2.2 are on day basis (day means a calendar day) and fraction of a day will be charged as full day purpose of recovery of hire charges.

...2/-



- iii) Operator's charges are on per day basis considering average 8 working hours. For services of less than 4 hours, half the rates will be charged. For services of 4 hours upto 8 hours, full daily rates will be charged. Overtime will be charged at double the rates on hourly basis.
- iv) The hire charges are recoverable on the basis of out time and in time i.e. from the time a particular item is issued to the contractor from BHEL's store till the time it is returned. However, the hourly rate is applicable for T&P which cannot be frequently returned due to intermittent use, logging shall be done for actual use and charged accordingly. In case of cranes, marching time for onward and return shall be charged at 50% of the hire charges rates.
-
- v) The rates do not include transportation charges from and to BHEL's store. Safe transportation of T&P from and to BHEL's store shall be the contractors responsibility.
- vi) Small T&P items i.e. items costing less than Rs. 10,000/- each shall not be issued to contractors on hire charges. Such items may however be issued to contractors on non-returnable basis at replacement cost plus 30% overheads reduced by depreciation as applicable or a certain reserve price whichever is higher.
- vii) If a contractor commits certain T&P at the time of award of contract/L.O.I. and fails to actually deploy the same in time at site, then even for contractors working for BHEL, higher rates of hire charges as given in Annex 2.1 & 2.2 shall be applicable for such items.

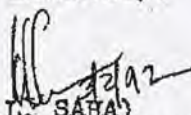
The revised rates of hire charges and operator's charges as enclosed, together with terms stated above and other aspects/conditions relating to issue of T&P to sub contractors as given in Appendix I shall be effective from 1.2.1992 till 31.10.93 and will be subject to revision thereafter.

...3/-



For any additional item not appearing in the enclosed list, rates of hire charges may be calculated by TS HQ in consultation with PS-HQ (Finance) on receipt of necessary details from regions and communicated to the regions.

This issues ^{with} the approval of competent authority.


(R.L. SAHA)
GENERAL MANAGER (F)
PS-HQ


Encl : As above.

DISTRIBUTION :

ED, PS-NR, New Delhi

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Advisor (Finance) Corporate Office, N.Delhi.

S.A. to Director (Power).

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	20100.00	19980.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	11320.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	55940.00
4	PORTAL CRANE, 360T	15	14070.00	13980.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	55110.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	68180.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	33300.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	20810.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	29970.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	31470.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	26220.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	36110.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	15030.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18850.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	16650.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	21640.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10820.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	13320.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10780.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10650.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8820.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9990.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9990.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5390.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	6110.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5340.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4390.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	3010.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2260.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2260.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	710.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	380.00
30	ELECTRIC GANTRY CRANE 3T	5	430.00	430.00
31	ELECTRIC GANTRY CRANE 5T	5	540.00	540.00
32	ELECTRIC GANTRY CRANE 30T	5	3640.00	3620.00
33	FORK LIFT 5T	5	650.00	650.00
34	FORK LIFT 3T	5	540.00	540.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	22340.00	22200.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12570.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	62160.00
4	PORTAL CRANE, 360T	15	15630.00	15540.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	61240.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	75760.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	37000.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	23120.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	33300.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	34960.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	29130.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	40120.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	16700.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20950.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	18500.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	24050.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	12020.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14800.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11970.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11840.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9800.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	11100.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	11100.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5980.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6790.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5940.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4880.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3350.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2510.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2510.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	790.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	430.00
30	ELECTRIC GANTRY CRANE 3T	5	480.00	480.00
31	ELECTRIC GANTRY CRANE 5T	5	600.00	600.00
32	ELECTRIC GANTRY CRANE 30T	5	4040.00	4030.00
33	FORK LIFT 5T	5	720.00	720.00
34	FORK LIFT 3T	5	600.00	600.00

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELCTRIC WINCH 5T	1270
6	ELCTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m ³ /Hr)	1160
22	Air Blower (Flow: 20000 m ³ /Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGNOSTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. : FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. : FLOW 15 M3/HR	430
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELECTRIC WINCH 5T	1410
6	ELECTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTRATION EQUIPMENT 6000LPH	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTRATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTRATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1510
6	OIL FILTRATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	2020
7	OIL FILTRATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m ³ /Hr)	1290
22	Air Blower (Flow: 20000 m ³ /Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGNOSTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast -	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH	510

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400

GUIDELINES FOR WELDING

IMPORTANT NOTE

THIS GUIDELINES FOR WELDING PROVIDES BROAD BASED GUIDELINES FOR CARRYING OUT WELDING WORK AT SITES. HOWEVER, SITES SHALL ENSURE ADHERENCE TO THE PRIMARY DOCUMENTS LIKE CONTRACT DRAWINGS, FIELD WELDING SCHEDULES, WELDING PROCEDURE SPECIFICATIONS, PLANT / CORPORATE STANDARDS, STATUTORY DOCUMENTS, CONTRACTUAL OBLIGATIONS, AS APPLICABLE AND SPECIAL INSTRUCTIONS, IF ANY, ISSUED BY RESPECTIVE MANUFACTURING UNITS SPECIFIC TO THE PROJECTS.

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4	A4	PROCEUDER FOR WELDER QUALIFICATION
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8	B2	ERECTION WELDING PRACTISES FOR SA 213 T91/T92 MATERIALS
9	B3	ERECTION WELDING PRACTISES FOR SA 213 T23 MATERIALS

CHAPTER-A1

WELDING - GENERAL

A1: WELDING-GENERAL

1.0 SCOPE:

- 1.1 This manual deals with activities and information related to welding at site. Where specific documents are supplied by the Manufacturing Units (MUs)/Engineering Centers (ECs), the same shall be adopted.

2.0 DOCUMENTS REFERRED:

- 2.1 The following documents are referred in preparation of this manual.
1. AWS D1.1
 2. AWS D1.6
 3. ASME sections I, II (A&C), V & IX
 4. ASME B31.1
 5. IBR
 6. BHEL Manufacturing Units/Engineering Centers Standards & practices

3.0 PROCEDURE:

- 3.1 The following documents shall be referred as primary documents
1. Contract drawings
 2. Field Welding Schedule or equivalent
 3. Plant / Corporate standards, wherever applicable
 4. Statutory documents
 5. Welding Procedure Specifications
 6. Contractual obligations, if any.

4.0 WELDER QUALIFICATION:

- 4.1 Ensure, personnel qualified as per statutory requirements are engaged, where required.
- 4.2 For welding not under the purview of statutory requirements, qualification of welders shall be as in this manual.
- 4.3 Monitor performance of qualified butt welders as in this manual.
- 4.4 Ensure selection, procurement, storage, drying & issue of welding consumables, as detailed in this manual.
- 4.5 List of approved vendors of general purpose welding electrodes as provided by BHEL-Tiruchy Unit shall be used for selection of brands at sites. Alternatively specific contractual requirements, if any may be followed.
- 4.6 Where Tiruchy list does not cover site requirements, such specific cases may be referred to concerned unit and Head (Quality) of the region.
- 4.7 Welding in-charge shall assign a unique identification for all the butt welds coming under the purview of statutory regulations. Such identification may be traceable through documents like drawings, sketches etc.
- 4.8 A welding "job card" incorporating the welding parameters and heat treatment requirements is recommended to be issued for all critical welds like pressure part welds, piping welds and

ceiling girder welds. The formats of the job card are enclosed for illustration in Annexure I, II, III and IV.

5.0 SELECTION OF ARGON GAS FOR GTAW:

5.1 USE OF ARGON GAS AT SITES:

In the welding process, Argon is used for **SHIELDING** and **PURGING (BACKING)** purpose. The welding process when exposed to air, most metals exhibit a strong tendency to combine with Oxygen, and to lesser extent with Nitrogen, especially when in the molten condition. The rate of oxide formation will vary with different metals, but even a thin film of oxide on the surface of metals to be welded can lead to difficulties. For the most part, the oxides are relatively weak, brittle materials that in no way resemble the metal from which they are formed. A layer of oxide can easily prevent the joining of two pieces by welding. Argon is a shielding gas used in Gas Tungsten Arc Welding (GTAW). It is also used for purging (backing) during the root welding of Gr.91/Gr.92/Stainless steel materials. Argon protects welds against oxidation as well as reduces fume emissions during welding. The compressed argon is supplied in cylinders. The cylinder used for argon will have the body colour of BLUE without band, size of 25 cm dia. & 1.5 m length, capacity of 6.2 m³ and pressure of 137 Kg/Cm² when fully charged at 15°C (approximately).

5.2 PURITY LEVEL OF ARGON

As per IS 5760: 1998 there are 3 grades of argon, namely:

- **Grade 1:** Ultra high purity argon for use in electronics and allied industries and indirect reading vacuum spectrograph.
- **Grade 2:** High purity argon for use in lamp and allied industries.
- **Grade 3:** Commercial grade argon for use in welding industry and for other metallurgical operations.

Accordingly the argon shall comply with the requirements given below:

Sl. No.	CHARACTERISTIC	REQUIREMENT		
		Grade 1	Grade 2	Grade 3
i.	Oxygen, ppm, Max.	0.5	5.0	10.0
ii.	Nitrogen, ppm, Max.	2.0	10.0	300
iii.	Hydrogen, ppm, Max.	1.0	2.0	5.0
iv.	Water vapors, ppm. Max.	0.5	4.0	7.0
v.	Carbon dioxide, ppm, Max.	0.5	0.5	3.0
vi.	Carbon monoxide, ppm, Max.	0.5	0.5	2.0
vii.	Hydrocarbons, ppm, Max.	0.2	0.5	-

5.3 PURCHASE SPECIFICATION FOR ARGON:

Argon gas as per Grade 2 of IS-5760: 1998 with Argon purity level of min. 99.99%. The supply should accompany Test Certificate for the batch indicating compliance to the above requirements.

5.4 HEAT TREATMENT:

- 5.4.1 Preheat, inter pass, post heat and Post Weld Heat Treatment (PWHT) requirements shall be as per applicable documents; where these are not supplied, reference may be made to Welding / Heat Treatment Manual.
- 5.4.2 Prior to PWHT operation, a "job card" containing material specification, weld reference, size, rate of heating, soaking temperature, soaking time and rate of cooling shall be prepared referring to applicable documents, and issued.
- 5.4.3 The PWHT chart shall contain the chart number, Weld Joint No., Temperature recorder details (like Sl. No. make, range, chart speed), date of PWHT, start and end time of operation.
- 5.4.4 The chart shall be evaluated and results recorded on the PWHT job card. Refer Heat Treatment Manual (Document No. AA/CQ/GL/011/ Part II-HTM- Latest) for details.

6.0 EQUIPMENT & INSTRUMENTS:

- 6.1 Equipment/accessories used shall be assessed for fitness prior to use.
- 6.2 Use calibrated thermocouples, temperature measuring instruments and recorders.
- 6.3 Preheating shall be checked and ensured using temperature indicating crayons.

7.0 INSPECTION:

- 7.1 Inspection of welding shall be done as per Chapter A5 of this manual and records maintained as appropriate.
- 7.2 Weld log containing the following information shall be prepared for all completed systems.
 - Project / Unit reference
 - Drawing No.
 - Weld Joint No.
 - FWS/ Equivalent
 - Material specification
 - Consumable used
 - Welder code
 - Date of welding
 - NDE report No. and results (including repair details)
 - PWHT Chart No. and results
 - Remarks, if any.

8.0 SAFETY:

8.1 Safe access to weld area shall be provided.

8.2 Adequate protection shall be provided against wind and rain water entry during welding.

9.0 RECORDS:

9.1 All records, as required, shall be maintained by welding in-charge and handed over to the appropriate authority at the end of the project closure.

Annexure – I: Welding Job Card

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Welding Job Card

Project :
Unit No. : Area: Boiler/TG/PCP:
Job Card No. : Date :
FWS Number :
Joint No. :
Drawing No. :
System Description :
Size (Dia. x thick) :
Material Specification :
Consumable used :
Welder No.(s) :
Date of welding :
Filler wire Specification :
Electrode Specification :
Preheat temperature :
Inter pass temperature :
Post Heat temperature :
PWHT temperature :

Welding engineer

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Filler wire/Electrode consumption

SMAW ϕ 2.5 mm :
 ϕ 3.15 mm :
 ϕ 4.0 mm :
Date of LPI for RG Plug :
Remarks :

Date of Return :

Annexure – II: Welding Job Card for P91/P92 Welds

<u>JOB CARD</u> <u>(WELDING, HEAT TREATMENT & ND EXAMINATION)</u> <u>FOR P91/P92 WELDS</u>											
Card No.:						Date:					
Project:				Unit No.				Contractor:			
System:						Drawing No.					
PGMA:						DU No.:		Joint No.:			
Material Specification:				+		OD (mm):				Thick(mm)	
Filler metal:		GTAW				SMAW					
Joint fit-up:		Min. WT:				Root gap:				Root mismatch:	
										Log sheet filled:	
										Y / N	
No. of T/Cs:				Location:				Distance from EP edge:			
										mm	
Welders' ID:						M/c No.:					
Preheat Temp.:		°C Minimum				Rate of heating:		°C per hour			
Purging flow rate:				Litres / min.		Purging time:				Minutes	
Shielding flow rate:				Litres / min. for GTAW		Distance bet. dams:				Metres	
Interpass Temp.:		° C Maximum				Rate of cooling:		°C per hour			
Holding Temp. before PWHT:		° C for min. 1 hour									
PWHT:		° C				Rate of heating / cooling:		°C per hour			
Soaking time				Minutes (2.5 minutes per mm)		Cooling to:		300° C			
Preheating started at				Hrs. on		Preheating completed at				Hrs.	
Root welding started at				Hrs.		Root welding completed at				Hrs.	
Welding started at				Hrs.		Welding completed at				Hrs.	
Interpass temp. maintained between						°C and		°C			
Holding temp. reached at				Hrs.		Holding completed at				Hrs.	
No. of T/Cs:				Location							
PWHT started at				Hrs. on		Soaking started at				Hrs.	
Soaking completed at				Hrs.		300°C reached at				Hrs.	
UT Equipment used:						Calibration validity:					
UT carried out on						Result : OK / Not OK					
MPI Equipment used:						Calibration validity:					
MPI carried out on						Result: OK / Not OK					
Hardness test Equipment used:						Calibration validity:					
Hardness test carried out on						Value:					
History of interruption if any, with time:											
<u>Contractor</u>				<u>BHEL</u>				<u>Customer</u>			

Annexure – III: Welding Job Card for T91/T92 Welds

<u>JOB CARD</u> <u>(WELDING, HEAT TREATMENT & ND EXAMINATION)</u> <u>FOR T91/T92 WELDS</u>											
Card No.:						Date:					
Project				Unit No.				Contractor:			
System:						Drawing No.					
PGMA:						DU No.:		Joint No.:			
Material Specification:				+		OD (mm):				Thick(mm)	
Filler metal:		GTAW				SMAW					
Joint fit-up:		Min. t:				Root gap:				Log sheet filled: Y / N	
No. of T/Cs:		Location				Distance from EP edge:				mm	
Welders' ID:						M/c No.:					
Preheat Temp.:		°C Minimum				Rate of heating:		°C per hour			
Purging flow rate:				Litres / min.		Purging time:				Minutes	
Shielding flow rate:				Litres / min. for GTAW		Distance bet. dams:				Metres	
Interpass Temp.:		° C Maximum				Rate of cooling:		°C per hour			
PWHT:		° C				Rate of heating / cooling:		°C per hour			
Soaking time				Minutes (2.5 minutes per mm)				Cooling to:		300° C	
Preheating started at				Hrs. on				Preheating completed at			
Root welding started at				Hrs.				Root welding completed at			
Welding started at				Hrs.				Welding completed at			
Hrs.											
Interpass temp. maintained between						°C and		°C			
Holding temp. reached at						Hrs.		Holding completed at			
Hrs.								Hrs.			
No. of T/Cs:		Location									
PWHT started at						Hrs. on				Soaking started at	
Hrs.										Hrs.	
Soaking completed at						Hrs.				300°C reached at	
Hrs.										Hrs.	
RT carried out on						Result : OK / Not OK					
Hardness test Equipment used						Calibration validity:					
Hardness test carried out on						Value:					
History of interruption if any, with time:											
<u>Contractor</u>				<u>BHEL</u>				<u>Customer</u>			

Annexure – IV: Welding Job Card for T23 Welds

<u>JOB CARD</u> <u>(WELDING, HEAT TREATMENT & ND EXAMINATION)</u> <u>FOR T23 WELDS</u>											
Card No.:						Date:					
Project:				Unit No.				Contractor:			
System:						Drawing No.					
PGMA:						DU No.:		Joint No.:			
Material Specification:				+		OD (mm):				Thick(mm)	
Filler metal:		GTAW				SMAW					
Joint fit-up:		Min. t:				Root gap:				Root mismatch:	
										Log sheet filled:	
Y / N											
No. of T/Cs:				Location:				Distance from EP edge:			
mm											
Welders' ID:						M/c No.:					
Preheat Temp.:		°C Minimum				Rate of heating:		°C per hour			
Purging flow rate:				Litres / min.		Purging time:				Minutes	
Shielding flow rate:				Litres / min. for GTAW		Distance bet. dams:				Metres	
Interpass Temp.:		° C Maximum				Rate of cooling:		°C per hour			
Holding Temp.:		° C for min. 1 hour. for post heating									
PWHT:		° C				Rate of heating / cooling:		°C per hour			
Soaking time				Minutes (2.5 minutes per mm)		Cooling to:		300° C			
Preheating started at				Hrs. on		Preheating completed at				Hrs.	
Root welding started at				Hrs.		Root welding completed at				Hrs.	
Welding started at				Hrs.		Welding completed at				Hrs.	
Interpass temp. maintained between						°C and		°C			
Holding temp. reached at				Hrs.		Holding completed at				Hrs.	
No. of T/Cs				Location							
PWHT started at				Hrs. on				Soaking started at			
Hrs.								Soaking completed at			
Hrs.								300°C reached at			
Hrs.								Hrs.			
RT carried out on						Result : OK / Not OK					
Hardness test Equipment used						Calibration validity:					
Hardness test carried out on						Value:					
						Result:		OK / Not OK			
History of interruption if any, with time:											
<u>Contractor</u>				<u>BHEL</u>				<u>Customer</u>			

CHAPTER-A2

BASE MATERIALS

1.0 SCOPE:

- 1.1. This chapter contains tabulations of chemical compositions and mechanical properties of various materials generally used at BHEL sites.

2.0 CONTENTS:

CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

Table A2.1	-	Pipes (ASME)
Table A2.2	-	Tubes (ASME)
Table A2.3	-	Forgings (ASME)
Table A2.4	-	Castings (ASME)
Table A2.5	-	Plates / Sheets (ASTM, ASME& IS)
Table A2.6	-	Pipes (Other specifications)
Table A2.7	-	Tubes (Other specifications)

- 3.0** The data are for general information purposes. The corresponding P numbers are also indicated.

- 4.0** For materials not covered in this chapter, refer the relevant Material Specification Standard. In case it is not available at site, same shall be referred to Head quality of the region.

TABLE-A2.1: PIPES (ASME)

Sl. No.	P. No. /Group No.	Material Specification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 1	SA 106 Gr. B (Remarks: Carbon restricted to 0.25% Max.)	0.30 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Min.	0.40 Max.	0.40 Max.	0.15 Max.	0.08 Max	-	415	240	30
2	P 1 / 2	SA 106 Gr. C (Remarks: Carbon restricted to 0.25% Max.)	0.35 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Min.	0.40 Max.	0.40	0.15 Max.	-	-	485	275	30
3	P4/1	SA 335 P 11	0.15 Max	0.30–0.60	0.025	0.025	0.50–1.00	-	1.00–1.50	0.44–0.65	-	-	380	205	30
4	P 4 / 1	SA 335 P 12	0.15 Max.	0.30-0.61	0.025 Max.	0.025 Max.	0.50 Max.	-	0.80-1.25	0.44-0.65	-	-	415	220	30
5	P 5A / 1	SA 335 P 22	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	1.90-2.60	0.87-1.13	-	-	415	205	30
6	P 15E /1	SA 335 P91	0.08-0.12	0.30-0.60	0.02 Max.	0.01 Max.	0.20-0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	585	415	20
7	P15E/1	SA 335 P 92	0.13 Max	0.30-0.60	0.020	0.010	0.50 max	0.40 max	8.50-9.50	0.0-	0.15-0.25	1.5-2.0	620	400	20

TABLE-A2.2: TUBES(ASME)

Sl. No.	P. No. /Group No.	MaterialSpecification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 1	SA 192	0.06-0.18	0.27-0.63	0.035 Max.	0.035 Max.	0.25 Max.	-	-	-	-	-	325	180	35
2	P 1 / 1	SA 210 Gr A1 (Remarks: Carbon restricted to 0.25% Max.)	0.27 Max.	0.93 Max.	0.035 Max.	0.035 Max.	0.10 Max.	-	-	-	-	-	415	255	30
3	P 1 / 1	SA 179	0.06-0.18	0.27-0.63	0.035 Max.	0.035 Max.	-	-	-	-	-	-	325	180	35
4	P 1 / 2	SA 210 Gr C (Remarks: Carbon restricted to 0.30% Max.)	0.35 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Max.	-	-	-	-	-	485	275	30
5	P 3 / 1	SA 209 T1	0.10-0.20	0.30-0.80	0.025 Max.	0.025 Max.	0.10-0.50	-	-	0.44-0.65	-	-	380	205	30
6	P 4 / 1	SA 213 T11	0.05-0.15	0.30-0.60	0.025 Max.	0.025 Max.	0.50-1.00	-	1.00-1.50	0.44-0.65	-	-	415	205	30
7	P 4 / 1	SA 213 T12	0.05-0.15	0.30-0.61	0.025 Max.	0.025 Max.	0.50 Max.	-	0.80-1.25	0.44-0.65	-	-	415	220	30
8	P 5 A / 1	SA 213 T22	0.05-0.15	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	1.90-2.60	0.87-1.13	-	-	415	205	30

TABLE-A2.2: TUBES(ASME) (Contd...)

Sl. No.	P. No. / Group No.	Material Specification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
9	P 5 B / 1	SA 213 T5	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	4.00-6.00	0.45-0.65	-	-	415	205	30
10	P 5 B / 1	SA 213 T9	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.25-1.00	-	8.00-10.00	0.90-1.10	-	-	415	205	30
11	P 1 5 E / 1	SA 213 T91	0.07-0.14	0.30-0.60	0.02 Max.	0.01 Max.	0.20-0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	585	415	20
12	P 8 / 1	SA 213 TP 304 H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	8.00-11.00	18.00-20.00	-	-	-	515	205	35
13	P8/1	SA 213 TP 321H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	9.00-12.00	17.00-19.00	-	-	-	515	205	35
15	P 8 / 2	SA 213 TP 347 H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	9.00-13.00	17.00-19.00	-	-	-	515	205	35
15	Code case 2199	SA213 T23	0.04-0.10	0.10-0.60	0.030	0.010	0.050	--	1.90-2.60	0.05-0.30	0.20-0.30	1.45-1.75	510	400	20
16	15E/1 (Code case 2169)	SA213 T92	0.07-0.13	0.30-0.60	0.020	0.010	0.50	0.40	8.5-9.5	0.30-0.60	0.15-0.25	1.5-2.0	620	440	20
17	P8/1 (Code case 2328 - S30432)	SA 213 UNS S30432 (Super 304H)	0.07-0.13	1.00	0.040	0.010	0.30	7.5-10.5	17.0-19.0	-	-	-	590	235	35

TABLE A2.3: FORGINGS (ASME)

Sl. No.	P. No. / Group No.	Material Specification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W, Cb	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 2	SA 105 (Remarks: Carbon restricted to 0.25% Max.)	0.35 Max.	0.60-1.05	0.035 Max.	0.04 Max.	0.1 - 0.35	0.40 Max.	0.30 Max.	0.12 Max.	0.08 Max	-	485	250	30
2	P 4 / 1	SA 182 F11 Class 3	0.10-0.20	0.30-0.80	0.04 Max.	0.04 Max.	0.50 - 1.00	-	1.00-1.50	0.44-0.65	-	-	515	310	20
3	P 4 / 1	SA 182 F 12 Class 2	0.10-0.20	0.30-0.80	0.04 Max.	0.04 Max.	0.10 - 0.60	-	0.80-1.25	0.44-0.65	-	-	485	275	20
4	P 5 A / 1	SA 182 F 22 Class 3	0.15 Max.	0.30-0.60	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00-2.50	0.87-1.13	-	-	515	310	20
5	P 1 5 E / 1	SA 182 F91	0.08-0.12	0.30-0.60	0.02 Max.	0.01 Max.	0.20 - 0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	620	415	20
6	P 1 5 E / 1	SA 182 F92	0.7-0.13	0.30-0.60	0.02 Max.	0.01 Max.	0.50 Max.	0.40 Max.	8.50-9.50	0.30-0.60	0.15-0.25	W:1.50-2.00; Cb: 0.04-0.09	620	440	20

TABLE A2.4: CASTINGS (ASME)

Sl. No.	P. No. /Group No.	Material Specification	Chemical Composition (%)								Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	MPa	MPa	% EMin.
1	P 1 / 2	SA 216 WCB (Remarks: Carbon restricted to 0.25% Max.)	0.30 Max.	1.00 Max.	0.04 Max.	0.045 Max.	0.60 Max.	0.50 Max.	0.50 Max.	0.20 Max.	485	250	22
2	P 1 / 2	SA 216 WCC	0.25 Max.	1.20 Max.	0.04 Max.	0.045 Max.	0.60 Max.	0.50 Max.	0.50 Max.	0.20 Max.	485	275	22
3	P 4 / 1	SA 217 WC6	0.20 Max.	0.50-0.80	0.04 Max.	0.045 Max.	0.60 Max.	-	1.00-1.50	0.45-0.65	485	275	20
4	P 5 A / 1	SA 217 WC 9	0.18 Max.	0.40-0.70	0.04 Max.	0.045 Max.	0.60 Max.	-	2.00-2.75	0.90-1.20	485	275	20
5	P 8 / 1	SA 351 CF 8	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	8.00-11.00	18.00-21.00	0.50 Max.	485	205	35
6	P 8 / 1	SA 351 CF 8M	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	1.50 Max.	9.00-12.00	18.00-21.00	2.00-3.00	485	205	30
7	P 8 / 1	SA 351 CF 8C	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	9.00-12.00	18.00-21.00	0.50 Max.	485	205	30
8	P 8 / 2	SA 351 CH 20	0.04-0.20	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	12.00-15.00	22.00-26.00	0.50 Max.	485	205	30
9	P15E / 1	SA 217 C12A	0.08-0.12	0.30-0.60	0.030 Max.	0.010 Max.	0.20-0.50	0.40 Max.	8.00-10.00	0.85-1.05	585	415	18

TABLE A2.5: PLATES/SHEETS

Sl. No.	P. No./ Group No.	Material Specification	Thickness mm	C	Mn	p	S	Si	Ni	Cr	Mo	V	T.S	Y.S	%E
			(MPa)										(MPa)	Min.	
1	P 1 / 1	ASTM A36	20 incl.	0.25	-	0.04	0.05	0.40	-	-	-	-	400	250	20
			20-40 incl.	0.25	0.80-1.20			0.40	-	-	-	-			
			40-65 incl.	0.26	0.80-1.20			0.40	-	-	-	-			
			65-100 incl.	0.27	0.85-1.20			0.15-0.40	-	-	-	-			
			over 100	0.29	0.85-1.20			0.15-0.40	-	-	-	-			
2	P 1 / 1	SA 516 Gr 60	12.5 incl	0.21	0.55-0.98	0.035	0.035	0.13-0.45	-	-	-	-	415	220	25
			12.5-50 incl	0.23	0.79-1.30				-	-	-	-			
			50-100 incl	0.25					-	-	-	-			
			100-200 incl	0.27					-	-	-	-			
			over 200	0.27					-	-	-	-			
3	P 1 / 2	SA516 Gr70	12.5 incl	0.27	0.79-1.30	0.035	0.035	0.13-0.45	-	-	-	-	485	260	21
			12.5-50 incl	0.28					-	-	-	-			
			50-100 incl	0.3					-	-	-	-			
			100-200 incl	0.31					-	-	-	-			
			over 200	0.31					-	-	-	-			
4	P 1 / 2	SA299 Gr.A	<25	0.26	0.84-1.52	0.035	0.035	0.13-0.45	-	-	-	-	515	275	19
			>25	0.28	0.84-1.62				-	-	-	-			
5	P 1 / 2	SA515 Gr70	<25	0.31	1.30	0.035	0.035	0.13-0.45	-	-	-	-	485	260	21
			25-50 incl	0.33					-	-	-	-			
			50-100 incl	0.35					-	-	-	-			
			100-200 incl	0.35					-	-	-	-			
			>200	0.35					-	-	-	-			
6	P311	SA204 Gr A	<25 incl	0.18	0.98	0.025	0.025	0.13-0.45	-	-	0.41-0.64	-	450	255	23
			>50 incl	0.21					-	-		-			
			>100 incl	0.23					-	-		-			
			>100	0.25					-	-		-			
7	P312	SA204 Gr B	<25 incl	0.20	0.98	0.025	0.025	0.13-0.45	-	-	0.41-0.64	-	485	275	21
			>50 incl	0.23					-	-		-			
			>100 incl	0.25					-	-		-			
			>100	0.27					-	-		-			
8	P411	SA 387 Gr 12 Class 2	<125 incl	0.04-0.17	0.35-0.73	0.025	0.025	0.13-0.45	-	0.74-1.21	0.40-0.65	-	450	275	22
			>125	0.17											
9	P5N1	SA387 Gr 22 Class 2	<125 incl	0.04-0.15.	0.25-0.66	0.025	0.025	0.50.		1.88-2.62	0.85-1.15	-	515	310	18
			>125	0.17											
10	P15EI1	SA387 Gr 91	all thickness	0.06-0.15	0.25-0.66	0.025	0.012	0.18-0.56	0.43	7.90-9.60	0.80-1.10	0.16-0.27	585	415	18

TABLE A2.5: PLATES/SHEETS (Contd...)

Sl. No.	P.No./ Group No.	Material Specification	Thickness mm	C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S	Y.S	%E
	(MPa)	(MPa)	Min.												
11	P811	SA240 TYPE 304	all thickness	0.07	2	0.045	0.03	0.75	8.00-10.50	17.5.-19.5.0	-	-	515	205	40
12	P 1 / 1	ASTM A572 Gr50	<40 incl	0.23	1.35	0.04	0.05	0.40	-	-	-	-	450	345	17
			>40					0.15-0.40	-	-	-0.01-0.1				
13	P 1 / 1	IS 2062 E250 Gr.A	all thickness	0.23	1.5	0.045	0.045	0.4	-	-	-	-	410	230	23
14	P 1 / 1	IS 2062 E250 Gr.BR BO	all thickness	0.22	1.5	0.045	0.045	0.4	-	-	-	-	410	230	23
15	P 1 / 1	IS 2062 E250 GrC	all thickness	0.2	1.5	0.04	0.04	0.4	-	-	-	-	410	230	23
16	P 1 / 1	IS 2062 E350 Gr A.BR,BO	all thickness	0.2	1.55	0.045	0.045	0.45	-	-	-	-	490	320	22
17	P 1 / 1	IS 2062 E350 GrC	all thickness	0.2	1.55	0.04	0.04	0.45	-	-	-	-	490	320	22
18	P 1 / 1	IS 2062 E450BR	all thickness	0.22	1.65	0.045	0.045	0.45	-	-	-	-	570	450	20
19	P 1 / 1	BSEN10025 Gr 420N	all thickness	0.2	1.0-1.7	0.03	0.025	0.6	0.8	0.3	0.1	0.2	500	320	18

TABLE A2.6: PIPES (OTHER SPECIFICATION)

Sl. No.	Equivalent P. No. /Group No.	Material Specification	Chemical Composition (%)									Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S Kg / mm ²	Y.S Kg / mm ²	% EMin.
1	P1/1	DIN St. 35.8	0.17 Max.	0.40-0.80	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	36.70-48.96	24	25
2	P1/1	DIN St. 45.8	0.21 Max.	0.45-1.20	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	41.80-54.10	26	21
3	P1/1	BS 3602 / 410	0.21 Max.	0.40-1.20	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	41.82-56.10	25	22
4	P1/1	BS 3602 / 460	0.22 Max.	0.80-1.40	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	46.90-61.20	28.60	21
5	P4/1	BS 3604 620-460 HFS	0.10-0.15	0.40 Max.	0.04 Max.	0.04 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	46.90- 62.22	18.36	22
		or CDS 620-440	0.10-0.18	0.40-0.70	0.04 Max.	0.04 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	44.90- 60.20	29.58	22
6	P5/1	BS 3604 622 HFS or CDS	0.08-0.15	0.40-0.70	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00-2.50	0.90-1.20	-	48.80	26.80	17
7	-	BS 3604 HFS 660 Or CDS 660	0.15 Max.	0.40-0.70	0.04 Max.	0.04 Max.	0.10-0.35	-	0.25-0.50	0.50-0.70	0.22-0.30	47.30	30	17
8	P5B/2	X20CrMoV121D IN17175	0.17-0.23	≤ 1.00	0.030 Max.	0.030 Max.	≥ 0.50	0.30-0.80	10.00-12.50	0.80-1.20	0.25-0.35	70-86	50	17

TABLE A2.7: TUBES (OTHER SPECIFICATIONS)

Sl. No.	Equivalent P. No. /Group No.	Material Specification	Chemical Composition (%)									Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S Kg / mm ² (MPa)	Y.S Kg / mm ² (MPa)	% E Min.
1	P1/1	DIN St. 35.8	0.17 Max.	0.40- 0.80	0.04 Max.	0.04 Max.	0.10- 0.35	-	-	-	-	36.70- 48.96	24	25
2	P1/1	DIN St. 45.8	0.21 Max.	0.40- 1.20	0.04 Max.	0.04 Max.	0.10- 0.35	-	-	-	-	41.80- 54.06	26	21
3	P1/1	BS 3059 / 360	0.17 Max.	0.40- 0.80	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	36.70- 51.00	22	24
4	P1/1	BS 3059 / 440	0.12- 0.18	0.90- 1.20	0.040 Max.	0.035 Max.	0.10- 0.35	-	-	-	-	44.88- 59.20	25	21
5	P3/1	15 Mo3 DIN17175	0.12- 0.20	0.40- 0.80	0.035 Max.	0.035 Max.	0.10- 0.35	-	-	0.25- 0.35	-	45.90- 61.20	27.50	22
6	P4/1	13 Cr Mo 4- 5DIN17175	0.10- 0.18	0.40- 0.70	0.035 Max.	0.035 Max.	0.10- 0.35	-	0.70- 1.10	0.45- 0.65	-	44.88- 60.18	29.60	22
7	P4 /1	BS 3059 / 620	0.10- 0.15	0.40- 0.70	0.040 Max.	0.040 Max.	0.10- 0.35	-	0.70- 1.10	0.45- 0.65	-	46.90- 62.20	18.40	22
8	P5/1	10 Cr Mo 9- 10DIN17175	0.08- 0.15	0.40- 0.70	0.035 Max.	0.035 Max.	0.50 Max.	-	2.00- 2.50	0.90- 1.20	-	45.90- 61.20	28.60	20
9	P5/1	BS 3059 (622) - 440	0.08- 0.15	0.40- 0.70	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00- 2.50	0.90- 1.20	-	44.90- 60.18	17.85	20
10	P5/1	BS 3059 (622) - 490	0.08- 0.15	0.40- 0.70	0.040 Max.	0.040 Max.	0.50 Max.	-	2.00- 2.50	0.90- 1.20	-	49.98- 65.00	28.05	20
11	-	14 Mo V 63 DIN17175	0.10- 0.18	0.40- 0.70	0.035 Max.	0.035 Max.	0.10- 0.35		0.30- 0.60	0.50- 0.70	0.22- 0.32	46.90- 62.22	32.60	20
12	P5B/2	X20CrMoV121 DIN17175	0.17- 0.23	≤ 1.00	0.030 Max.	0.030 Max.	≥ 0.50	0.30- 0.80	10.00- 12.50	0.80- 1.20	0.25- 0.35	70-86	50	17

**CHAPTER A3: WELDING
MATERIAL SPECIFICATION AND
CONTROL**

SECTION A3.1-WELDING MATERIAL SPECIFICATION AND CONTROL

1.0 SCOPE:

1.1. This chapter details out the welding material specification and controls at sites.

2.0 CONTENTS:

1. Table- A3.1 - Weld Metal Chemical Composition.
2. Table - A3.2 - Mechanical property requirement for all-weld metal.
3. Receipt inspection of welding electrodes/filler wires.
4. Storage and identification of welding electrodes/filler wires.
5. Drying and holding of welding electrodes.
6. Selection and issue of welding electrodes/filler wires.
7. Table-A3.3 - Selection of GTAW filler wire, SMAW electrodes for butt welds in tubes, pipes, headers.
8. Table-A3.4 - Selection of electrodes for welding attachments to tubes.
9. Table-A3.5 - Selection of electrodes, preheat, PWHT for attachment to attachment welds.
10. Table-A3.6 -Selection of electrodes for welding nozzle attachments, hand hole plate, RG plug etc. to headers, pipes.
11. Table-A3.7 –Selection of filler wire and electrodes for non-pressure parts(including structures)
12. Table-A3.8 -A numbers
13. Table-A3.9 -F numbers
14. SFA Classification

3.0 For welding consumables not covered in this chapter, relevant details may be obtained from the concerned Manufacturing Units.

Table-A3.1
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements % ^a
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
E 6010	5.1	0.20	1.20	1.00	NS	NS	0.30	0.20	0.30	0.08	NS	Combined Limit for Mn+Ni+Cu+Mo+V=1.75
E 6013	5.1	0.20	1.20	1.00	NS	NS	0.30	0.20	0.30	0.08	NS	
E 7018	5.1	0.15	1.60	0.75	0.035	0.035	0.30	0.20	0.30	0.08	NS	
E 7018-1	5.1	0.15	1.60	0.75	0.035	0.035	0.30	0.20	0.30	0.08	NS	
E 7018-A1	5.5	0.12	0.90	0.80	0.03	0.03	NS	NS	0.40- 0.65	NS	NS	
E 8018-B2	5.5	0.05- 0.12	0.90	0.80	0.03	0.03	NS	1.00- 1.50	0.40- 0.65	NS	NS	
E 9018-B3	5.5	0.05- 0.12	0.90	0.80	0.03	0.03	NS	2.00- 2.50	0.90- 1.20	NS	NS	
E 9015-B91	5.5	0.08- 0.13	1.20	0.30	0.01	0.01	0.80	8.00- 10.50	0.85- 1.20	0.15- 0.30	0.04 - 0.25	
E9015-B92	5.5	0.08- 0.15	1.20	0.60	0.020	0.015	1.0	8.0-10.0	0.30- 0.70	0.15- 0.30	0.25	W: 1.50-2.00; Nb: 0.02-0.08 B:0.006; Al: 0.04; N: 0.03- 0.08
E9018-B23/ E9015-B23	5.5	0.04- 0.12	1.00	0.60	0.015	0.015	0.5	1.9-2.9	0.30	0.15- 0.30	0.25	W: 1.50-2.00; Nb: 0.02-0.10 B:0.006; Al: 0.04; N: 0.05
E 308	5.4	0.08	0.50- 2.50	1.00	0.04	0.03	9.00- 11.00	18.00- 21.00	0.75	NS	0.75	
E 308-L	5.4	0.04	0.50- 2.50	1.00	0.04	0.03	9.00- 11.00	18.00- 21.00	0.75	NS	0.75	

Table-A3.1 (Contd...)
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements % ^a
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
E 309	5.4	0.15	0.50- 2.50	1.00	0.04	0.03	12.00- 14.00	22.00- 25.00	0.75	NS	0.75	
E 309-L	5.4	0.04	0.50- 2.50	1.00	0.04	0.03	12.00- 14.00	22.00- 25.00	0.75	NS	0.75	
E 347	5.4	0.08	0.50- 2.50	1.00	0.04	0.03	9.00- 11.00	18.00- 21.00	0.75	NS	0.75	Cb+Ta 8XC Min. to 1.00 Max.
E316	5.4	0.08	0.5-2.5	1.00	0.04	0.03	11.0- 14.0	17.0- 20.0	2.0-3.0	NS	0.75	
E2209-16	5.4	0.04	0.5-2.0	1.00	0.04	0.03	7.5-9.5	21.5- 23.5	2.5-3.5	NS	0.75	N:0.08-0.20
ENiCrFe-3	5.11	0.10	5.0-9.5	1.00	0.03	0.015	59.0 min	13.0- 17.0	NS	NS	0.50	Fe: 12.0; Ta+ Cb: 1.0- 2.5; Ti: 1.0; others: 0.5
ENiCrFe-7	5.11	0.05	5.0	0.75	0.03	0.015	Rem	28.0- 31.5	0.5	NS	0.50	Fe: 7.0-12.0; Ta+ Cb: 1.0-2.5; others: 0.5
ENi-CI	5.15	2.00	2.50	4.00	NS	0.03	85 ^d min	NS	NS	NS	2.5 ^e	Fe Al others 8.0 1.0 Total 1.0
ENiFe-CI	5.15	2.00	2.50	4.00	NS	0.03	45 ^d -60	NS	NS	NS	2.5 ^e	Fe Al others Rem ^f 1.0 Total 1.0
ER70S-2	5.18	0.07	0.90- 1.40	0.40- 0.70	0.025	0.035	0.15	0.15	0.15	0.03	0.50 ^b	Ti Zr Al 0.05- 0.02- 0.05- 0.15 0.12 0.15
ER70S-A1	5.28	0.12	1.30	0.30- 0.70	0.025	0.025	0.20	NS	0.40- 0.65	NS	0.35	Others : 0.50
E8018-G	5.5	0.08	1.0-1.8	0.5	0.025	0.025	0.5-1.20	NS	0.5	NS	NS	

Table-A3.1 (Contd...)
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements % ^a
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
ER80S-B2	5.28	0.07- 0.12	0.40- 0.70	0.40- 0.70	0.025	0.025	0.20	1.20- 1.50	0.40- 0.65	NS	0.35 ^c	Total other Elements 0.50
ER90S-B3	5.28	0.07- 0.12	0.40- 0.70	0.40- 0.70	0.025	0.025	0.20	2.30- 2.70	0.90- 1.20	NS	0.35 ^c	Total other Elements 0.50
ER80S-D2	5.28	0.07- 0.12	1.60- 2.10	0.50- 0.80	0.025	0.025	0.15	NS	0.40- 0.60	NS	0.50 ^c	Total other Elements 0.50
ER90S-B9	5.28	0.07- 0.13	1.20	0.15- 0.30	0.01	0.01	0.80	8.00- 10.50	0.80- 1.20	0.15- 0.23	0.20	Total other Elements 0.50
ER 308	5.9	0.08	1.00- 2.50	0.30- 0.65	0.03	0.03	9.00- 11.00	19.50- 22.00	0.75	NS	0.75	
ER 309	5.9	0.12	1.00- 2.50	0.30- 0.65	0.03	0.03	12.00- 14.00	23.00- 25.00	0.75	NS	0.75	
ER 309-L	5.9	0.03	1.00- 2.50	0.30- 0.65	0.03	0.03	12.00- 14.00	23.00- 25.00	0.75	NS	0.75	
ER316L	5.9	0.03	1.0-2.5	0.30- 0.65	0.03	0.03	11.0- 14.0	18.0- 20.0	2.0-3.0	NS	0.75	---
ER 347	5.9	0.08	1.00- 2.50	0.30- 0.65	0.03	0.03	9.00- 11.00	19.00- 21.50	0.75	NS	0.75	Cb+Ta 10XC Min. to 1.0 Max.
ER2209	5.9	0.03	0.5-2.0	0.90	0.03	0.03	7.5-9.5	21.5- 23.5	2.5-3.5	NS	0.75	N:0.08-0.20

Table-A3.1 (Contd...)
WELD METAL CHEMICAL COMPOSITION

[illegible]

TABLE – A3.1 (Contd...)
WELD METAL CHEMICAL COMPOSITION

Notes:

- a) Other elements listed without specified values shall be reported, if intentionally added. The total of these latter unspecified elements and all other elements not intentionally added shall not exceed 0.50%.
- b) The maximum weight percent of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall be 0.50.
- c) The maximum weight percent of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall comply with the stated value.
- d) Nickel plus incident Cobalt.
- e) Copper plus incident Silver.
- f) "Rem" stands for remainder.
- g) Manufacturer's certification to have met the requirements of ASME Sec. II Part C is acceptable in cases where the chemical analysis are not reflected.
- h) Single values are maximum.
- i) NS – Not Specified

TABLE-A3.2
MECHANICAL PROPERTY REQUIREMENT FOR ALL-WELD METAL

Electrode	SFA No.	Tensile Strength Ksi / MPa	Yield Strength at 0.2% of Proof Stress, Ksi/ MPa	Elongation In 2 inch (50.8 mm) %
E6010	5.1	60 / 430	48 / 330	22
E6013	5.1	60 / 430	48 / 330	17
E7018	5.1	70 / 490	58 / 400	22
E7018-1 ^a	5.1	540	58 / 400	22
E7018-A1	5.5	70 / 490	57 / 390	22
E8018-G ^b	5.5	570	450	19
E8018-B2	5.5	80 / 550	67 / 460	19
E9018-B3	5.5	90 / 620	77 / 530	17
E9015-B91	5.5	90 / 620	77 / 530	17
E9015-B92	5.5	90/620	77/530	17
E9018-B23	5.5	90/620	77/530	17
E308	5.4	80 / 550	-	35
E308L	5.4	75 / 520	-	35
E309	5.4	80 / 550	-	30
E309L	5.4	75 / 520	-	30
E347	5.4	75 / 520	-	30
E316	5.4	75/520	--	30
E2209	5.4	100/690	--	22
ENiCrFe-3	5.11	80/550	--	30
ENiCrFe-7	5.11	80/550	--	30
ENi-CI	5.15	40-65 / 276-448	38-60 / 268-414	3-6
ENiFe-CI	5.15	58-84 / 400 -579	43-63 / 294 -434	6-18

- a. These electrodes shall meet the lower temperature impact requirement of average minimum. (27 Joules at – 45° C) and other properties at 620±20°C for 300 minutes.
- b. These electrodes shall meet the impact requirement of average minimum (20 Joules at + 25° C) and other properties at 550±10°C for 60 minutes.

Table- A3.2 (Contd...)

MECHANICAL PROPERTY REQUIREMENT FOR ALL-WELD METAL

Electrode	SFA No.	Tensile Strength Ksi / MPa	Yield Strength at 0.2% of Proof Stress, Ksi / MPa	Elongation In 2 inch (50.8 mm) %
ER70S-6	5.18	70/480	58/400	22
ER70S-A1	5.28	75/515	58/400	19
ER80S-B2	5.28	80 / 550	68 / 470	19
ER90S-B3	5.28	90 / 620	78 / 540	17
ER80S-D2	5.28	80 / 550	68 / 470	17
ER90S-B9	5.28	90 / 620	60 / 410	16
ER308	5.9	These values are not required in the test certificate		
ER308L	5.9			
ER309	5.9			
ER309L	5.9			
ER347	5.9			
ER316	5.9			
ER2209-16	5.9			
ERNiCr-3	5.14	80/550	--	
ERNiCrFe-7A	5.14	85/590	--	

NOTE:

- a) Single values are minimum.
- b) Manufacturer's certification to have met the requirements of ASME-Section II Part C is acceptable in cases where the mechanical properties are not reflected.
- c) 1Ksi is approximately equal to 6.89 MPa.

Section A3.2- Receipt Inspection of Welding Electrodes / Filler Wires

- 1.0 All electrodes/filler wires received at site stores shall be segregated for type and size of electrode.
- 2.0 Ensure that electrode packets received are free from physical damage.
- 3.0 Where electrodes are damaged, the same shall be removed from use.
- 4.0 Only electrodes identified in the "list of approved vendors of welding electrodes" shall be accepted.
- 5.0 Where filler metals are supplied by manufacturing unit, inspect for damages, if any.
- 6.0 Ensure availability of relevant test certificates. Refer tables of chemical compositions and mechanical properties for acceptance.
- 7.0 Endorse acceptance/rejection on the test certificate.

Section A3.3- Storage & Identification of Welding Electrodes/Filler Wires

1.0 SCOPE:

1.1 This procedure is applicable for storage of welding electrodes/filler wires used at sites.

2.0 PROCEDURE:

2.1 Only materials accepted (based on receipt inspection) shall be taken into account for storage.

2.2 STORAGE FACILITY:

2.2.1 The storage facility shall be identified.

2.2.2 Access shall be made available to authorized personnel.

2.2.3 The storage area shall be clean and dry.

2.2.4 Steel racks may be used for storage. Avoid usage of wooden racks for storing inside the storage room.

2.2.5 Maintain the temperature of the storage facility above the ambient temperature. This can be achieved by the use of appropriate heating arrangements.

2.3 The electrodes/filler wire shall be segregated and identified for

a. Type of electrode e.g. E7018.

b. Size of electrode e.g. Dia. 3.15 mm.

2.4 Identification of filler wires:

2.4.1 On receipt of GTAW filler wires, check AWS No. or brand name embossed and retain the same identification throughout.

Section A3.4-Drying and Holding of Welding Electrodes

1.0 SCOPE:

- 1.1 This section details activities regarding drying and holding of welding electrodes used at sites.

2.0 PROCEDURE:

- 2.1 While handling, avoid contact of oil, grease with electrodes. Do not use oily or wet gloves.
- 2.2 It is recommended that not more than two days' requirements electrodes are dried.

3.0 GTAW Filler Wires:

- 3.1 These wires do not require any drying.

4.0 Covered Electrodes:

4.1 Drying and holding :

- 4.1.1 Identify drying oven and holding oven.
- 4.1.2 They shall preferably have a temperature control facility upto 400°C for drying oven and 200°C for holding oven.
- 4.1.3 A calibrated thermometer shall be provided for monitoring temperature.
- 4.2 On opening a packet of electrodes, segregate and place them in the drying oven. Mix-up of electrodes shall be avoided.
- 4.2.1 After loading, raise the drying oven temperature to the desired range as per table in 4.2.5.
- 4.2.2 Note the time when the temperature reaches the desired range. Maintain this temperature for the duration required as per Table in 4.2.5.
- 4.2.3 On completion of drying, the electrodes shall be transferred to holding oven immediately and maintained at minimum temperature of 150°C till issue.
- 4.2.4 The electrode shall not be subjected to more than three cycles of drying.
- 4.2.5 Maintain a register containing following details:

Sl. No.	Date	AWS number/Specification	Batch No./Size	Dia.	Qty.	Drying temperature Start time	Drying Temperature end time	Remarks

Drying and Holding Parameters

AWS Classification	Drying (*)		Minimum Holding Temperature °C (@)
	Temperature °C	Time (Hours)	
E7018	250 - 300	2	150
E7018-1	250 - 300	2	150
E7018-A1	250 - 300	2	150
E8018-G	250 - 300	2	150
E8018-B2	250 - 300	2	150
E9018-B3	250 - 300	2	150
E9018-B23	250 - 300	2	150
E9015-B91	250 - 300	2	150
E9015-B92	250 - 300	2	150
E308, E309, E310 E316& E347	250 - 300	1	150
ENiCrFe-3	250 - 300	2	150
ENiCrFe-7	250 - 300	2	150

Note: (*) - Guideline has been given however, supplier's recommendations shall be followed.

(@) - Maintain the temperature in the oven till issue.

4.2.4 After issue, maintain the electrodes in a portable oven at a minimum temperature of 65°C till use. This is not applicable for E6013 (Rutile) electrodes, however the following instruction shall be followed for E6013 electrodes:

- (1) Rutile electrodes require some moisture in the coating and they would not require drying. If they become damp, re-drying at around 120 to 150°C for 1 hour will be sufficient.
- (2) These electrodes with potassium silicate binder can be used on both DCEP/DCEN polarities and on AC. E6013 electrodes generally have better arc striking and stability characteristics with an easily detachable slag.

4.3 Unused, returned electrodes shall be segregated and reused only after repeating drying and holding cycles.

Section A3.5- Selection and Issue of Welding Electrodes / Filler Wires

1.0 SCOPE:

- 1.1. This procedure details methods for selection and issue of welding electrodes/filler wires for site operations.

2.0 PROCEDURE:

2.1 Selection:

- 2.1.1 The type of filler wire/electrode for welding shall be based on the details given in the contract documents like Field Welding Schedule, drawings, Welding Procedure Specifications as supplied by the concerned manufacturing units.
- 2.1.2 Where not specified by the manufacturing units, selection shall be based on the tables enclosed (Table A3.3 to Table A3.7. as applicable).
- 2.1.3 Where electrodes/ filler wires are not covered in the documents mentioned in 2.1.1 and 2.1.2, refer to the concerned manufacturing units.

2.2 Issue:

- 2.2.1 Issue of welding electrodes / filler wires shall be based on authorised welding electrodes issue voucher.
- 2.2.2 It is recommended to restrict quantity issued to not more than 4 hours' requirements.
- 2.2.3 Re-dried low hydrogen electrodes shall be carried to the work spot in a portable oven.
- 2.2.4 Maintain the temperature in the portable oven at the work spot above 65°C.
- 2.2.5 Unused electrodes shall be segregated and reused only after repeating drying and holding cycles.

Table- A3.3
SELECTION OF GTAW FILLER WIRE, SMAW ELECTRODE FOR
BUTT WELDS IN TUBES, PIPES AND HEADERS

Material	Welding Process	P1 Gr 1/ P1 Gr 2	P3 Gr 1	P4 Gr 1	P5A Gr 1	P15 E Gr 1	T23	T92/P92	P8	P8 SA 213 UNS S 30432	DIN14MoV6 3 or equivalent
P1 Gr 1	GTAW	ER 70S-A1									
P1 Gr 2	SMAW	E7018-1 Note 1									
P3 Gr 1	GTAW	ER 70S-A1	ER 70S-A1								
	SMAW	E7018-1	E7018-A1								
P4 Gr 1	GTAW	ER 70S-A1	ER 70S-A1	ER 80S-B2							
	SMAW	E7018-1	E7018-A1	E8018-B2							
P5A Gr 1	GTAW	ER 70S-A1	ER 70S-A1	ER 80S-B2	ER 90S-B3	ER 90S-B3	ER90S-B3				
	SMAW	E7018-1	E7018-A1	E8018-B2	E9018-B3	E9018-B3	E9018-B3				
P15 E Gr.1 Gr.91	GTAW					ER90S-B9	TGS2CW/ 2CrWVTIG/ YT-SCM2S	ER90S-B9			
	SMAW					E9015-91	E9018-B23	E9015-B91			
T23	GTAW						TGS2CW/ 2CrWVTIG/YT- SCM2S	TGS2CW/ 2CrWVTIG/ YT-SCM2S			
	SMAW						E9018-B23	E9018-B23			

Table- A3.3 (Contd...)

Material	Welding Process	P1 Gr 1 P1 Gr 2	P3 Gr 1	P4 Gr 1	P5A Gr 1	P15 E Gr 1	T23	T92/P92	P8	P8 SA 213 UNS S 30432	DIN14MoV63 or equivalent
P15 E Gr.1 Gr.92	GTAW							9CrWV-TIG/ Themanit- MTS616			
	SMAW							E9015-B92			
P8	GTAW			ERNi Cr3	ERNiCr3	ERNiCr3	ERNiCr3	ERNiCrFe7A	ER347		
	SMAW			ENiC rFe3	ENiCrFe3	ENiCrFe3	ENiCrFe3	ENiCrFe7	E347		
P8 SA 213 UNS S30432	GTAW									YT304H/ THERMANIT 304H Cu	
DIN14MoV63 or equivalent	GTAW				ER 90S- B3						ER90S-B3
	SMAW				E9018-B3						E9018-B3

Note-1: E7018-A1 for P1 Gr2 + P1 Gr2 when PWHT is involved.

Table- A3.4
SELECTION OF ELECTRODES FOR WELDING ATTACHMENTS TO TUBES

Tube Material	Attachment Material			
	P1 Group 1	P4 Group 1	P5A Group 1	P8
P1 Group 1 P1 Group 2	E 7018	E 7018	E 7018	E 309
P3	E 7018-A1	E 7018-A1	E 7018-A1	E 309
P4 Group 1	E 8018-B2	E 8018-B2	E 8018-B2	E 309
P5A Group 1	E 9018-B3	E 9018-B3	E 9018-B3	E 309
P8 including SA 213 UNS S30432		E 309	E 309	E 347
P15E Gr.1 (Gr. 91/92)			E9018-B3	ENiCrFe-3
SA213T23			E9018-B3	ENiCrFe-3

Table- A3.5
SELECTION OF ELECTRODES, PREHEAT, PWHT
FOR ATTACHMENT TO ATTACHMENT WELDS
(Seal Bands, High Crown Bars, End Bars, End Bar Lifting Lugs and Collector Plates etc.)

Material (Note 2)	Welding Requirements	P1	P3	P4	P5 A	P8 Group 1	P8 Group 2	P 15E / 1
P1	Electrode Preheat PWHT	E7018 Nil Nil	-	E 7018 150°C 650 – 670°C	-	-	-	-
P3	Electrode Preheat PWHT	E7018 150°C (Note 1) For Thickness>16mm: 620-650°C	E7018-A1 150°C For Thickness>16mm: 620- 650°C	-	-	-	-	-
P4	Electrode Preheat PWHT	E7018 150°C (Note 1) For Thickness>13mm: 650-670°C	E7018-A1 150°C For Thickness>13mm: 650- 670°	E8018-B2 150°C (Note 1) For Thickness>13mm: 650-670°C	-	-	-	-
P5 A	Electrode Preheat PWHT	-	-	E8018-B2 150°C (Note 1) For Thickness>13: 680- 710°C	E9018-B3 150°C (Note 1) For Thickness>13:680- 710°C	-	-	-
P8	Electrode Preheat PWHT	E309 Nil Nil	-	E309 Nil Nil	E309 Nil Nil	E347 Nil Nil	E309 Nil Nil	-
P 15E/ 1	Electrode Preheat PWHT	-	-	-	E9018-B3 220°C 730-760 °C	ENi Cr Fe3 220°C (only on P15E side) 730-760 °C	ENi Cr Fe3 220°C (only on P15E side) 730-760 °C	E9015-B91 220°C 740-770 °C

Note – 1 : Preheat is not required for P3/P4 up to 16 mm & for P5 A up to 13 mm, if PWHT is carried out.

Note - 2: For load carrying members, PWHT is required irrespective of thickness.

Table- A3.6
SELECTION OF ELECTRODES FOR WELDING NOZZLE ATTACHMENTS, HAND HOLE PLATE,
RG PLUG ETC. TO HEADERS, PIPES

Header, Pipe Material	Attachment Material					
	P1	P3	P4	P5 A	P15 E/1	P8
P1	E7018-1	E7018-1	E7018-1	-	-	ENiCrFe3
P4	E7018-1	E7018-A1	E8018-B2	E8018-B2	-	-
P5 A	-	-	E8018-B2	E9018-B3	E9018-B3	ENiCrFe3
P15 E/1	-	-	-	E9018-B3	E9015-B91	ENiCrFe3
DIN 14MoV63 or equivalent	-	-	-	E9018-B3	-	ENiCrFe3

Table – A3.7
SELECTION OF ELECTRODES FOR NON-PRESSURE PARTS
(INCLUDING STRUCTURES) (NOTE 1)

Material	SMAW Electrodes	SAW Wires	CO ₂ Wires
P1 + P1 (IS2062 E250)	For butt welds ≤ 6 mm: E 6013 (only for Ducts) > 6 mm: E 7018 For fillets ≤8 mm : E 6013 >8 mm: E 7018	EL 8 EM 12 K EL 8 EM 12 K	E 71 T - 1
Corten Steel + P1	E 6013 or E 7018	EM 12 K	
Corten Steel + Corten Steel	E 8018 – B2	EB 2	E 81 T 1 – B2
IS2062 E350+E350/ E250	E7018-1	EM 12 K	NA
IS2062 E450+E450	E8018-G	EG	NA
SA 204 Gr.A	E7018-A1	NA	NA

Note 1: E 6013 Electrodes can be used for all non-load carrying welds of all thickness of IS 2062 plates up to 20 mm thickness and 8 mm fillets

TABLE- A3.8
A NUMBERS
CLASSIFICATION OF FERROUS WELD METAL ANALYSIS FOR
PROCEDURE QUALIFICATION

A. No.	Types of Weld Deposit	Analysis, % (Note 1)					
		C	Cr	Mo	Ni	Mn	Si
1	Mild steel	0.20	–	–	–	1.60	1.00
2	Carbon-Molybdenum	0.15	0.50	0.40-0.65	–	1.60	1.00
3	Chrome (0.4% to 2%)-Molybdenum	0.15	0.40-2.00	0.40-0.65	–	1.60	1.00
4	Chrome (2% to 6%)-Molybdenum	0.15	2.00-6.00	0.40-1.50	–	1.60	2.00
5	Chrome (6% to 10.5%)-Molybdenum	0.15	6.00-10.50	0.40-1.50	–	1.20	2.00
6	Chrome-Martensitic	0.15	11.00-15.00	0.70	–	2.00	1.00
7	Chrome-Ferritic	0.15	11.00-30.00	1.00	–	1.00	3.00
8	Chromium-Nickel	0.15	14.50-30.00	4.00	7.50-15.00	2.50	1.00
9	Chromium-Nickel	0.30	19.00-30.00	6.00	15.00-37.00	2.50	1.00
10	Nickel to 4%	0.15	–	0.55	0.80-4.00	1.70	1.00
11	Manganese-Molybdenum	0.17	–	0.25-0.75	0.85	1.25-2.25	1.00
12	Nickel-Chrome-Molybdenum	0.15	1.50	0.25-0.80	1.25-2.80	0.75-2.25	1.00

Note 1: Single values shown above are maximum.

Table A3.9
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR
QUALIFICATION

	ASME Specification No.	AWS Classification No.
1	SFA-5.1	EXX20
1	SFA-5.1	EXX22
1	SFA-5.1	EXX24
1	SFA-5.1	EXX27
1	SFA-5.1	EXX28
1	SFA-5.4	EXXX(X)-26
1	SFA-5.5	EXX20-X
1	SFA-5.5	EXX27-X
2	SFA-5.1	EXX12
2	SFA-5.1	EXX13
2	SFA-5.1	EXX14
2	SFA-5.1	EXX19
2	SFA-5.5	E(X)XX13-X
3	SFA-5.1	EXX10
3	SFA-5.1	EXX11
3	SFA-5.5	E(X)XX10-X
3	SFA-5.5	E(X)XX11-X
4	SFA-5.1	EXX15
4	SFA-5.1	EXX16
4	SFA-5.1	EXX18
4	SFA-5.1	EXX18M
4	SFA-5.1	EXX48
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-15
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-16
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-17
4	SFA-5.5	E(X)XX15-X
4	SFA-5.5	E(X)XX16-X
4	SFA-5.5	E(X)XX18-X
4	SFA-5.5	E(X)XX18M
4	SFA-5.5	E(X)XX18M1

Table- A3.9 (Contd...)
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
5	SFA-5.4 austenitic and duplex	EXXX(X)-15
5	SFA-5.4 austenitic and duplex	EXXX(X)-16
5	SFA-5.4 austenitic and duplex	EXXX(X)-17
6	SFA-5.2	All classifications
6	SFA-5.9	All classifications
6	SFA-5.17	All classifications
6	SFA-5.18	All classifications
6	SFA-5.20	All classifications
6	SFA-5.22	All classifications
6	SFA-5.23	All classifications
6	SFA-5.25	All classifications
6	SFA-5.26	All classifications
6	SFA-5.28	All classifications
6	SFA-5.29	All classifications
6	SFA-5.30	INMs-X
6	SFA-5.30	IN5XX
6	SFA-5.30	IN3XX(X)
Aluminium and Aluminium-Base Alloys		
21	SFA-5.3	E1100
21	SFA-5.3	E3003
21	SFA-5.10	ER1100
21	SFA-5.10	R1100
21	SFA-5.10	ER1188
21	SFA-5.10	R1188
22	SFA-5.10	ER5183
22	SFA-5.10	R5183
22	SFA-5.10	ER5356
22	SFA-5.10	R5356
22	SFA-5.10	ER5554
22	SFA-5.10	R5554
22	SFA-5.10	ER5556

TABLE- A3.9 (Contd...)
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
22	SFA-5.10	R5556
22	SFA-5.10	ER5654
22	SFA-5.10	R5654
23	SFA-5.3	E4043
23	SFA-5.10	ER4009
23	SFA-5.10	R4009
23	SFA-5.10	ER4010
23	SFA-5.10	R4010
23	SFA-5.10	R4011
23	SFA-5.10	ER4043
23	SFA-5.10	R4043
23	SFA-5.10	ER4047
23	SFA-5.10	R4047
23	SFA-5.10	ER4145
23	SFA-5.10	R4145
23	SFA-5.10	ER4643
23	SFA-5.10	R4643
24	SFA-5.10	R206.0
24	SFA-5.10	R-C355.0
24	SFA-5.10	R-A356.0
24	SFA-5.10	R357.0
24	SFA-5.10	R-A357.0
25	SFA-5.10	ER2319
25	SFA-5.10	R2319
Copper And Copper Alloys		
31	SFA-5.6	ECu
31	SFA-5.7	ERCu
32	SFA-5.6	ECuSi
32	SFA-5.7	ERCuSi-A

TABLE- A3.9 (Contd...)
F NUMBERS
GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
33	SFA-5.6	ECuSn-A
33	SFA-5.6	ECuSn-C
33	SFA-5.7	ERCuSn-A
34	SFA-5.6	ECuNi
34	SFA-5.7	ERCuNi
34	SFA-5.30	IN67
35	SFA-5.8	RBCuZn-A
35	SFA-5.8	RBCuZn-B
35	SFA-5.8	RBCuZn-C
35	SFA-5.8	RBCuZn-D
36	SFA-5.6	ECuAl-A2
36	SFA-5.6	ECuAl-B
36	SFA-5.7	ERCuAl-A1
36	SFA-5.7	ERCuAl-A2
36	SFA-5.7	ERCuAl-A3
37	SFA-5.6	ECuNiAl
37	SFA-5.6	ECuMnNiAl
37	SFA-5.7	ERCuNiAl
37	SFA-5.7	ERCuMnNiAl
Nickel And Nickel Alloys		
41	SFA-5.11	ENi-1
41	SFA -5.11	ENiCrFe-3 & ENiCrFe-7A
41	SFA-5.14	ERNi-1
41	SFA-5.14	ERNiCr-3 & ENiCrFe-7A
41	SFA-5.30	IN61
42	SFA-5.11	ENiCu-7
42	SFA-5.14	ERNiCu-7
42	SFA-5.14	ERNiCu-8
42	SFA-5.30-7	IN60

TABLE- A3.9 (Contd...)
F NUMBERSGROUPING OF ELECTRODES AND WELDING RODS FOR
QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
45	SFA5.11	ENiCrMo-11
45	SFA5.14	ERNiCrMo-1
45	SFA5.14	ERNiCrMo-8
45	SFA5.14	ERNiCrMo-9
45	SFA5.14	ERNiCrMo-11
45	SFA5.14	ERNiFeCr-1
Hard-Facing Weld Metal Overlay		
71	SFA-5.13	E Co Cr – A & All classifications
72	SFA-5.21	ER Co Cr – A & All classifications

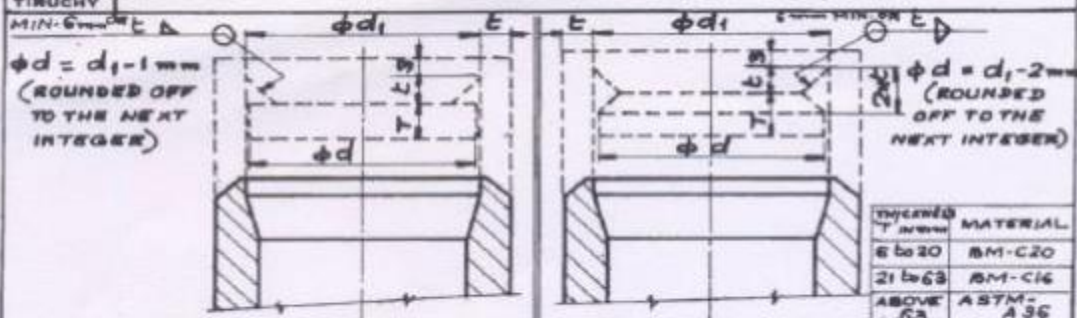


TIRUCHY

SELECTION CHART FOR DUMMY END COVERS FOR HYDRAULIC

THICKNESS $t = 0.5 d_1 \sqrt{\frac{f}{\sigma}}$ (ISO - REC. # 531/1968) $f = 1900 \text{ kg/cm}^2$
 ROUNDED OFF TO THE NEXT NEAREST RATIONALISED PLATE SIZE

TEST



CASE WHEN $T \leq 20$

CASE WHEN $T > 20$

THICKNESS OF DUMMY END COVERS FOR HYDRAULIC TEST (T)

15	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
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MICROFILMED ON

ROLL	00037	FRAME	528
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PREPARED BY

CHECKED BY _____

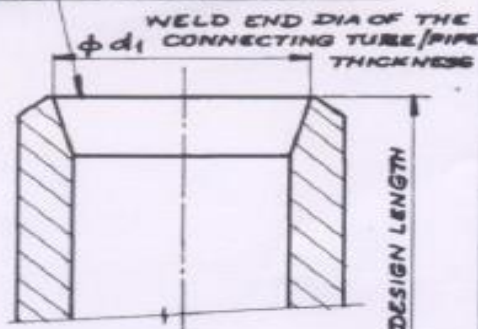
40-B-006, 2897.



NIPPLES-FREE END DETAILS.

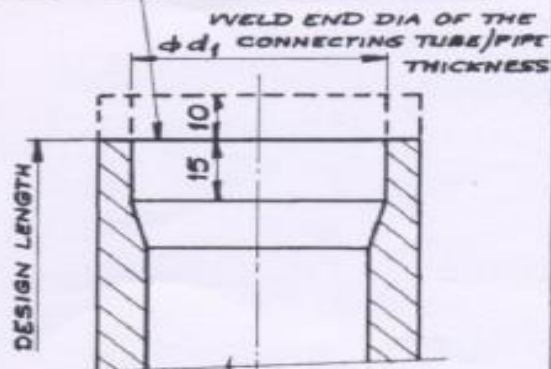
(FOR HEADERS ONLY.)

INDICATE STYLE NR 'D' - d₁
TO BPS NR 710004-74 (LAT. REV.)



STRAIGHT NIPPLES WHICH
DO NOT REQUIRE ANY ALLO-
-WANCE. (NO SHOP HYD. TEST.)

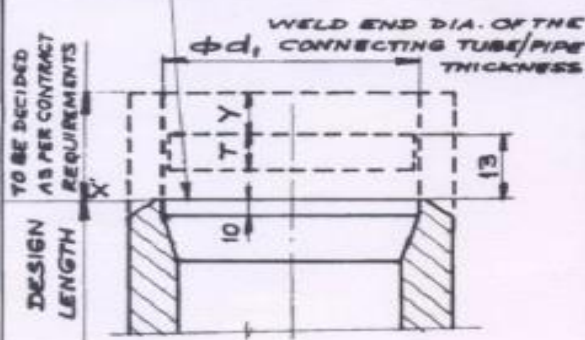
INDICATE STYLE NO 'C' - d₁
TO BPS NO. 710004-74 (LAT. REV.)



STRAIGHT & BENT NIPPLES
WHICH REQUIRE 10TH ALLOWANCE. (NO SHOP HYD. TEST.)

CASE WHEN $T \leq 20$

A) INDICATE STYLE NR 'C' - d,
TO SPS NO 710004-74 (LAT. REV.)



STRAIGHT & BENT NIPPLES THAT ARE HYD: TESTED AT SHOPS. (WHETHER THEY REQUIRE ANY ALLOWANCE OR NOT)

NOTE: 1. FOR VALUES OF T BY FOR DIFFERENT SIZES OF NIPPLES AT VARIOUS TEST PRESSURES REFER DRG. No 40-B-000-2837.

2. IN CASE THE THICKNESS REQUIRED FOR THE DUMMY
END COVER IS MORE THAN 25mm THE INSIDE HEIGHT
OF MACHINING (WHICH IS NOW 10mm) WILL BE INCREASED
ACCORDINGLY.

△ MICROFILMED ON 4/2/71

ROLL 00037 FRAME 53

PREPARED BY

CHECKED BY.

Quantum

2. intergroup

40-B-006-2899

CHAPTER A4 - PROCEDURE FOR WELDER QUALIFICATION

SECTION A4.1-PROCEDURE FOR WELDER QUALIFICATION FOR NON-IBR APPLICATIONS

1.0 SCOPE:

1.1 This chapter details the procedure for qualification of welder and performance monitoring.

2.0 CONTENTS:

1. Qualification of Welder.
2. Table- A6.1 - Welder Qualification Requirements for non-IBR applications.
3. Figure-A6.1 - Structural Tack Weld Specimen.
Figure- A6.2 - Break test.
Figure- A6.3 - Weld Positions.
Figure- A6.4 - 6G position
Figure- A6.5 - Flat position
Figure- A6.6 - Vertical position
Figure- A6.7 - Horizontal position
Figure- A6.8 - Overhead position
Figure- A6.9- Plate Butt Weld Specimen.
Figure- A6.10- Pipe Butt Weld Specimen.
4. Record of Welder Performance Qualification Tests.
5. Welder performance monitoring.

SECTION A4.2-QUALIFICATION OF WELDER

1.0 BASE METAL:

1.1 For selection refer Tables provided in Chapter II (Base Materials) of this manual.

2.0 TEST COUPON:

2.1 Depending on the range to be qualified, choose the appropriate test coupon from Table – A6.1

2.2 For plate butt welds, details of edge preparation shall be as per Figure-A6.9.

2.3 For pipe butt welds, details of edge preparation shall be as per Figure-A6.10.

2.4 For structural tack welds, refer Figure-A6.1.

3.0 REQUIREMENT OF TESTS:

3.1 For Structural Tack Welders:

3.1.1 Break Test as per Figure-A6.2.

3.2 For Plate and Pipe Butt welders:

3.2.1 100 % Radiographic examination of test welds shall be carried out. Procedure and acceptance criteria shall be as per NDE Manual (BHEL:PS:NDEM – Latest)

4.0 ESSENTIAL VARIABLES :

4.1 Changes to the following variables require requalification.

4.1.1 **Process:** Example: Change from GTAW to SMAW or vice versa.

4.1.2 **Joint:** A change from one type of bevel to another. Example: 'V' bevel to 'U' bevel.

4.1.3 **Base Metal :**A change in thickness or pipe diameter beyond the limits as prescribed in Table- A6.1

4.1.4 **Filler Metal:**A change from one F number to another F-number, except as specified in Table-A6.1.

4.1.5 **Positions:**This procedure envisages qualification of welders to perform in all positions. Deviation to this is not recommended.

4.1.6 **Gas:**This procedure envisages test to pre-prescribed gas as for production welds. Deviation to this is not recommended.

4.1.7 Electrical Characteristics:

a) AC to DC and vice versa.

b) In DC, DCEN (Electrode Negative) to DCEP (Electrode Positive) and vice versa.

4.1.8 **Technique:** This procedure envisages only use of uphill progression technique.

Acceptance Criteria:

Structural Tack Welding:

- No cracks.
- No lack of fusion.
- Undercut not exceeding 1 mm.
- Not more than 1 porosity (max. diameter of porosity 2 mm).

Plate/Pipe Welding:

Visual Inspection:

- a) No cracks.
- b) No lack of fusion or incomplete penetration.
- c) Not more than 1 porosity in a length of 100 mm of length of weld (max. porosity diameter 2mm).

5.0 VALIDITY:

- 5.1 When a welder meets the requirements of this procedure, the validity will be for a maximum of 2 years from the date of test, limited to validity specified by statutory authority, as applicable. The validity may be extended by one year each time, based on satisfactory performance, with sufficient back up records.

6.0 REQUALIFICATION :

- 6.1 Requalification is required for the following :
- a) Where there is a specific reason to doubt the skill of the welder.
 - b) Due to non-engagement of the welder for a continuous period of 6 months.

7.0 RECORDS:

The welding in charge at site shall maintain the following records:

- a) Record of Welder Performance qualification Test (as per Annexure V).
- b) Register of qualified welders (employer-wise) containing the following details:
 - 1) Name of welder.
 - 2) Age.
 - 3) Tested for pipe / tube / plate / tack.
 - 4) Performance Test No.
 - 5) Validity.
 - 6) Welder Code.
 - 7) Remarks.

The above register shall be updated for deletions also. Copies of welder identity card (including details as in 7 b and relevant variables qualified) and pertinent radiography reports.

8.0 ENCLOSURES :

1. Table –A6.1: Welder Qualification Requirements.
2. Record of Welder Performance Qualification Test.
3. Figure-A6.1: Structural Tack Weld Specimen.
4. Figure-A6.2: Break Test.
5. Figure-A6.3: Weld Positions.
6. Figure- A6.4 - 6G position
7. Figure- A6.5 - Flat position
8. Figure- A6.6 - Vertical position
9. Figure- A6.7 - Horizontal position
10. Figure- A6.8 - Overhead position
11. Figure-A6.9: Plate Butt Weld Specimen.
12. Figure-A6.10: Pipe Butt Weld Specimen

ANNEXURE - V: RECORD OF WELDER PERFORMANCE QUALIFICATION TEST

WELDER/TACK WELDER QUALIFICATION TEST RECORD -NON IBR										
Site :			Test Record No. :			 Joint Details  Affix welder photo				
Contractor Name :			DATE :							
NAME Sri.										
ID NO :										
WPS No. :			Rev :							
Variables			Recorded Actual values used in Qualification			Qualification Range				
Process / Type										
Electrode (Single or Multiple)										
Current / Polarity										
Position										
Weld Progression										
Backing										
Material / Specification			to							
Thickness : (Plate)										
Groove										
Fillet										
Thickness : (Pipe / Tube)										
Groove										
Fillet										
Diameter : (Pipe)										
Groove										
Fillet										
Filler Rod / Electrode										
SFA No										
AWS Class										
F.No										
Gas / Flux Type :										
Pre-heat temp :			Inter-pass Temp :			Post-heat Temp :				
VISUAL INSPECTION										
ACCEPTABLE :		YES		or		NO		DATE :		
Guided Bend Test Results										
Type		Result		Type		Result				
Fillet Test Results										
Appearance						Fillet Size				
Fracture Test root Penetration						Macroetch				
Inspected by						Test Number				
Organization						Date				
RADIOGRAPHIC TEST RESULTS										
Report No/Date			Result			Report No/Date			Result	
Reviewed by						Reviewer Level :				
NDT Company Name :						Date				
We certify that the statement in this record is correct and that the test weld were prepared, welded and tested in accordance with requirements.										
This is valid upto										
Contractor :			Signature :			Date :				
BH&L :			Signature :			Date :				
Customer :			Signature :			Date :				

TABLE – A6.1
WELDER QUALIFICATION REQUIREMENTS (FOR NON-IBR APPLICATIONS)

Sl. No.	Test For	Base ⁶ Metal Note 1	Test Coupon Dimension OD, t	Electrode ⁶ to be used Note 2, 4	Weld Positions	Reference Figure	Range Qualified Dia. & T	Position Qualified	Electrode Qualified Note 2, 4
1	Structural tack	P1 Gr 1	t=10mm or 12mm	(E6013) F2 (E7018) F4	3F&4F 3F&4F	Fig. A6.1 A6.2 & A6.3	T-Unlimited T-Unlimited	All All	F2, F1 F4 & Below
2	Plate Welder (Structural)	- do -	t≥25mm	F4	3G & 4G	Fig.A6.7 & A6.8	T≥3.0 mm*	All	F4 & Below
			t<25mm	F4	3G & 4G		T>3.0 mm*≤2t	All	F4 & Below
3	Plate Welder (Other than structural)	- do -	t≥13mm	F4	2G, 3G & 4G	Fig.A6.6 , A6.7 & A6.8	T-Unlimited OD≥600mm	All	F4 & Below
			t<13mm	F4	2G, 3G & 4G		T≤2t OD≥600mm	All	F4 & Below
4	Pipe/Tube Welder	- do -	OD<25mm	F4	6G	Fig.A6.4	Test piece Dia.& above 25mm & above 73mm & above	All	F4 & Below
			OD≥25mm &≤73mm	F4	6G			All	F4 & Below
			OD>73mm	F4	6G			All	F4 & Below
			t<13mm	F4	6G		T≤2t	All	F4 & Below
			t≥13mm	F4	6G		T-Unlimited	All	F4 & Below

* Also qualifies for welding fillet welds on material of unlimited thickness.

TABLE – A6.1 (contd...)

NOTES:

1. For P grouping refer Chapter II.
2. For F grouping refer Chapter III.
3. Base material limitation:
 - a. Where test coupons belong to P1 thro' P15E, welder is qualified for base materials P1 thro' P15E.(ASME Sec IX QW 423, Alternate base material for welder qualification)
It means, if a welder is qualified with carbon steel material, he is also qualified for alloy steel and vice versa.
 - b. Use appropriate F group electrodes.
4. Qualification in one F number, qualifies for that F-number only, except as stated below in A, B, C & D.
 - A. Qualification in F4 qualifies for F4 and below.
 - B. Qualification in F5 qualifies for F5 only.
 - C. Qualification in any of F41 thro' F45 qualifies for F41 thro' F45.
 - D. For non-ferrous materials, the base materials shall be typical of production material and appropriate filler materials shall be selected. Qualification is limited to the base material, process and filler F group. Diameter and thickness limitations apply as per Table –A6.1

OD = outer diameter, t = thickness of test coupon; T = thickness qualified.
5. Where qualification is for GTAW followed by SMAW, the welder is also qualified up-to 6 mm thickness by GTAW process.
6. Base material indicated is carbon steel; for other base materials, corresponding electrodes are to be chosen. Also for GTAW process, the corresponding filler wire should be chosen.

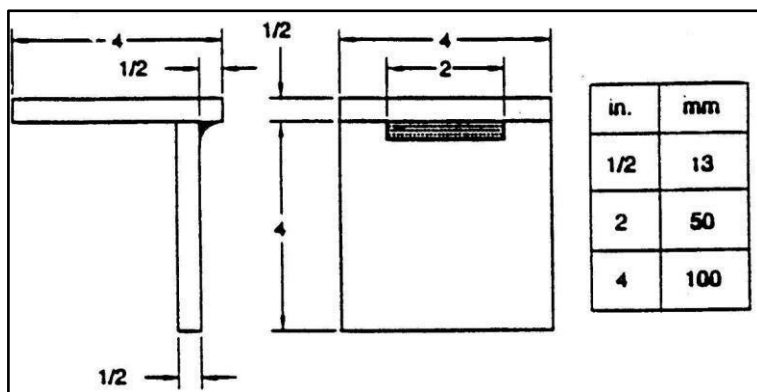


Figure A6.1 – Structural Tack Weld Specimen

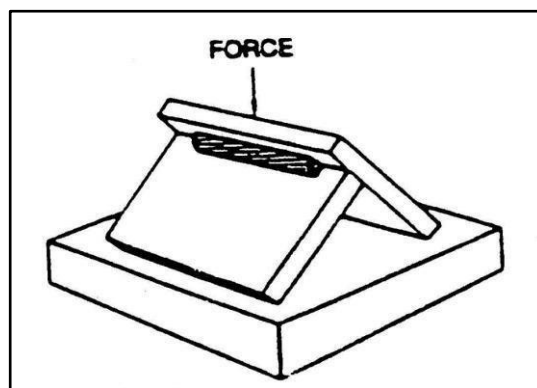


Figure A6.2 – Break Test

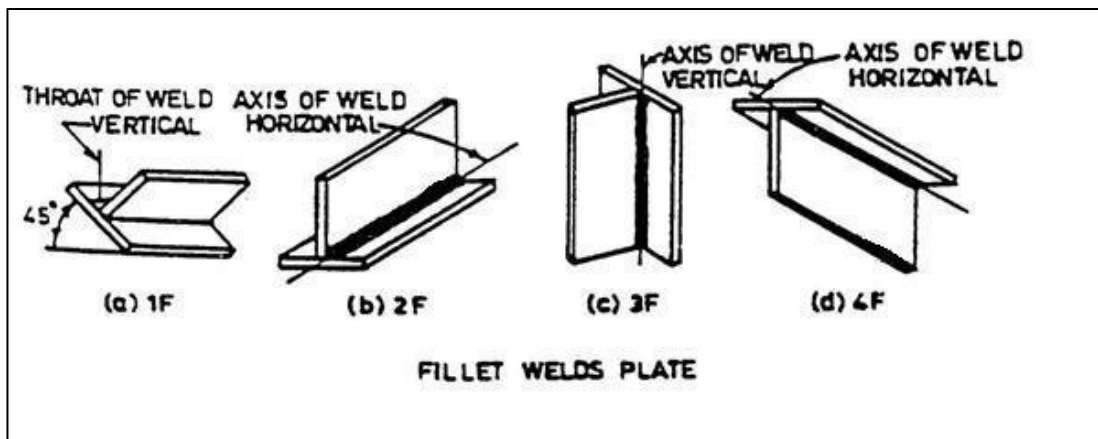


Figure A6.3 - Weld Positions

SECTION A4.3-PROCEDURE FOR WELDER QUALIFICATION FOR IBR APPLICATIONS

1.0 SCOPE

- 1.1 These requirements shall apply to testing of welders/welding operators engaged in the manufacture and welding connected with site fabrication, erection and repair of boilers and piping of ferrous material under the purview of IBR.

2.0 DEFINITION

Welder: one who performs manual or semiautomatic welding.

3.0 ENGAGING OF CERTIFIED WELDERS

All welders engaged on welding of boilers or piping under fabrication, erection and repair at site shall possess a valid certificate as required by IBR, as per Form XIII issued by the Competent Authority under IBR.

4.0 QUALIFICATION TEST AND ISSUE OF CERTIFICATE

Every welder shall be duly tested and qualified at site to the satisfaction of BHEL/Customer. Every welded test piece for the examination of welders/welding operator shall be stamped by BHEL with an identification mark on either side of the weld. After satisfactory completion of the tests, BHEL shall issue a Certificate/ID Card to each Qualified Welder as per the Format given in Figure no. A6.9.

4.1 Each welder shall have basic knowledge on the following:

- i. Weld edge preparation
- ii. Working of welding equipment.
- iii. Properties of material to be welded – cold and hot working, thermal conductivity, fusion point, oxidation (for welders engaged in alloy steel welding).
- iv. Electro-technical principles viz. kinds of current, striking arc voltage, welding arc voltage, etc.
- v. Weld defects, their causes and prevention.
- vi. Electrodes for different types of materials, welds and joints in different positions.

4.2 MATERIAL FOR TESTS – The material of plates, tubes, pipes and electrodes used for these tests shall conform to the requirements given below:

4.2.1 TEST WELDS FOR QUALIFICATION

(a) PLATE WELDING –

- i. One weld joint of two pieces of boiler quality plates with double 'V' or double 'U' grooves over a minimum length of 300 mm shall be made in the following positions (size of plates to be welded being not less than 229 mm x 381 mm x 16 mm each):
 - (1) Flat position (figure A6.5) - Plate in a horizontal plane with the weld metal deposited from above.

- (2) Horizontal Position (figure A6.6) – Plate in a vertical plane with the axis of the weld horizontal.
- (3) Vertical Position (figure A6.7)- Plate in a vertical plane with the axis of the weld vertical
- (4) Overhead Position (figure A6.8) – Plate in a horizontal plane with the weld metal deposited from underneath.

Qualification in Horizontal position shall automatically qualify Flat position. Qualification in Vertical position shall automatically qualify Flat and Horizontal positions. Also, qualification in Overhead position shall automatically qualify Flat, Horizontal and Vertical positions.

(b) For Pipe Welding –6G-Position:

Tube/Pipe with its axis inclined at 45 Deg. to horizontal. Welding shall be done without rotating the Tube/ pipe. Refer FigureA6.4.

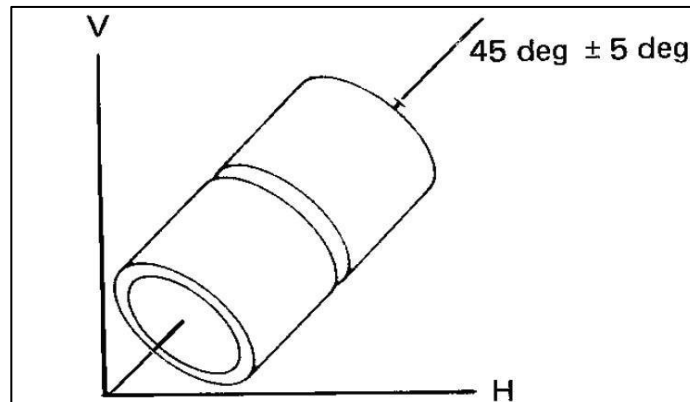


Figure A6.46G-Position

5.0 VALIDITY OF CERTIFICATE

- a) Certificate issued to a welder shall remain valid for a period of twenty-four months from the date of issue, provided that the welder has, subsequent to the test, been continuously (gap not more than six months) employed on the class and type of work for which he is qualified.
- b) The certificate may be extended, after the validity period, for another twenty-four months after conducting the re-qualification tests in-line with the initial Qualification tests.
- c) In case of unsatisfactory performance of the Certified Welder as observed by the site engineer, the welder shall be re-qualified as per the requirements prior to engaging in subsequent welding works.
- d) A welder qualified for a type and process of higher grade of steel can be allowed to weld the lower grade of steel.
- e) A welder qualified on groove weld shall automatically qualify for fillet and socket welds.

6.0 EXAMINATION OF TEST SPECIMENS FOR QUALIFICATION TESTS

- (a) The test specimens shall be visually examined as per Cl 6.0 of Chapter A7 of this Manual.
- (b) After visual examination, the test specimen shall be subjected to radiographic examination as per the requirements specified in NDE Manual (BHEL:PS:NDEM-Latest).

7.0 MAINTENANCE OF RECORDS

Records of Qualified welders shall be maintained by the site engineer till the closure of the project. At the time of project closure, these records shall be handed over to the customer, if required by the Contract.

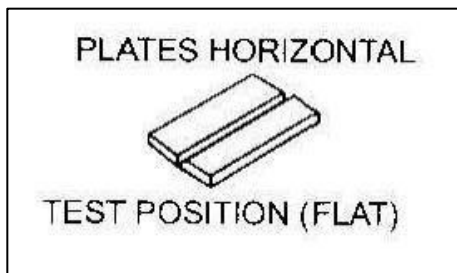


Figure A6.5 Flat position

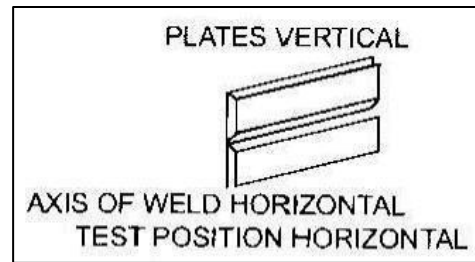


Figure A6.6 Horizontal Position

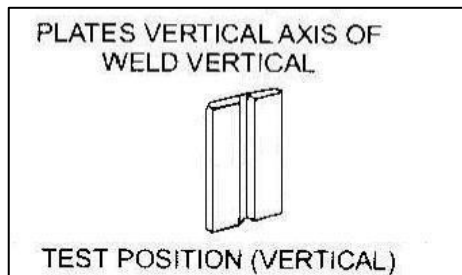


Figure A6.7 Vertical Position

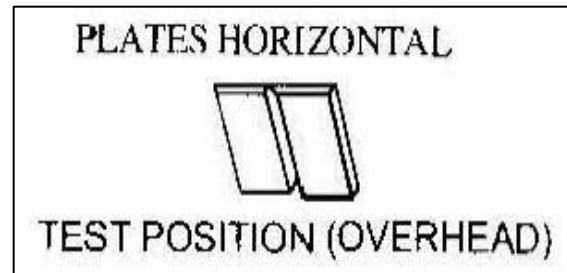


Figure A6.8 Overhead Position

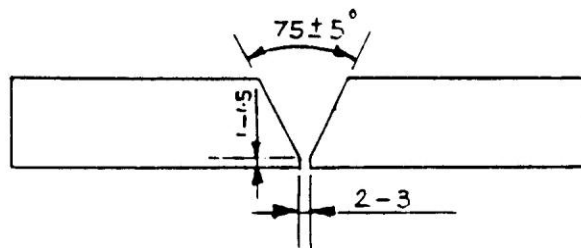
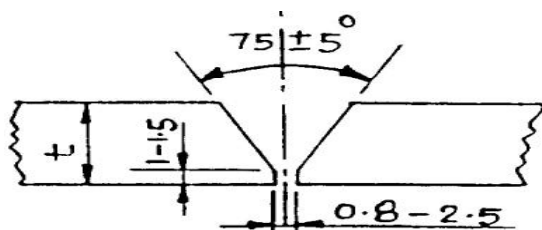
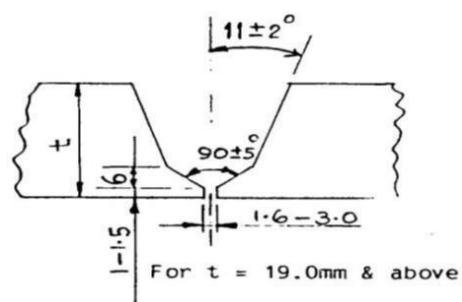


Figure A6.9- Plate butt weld specimen



(A) for T upto 19 mm



(B) For T = 19.0mm & Above

Figure – A6.10 – Pipe Butt Weld Specimen

WELDER PERFORMANCE QUALIFICATION (WPQ)- For IBR				Affix the Welder Recent Photo	
Performance Test No. :		Date :			
Welder's Name :			ID No. :		
Contractor :					
<u>Test Description</u>					
Identification of WPS followed				Type :	
Test Coupon(TC) /Production Weld (PW):		Welding process(es) used :			
Specification of base metal (s)				Thickness :	
<u>Testing Conditions and Qualification Limits</u>					
Welding Variables		Actual Values		Range Qualified	
Backing (metal, weld metal, double welded, flux)					
Pipe Diameter					
Base metal P-No or Code case to P.No or Code case					
Filler metal or Electrode SFA No					
Filler metal or Electrode Classification					
Filler metal or Electrode F.Number					
Deposit thickness for each process					
Position Qualified					
Vertical progression (Uphill or downhill)					
Inert gas backing for GTAW					
Current type / polarity					
<u>RESULTS</u>					
Guided Bend Test :					
Type	Result	Type	Result	Type	Result
N.A	N.A	N.A	N.A	N.A	N.A
N.A	N.A	N.A	N.A	N.A	N.A
Visual examination results		ACCEPTABLE			
Radiographic test results		Lab.Name			
Fillet Weld - Fracture test		Length & %age of defects			
Macro examination		Fillet size			
Concavity/convexity					
Welding test conducted by					
Welding test witnessed by					
We certify that the statements in this record are correct and that the test coupons were prepared, welded and tested in accordance with the requirements.					
This is valid up to					
CONTRACTOR			BHEL		
Name :					
Signature :					
Date :					
Engineer			Erection Engineer		

Figure A6.11: BHEL issued Welder Qualification Certificate

SECTION A4.4-WELDER PERFORMANCE MONITORING

1.0 PURPOSE:

- 1.1 This procedure deals with monitoring the performance of welders engaged at sites.
This procedure is applicable where radiography is performed.

2.0 PROCEDURE:

- 2.1 The welder performance shall be monitored on a calendar month basis.
 - 2.2 Extent of radiography shall be representative of weekly outputs of the welder.
 - 2.3 Quantum of radiography shall be as per contractual requirements.
 - 2.4 Evaluation of welds radiographed shall be as per NDE manual or other documents as specifically applicable.
 - 2.5 **Welder performance evaluation:**
 - 2.5.1 **For welds having diameter ≤ 88.9 mm:**
 - 2.5.1.1 The percentage of defects shall be calculated as a percentage of number of unaccepted welds to those radiographed.
 - 2.5.1.2 Upto and including 5% defects: Performance is satisfactory else unsatisfactory.
 - 2.5.2 **For welds having diameter >88.9 mm and plate welds:**
 - 2.5.2.1 The percentage of defects shall be calculated as a percentage of length of defects to the length radiographed.
 - 2.5.2.2 Upto and including 2.5% defects: performance is satisfactory else unsatisfactory.
 - 2.6 When a welder gives unsatisfactory performance for a continuous period of 3 months, he shall be re-qualified.
 - 2.6..1 Requalification of welder shall be called for when there is a specific reason to question his ability to make acceptable welds. This shall override requirements of clause 2.6.
 - 2.7 Welds produced during any month shall be radiographed and evaluated latest by 10th of the succeeding month.
 - 2.7..1 Under circumstances when clause 2.7 is not satisfied for any particular welder, he may be disengaged from the job till such time his performance is evaluated for the month in study.
 - 2.7..2 Site in-charge may waive the restriction imposed in 2.7.1 reviewing the situations for non-compliance with Cl.2.7 and may allow engagement of the welder in question for a period not exceeding one successive month to the month in study.
- ### 3.0 RECORDS:
- 3.1 Welding in-charge shall prepare and maintain Welder Performance Records, welder-wise as per the Annexure VI.

ANNEXURE VI: WELDERS PERFORMANCE MONITORING RECORD

[illegible]

Note : 1. Upto and including 5% defects., performance is satisfactory else unsatisfactory.

2. Upto and including 2.5% defects, performance is satisfactory else unsatisfactory.

CHAPTER – A5
INSPECTION OF WELDING

1.0 SCOPE:

- 1.1 This procedure provides details for performing visual inspection of weld fit-ups, welding in progress and completed welds.

2.0 REFERENCE:

- 2.1 Contract drawings.
2.2 Field Welding Schedule (supplied by Units) or equivalent.
2.3 Welding Procedure Specification, where supplied.
2.4 Indian Boiler Regulations (for boilers erected in India)

3.0 GENERAL REQUIREMENTS:

- 3.1 Ensure that the components to be welded are in accordance with the contract drawings, Welding Schedule and other relevant documents.
3.2 The condition of welded surfaces to be inspected shall be clean and dry.
3.3 There shall be sufficient lighting to allow proper interpretation of visual inspection.

4.0 WELD FIT-UP INSPECTION:

- 4.1 The surface to be welded shall be smooth and free from deep notches, irregularities, scale, rust, oil, grease and other foreign materials.
4.2 Positive Material Identification (PMI) shall be carried out for all alloy steel and stainless steel materials for the parent metal before fit-up and for weld after welding. However, in case of tubes random PMI check shall be done on the parent metal and on 10% of the welds made by each welder per day. The procedure recommended by the PMI equipment manufacturer shall be followed for testing.
4.3 Piping, tubing and headers to be joined shall be aligned within allowable tolerances on diameters, wall thicknesses and out-of-roundness as below:

Maximum permissible misalignment at bore

Bore (mm)	Max. Misalignment (mm)	
	For GTAW	For SMAW
Up to 100	1.0	1.0
Over 100 to 300	1.6	1.6
Over 300	1.6	2.4

- 4.4 While fit up, components to be welded shall not show any appreciable off-set or misalignment when viewed from positions apart.
4.5 The root opening of components to be joined shall be adequate to provide acceptable penetration.
4.6 On fillet welds, the parts to be joined shall be brought as close to contact as practical, although in most instances a small opening between the parts is desirable.
4.7 Weld area shall be protected from drafts and wind, to maintain inert gas shield.

5.0 CHECKS DURING WELDING OPERATION:

- 5.1 Ensure the required minimum preheat temperature is maintained during welding. Preheating shall be done using resistance heating or induction heating or LPG burners. Preheating by cutting/ heating torches is not permitted.
- 5.2 Ensure correct electrode / filler metal is used for welding.
- 5.3 Tack welds shall be examined by the welder before they are incorporated in the final weld.
- 5.4 Ensure proper drying / holding of electrodes prior to use.
- 5.5 Ensure inter pass temperature mentioned in WPS is not exceeded during welding.
- 5.6 Ensure proper cleaning of weld between beads.

6.0 CHECKS ON THE COMPLETED WELD:

- 6.1 There shall be no visible cracks, pin-holes or incomplete fusion.
- 6.2 The weld surface must be sufficiently free of coarse ripples, grooves, overlaps, abrupt ridges and valleys, visible slag inclusions, porosity and adjacent starts and stops.
- 6.3 Undercuts shall not exceed 0.8 mm (0.4 mm for tubes) or 10% of wall thickness whichever is less.
- 6.4 Where inside surface is readily accessible, the same shall be inspected for excess penetration and root concavity. The permissible limits are given below:
 - Root concavity: max of 2.5 mm or 20% of thickness at weld, whichever is lesser, provided adequate reinforcement is present.
 - Excess penetration: up to and including 3.2 mm.
- 6.5 For plate butt welds, the weld reinforcement shall not exceed 3.2 mm.
- 6.6 For circumferential joints in piping and tubing the maximum weld reinforcements permitted are given below :

Maximum Permissible Reinforcements (ASME Sec I –PW 35)

Thickness of base metal in mm	Reinforcement in mm
Up to 3.0	2.5
Over 3 to 5	3.0
Over 5 to 13	4.0
Over 13 to 25	5.0
Over 25 to 50	6.0
Over 50	Max of 6.0 or 1/8 of weld width

- 6.7 There shall be no overlaps. The faces of fillet welds are not excessively convex or concave and the weld legs are of proper length.
- 6.8 In case of weld joints in pressure parts and joints like ceiling girder, the weld joint shall be suitably identified.

CHAPTER – A6
SAFE PRACTICES IN WELDING

(This is included for information purposes only)

1.0 This covers many of the basic elements of safety general to arc welding processes. It includes many, but not all, of the safety aspects related to structural welding. The hazards that may be encountered and the practices that will minimize personal injury and property damage are reviewed here.

2.0 Electrical Hazards

2.1 Electric shock can kill. However, it can be avoided. Live electrical parts should not be touched. Read and understand the manufacturer's instructions and recommended safe practices. Faulty installation, improper grounding, and incorrect operation and maintenance of electrical equipment are all sources of danger.

2.2 **All electrical equipment and the work-pieces should be grounded.** A separate connection is required to ground the work-piece. The work lead should not be mistaken for a ground connection.

2.3 To prevent shock, the work area, equipment, and clothing should be kept dry at all times. Dry gloves and rubber soled shoes should be worn. The welder should stand on a dry board or insulated platform.

2.4 Cables and connections should be kept in good condition. Worn, damaged or bare cables should not be used. In case of electric shock, the power should be turned off immediately. If the rescuer must resort to pulling the victim from the live contact, non-conducting materials should be used. A physician should be called and CPR continued until breathing has been restored, or until a physician has arrived.

3.0 Fumes and Gases

3.1 Many welding, cutting, and allied processes produce fumes and gases which may be harmful to one's health. Fumes and solid particles originate from welding consumables, the base metal, and any coating present on the base metal. Gases are produced during the welding process or may be produced by the effects of process radiation on the surrounding environment. Everyone associated with the welding operation should be aware of the possible effects of over-exposure to fumes and gases range from irritation of eyes, skin, and respiratory system to more severe complications. Effects may occur immediately or at some later time. Fumes can cause symptoms such as nausea, headaches, dizziness, and metal fumes fever. Sufficient ventilation, exhaust at the arc,

or both, should be used to keep fumes and gases from breathing zones and the general work area.

4.0 Noise

- 4.1 Excessive noise is a known health hazard. Exposure to excessive noise can cause a loss of hearing. This loss of hearing can be either full or partial, and temporary or permanent. Excessive noise adversely affects hearing capability. In addition, there is evidence that excessive noise affects other bodily functions and behaviour. Personal protective devices such as ear muffs or ear plugs may be employed. Generally, these devices are only accepted when engineering controls are not fully effective.

5.0 Burn Protection

- 5.1 Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting and allied process. These can cause burns if precautionary measures are not used.
- 5.2 Workers should wear protective clothing made of fire resistance material. Pant cuffs or clothing with open pockets or other places on clothing that can catch and retain molten metal or sparks should not be worn. High top shoes or leather leggings and fire resistant gloves should be worn. Pant legs should be worn over the outside of high top boots. Helmets or hand shields that provide protection for the face, neck, and ears, should be worn, as well as head covering to protect. Clothing should be kept free of grease and oil. Combustible materials should not be carried in pockets. If any combustible substance is spilled on clothing it should be replaced with fire resistance clothing before working with open arc or flame.
- 5.3 Appropriate eye protection should be used at all times. Goggles or equivalent also should be worn to give added eye protection.
Insulated gloves should be worn at all times when in contact with hot items or handling electrical equipment.

6.0 Fire Prevention

- 6.1 Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting, and allied processes. These can cause fire or explosion if precautionary measures are not used.
- 6.2 Explosions have occurred where welding or cutting has been performed in spaces containing flammable gases, vapours, liquid, or dust. All combustible material should be removed from the work area. Where possible, move the work to a location well

away from combustible materials. If neither action is possible, combustibles should be protected with a cover or fire resistant material. All combustible materials should be removed or safely protected within a radius of 35 ft. (11m) around the work area.

- 6.3 Welding or cutting should not be done in atmospheres containing dangerously reactive or flammable gases, vapours, liquid, or dust. Heat should not be applied to a container that has held an unknown substance or a combustible material whose contents when heated can produce flammable or explosive vapours. Adequate ventilation should be provided in work areas to prevent accumulation of flammable gases, vapours or dusts. Containers should be cleaned and purged before applying heat.

7.0 Radiation

- 7.1 Welding, cutting and allied operations may produce radiant energy (radiation) harmful to health. Everyone should acquaint themselves with the effects of this radiant energy.
- 7.2 Radiant energy may be ionizing (such as X-rays) or non-ionizing (such as ultraviolet, visible light, or infrared). Radiation can produce a variety of effects such as skin burns and eye damage, if excessive exposure occurs.
- 7.3 Some processes such as resistance welding and cold pressure welding ordinarily produce negligible quantities of radiant energy. However, most arc welding and cutting processes (except submerged arc when used properly), laser welding and torch welding, cutting, brazing, or soldering can produce quantities of non-ionizing radiation such that precautionary measures are necessary.
1. Welding arcs should not be viewed except through welding filter plates.
 2. Transparent welding curtains are not intended as welding filter plates, but rather, are intended to protect passersby from incidental exposure.
 3. Exposed skin should be protected with adequate gloves and clothing as specified.
 4. The casual passersby to welding operations should be protected by the use of screens, curtains, or adequate distance from aisles, walkways, etc.
 5. Safety glasses with ultraviolet protective side shields have been shown to provide some beneficial protection from ultraviolet radiation produced by welding arcs.

CHAPTER – B1
ERECTION WELDING PRACTICES FOR
SA335 P91/P92, SA182 F91/F92 &
SA217 C12A MATERIALS

1.0 SCOPE:

- 1.1. This document details out the practices to be adopted during erection of SA335 P91/P92,SA182 F91/F92 and SA 217 C12A materials.

2.0 MATERIAL:

- 2.1 Pipe materials shall be identified as follows:-
- 1) Colour codes given by the MUs.
 - 2) Hard Stamping: Specification, Heat No, Size.
 - 3) Paint / Stencil: WO DU, as per the relevant drawing & document.
- 2.2 When any defect like crack, lamination, and deposit noticed during visual examination the same shall be confirmed by Liquid Penetrant Inspection. If confirmed, it shall be referred to unit.

3.0 ERECTION:

3.1 Edge Preparation and fit up:

- 3.1.1 Cutting of P91/P92/F91/F92 material shall be done by band saw / hacksaw / machining / grinding only.Edge preparation (EP) shall be done by grinding/machining. During machining /grinding, care shall be taken to avoid excessive pressure to prevent heating up of the pipe edges.
- 3.1.2 All Edge Preparations done at site shall be subjected to Liquid Penetrant Inspection (LPI). Weld build-up on Edge Preparation is prohibited.
- 3.1.3 The weld fit-up shall be carried out properly to ensure proper alignment and root gap. Neither tack welds nor bridge piece shall be used to secure alignment. Partial root weld of minimum 25mm length by GTAW at minimum 4 locations and fit-up by a clamping arrangement is recommended. Use of site manufactured clamps for fit up is acceptable.The necessary purging and preheat shall be done as per clause 3.3 and 5.0 respectively. Welding shall be done employing IBR qualified welders only.
- 3.1.4 The fit-up shall be as per the drawing. Root gap shall be 2 to 2.5mm and root mismatch shall be within 1.6mm. Suitable reference punch marks shall be made on both the pipes (at least on three axis).
- a) At 200 mm from the EP for UT.
 - b) At 1000 mm from the EP for identifying weld during PWHT.

3.2 Fixing of thermocouple (TC) and heating elements during preheating and PWHT:

- 3.2.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest),Chapter 1, Clause no. 3.1.1, 3.1.5, 3.2.1, 3.2.2&3.2.6shall be referred for guidelines for fixing of thermocouples and heating elements on the jobs

3.3 Arrangement for purging:

- 3.3.1 Argon gas conforming to Gr 2 of IS 5760 (latest) shall be used for purging the root side of weld. The purging dam (blank) shall be fixed on either side of the weld bevel prior to pre-heating. The dam shall be fixed inside the pipe and it shall be located away from the heating zone. Purging shall be done for root welding (GTAW) followed by two filler passes of SMAW in case of butt welds. Purging is not required in the case of nozzle and attachment welds, when they are not full penetration joints.
- 3.3.2 The flow rate which shall be maintained during purging is 10 to 26 litres/minute. Purging shall be started from inside of pipe when root temperature reaches 220°C. Continuous and adequate Argon Gas shall be provided to ensure complete purging in the root area. The minimum pre-flushing time for purging before start of welding shall be 5 minutes, irrespective of the pipe size.
- 3.3.3 Wherever possible, solid purging gas chambers shall be used which shall be removed after welding. If not possible, only water-soluble paper is to be used. Plastic foils that are not water-soluble are NOT acceptable.
- 3.3.4 **Using Aluminium dam arrangement:**

In order to retain the Argon gas at the inside of the pipe near root area of the weld joint, the purging dams made of Aluminium (or other suitable material like mild steel) and permanent gaskets may be provided during the weld fit-up work similar to one as indicated in the Figure B2.1. The Aluminium discs shall be firmly secured with a thin wire rope. After completion of the root welding followed by two filler passes, the disc shall be pulled outwards softly.

CAUTION: ENSURE REMOVAL OF PURGE DAM ARRANGEMENT AFTER WELDING

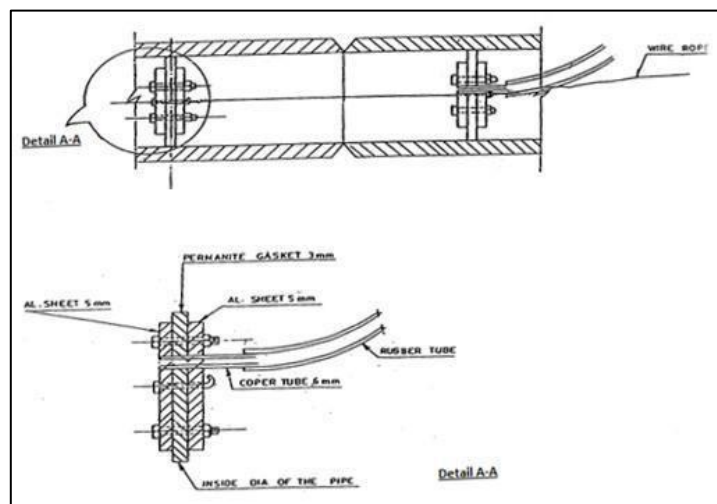


Figure B2.1

3.3.5 Using water soluble paper:

The dams can be made of water-soluble paper/water soluble tissue paper for creating the purging chamber. The advantage in such dam arrangement is that dissolving in water can flush the dams. The following are different methods used.

The Purge damming process illustrated as below:

- 3.3.5.1. For small diameter pipes, simply stuff water soluble paper/water soluble tissue paper into each section to be joined (Refer Figure B2.2).

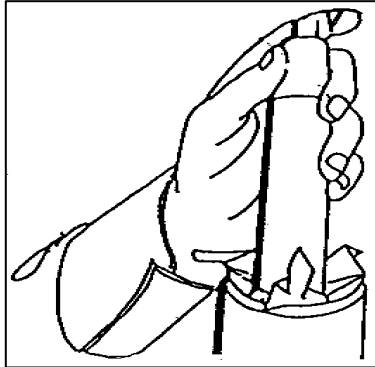


Figure B2.2

- 3.3.5.2. For larger pipes, cut out a circular aluminium foil disc slightly larger than the diameter and shape it to the inside pipe circumference. (A small hole may be punched in the paper to ensure complete evacuation of air when purging) (Refer Figure B2.3).

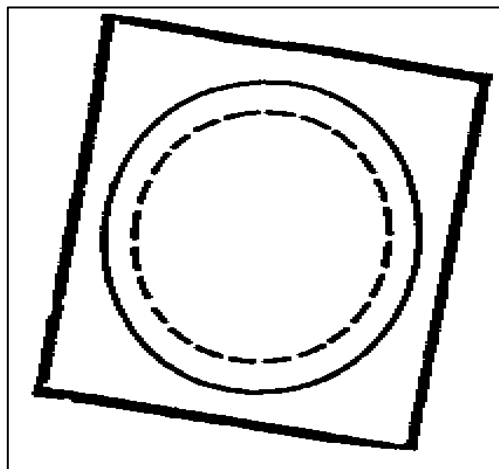


Figure B2.3

- 3.3.5.3. Position the disc within the pipe and tape in place with water soluble paper. Repeat procedure for other section. Insert the backing gas into the joint with a needle valve and make root pass in the usual manner (Refer Figure B2.4).

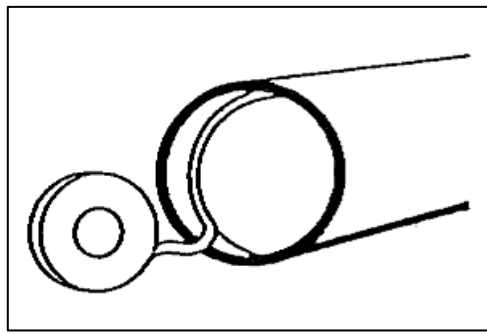


Figure B2.4

- 3.3.5.4. For pipes larger than 508 mm diameter, simply splice two sheets of water soluble paper together with water soluble tape as per Figure B2.5 and repeat procedure as shown in Figure B2.3 and B2.4 above.

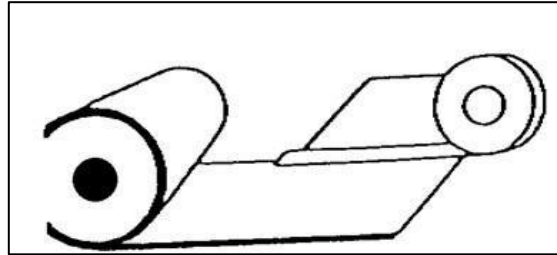


Figure B2.5

4.0 WELDING / WELDERS QUALIFICATION:

Welders Qualified as per IBR and qualified at site with Gr.91/Gr.92 material only shall be engaged. Welders log book shall be maintained and welders performance shall be monitored by site engineer. The applicable WPS as per FWS shall be followed for welder qualification and welding.

5.0 PREHEATING:

Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest), Chapter 1, Clause 3.1 shall be referred for guidelines for preheating.

6.0 WELDING:

- 6.1 Root Welding shall be done using GTAW process (as per WPS) five minutes after the start of argon purging. Filler wire shall be cleaned and free from rust or oil. Argon Purging shall be continued till minimum two filler passes of SMAW.
- 6.2 The inter-pass temperature shall not exceed 350°C. After completion of welding bring down the temp to 80–100°C and hold it at this temperature for one hour minimum. The PWHT shall commence after completing one hour of holding.

7.0 STORAGE OF WELDING CONSUMABLES:

Refer Chapter A3, Section A-3.4 of this Manual for guidelines which shall be followed for receipt, storage, drying & holding and issue of welding consumables.

CAUTION: No LPI / Wet MPI/UT shall be carried out on weld before PWHT

8.0 POST WELD HEAT TREATMENT:

8.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, Clause no. 3.2 shall be referred for guidelines on PWHT. In addition, the below requirements and precautions shall also be followed:

8.2 Welding and PWHT shall be monitored every one hour by site authorized personnel.

8.3 Preventive measures during power failure and non-functioning of equipment: No interruption is allowed during welding and PWHT. Hence all the equipment for the purpose of power supply, welding, heating etc., shall have alternative arrangements. (Diesel generator for providing power to the welding and heating equipment, standby welding and heating equipment, reserve thermocouple connections, gas burner arrangement for maintaining temperature etc.). Following preventive measures shall be adopted until normal power supply or backup power supply through diesel generator is restored.

8.3.1 Interruption during start of preheating:

In case of any power failure/interruption during preheating, the weld fit-up shall be insulated and brought to room temperature. After the electric supply resumes the joint shall be preheated as per Clause No: 5.0.

8.3.2 Interruption during GTAW / SMAW:

Maintain a preheat temperature of 220°C minimum using LPG gas burners till the welding is restarted. In case, preheat temperature is not maintained, an inter-stage stress relieving shall be carried out followed by visual inspection to ensure that no surface cracks are present in the weld, prior to restart of the welding.

8.3.3 Interruption during cooling cycle: After SMAW welding completion and cooling to holding temperature at 80 to 100°C, care shall be taken to avoid faster cooling rate by providing adequate insulation. The required temperature of 80 – 100°C shall be maintained by gas burner arrangements till power resumes / start of PWHT (within 8 hours).

8.3.4 Interruption during post weld heat treatment; Heat treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, clause no. 3.2.5 shall be referred for guidelines to be followed for interruption during PWHT.

8.3.5 In all the above cases (8.3.1 to 8.3.4), the temperature measurement on the weld joint shall be recorded using calibrated gauges/instruments at regular intervals of 15 minutes in the log book by Site Engineer.

8.4 Caution:

The PWHT temperature recorded in the chart shall not deviate from the specified values since any deviations to the specified soaking temperature Range, will adversely affect the mechanical properties of the weldment and may lead to rejection of the weldment. The weld Joints should be kept dry and no water/liquid is allowed to come in contact with the weld or preheated portion of pipe under any circumstances, till PWHT is completed.

9.0 CALIBRATION:

All equipment like recorder, thermocouple, compensating cable, oven thermostat etc. shall have valid calibration carried at BHEL approved laboratories. The calibration reports shall be reviewed and accepted by welding In-charge at site prior to use.

10.0 NONDESTRUCTIVE EXAMINATION (Refer NDE Manual AA/CQ/GL/011/ Part III- NDEM latest):

10.1 All NDE shall be done after PWHT only. Prior to testing all welds shall be smoothly ground. All welds (fillet & butt) shall be subjected to MPI (MPI shall be done by YOKE type only). In addition to MPI, butt-welds and all full penetration welds shall be examined by UT.

UT procedure shall be as per BHE: NDT: PB: UT21 with additional requirements as in (a) through (e):

- a) The calibration blocks used shall be of the same product form and material specification or equivalent P-Number grouping as one of the materials being examined. P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent for this purpose.
- b) The UT equipment shall be calibrated prior to use and should be of 'digital type' capable of storing calibration data as well as ultrasonic test results as per procedure number BHE: NDT: PB: UT-21.
- c) All recordable indications shall be stored in memory of – either the digital flaw detector or a PC for review at a later period.
- d) The equipment calibration data for specific weld as well as the hard copy of 'Static echo-trace pattern' – showing the flaw-echo amplitude with respect to DAC, flaw depth, projection surface distance (probe position) and beam-path shall be attached to UT test report. This hard-copy of echo-trace with equipment calibration data shall form part of test documentation.
- e) The examination as well as evaluation shall be performed by a qualified Level II personnel, and a test report shall be issued. Any defect noticed during NDT shall be marked with marker.

11.0 REPAIR OF WELD JOINTS:

11.1 Weld repair at root:

If any surface defect is revealed at the time of visual inspection during root welding, the following steps shall be followed:

1. Maintain the temperature at 80-100°C for 1 hour.
2. Perform inter-stage PWHT.
3. Remove the defect by grinding.
4. After complete removal of defect, preheat the weld area to 220°C minimum and re weld with GTAW before starting SMAW, if required.

11.2 Weld repair on completion:

11.2.1 Any defect observed on the weld shall be brought to the notice of Site engineer. Any repair on weld shall be carried out with their approval only.

11.2.2 If any defects are noticed on the fully completed weld while performing UT after completion of PWHT, the depth of the defect shall be located from the weld outside surface. The defect area shall be marked and repaired as below:

- a) The weld shall be removed by grinding (gouging not permitted) such that the area for repair welding shall be free from sharp corners and provided with sufficient slope towards the weldface sides.
- b) Surface examination (MPI/LPI) on the ground area shall be performed to ensure complete defect removal before re-welding. Repair welding shall be carried as per the applicable WPS as for original welding.

12.0 HARDNESS SURVEY:

Hardness shall be measured using portable hardness tester. The equipment used for the hardness measurement shall be calibrated as recommended by the equipment manufacturer.

The surface shall be cleaned and prepared as per hardness test instrument manufacturer's recommendation prior to hardness survey. Hardness survey shall be done on each joint at three locations along the circumference. At each location three readings shall be taken on weld and parent metal. The readings on the parent metal shall be taken within 15mm from the edge of the weld. All the hardness values shall be recorded.

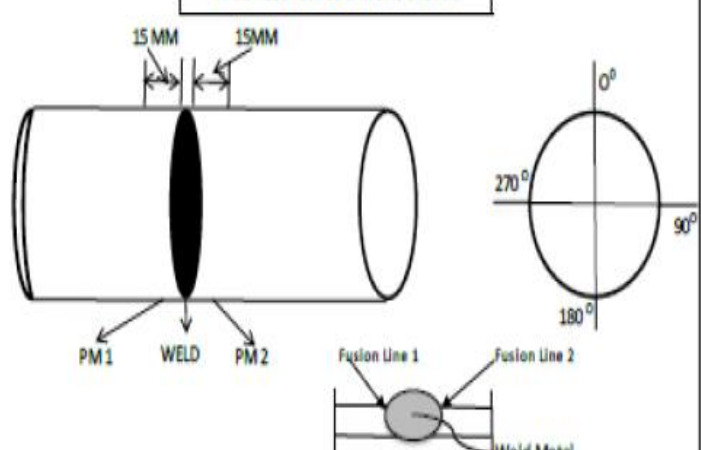
The hardness of the weld metal and the base metal in the soak band (heating band), excluding welding heat-affected zone shall be between 160HB & 300HB for Gr.91 and Gr.92 joints. The hardness measurements shall be recorded in the format as given in Annexure IX. Joints having hardness above 300HB shall be re-heat treated

and hardness shall be checked again. If hardness is still more, the case shall be referred to concerned MUs/ECs. In case Hardness falls below 160HB also, the case shall be referred to the concerned MUs/ECs.

Cautionary note: To achieve meaningful and consistent hardness results, below recommendations should be followed:

- The accuracy of the instrument shall be verified prior to use.
- The surface to be tested shall be reasonably flat and free of scale and oxides, grease, paint, etc.
- Prior to hardness test, the de-carburized surface layer with a thickness up to 0.8mm shall be removed by grinding/buffing, without encroaching the specified minimum wall thickness of the pipe/tube.

ANNEXURE IX – HARDNESS MEASUREMENT

		BHARAT HEAVY ELECTRICALS LTD	
T91/T92/P91/P92/F91/F92/C12A HARDNESS TESTING PROTOCOL			
PROJECT NAME :	UNIT No. :	Customer Name :	
Report No.:	Date :	Contractor :	
Description :	Specn :	Stage of test : After PWHT	
Calibration Block No.:	Equipment details:		
PGMA :	Model No :		
JOINT NO. :			
Location	PM 1	WELD	PM 2
Readings	AVERAGE OF 3 READINGS	AVERAGE OF 3 READINGS	AVERAGE OF 3 READINGS
12 O'Clock/ 0°			
3 O'Clock/ 90°			
6 O'Clock/ 180°			
9 O'Clock/ 270°			
PM: PARENT MATERIAL (15 MM FROM THE WELD FUSION LINE). ALL AVERAGE READINGS SHOULD BE LESS THAN THE PERMISSIBLE HARDNESS VALUE.			
HARDNESS TEST LOCATIONS SKETCH 			
Gap between successive reading shall be 1mm in the same spot			
RECOMMENDATION / RESULT : ACCEPTED / NOT ACCEPTED / RE-PWHT			
	AGENCY	NAME	SIGNATURE & DATE
INSPECTED BY	CONTRACTOR		
CHECKED BY	BHEL		
WITNESSED BY	CUSTOMER		

13.0 COMBINATION WELDING:

For other combination of materials with Gr.91/Gr.92, the applicable WPS for the same shall be obtained from concerned MUs/ECs.

14.0 DEMAGNETIZATION:

Refer NDE Manual BHEL:PS:NDM:latest Chapter 1.10

15.0 TRAINING:

15.1 The personnel engaged in P91 piping fabrication shall be trained in the following areas.

- a. Method and care to be taken during fit-up.
- b. Argon gas root purging arrangement.
- c. Fixing of thermocouple and wires.
- d. Arrangements for Pre/Post heating requirements and methods.
- e. Adjustment of heating pads/cables at the time of controlling the temperature within specified tolerance limits during welding or PWHT in case of induction heating.
- f. Good knowledge of the WPS requirements.
- g. Handling of P91 welding consumables and re-drying conditions.
- h. Special precautions to be taken during the power/equipment failure.
- i. Weld joints of dissimilar thickness / material specification.
- j. Weld defect control and weld repair systems.

15.2 Specific training for welders:

- a. The qualified welders who will be engaged in P91 welding shall be given training on pipe joints simulated with P91 welding and heating cycle conditions.
- b. The acquaintance on welding positions, as applicable shall be given using P91 pipes and P91 welding consumables.
- c. Welding techniques and instructions on Dos and DON'Ts of P91 welding.
- d. Welders only who are qualified on P91 welding alone shall be engaged.
- e. Whenever new welders have to be engaged they shall undergo all the training as above and shall be qualified with P91 material only.

16.0 CONTROL ON WELDERS:

The welder during welding at site follow the following procedures. The welder shall interact with the HT operator (Induction equipment operator) to ensure that preheat and inter-pass temperature during welding are maintained as per requirements. The

welder shall not mix the welding electrodes with that of the other welder. At the end of the shift, the unused electrodes shall be returned to the stores.

17.0 PERSONNEL / CONTRACTORS ENGAGED FOR HEATING CYCLES (HT OPERATOR):

17.1 The Personnel / Contractor shall have adequate heat treat experience on P91 or similar material.

17.2 HT operator shall be aware of the following:

- a. The equipment used and its working principle and operation.
- b. The procedures to be followed in using heating equipment.
- c. Procedure to be followed in case of power failure or equipment non-functioning so that heating cycle is not disrupted.
- d. Calibration of equipment.
- e. Method of fixing thermocouples and compensating cables leading to HT recorder.
- f. Fixing of heating pads or elements on the pipe joints and also in maintaining the temperature within the specified limits.

18.0 NDE PERSONNEL QUALIFICATIONS:

All NDE personnel performing NDT like UT & MPI/LPI shall be qualified in accordance with BHEL Procedure meeting the requirements of recommended practice SNT-TC-1A. MPI & LPI shall be carried out by level I qualified personnel and shall be evaluated by level II qualified personnel. However UT examination and evaluation shall be done by level II qualified personnel.

19.0 LEVEL OF SUPERVISION

Site In charge shall be responsible for the completion of all activities from weld fit-up to final clearance of weld joints after satisfactory NDE and acceptance by BHEL/Customer/IBR.

20.0 DO'S AND DON'T'S DURING P 9 1 /P 92 /F9 1 /F92 /C1 2 A WELDING,HEAT TREATMENT AND NDE AT CONSTRUCTION SITE:

20.1 DO ' S:

- a. Cutting by Band saw/Hack saw/Machining.
- b. Pipes Edge Preparation by machining. Machining shall be done without excessive pressure to prevent heating up of pipe
- c. Grinding may be done on exceptional cases after approval and taking adequate care to prevent overheating.

- d. Thermocouple wire (hot/Cold junctions) shall be welded with capacitor discharge portable spot-welding equipment.
- e. Reserve Thermocouples shall be made available, in case of failure of connected thermocouple elements.
- f. Ensure adequate Argon Gas for complete purging of air inside the pipe before starting GTAW root welding.
- g. Ensure Preheating at 220 °C minimum before GTAW root welding.
- h. Start preheating only after clearance from Welding engineer / Quality assurance engineer for weld fit-up and alignment of the joint as well as fixing of Thermocouple connections (for Induction heating)
- i. Do visual inspection on root weld maintaining weld preheating temp.
- j. Continue Argon purging until the GTAW root welding followed by minimum two filler passes of SMAW, is completed.
- k. Perform partial root welding to facilitate fit-up if necessary.
- l. Ensure proper use of TIG wires as identified by color coding or suitable hard punching.
- m. Keep the GTAW wires in absolutely clean condition and free from oil, rust, etc.
- n. Dry the SMAW electrodes before use.
- o. Ensure the inter-pass temperature is less than 350°C.
- p. Hold at 80-100°C for a period of Minimum 1 hour before the start of PWHT.
- q. Record entire heating cycle on Chart through recorders.
- r. Exercise control during grinding of weld and adjoining base metal while removing surface/sub-surface defects or during preparation for NDE.
- s. Ensure no contact with moisture during preheat, welding, post heat and PWHT of Weld Joints.
- t. Ensure removal of argon purging arrangements after welding.
- u. Use short Arc only. The maximum weaving shall be limited to 1.5 times the Dia. of the electrode.

20.2 DO N' T' s:

- a. Avoid Oxy-Acetylene flame cutting.
- b. Avoid Weld-build up to correct the weld end-d1 or to set right the lip of the weld bevel.
- c. Avoid Arc strike on materials at the time of weld fit up or during welding.
- d. Do not Tack weld the Thermocouple wires with Manual Arc/TIG welding.
- e. NO GTAW root welding without thorough purging of root area.
- f. Do not use Oxy-acetylene flame heating for any heating requirements.
- g. Do not use Thermal chucks on the weld groove.

- h. Do not stop argon purging till completion of GTAW root welding and two layers of SMAW.
- i. No Tack welding or Bridge piece welding is permitted.
- j. Do not use unidentified TIG wires or electrodes.
- k. Do not exceed the maximum interpass temperature indicated in WPS
- l. Do not allow moisture, rain, water, cold wind, cold draft etc. to come in contact with the weld zone or heating zone during the entire cycle from preheat to PWHT.
- m. Do not exceed the limits of PWHT soaking temperature.
- n. Do not Interrupt the Welding/heating cycle except for unavoidable power failures
- o. Do not use un-calibrated equipment for temperature measurement during heating, welding, post weld, heat treating etc.

21.0 DOCUMENTATION:

The documentation shall be as per the approved Quality Plan.

CHAPTER – B2
ERECTION WELDING PRACTICES
FOR SA 213 T91/T92 MATERIALS

1.0 SCOPE:

- 1.1 This document details out the practices to be adopted during welding of SA213 T91/T92 material.

2.0 MATERIAL:

- 2.1 Tube materials shall be identified as follows:-

- a) Colour codes given by the Manufacturing Units (MU).
- b) Paint / Stencil: WO DU, as per the relevant drawing & document.

- 2.2 When any defect like crack, lamination, and deposit noticed during visual examination, the same shall be confirmed by Liquid Penetrant Inspection. If confirmed, it shall be referred to unit.

3.0 ERECTION:

3.1 Edge preparation and Fit up:

- 3.1.1 Cutting of T91/T92 material shall be done by band saw/hacksaw/machining/ grinding only. Edge preparation (EP) shall be done by grinding/machining. During machining/ grinding, care should be taken to avoid excessive pressure to prevent heating of the tube edges.

- 3.1.2 The weld fit-up shall be carried out to ensure proper alignment and root gap. Neither tack welds nor bridge pieces shall be used to secure alignment. Use site fabricated clamps for fit up. Ensure that coil load does not come on stubs/header. Coil load shall be transferred to the crown plate/ end bar assembly. The necessary purging and preheat shall be done as per clause 3.3 and 5.0 respectively.

3.2 Fixing of thermocouple (TC) and heating elements during preheating and PWHT

- 3.2.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest), Chapter 1, Clause no. 3.1.1, 3.1.5, 3.2.1, 3.2.2, 3.2.6 & 3.2.7 shall be referred for guidelines for fixing of thermocouples and heating elements on the jobs.

3.3 Arrangement for purging:

- 3.3.1 Argon gas with requisite quality shall be used for purging the root side of weld. The purging dam (water soluble paper) shall be fixed on header nipple side of the weld bevel prior to fit-up and pre-heating. Purging is to be done from cross over tube downstream end. (Refer Figure B3.2 and B3.3). Ensure that atmospheric air is completely purged out through the root gap before starting welding and welding can be continued with Argon backing. The flow rate which shall be maintained for purging is 6 to 8 litres per minute.

- 3.3.2 When root temperature reaches 220°C, start purging through cross over tube downstream end for 5 minutes. Then the root gap is to be covered by insulating material. Continuous and adequate argon gas shall be provided to ensure complete

purging in the root area. Only water-soluble paper is to be used. Plastic foils that are not water-soluble are NOT acceptable.

3.3.3 Usage of water soluble paper:

3.3.3.1 The dams can be made of water-soluble paper /water soluble tissue paper for creating the purging chamber. The advantage in such dam arrangement is that the dissolving paper dam gets flushed during hydraulic test. The following is the method to be used:

3.3.3.2 Stuff the water-soluble paper/ water soluble tissue paper into the Header Nipples at a distance of 60mm(approximately) from the weld end as per attached Figure B3.1

4.0 WELDING/WELDERS QUALIFICATION:

4.1 Welders Qualified as per IBR and qualified at site with Gr.91/Gr.92 material only shall be engaged. Welders log book shall be maintained and welders performance shall be monitored by site engineer. The applicable WPS as per FWS shall be followed for welder qualification and welding.

5.0 PREHEATING (Bunching of tubes can be followed):

5.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest), Chapter 1, Clause 3.1 shall be referred for guidelines for preheating.

6.0 WELDING:

6.1 Welding shall be done as per the WPS. Filler wire shall be clean and free from rust or oil. Argon Purging shall be continued till completion of welding in case of full GTAW and for minimum two filler passes of SMAW in case of GTAW + SMAW.

7.0 POST WELD HEAT TREATMENT (PWHT) – RESISTANCE HEATING

METHOD(Bunching of tubes can be followed):

7.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, Clause no. 3.2.12 shall be referred for guidelines on PWHT.

8.0 HARDNESS SURVEY:

8.1 100% hardness survey shall be conducted on welds and parent material in first five coils. Based on satisfactory results, the hardness survey can be reduced to 10% covering each heat treatment cycles as per FWS requirement. The equipment recommended to measure the hardness is EQUOTIP or equivalent. Portable equipment used in the hardness measurement shall be calibrated.

8.2 The surface shall be cleaned and prepared as per hardness test instrument manufacture's recommendation prior to hardness survey. Hardness survey of weld and parent metal (both tubes) shall be carried out. The hardness shall be between 160HB & 300HB. The hardness measurements shall be recorded in the format as given in Annexure IX. Joints having hardness above 300HB shall be re-heat treated and hardness shall be checked again. If hardness is still more, the case shall be

referred to concerned MUs. In case Hardness falls below 160HB also, the case shall be referred to the concerned MUs.

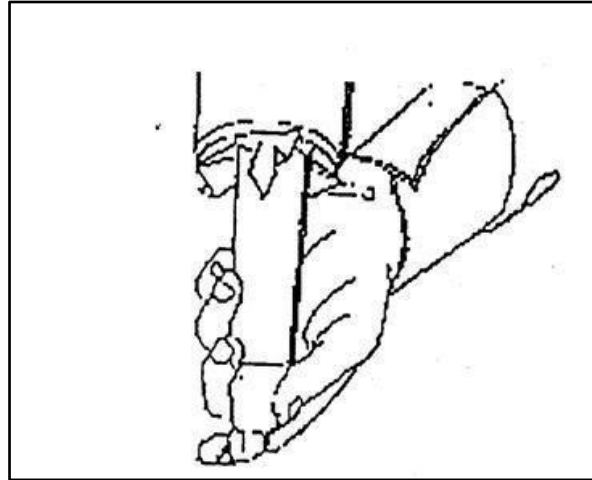


Figure B3.1: Insertion of Water Soluble Tissue paper

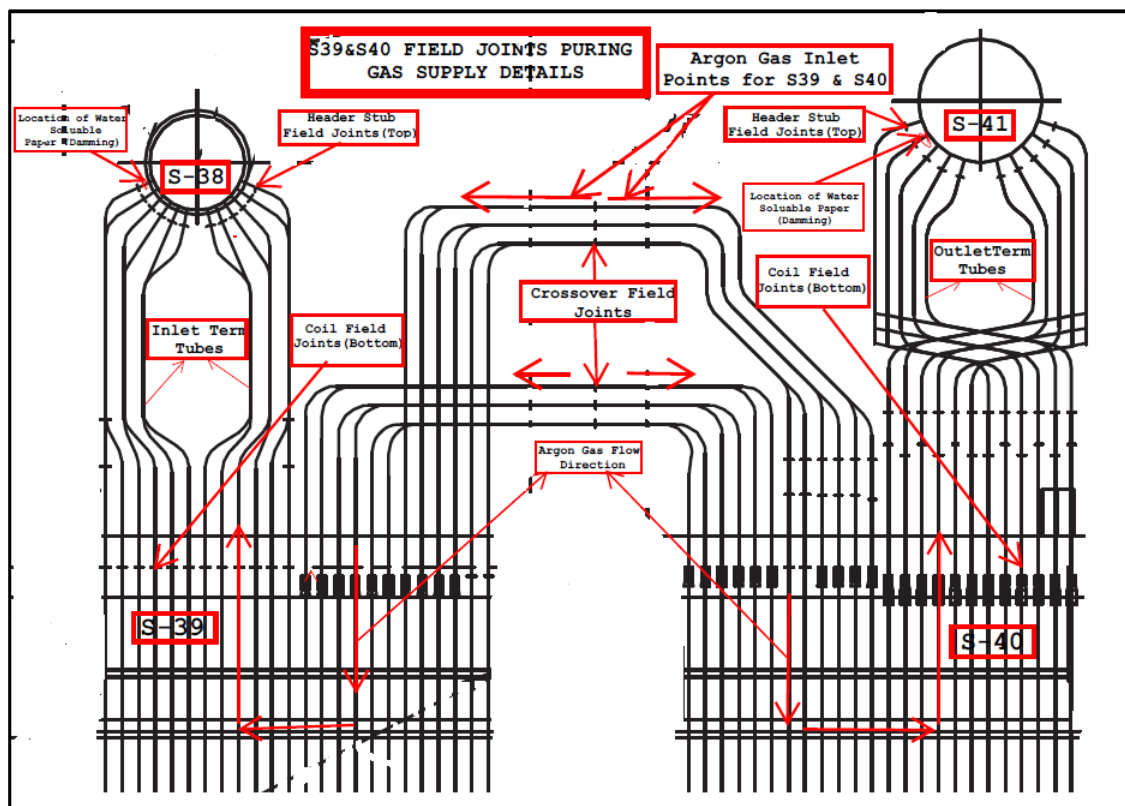


Figure B2.2: Purging Arrangement for SH Header Field Joints

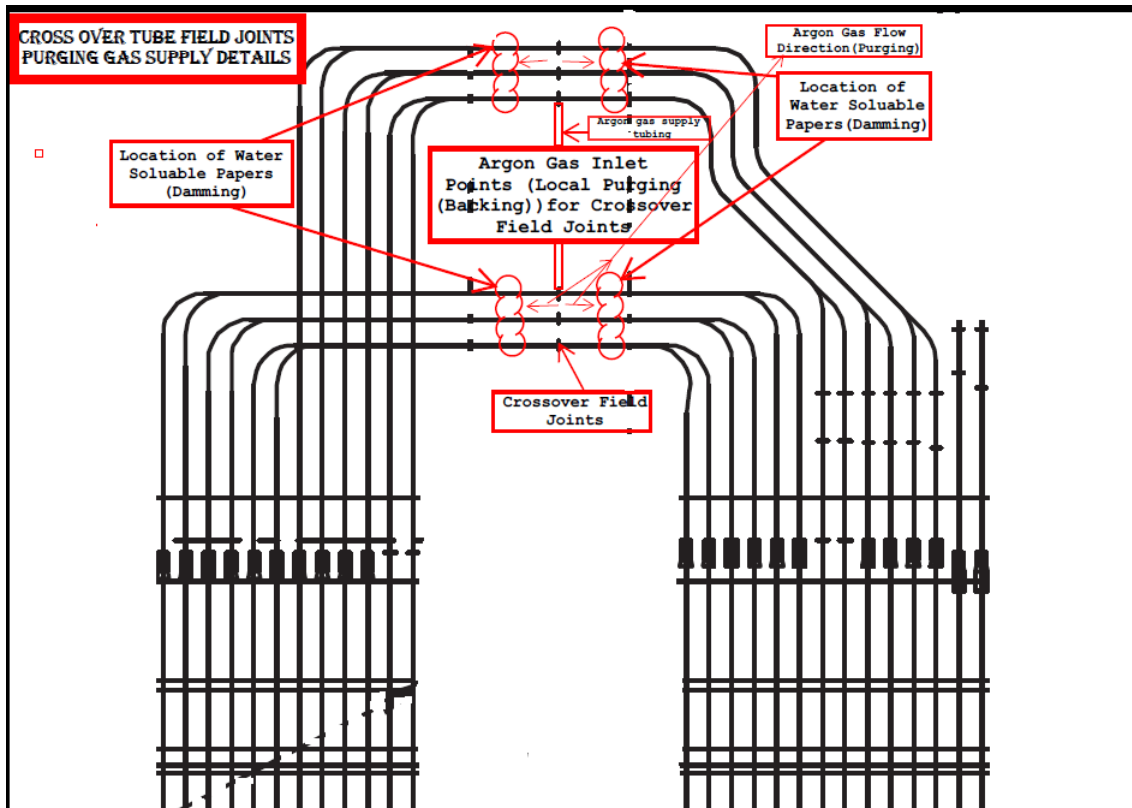


Figure B2.3: Purging Arrangement for Cross Over Tube Field Joints

CHAPTER –B3
ERECTION WELDING PRACTICES
FOR SA213 T23 MATERIAL

1.0 SCOPE:

1.1 This procedure is applicable for the welding of T23 tubes at sites.

2.0 Ensure the availability of the following items/characteristics before preparing the joint for welding:

- a) LPG gas (for heating in case of interruption in preheating)
- b) Grinding machine
- c) Mini cutter
- d) Conical grinder
- e) Proper illumination
- f) Thermal chalk or pyrometer
- g) Torch light
- h) Portable Oven
- i) Hacksaw and chisel

3.0 PROCEDURE:

The following procedure shall be followed for T23 Welding at Site:

- 3.1 Clean the edges of the tube, both OD & ID by buffing upto 30 mm from the edge of the tube.
- 3.2 Create a purging dam on both tubes at about 200 to 250 mm away from the joint before fit-up.
- 3.3 Fit-up the tubes for butt joint with a root gap of 2 to 2.5 mm and ensure a land of 1 to 1.5 mm.
- 3.4 Set up Argon purging for the tube to tube butt joint.
- 3.5 Carryout preheating by wrapping heating pads/coils uniformly for a width of 200 mm on both sides of the joint. Each tube should be provided with a thermocouple (K type) at a distance of 75 mm from the joint.(Refer Figure B4.1, B4.2 & B4.3)
- 3.6 Preheat the joint to a minimum of 200°C and ensure the same with a thermal chalk or a pyrometer before the start of welding.
- 3.7 Ensure drying of SMAW electrodes at 250 to 300°C for 2 hours and keep them at a temperature of 150°C in a Holding oven after drying.
- 3.8 The electrodes shall be maintained dry at 65 to 100 °C in a portable oven after issue from the holding oven till use.
- 3.9 Perform welding as per applicable WPS using IBR qualified welders.
- 3.10 Ensure the welding of root and second pass by TIG welding process and further layers by SMAW process. Alternatively, the entire joint may be welded by TIG process using the applicable WPS.
- 3.11 Maintain the Interpass temperature at 350°C max. Ensure the same using thermal chalk or pyrometer after each pass of welding.
- 3.12 Conduct post heating on the completed weld at 250 to 280°C for a minimum of 1 hour immediately after completion of welding and then allow the joint to cool in air to ambient temperature.(Refer Figure B4. 4)

- 3.13 Perform RT to ensure that the joints are defect free.
- 3.14 If RT reveals any unacceptable defect, cut the joint and put a spool piece in place for a minimum length of 200 mm. Repeat the procedure from step 3.1 to 3.13.
- 3.15 Perform PWHT on the weldment within 7 days after post heating.
- 3.16 Use only calibrated PWHT accessories (thermocouples, temperature recorder, etc.).
- 3.17 Use only ceramic resistance pads with low voltage heating arrangement for PWHT.
- 3.18 Ensure the PWHT arrangement to meet the following conditions;
- 3.19 When heat treating butt welds, the width of the circumferential heating band on either side of the weld must be at least 3 times the width of the widest part of the weld groove but not less than twice the thickness of the thicker part welded. The width of the insulation band shall be at least twice the total width of the heating band.
- 3.20 Ensure wrapping of heating pads, location of thermocouples before covering with insulation.(referFigure B4.5& B4.6)
- 3.21 PWHT shall be carried out with 1 thermocouple per joint.
- 3.22 PWHT time and temperature shall be as per applicable WPS.
- 3.23 Measure hardness on the joint and ensure it to be within 160 to 260 HB. If hardness exceeds 260 HB, PWHT shall be repeated and hardness checked. The total no. of PWHT cycles shall not exceed 3 times for a joint.
- 3.24 In case the hardness measures above 260HB even after 3 PWHT cycles, cut the joint and put a spool piece in place for a minimum length of 200 mm. Repeat the procedure from step 3.1 to 3.23. In case the hardness measures below 160HB, it shall be referred to the MUs.

4.0 DOCUMENTATION:

Record the details of welding carried out in correlation to welders, heat treatment and NDE reports.



Figure B3.1: Preheating by Resistance coil winding



Figure B3.2: K - Type Thermocouple



Figure B3.3: Preheating arrangement with thermocouples in place



Figure B3.4: Post heating arrangement



Figure B3.5: Heating pads in place for PWHT



Figure B3.6: PWHT in progress

GUIDE LINES FOR HEAT **TREATMENT**

IMPORTANT NOTE

THIS GUIDELINES FOR HEAT TREATMENT PROVIDES BROAD BASED GUIDELINES FOR CARRYING OUT HEAT TREATMENT WORKS AT SITES. HOWEVER, SITES SHALL ENSURE ADHERENCE TO THE PRIMARY DOCUMENTS LIKE CONTRACT DRAWINGS, FIELD WELDING SCHEDULES, WELDING PROCEDURE SPECIFICATIONS, PLANT / CORPORATE STANDARDS, STATUTORY DOCUMENTS, CONTRACTUAL OBLIGATIONS, AS APPILCABLE AND SPECIAL INSTRUCTIONS, IF ANY, ISSUED BY RESPECTIVE MANUFACTURING UNITS SPECIFIC TO THE PROJECTS.

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CHAPTER-1
HEAT TREATMENT PROCEDURE -
BOILER AND AUXILIARIES

1.0 SCOPE:

- 1.1 This procedure provides information, method and control for Pre-Heat, Post Heat and Post Weld Heat Treatment (PWHT) of welds of boiler and piping components at sites.

2.0 DOCUMENTS:

- 2.1 The following documents are referred in preparation of this procedure:

- ASME Sec I & Sec IX
- ASME B31.1
- Indian Boiler Regulations
- AWS D1.1
- BHEL Welding Manual (AA/CQ/GL/011/ Part I-WM – Latest)

- 2.2 The following are to be referred as Primary Documents:

- Contract drawings
- Field Welding Schedule or equivalent
- Plant / Corporate standards, wherever supplied
- Welding procedure specification
- Contractual obligations, if any

- 2.2.1 Where parameter for Pre-Heat, Post Heat and PWHT are not available in the primary documents, reference may be made to this procedure.

- 2.2.2 Where such parameters are not contained either in the primary documents or in this procedure, reference may be made to Manufacturing Units.

3.0 PROCEDURE:

3.1 Preheating & Post heating:

- 3.1.1 Prior to start of preheating, ensure that surfaces are clean and free from grease, oil and dirt.

Preheating temperature shall be maintained as per applicable WPS. Preheating shall be checked and recorded, using thermal chalks/ crayons or pyrometers in case of tubes other than T91/T92/T23. For all other components including T91/T92/T23 tube joints, the preheat temperature shall be ensured by using a calibrated chart recorder and two calibrated thermocouples fixed at 0° and 180° positions on both sides of the joint. Preheating shall be checked at a distance of 1.5 times the part thickness or 75mm (whichever is greater) from weld end. The thermocouple shall be fixed using the capacitor discharge welding machine. The preheating arrangements shall be inspected and approved by site engineer.

- 3.1.1.1 Bunching of tubes for Preheating:

Where a bunch of closely placed tube welds (e.g. Super Heater / Reheater Coils) requires to be preheated, the same may be grouped together as if they form a single component. The maximum number of tubes bunched together in such cases shall be limited to 12. Each joint

within the bunch shall have at least one thermocouple fixed near the joint for preheat monitoring.

- 3.1.2 When parts of two different thicknesses are welded together, the preheating requirements of the thicker part shall govern.
- 3.1.3 When parts of two different P numbers are joined together, the material requiring higher preheat shall govern (please refer Tables A2.1 to A2.7 of Welding Manual, AA/CQ/GL/011/ PART I-WM – Latest, for P numbers).
- 3.1.4 In case of any power interruption during welding, the joint shall be wrapped with dry thermal insulating blankets to ensure slow and uniform cooling. **Requirement of uninterrupted power supply shall be ensured for materials like Gr.91, 92 & 23 and BS EN 10025**
- 3.1.5 Preheating & Post Heating Methods:
 - 3.1.5.1 Preheating & Post heating shall be applied by any of the methods given below:
 - a) Electrical resistance heating
 - b) Induction heating
 - c) LPG burners
 - 3.1.5.2 Preheating/post heating using cutting/ heating torches with oxy-acetylene flame is not permitted.
- 3.1.6 In addition, the following requirements shall also be followed:
 - 3.1.6.1 Alternate burner arrangements shall be made for preheating/post heating during power failure to maintain the required temperature.
 - 3.1.6.2 Two additional spare thermocouples shall be fixed for emergency use.
 - 3.1.6.3 Preheating/Post heating shall be done locally BY heating a circumferential band covering the parent material away from the weld groove by induction or electrical resistance heating. The heating element (Coil/Finger/Ceramic Pad) placed on the heating band shall be closely packed without any gaps between the element. The area shall be free of grease, oil etc. prior to preheating/post heating.
- 3.2 **Post Weld Heat Treatment (PWHT):**
 - 3.2.1 PWHT shall be done by locally heating a circumferential band covering the entire weld and adjacent area of base metal, by induction or electrical resistance heating. The heating element (coil/ finger element/ pad) placed on the heating band shall be closely packed without any gaps between the elements. The area shall be free of grease, oil etc. prior to PWHT.
 - 3.2.1.1 Unless otherwise specified in the FWS/WPS, the PWHT parameters shall be as per the Tables 1.1, 1.2, 1.3, 1.4.
 - 3.2.2 **Heating and Insulation band for PWHT:**

- 3.2.2.1 When heat treating butt joints, width of the circumferential heating band on either side of the weld must be at least 3 times the width of the widest part of the weld groove; but not less than twice the thickness of the thicker part being welded. When heat treating nozzles and attachment welds, the width of the heating band beyond the welding to be heat treated on either side of weld shall be at least 3 times the base material thickness. The heating band shall extend axially around the entire vessel. Width of the insulation band on either side shall be at least twice the width of the heating band.
- 3.2.2.2 In case of fin welded panels where circumferential winding of the coil is not possible heating elements shall be placed on both sides of the panels
- 3.2.3 Post weld heat treatment temperature cycle shall be measured and monitored by use of thermocouples with calibrated recorders.
- 3.2.4 Where the soaking temperature is found to be lesser than specified, the PWHT cycle shall be repeated.
- 3.2.5 In case of interruption during PWHT, the following actions shall be taken depending on the stage during which interruption has occurred.
- 1) **During heating cycle**
Repeat the whole operation from beginning.
 - 2) **During soaking**
Heat treat subsequently for balance soaking. If the balance soaking time required is less than 15 minutes, soaking time shall be maintained for 15 minutes minimum.
 - 3) **During cooling (above 300 °C).**
If the Rate of Cooling (ROC) during interruption meets the specified rate, cool subsequently at the required rate. Otherwise, reheat to the soaking temperature, hold for 15 minutes and then cool at the specified rate.
- 3.2.6 **Fixing of thermocouple (TC) during preheating, post heating and PWHT:**
- 3.2.6.1 Thermocouples shall be fixed on the job using capacitor discharge welding method. Thermocouple leads shall be attached within 6 mm of each other. A Welding Procedure Specification shall be prepared, describing the low-energy capacitor discharge equipment, the combination of materials to be joined, and the technique of application. No preheating is required. Also Qualification of the welding procedure is not required. The energy output of the welding process shall be limited to 125 W-sec. After temporary attachments are removed, the areas shall be examined by LPI.
- Following are the equipment / facilities for heating cycles.
- (1) Thermo couples: Ni-Cr / Ni-Al of 0.5 mm gauge size (K-Type).
 - (2) Temperature Recorders: 6 Points / 12 Points/ 24 Points.

3.2.6.2 Following are guidelines regarding number and placement of thermocouples:

- Minimum of two thermocouples shall be placed for each joint, 180° apart.
- Thermocouples shall be located at a distance of approximately 1.5 times the parent metal thickness from the weld centre.
- Additionally, one point of the temperature recorder shall be used for recording ambient temperature.
- For placement of thermocouples on P91/P92/F91/F92/C12A Figure 1.1 shall be referred for preheating and Figure 1.2 shall be referred for PWHT.

3.2.6.3 Thermocouple leads shall be suitably insulated to protect the ends from direct radiation from heating elements.

3.2.6.4 The temperature variation between any two thermocouples shall be within 50°C for temperature above 300°C during heating and cooling.

3.2.7 Bunching of tubes for PWHT:

3.2.7.1 Where a bunch of closely placed tube welds (e.g. Super Heater / Reheater Coils) require to be Post weld heat treated, the same may be grouped together as if they form a single component. The maximum number of tubes bunched together in such cases shall be limited to 12. Each joint within the bunch shall have at least one thermocouple fixed near the joint for PWHT temperature monitoring.

3.2.8 Soaking Time:

3.2.8.1 Unless otherwise specified in the FWSMPS, the soaking time shall be calculated as 2.5 minutes per mm of thickness with 30 minutes minimum for tube welds and 60 minutes minimum for other welds. For P1 material, the soaking time shall be calculated as 2.5 minutes per mm of thickness upto 50mm with an additional 15 minutes for every 25mm thickness above 50mm.

3.2.8.2 The following guidelines shall be used to determine the thickness and subsequent selection of the soaking time of PWHT:

- (a) For full penetration butt welds, the nominal thickness is the thinner of the parts being joined.
- (b) For full penetration corner welds, the nominal thickness is the depth of the weld.
- (c) For partial penetration groove and material repair welds, the nominal thickness is the depth of the weld. The total depth of partial or full penetration groove welds made from both sides shall be taken as the sum of the depth of both sides at a given location.
- (d) For fillet welds, the nominal thickness is the weld throat. When a fillet weld is used in conjunction with a groove weld, the nominal thickness is the total of groove depth and fillet throat thickness.

3.2.8.3 Soaking time is to be reckoned from the time temperature of the joint crosses the recommended lower temperature of the cycle, to the time it comes down below the same recommended lower temperature of the cycle.

3.2.9 **Heating and Cooling Rates:**

3.2.9.1 Wherever not specified, the heating rate above 300°C and cooling rate after soaking upto 300°C shall be as follows: This is applicable for all materials except Gr.91/Gr.92 materials for which Cl. 3.2.11.3 shall be referred.

Thickness of Material	Maximum Heating Rate Above 300°C	Maximum Cooling Rate Upto 300°C
≤ 25 mm	220°C/hour	220°C/hour
> 25 ≤ 50 mm	110°C/hour	110°C/hour
> 50 ≤ 75 mm	75°C/hour	75°C/hour
> 75mm	55°C/hour	55°C/hour

3.2.10 **PWHT Job Card:**

3.2.10.1 Prior to start of PWHT operations, a job card shall be prepared including details of weld reference, soaking time, soaking temperature, maximum rates of heating and cooling, temperature recorder details and date of PWHT as per Annexure I of this manual except Gr.91/Gr.92/Gr.23 materials. For P91/P92/F91/F92/C12A/T91/T92/T23 materials Annexures II, III, IV in Chapter A1 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest, as applicable, shall be referred.

3.2.10.2 Obtain the clearance for post weld heat treatment cycle from the site engineer.

3.2.10.3 On completion of PWHT, the actual parameters shall be recorded on the job card.

3.2.10.4 A chart number shall be given to each chart and attached to the job card.

3.2.11 **Heat Treatment of P91/P92/F91/F92/C12A welds:**

3.2.11.1 A minimum of four thermocouples shall be placed such that at least two are on the weld and the other two on the base material on either side of the weld within the heating band, 180° apart, at a distance of 50mm (approximately) from the center of the weld joint as per Figure 1.2. Two standby thermocouples shall also be provided on the weld (to be used in case of any failure of the thermocouple).

3.2.11.2 The PWHT temperature shall be 740-770°C and the soaking time shall be 2.5 minutes per mm of weld thickness, subject to a minimum of one hour. All records shall be reviewed by site Engineer prior to PWHT clearance. Heating shall be done by Induction heating only. However for thickness upto 32 mm, Resistance heating may also be used.

3.2.11.3 The rate of heating / cooling (above 300 ° C):-

Thickness up to 50 mm -	110°C / hour (max)
Thickness 50 to 75mm -	75°C / hour (max)
Thickness above 75mm -	55°C / hour (max)

- 3.2.11.4 Welding and PWHT shall be monitored every one hour by site engineer. Job card for PWHT shall be maintained as per Annexure II, Chapter A1 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest.

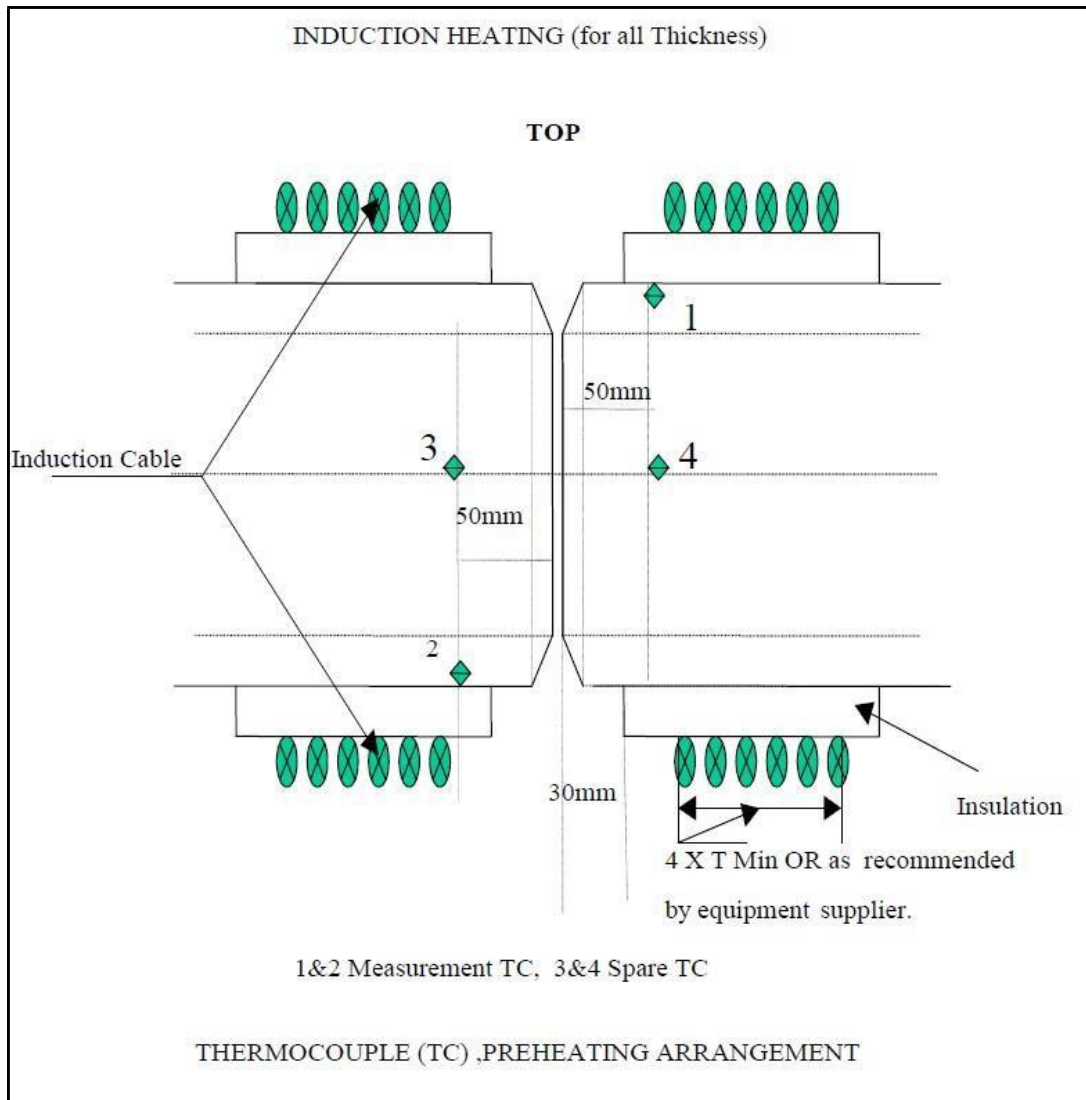


Figure 1.1: Placement of Thermocouples on P91/P92/F91/F92/C12A materials for Preheating

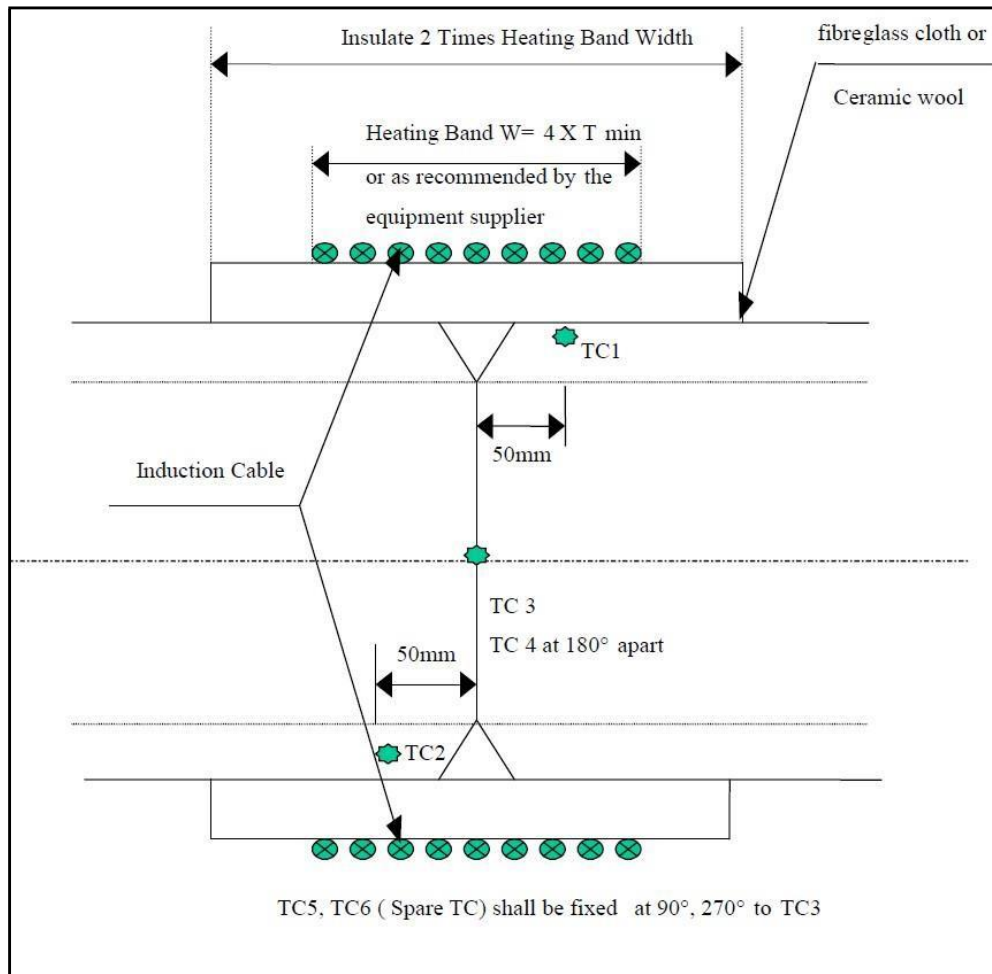


Figure 1.2: Placement of Thermocouples on P91/P92/F91/F92/C12A materials for PWHT

3.2.12 Heat Treatment of T91/T92/T23 welds:

- 3.2.12.1 Heat treatment controls of T91/T92 welds shall be as detailed in Cl. 3.2.1 to Cl.3.2.10 of this Manual.
 - 3.2.12.2 Figure 1.2 & 1.3 of this manual shall be referred for Resistance heating coil arrangement for Preheating and PWHT of T91/T92 tube assembly.
 - 3.2.12.3 The PWHT temperature shall be 730-760°C and the soaking time shall be 2.5 minutes per mm of weld thickness, subject to a minimum of 30minutes. All records shall be reviewed by site Engineer prior to PWHT clearance.
 - 3.2.12.4 The rate of heating / cooling (above 300 ° C) for T91/T92 welds shall not exceed 140°C/hour.
 - 3.2.12.5 Heat treatment controls of T23 welds shall be as detailed in Chapter B4 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest.
- ### 3.3 Heat Treatment of Components /Systems other than Boiler and Piping:
- 3.3.1 Preheating, post heating and PWHT methodologies and parameters shall be as recommended by the concerned equipment suppliers.

3.4 Heat Treatment Operator Requirements:

The operator for the Heat Treatment shall be a qualified technician and shall be conversant in the operation & maintenance of heat treatment machines & process. He shall be trained by the concerned Site Engineer in order to operate and maintain the equipment and carry out the process properly.

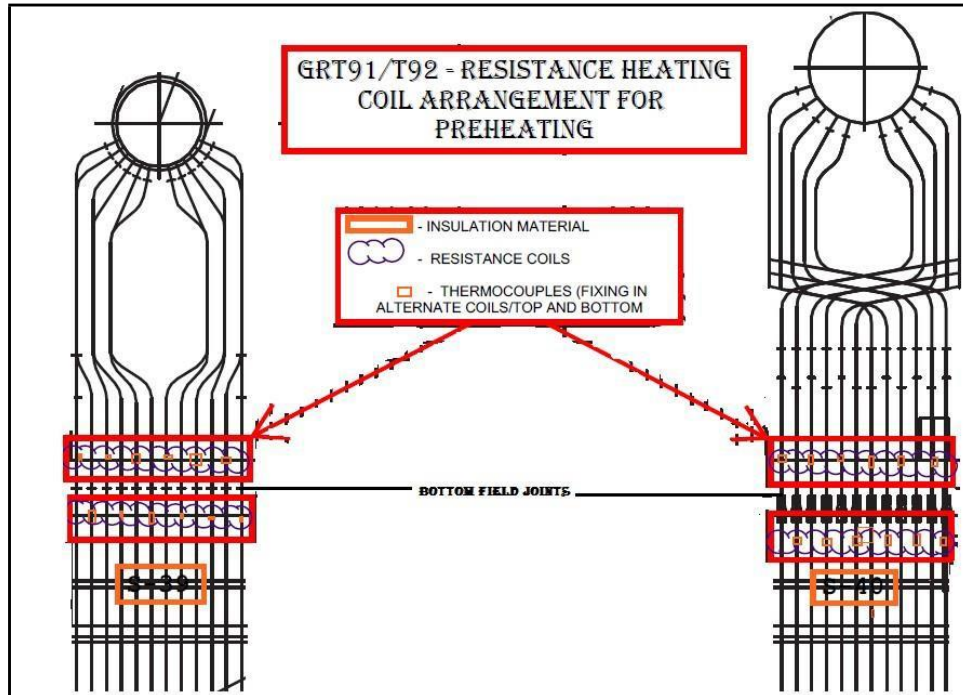


Figure 1.3: Resistance heating Coil arrangement for Preheating of T91/T92 tube assembly

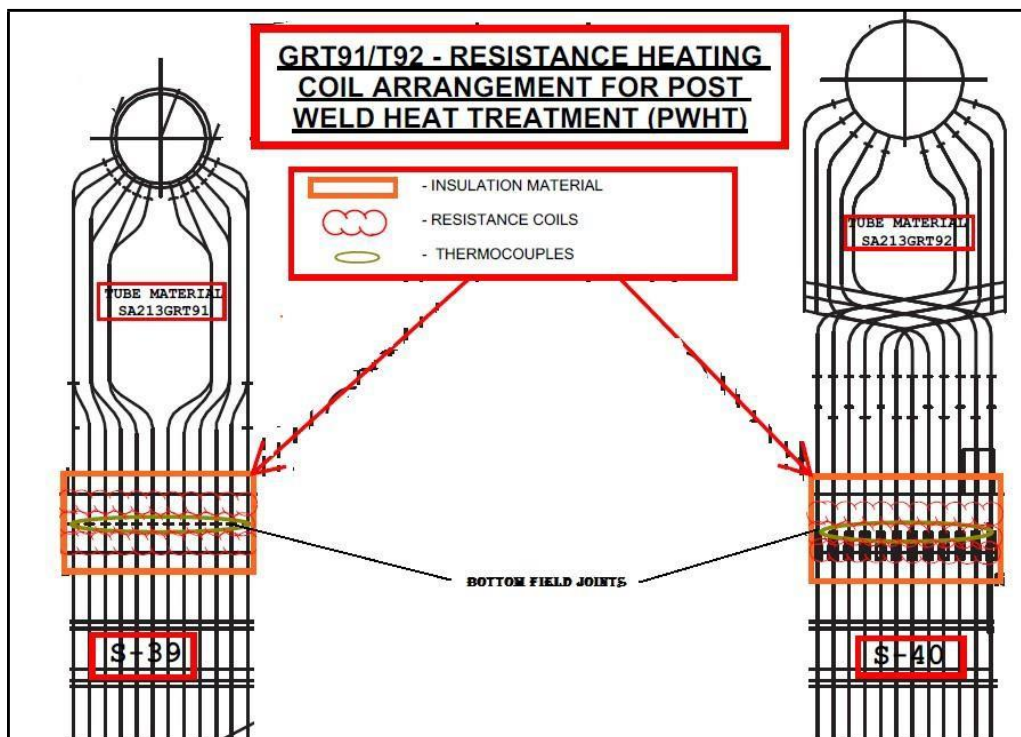


Figure 1.4: Resistance heating Coil arrangement for PWHT of T91/T92 tube assembly

3.5 List of Tables:

- Table-1.1: Weld preheat and PWHT for tubes and pipes outside diameter ≤ 102 mm.
- Table-1.2: Weld preheat and PWHT for Boiler Header welds.
- Table-1.3: Weld preheat and PWHT for pipes outside diameter > 102 mm.
- Table-1.4: Pre-heat and PWHT for Non-Pressure Parts including Structural.

4.0 RECORDS:

Relevant records like Job card and HT Charts shall be maintained by the Site Engineer till the closure of the project. The records may be handed over to the customer at the time of project closure if required by the contract

ANNEXURE I: PWHT JOB CARD

POST WELD HEAT TREATMENT (PWHT) JOB CARD

Project: _____

Card No. : _____ Date : Unit

No. : _____ Package :

Description: Temp. Recorder Details :

Weld Reference : _____ 1. Make : _____

Material Spec. : _____ 2. Type : _____

Size: Dia. mm _____ 3. Sl. No. _____

Thick (t) mm _____ 4. Chart speed: _____ mm / hour

NDE Cleared on : _____ 5. Calibration Due on : _____

Report No. : _____

Thermocouple Locations :

Minimum 2

Distance of TC from the weld centre =

Heating Band =

Insulation Band =

Date of PWHT Chart No. : _____

Start Time : _____ End Time :

	Required	Actual		
Rate of Heating (Max) °C/h				
Soaking Temperature °C				
Soaking Time (Minutes)				
Rate of cooling (Max)° C				

Ambient temperature recorded on the PWHT Chart: _____

TABLE – 1.1
WELD PRE HEAT AND PWHT FOR TUBES & PIPES
OUTSIDE DIAMETER ≤ 102 mm
(Applicable for Butt Welds and Socket Welds)

P. No. of Material	Thickness (mm)	Preheat (°C)	PWHT (°C)
P1 Gr 1	≤ 19	Nil	Nil
P1 Gr 2 (C $\leq 0.25\%$)	≤ 19	Nil	Nil
P1 Gr 2 (C $> 0.25\%$)	≤ 9	Nil	Nil
	> 9	Nil	595-625
P3 Gr 1	≤ 13	Nil	Nil
P3 Gr 2	> 13	100 (Note 1)	620 - 650
P4 Gr 1	≤ 13	150	Nil
	> 13	150	650 - 670
P5 A Gr 1	≤ 8	150	Nil
	> 8	150	680 - 710
P15 E Gr 1 (Gr. 91 & Gr.92)	All	220	730 - 760
SA 213 T23	All	220	730 - 760
P8	All	Nil	Nil

Note 1: Pre-heating is necessary for t >16mm.

TABLE – 1.2
WELD PREHEAT AND PWHT FOR BOILER HEADER WELDS
(Applicable For Welding of Header to Header Joints)

P. No. of Header Material	Thickness (mm)	Preheat °C	Post Heating °C	PWHT °C
P1Gr 1	$t \leq 19$	Nil	Nil	Nil
	$19 < t \leq 25$	Nil	Nil	595 - 625
	$25 < t \leq 75$	100	Nil	595 - 625
	$t > 75$	150	Nil	595 - 625
P1Gr 2	$t \leq 19$	Nil	Nil	620 – 635
	$t > 19$	150	150 for 2 hours	620 – 635
P4 Gr 1	All	150	Nil	650 - 670
P5 A	All	150	250 for 2 hours	680 - 710
P15E Gr1 (Gr 91 & Gr 92)	All	220	Nil	740 - 770
P15 E Gr1 + P5 A	All	220	Nil	730-760
T23	All	220	250 for 1 hour	730 - 760

TABLE – 1.3
WELD PREHEAT AND PWHT FOR PIPES
OUTSIDE DIAMETER >102 MM

P No. of Material	Thickness (mm)	Butt Welds		Stub and Attachment welds				Post heat °C
		Preheat °C	PWHT °C	Throat ≤ 19 mm		Throat > 19 mm		
				Preheat °C	PWHT °C	Preheat °C	PWHT °C	
P1 Gr 1	≤ 19	Nil	Nil	Nil	Nil	Nil	595 - 625	Nil
	>19≤25	Nil	595 - 625	Nil	595 - 625	Nil	595 - 625	Nil
	>25≤75	150	595 - 625	150	595 - 625	150	595 - 625	Nil
	>75	150	595 - 625	150	595- 625	150	595 - 625	Nil
P1 Gr 2	≤9	Nil	Nil	Nil	Nil	Nil	595 - 625	Nil
	>9≤19	Nil	595 - 625	Nil	595 - 625	Nil	595 - 625	Nil
	>19	150	595 - 625	150	595 - 625	150	595 - 625	150 for 2 hrs
P4 Gr 1	All	150	640-670	150	640-670	150	640-670	Nil
P5 A	All	150	680 - 710	150	680-710	150	680-710	250 for 2 hrs
P15 E Gr1	All	220	740-770	220	740-770	220	740-770	NA
P15 E Gr1 + P5 A	All	220	730-760	220	730-760	220	730-760	NA

For butt welds of different P group combinations, PWHT temperature may be as follows:

P1 + P3 - 620 to 650°C

P1 + P4 - 640 to 670°C

P4 + P5A- 680 to 710°C

(For other P Group combinations, refer to Manufacturing unit)

TABLE – 1.4
PREHEAT AND PWHT FOR NON PRESSURE PARTS INCLUDING STRUCTURALS

P. No. of Material / Material Specification	Gas Cutting		Welding		
	Thickness (mm)	Preheat °C	Thickness (mm)	Preheat (°C)	PWHT (°C)
P1 / IS 2062 E250 BR, E350 BR,E350C	> 50	Nil 100	> 63	Nil 100 150	595-625 1.0 All butt welds > 50 mm thick 2.0 For Ceiling girders if thickness > 50 mm 3.0 No HT required for web to flange fillet welds.
BS EN 10025 Gr 420 N (Ceiling Girder)	All	220	All	220	620 – 650
P3 Gr 1 and Gr 2	T>25	150	All	150	620-650 a) All butt welds in tension member b) All butt welds of fabricated components > 16mm thick and fillet welds with throat thickness > 13 mm
P4 Gr 1	All	150	All	150	650-680 a) All butt welds in tension member b) All butt welds of fabricated components > 16mm thick and fillet welds with throat thickness > 13 mm
P5A Gr 1	All	150	All	150	680-710 All welds (Note 2)
P15E Gr.1	Not permitted	Not permitted	All	220	740-770

NOTE:

1. All gas cut edges shall be ground for a width of 3mm to remove the HAZ.
2. All welds of P5A material shall be post heated at 250°C for 2 hours immediately after welding.

GENERAL GUIDELINES FOR INSULATION WORKS

This booklet is given as a general guideline to this tenderers about insulation works, However instructions given in the drawings & other schedule issued during execution of the work shall be final and binding of the contractor.



**Bharat Heavy Electricals Limited
(A Govt. Of India Undertaking)
Power Sector Southern Region
690, Anna Salai , Nandanam,
Chennai – 600 035**

GENERAL NOTES ON ERECTION OF INSULATION

1. It is important that the sheet metal covering is done, by a experienced and competent tinsmith.
2. Person, who is doing the actual job, can alter the following said methods of fixing the sheet metal, as and when necessary, only after consulting the BHEL Erection Engineer.
3. Fixing pin of corresponding thickness of insulation shall be welded by **STUD WELDING** process.
4. Circumferential and axial overlapping of outer casing should be 50 mm unless specified otherwise.
5. **FOR HORIZONTAL AND INCLINED DUCT AND PIPE:**
 - 1) All overlapping in axial direction should be at the bottom of the duct and pipe. Provision of beading and Sealing compound is not required.
 - 2) For circumferential overlapping of inclined duct and pipe, provision of beading and Sealing compound is not required.
 - 3) For circumferential overlapping of horizontal pipe and duct, provide beading. Apply Sealing compound if necessary.
- 5A. **FOR VERTICAL DUCT AND PIPE:**
 - 1) For overlapping in the axial direction provide beading. Apply Sealing compound if necessary.
 - 2) For circumferential overlapping provision of beading and Sealing compound is not required.
6. The joints of wool mattresses should be staggered in both circumferential and axial direction. The Wire netting at the joints of Wool mattresses are to be sewn together by G.I. sewing wire dia 0.71 mm.
7. In case more than one layer of Wool mattress is to be applied for pipe insulation the inner layer should be tied by two turns of G.I binding wire dia 1.22 mm at a pitch of 240 mm, and the outer layer should be tied by two turns of G.I. binding wire dia 1.22 mm at a pitch of 160 mm. The ends of the wire should be twisted and pressed in to the insulation.

8. All the overlapping of outer casing should be made such that no rain water enters into the insulation through the joints.
9. In case of insulation fixing pin welding to tubes, equal circumferential pitch is to be maintained. Use a minimum number of 4 pins, at 90 degree radial spacing.
10. The inner side of the Aluminum / G.I sheet of outer casing should be painted with two coats of anticorrosive Paint (IS:158). Retainer – Type A must be coated with Aluminum paint to avoid bi-metal corrosion or Neoprene strip must be provided between Retainer – Type A and Casing support.

The above mentioned paints are not in BHEL scope of supply

11. Self tapping screws should be fixed over the circumferential overlapping. The axial joints should be on the Casing supports and outer casing should be fixed to Casing supports with Self tapping screws at a pitch of 150 mm approximately.
12. The outer casing should be wound tightly around the insulation and then fixed with Self tapping screws when there is not any Fixing pin for insulation.
13. Loose wool can be taken from the Wool mattresses wherever required.
14. Clean the surface to be insulated of rust, dust, grease, loose scale, oil, moisture, etc.
15. Care shall be taken that flexible insulation is not unduly compressed.
16. After insulating the equipment with Calcium silicate / Mineral wool mattress, all voids in the joints shall be filled with Moldable insulation / loose mineral wool respectively.
17. Each day application of insulation should be weather proofed overnight by either with the final protective casing or with some temporary weatherproof covering so that it does not get drenched in rain.
18. The indicated thickness of insulation is the minimum requirement which should be provided. Any alteration in the thickness of insulation should be done only after getting the prior approval from the Design Engineer.
19. The layers of Wool mattresses are to be taken as indicated below:

THICKNESS IN mm	LAYER IN mm				
	1 st	2 nd	3 rd	4 th	5 th
250	50	50	50	50	50
230	50	60	60	60	
210	50	50	50	60	
200	50	50	50	50	
190	40	50	50	50	
180	60	60	60		

160	50	50	60
150	50	50	50
140	40	50	50
120	60	60	
100	50	50	
80	40	40	

20. Where junctions between two or three bodies of different dia, occur and different insulation thickness is specified the greater thickness shall be continued for a length equal to one dia of the smaller body then smoothly tapered to the required smaller thickness over a length equal to two dia of the smaller body. When there is a differential thermal expansion between these bodies, they should be insulated individually.

21. The required fixing components and outer casing sheets have been released under PG_32. The insulation materials have been released under PG-33.

22. **STORAGE INSTRUCTIONS:**

22a) Mineral wool mattress:

These materials should be stored under fully covered sheds. Stocking must be done over planks and must be out of contact with ground. Height of stacking should not exceed 3 Meters.

Once drenched in water these materials lose all the desired properties and become unsuitable for use. Drying the material does not restore the desired properties.

22b) Outer casing sheets:

Outer surfaces are meant for improving the appearances also scratch marks, dents, etc, spoil the appearance.

23. Typical insulation arrangement drawings are indicated below.

1)	Tees	4-00-235-08546
2)	Elbows	4-00-235-08547
3)	Flanges	4-00-235-08548
4)	Expansion joint for pipe	4-00-235-08549
5)	Expansion piece for duct	3-00-235-06258 & 3-00-235-06259
6)	Manhole door for duct	3-00-235-06260

INSULATION OF DRUM END

MATERIAL:

- 1) FLAT 50 X 6
- 2) FIXING PIN INSLN DIA – 6
- 3) RETAINER TYPE – A
- 4) G.L. BINDING WIRE DIA – 1.22 / 0.914
- 5) WOOL MATTRESS
- 6) OUTER CASING
- 7) SELF TAPPING SCREW – M4 X 13
- 8) G.L. SEWING WIRE DIA – 0.71 / 0.914

APPLICATION:

Install Flat 50 x 6 circumferential bands to fit snugly around the drum.

Flat 50 x 6 lattice bar 8 numbers should be radially placed over the dished end and contouring the same and it is to be welded over circumferential bands.

Weld the Fixing pins to the lattice bars circumferential bands.

Fix the Wool mattress.

Position the Retainer and tack weld to the Pin.

Tie with Binding wire across the Pins.

Fix the outer casing strips by Self tapping screws.

INSULATION OF PIPES AND BUNCH OF TUBES

MATERIAL:

- 1) WOOL MATTRESS
- 2) G.L. SEWING WIRE DIA-0.71 / 0.914
- 3) G.L. BINDING WIRE DIA – 1.22 / 0.914
- 4) OUTER CASING
- 5) SELF TAPPING SCREW – M4 x 13

APPLICATION:

Fix the insulation over the bunch of tubes / pipes.

Tie the insulation with G.I. binding wire circumferentially.

Fix the outer casing sheet with self-tapping screws.

**INSULATION OF VERTICAL PIPES
(WELDING OF FIXING PINS NOT PERMITTED ON PIPES)**

MATERIALS:

- | | |
|-------------------------------|---------------------------------------|
| 1) FIXING PIN INSLN DIA – 6 | 9) FLAT 50 x 6 |
| 2) RETAINER TYPE – A | 10) PACKING CLOTH – 3 MM TK |
| 3) CASING SUPPORT – 850MM | 11) HEX HD BOLT M8X40 |
| 4) OUTER CASING | 12) HEX NUT M8 |
| 5) WOOL MATTRESS | 13) PNCHD WASHER A9 |
| 6) SELF TAPPING SCREW – M4X13 | 14) GI BINDING WIRE DIA – 1.22 /0.914 |
| 7) CLAMP | 15) GI SEWING WIRE DIA – 0.71 / 0.914 |
| 8) SUPPORTING SHEET | 16) SHEET 3.15x30x3000 |

APPLICATION:

At every three meters provide the Clamps over the pipe with bolt but and washer by using packing cloth in between the pipe and clamp. Fix the sheet 3.15x30x3000 over the pipe and weld to the clamps. Weld the fixing pin over the sheet. Consult the Welding engineer before welding.

Weld the Flat to the Clamps.

Weld the Supporting sheets to the Flats.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Pins.

Tie the insulation to the pipe with GI biding wire circumferentially.

Fix the casing support to the Retainer by using two numbers of Self tapping screws, fixed diagonally for each Retainer.

Fix the outer casing sheet with self tapping screws.

INSULATION OF VALVE

MATERIAL:

- 1) SM CLAMP FOR DETACHABLE INSULATION TYPE – A (To be used up to 200 mm overall dia)
- 1)a SM CLAMP FOR DETACHABLE INSULATION TYPE – B (To be used above 200 mm overall dia)
- 2) WOOL MATTRESS
- 3) OUTER CASING
- 4) SELF TAPPING SCRES – M4 x 13
- 5) G.I SEWING WIRE DIA – 0.71
- 6) SNAP HD RIVET 3 x 8
- 7) CHS SCREW M4 x 20
- 8) HEX NUT M4

APPLICATION:

The sheeting shall be made in two halves and the Sheet metal clamp mounted.

Wool mattress thickness according to adjacent pipe lines shall be pressed in to two halves.

The two halves shall be fitted over the valve to be insulated and locked by Sheet metal clamp.

Self tapping screws shall be used for clamping the two edges of the outer sheet casing when the length of the valve is more.

After assembling the Clamp put a bit of GI Binding wire as a pin through 1.6 mm hole provided.

INSULATION OF DUCT / FLAT SURFACE

MATERIALS:

- | | |
|-----------------------------|--------------------------------------|
| 1) FIXING PIN INSLN DIA – 6 | 5) GI BINDING WIRE DA – 1.22 / 0.914 |
| 2) WOOL MATTRESS | 6) CASING SUPPORT – 650 MM |
| 3) OUTER CASING | 7) SELF TAPPING SCREW M4 x 13 |
| 4) RETAINER TYPE – A | 8) GI SEWING WIRE DIA – 0.71 / 0.914 |

APPLICATION:

Weld the Fixing pin over the Duct / Flat surface.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Fixing pins.

The GI Binding wire dia 1.22 shall be wound across the Fixing pins diagonally underneath the Retainer Type – A.

Fix the Casing support – 650 long to the Retainer Type – A by using two numbers of Self tapping screws, fixed diagonally for.

Retainer Type – A.

Fix the outer casing by using Self tapping screws.

DUCT STIFFENERS

When the stiffeners protrudes through the insulation and are exposed to atmosphere, provide an additional 40 mm insulation over the stiffener.

DUCT DAMPER & GATE

Insulation thickness shall be as per the adjacent duct insulation. The stuffing boxes should not be insulated. A clear gap of 50 mm (minimum) should be maintained all around the stuffing boxes.

AIR HEATERS

DO NOT insulate over the axial seal, adjuster seal access covers and basket removal doors insulation should be applied in a manner to permit a free circulation of ambient air around the bearing.

INSULATION OF DUCT (CLEARING STIFFENERS)

MATERIALS:

- | | |
|--------------------------------------|-----------------------------|
| 1) FIXING PIN INSLN DIA – 6 | 7) OUTER CASING |
| 2) RETAINER TYPE – A | 8) SELF TAPPING SCREW M4X13 |
| 3) RETAINER TYPE – C | 9) WOOL MATTRESS |
| 4) CASING SUPPORT – 650 MM | 10) WELD MESH |
| 5) GI BINDING WIRE DIA – 1.22/0.914 | 11) CORNER SUPPORT |
| 6) GI SEWING WIRE DIA – 0.71 / 0.914 | 12) ANGLE 40X40X5 – 100 |

APPLICATION:

Weld the Fixing pin over the Duct.

Position the Retainer Type – C so that it will be in the same plane as that of the top surface of the stiffener.

Tack weld the Retainer – Type – C to the Fixing pin.

For the top plate of the horizontal duct, spread the Weld mesh over the Retainer Type – C.

This serves as the additional support where people walk over the insulation.

Weld the Corner support to the bottom corners of the duct.

Weld the Angle to the corner support.

This arrangement will help to achieve a sharp corner for the insulation and outer casing.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Fixing pin.

The Binding wire shall be wound across the pins diagonally underneath the Retainer Type – A.

Fix the Casing support - 650 mm long to the Retainer by using 2 numbers of Self tapping screws, fixed diagonally for each Retainer.

Fix the outer casing by using Self tapping screws.

PROCEDURE FOR CURING OF CASTABLE REFRECTORY

CURING OF REFRACTORY WORK

Curing of refractory means retaining the moisture for a minimum period in order to ensure the proper hydration of the binder. Curing of exposed castable surfaces should start after the surface has become firm. This can be tested when a finger rubbed across the surface comes away clean or when the surface feels warm to the touch. Moisture loss for the first 24 hours, after the material has been installed shall be retarded. Initial set occurs within one or two hours.

Castables should be cured for 24 hours. Moist conditions can be maintained by protection with damp sacking or plastic sheet which should not come into immediate contact with the refractory or alternatively by dry coating the castable with an impervious organic based sealing compound. In some instances, satisfactory results can be obtained by sparkling water over the surface. It should be watered for a period of 20 to 24 hours after 4 to 5 hours of construction. The rate of water applicable should be carefully controlled to prevent washing of the fines and to prevent collection of pools in low spots. Shield the surface from direct sunlight at least for about 48 hours. 8 hours after casting and pouring, remove the wooden frames which have no load bearing function in order to permit watering of the lateral parts of the structures. In case of steel frames apply water without stripping them. On completion of the curing period the application of moisture should be stopped. The exposed castable should be allowed to air dry for 24 hours. Naturally air drying of castable after curing will actually cause slight increase in strength. The castable can be all dried indefinitely without adverse effect. Optimum results can be obtained with a drying period of 48 hours.

Before lighting the boiler for drying the setting the following shall be attended.

1. All dirt and foreign objects sticking to tube surface are to be removed to ensure a thoroughly clean surface.
2. Expansion joints are to be cleaned and inspected for the proper functioning of expansion during operation.
3. Test sample of castable refractory is to be taken from entry door regions to determine the moisture content in the laboratory.

Sample of castable are to be taken for the determination of moisture content before and after drying. When the moisture content drops below 0.58 the castable is considered to be dry and the boiler is ready for commissioning. All result of measurement should be duly recorded.

CARE OF THE REFRACTORY WORK

The refractory work is subjected to considerable thermal stresses during boiler operation. Sudden application of heat or cooling introduces severe stresses and endangers the refractory work. Even when the boiler is operated in the recommended regime possibilities of damage occurring to the refractories (due to severed reasons such as bad workmanship, poor quality, slag deposition, corrosive atmosphere etc) must be kept in mind. The following simple rules to be observed.

- (i) Avoid sudden cooling of the furnace after a shut down. A cooling rate of 20° to 30° per hour for the refractory lining in the initial period is recommended. This means that FD fans must be stopped after a shut down of the boiler. Ventilation of the furnace by natural draft is permissible only after six hours of shut down. Forced cooling can be started only after 16 hours.
- (ii) Avoid quick heating of the furnace. Boiler starting diagram is usually a reliable guide.
- (iii) Thoroughly examine the refractory work during shut downs for cracks, chipping off spelling etc. During operation also this can be checked periodically by visual examination through observation holes.

Whenever defects are notice arrange for their quick alimentation, by shutting down the boiler at the earliest depending on the scarceness of the defect.

- (iv) Abnormal heating of outside metal sheet covering of the boiler and hot spots are usually a good indication of damaged refractory and insulation in this area. The leakage of flue gas will spoil the property of good mattresses within a short time.
- (v) Deep the access door, observation doors, etc. properly shut. They are entry points for cold air and this cold air can damage the refractory work by localized cooling.
- (vi) Sufficient quantity of water is to be added to the castable refractory for mixing before application as per supplier's recommendations.

METHOD OF APPLICATION AND CURING
OF POURABLE INSULATION

- (i) Typical application are for insulating behind buckstays and areas such as roofs having multiplicity of hangers, rods and other penetrations.
- (ii) The application of pourable insulation can be pumping and gunning.
- (iii) Density of the pourable insulation installed and cured is around 600 to 650 Kgs/M
- (iv) Pourable insulation is a hydraulic setting insulation additive or air entrainment agents shall not be used.
- (v)
 - (a) Empty the entire bag at a time and mix the whole material so that segregated particles get mixed.
 - (b) The pourable insulation should be thoroughly mixed with clean water to develop casing and pump consistencies.
 - © The correct quantity of water shall be placed in the mixer before adding the dry pourable insulation normally about 70 to 100 by weight. However this has to be confirmed from the supplier while purchasing this material.
 - (d) Mixing time shall not be less than five minutes or more than five minutes.
 - (e) Dried out material shall not be remixed.
 - (f) Pourable insulation once mixed must be in place within half an hour.
- (vi)
 - (a) All areas where pourable insulation will be placed must be free of scale, rust, dust or other loose materials.
 - (b) All porous forms used such as wood etc shall be oiled before pouring.
 - © All absorbent surface such as insulation brick, concrete, shall be wet down thoroughly to prevent water absorption.
 - (d) Waiting of wall insulation used as forms at buckstay levels is not required.
- (vii)
 - (a) The surface of pourable insulation once in place will become firm in approximately two hours. The surfaces should be kept damp with an occasional light spray or covering with a cloth that is kept damp for the entire 24 hours curing period.
 - (b) For mixing and spraying the water should be clean and cold.
 - © Application of moisture after 24 hours should be stopped forms etc should be removed and the materials allowed to air dry for 24 hours.
- (viii) The shuttering scaffolding moulds should be removed after about 36 hours of casing.

**APPLICATION OF INSULATION FOR BOILER PIPING,
PIPING AND EQUIPMENTS / VESSELS AND ACCESSORIES.**

Bonded mattress having standard thickness to 25, 40, 50, 60, 75 mm confirming IS 8103 having a density of 150 kg/cubic meter and light bonded mattress having a density of 150 kg/cubic meter and light bounded mattress having standard thickness of 25, 40, 50, 60, 75 mm conforming to IS 9842 having a density of 144 kg/cubic meter and pipe section in the standard thickness of 25, 40, 50, 60, 75 mm confirming IS 9842 having density of 144 kg/cubic meter will be 100 kg/cubic Mtr.

The application of insulation will be done as per general notes/ drawings enclosed. The application commissioning shall be as per latest editions of IS 7413 code of practice for application and finishing of thermal insulation materials between 40° C to 700° C of Bs 5970 code for practice for thermal insulation of pipe work and equipment (in the temperature range – 100° C to + 870° C).

Inspection before application, during the application and after the application of insulation will be carried out by BHEL Field Quality Engineer as per BHEL Field Quality Plan. Every layer of insulation shall be got approved by BHEL Engineer / FQA Engineer.

Prior to applying insulation the surfaces to be insulated shall be made clean and dry and free from dirt and grease. Where cladding is attached to carbons steel or low alloy steels the steel shall be first prime painted with zinc chromate and then painted with Aluminum paintings. Wherever required to provide aluminum foil as protective covering for bolts and other fittings shall be arranged by contactor. The prints wherever required for preservation coating shall be supplied by contractor.

For insulation of piping with performed pipe sections the came shall be applied over pipe and finally be held in position with 15 mm wide aluminum band at greater than 300 mm spacing for mineral wool insulation.

For insulation of piping with mattresses having backing GI wire netting, the required lengths and shapes are to be cut from the blankets and wrapped on the piping and held in position with proper support by fastening the binding to be done circumferential at not greater than 300 mm spacing.

Performed insulation on vertical or near vertical piping must be supported in position by means of metal ring at interval not greater than 960 mm.

The support attachment may be welded or clamped to the pipe, subject to the approval of BHEL Site Engineer Necessary fabrication of support rings to be done as per site requirement.

Piping bends shall be insulated to the same specification as adjacent straight piping and should form a smooth external surface. Where performed material is used it should be cut lobster-back fashion and wired or strapped into position.

Pipe insulation shall be cut to fit nearly around hangers and supports. On horizontal lines which are supported directly on pipe racks the insulation and weather proofing shall be sufficiently cut away at the support to accommodate pipe movement.

Protrusions through insulations which themselves do not required insulations such as pipe clamps supports of small pipings instrument take offs etc shall be covered to the same thickness as the adjacent insulation expect for hanger rods.

At outdoor location the hanger rod protraction shall be shielded with metal flashing to deflect rain and protect the insulation from moisture while permitting the movement of the hanger rod.

Arrangement of securing the metal finish even the insulation shall ensure that direct metal contact between the insulated surface and outer meter cladding is avoided. 4mm thick asbestos board packing shall be used at interface to thermally isolate the metal covering from supporting arrangement. All cladding joints shall be vapours tight and shall be able to accommodate thermal movements. Paste type self setting vapours sealing compound shall be used.

Metal cladding on piping shall be screwed with self tapping screws. These joints should be arranged approximately 30° below horizontal centre line so as to shed water on any horizontal pipe line. The screws shall be flat or round head types of 12mm size and overlapping of 50 mm on both longitudinal and circumferential joints. The screws shall be provided at not greater than 150 mm spacing.

Insulation expansion joints shall be provided in all pipelines to allow movements and expansion of the pipe. The recommended intervals of expansion joints are.

Pipe Temperature	Spacing of Insulation Expansion joints
Below 200°C	5.5 M
201° - 300°C	3.5 M
301°C - 400°C	3.0 M
Above 400°C	2.0 M

All joints in the insulation shall be staggered. For multiple layer of insulation the different layers shall be applied so that the butt joints of one layer do not coincide with those of the other layers. At the joint of each layer of insulation loose insulation shall be packed firmly.

Equipments Insulation Application Procedure

For equipment and shells a matrix of insulation support shall be developed by:-

- (a) Welding the insulation support lugs on a frame work prepared with 20 mm x 3 mm size MS Straps where direct welding of lugs to the sheet is not permitted.
- (b) Welding the directly on shell after written permission by Site Engineer. The material of the support shall be similar to the material of the shell in this case.

The support shall be pitched at 300 mm for vertical and underside surfaces and 500 mm for oppressed surfaces. A support shall be located above each vessel flange at a sufficient distance above the flange bolts to allow for easy removal. The top and bottoms supports shall be slotted suitably for attachments of straps and wires.

The support lugs shall be 6 mm

Insulation with back up GI wire noting, shall be cut to fit the equipments and shall be wrapped on the equipment and held in position with proper support and tie wires. All joints between course shall be staggered and tightly butter and adjacent edges laced together with lacing wire.

Insulation shall be fastened in place with MS Straps of 20 x 3 mm, on approx., 300 mm centers where contour of equipment permits. Straps shall be tightened with a banding machine and champed with seals.

Insulation on top of horizontal heads shall be cut to fit the curvature of the head and shall be secured in place with the help of radial straps fixed in between circumferential rings. Insulation on bottom heads shall be wired to nuts welded to head. Insulation shall also be strapped to bottoms insulation support. For outdoor equipments insulation shall be arranged to be weather proof.

Metal jacketing shall be applied directly over the met insulation and neatly fitted to place. All gaps shall be arranged so as to shed water. Suitable flashing and weather proofing shall be provided at all nozzles, manholes and other projections to prevent the entrance of water.

VALVES & FLANGES INSULATION APPLICATION

The insulation on all valves and flanged joints shall be enclosed in a removable jacketing so that it may be removed without disturbing the concerned equipment or piping. The thickness of insulation shall be same as that of the pipe line in which these valves and fittings are located.

The layout of wool mattresses to be adopted to obtain the specified insulation thickness are as per be on unless otherwise specified:

Thickness of Insulation (mm)	Layer			
	I	II	III	IV
25	25			
40	40	-	-	-
50	50	-	-	-
60	60	-	-	-
65	40	25	-	-
75	75	-	-	-
80	40	40	-	-
100	50	50	-	-
110	60	50	-	-
125	75	50	-	-
135	75	60	-	-
150	75	75	-	-
155	75	40	40	-
160	75	60	25	-
165	75	50	40	-

The material density of boned mineral wool used for pipe having outside diameter more than 355.6 mm is 150 kg/cubic meter 13 8183.

The material density of bonded mineral wool used for pipe having outside diameter less than or equal to 355.6 mm is 144 kg/cubic meter IS 9842.

Cladding material used is galvanised steel sheet as per IS 277 GRADE 375.

Cladding material gauge for pipe outside diameter less than or equal to 300 mm is 24 SWG.

Cladding material gauge for pipe outside diameter greater than 300 is 22 SWG.

For piping up to including 355.6 mm OD, first layer shall be pipe sections and subsequent layer shall be bonded. Wherever pipe sections are not supplied the first layer has to be wrapped using bonded wool material for piping 355.6 mm OD, bonded mattress shall be used or all the layers.

Description of type of insulation and the method of Application for Boiler Feed Pumps

1. Type of insulation

The pumps should be insulated with 125 mm thick flexible wire backed mineral wool mattress of 150 kg/ density.

2. Method of Application

The above insulation is to be applied to 2.0 mm thick flats aluminum sheeting (18 SWG) and secured by 19 mm wide aluminum retaining dips and 1/8 inch diameter aluminum pop rivets, all to be secured by 2 inch long X No.8 spacing to a 40 mm wide x 3 mm thick angle iron frame work of all welded construction bound by 40 mm PVC tape.

<u>SECTION</u>	<u>TITLE</u>	<u>NO. OF SHEETS</u>
A	METHOD OF APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS AND MATERIAL SPECIFICATIONS (ANNEXURE-1)	4
B	THERMAL INSULATION APPLICATION DRAWINGS	13

SECTION - A

THERMAL INSULATION FOR PIPING AND EQUIPMENTS

1.0 INTRODUCTION

In a thermal power station or process plant, thermal insulation or heat lagging of piping and equipment's carrying hot fluids is essential for best economy and protection of operating personnel. Any pipe which is at a temperature higher than its surroundings will lose heat and the amount of heat lost will depend upon the temperature of the fluid and the thermal conductivity of the piping material/covering.

The heat lost through bare pipe increases with

- a) Increase in the temperature of fluid conveyed
- b) Decrease in ambient temperature and
- c) Increase in wind velocity of the surroundings.

The heat so lost has potential for work and rapidly increasing cost of fuel in the recent past has promoted to find all possible means to conserve energy. Providing proper and adequate insulation on to the piping and equipments controls heat transfer and maintains the required service temperature.

2.0 METHOD OF APPLICATION

The method of application is highly skilled job. Badly fitted/laid insulation can lead to greater heat loss, higher cold surface temperature than that estimated and frequent maintenance. Following are the important points to be considered in the application of the insulation.

- 2.1 Before applying insulation, it should be ensured that all instrument tappings, clamps, lugs and other connections on the surface to be insulated have been properly installed as per relevant drawings.
- 2.2 All surfaces to be insulated shall be cleaned of all foreign materials such as dirt, grease, loose scale, moisture etc.
- 2.3 Welding of lugs, attachments, clips etc. on the surface to be insulated for supporting insulation shall not be carried out without the permission of the authorized person.
- 2.4 All flanged joints shall be insulated only after final tightening and testing.
- 2.5 The insulation shall be applied to all surfaces when they are at ambient temperature.
- 2.6 Where more than one layer of insulation is involved, mattresses should have staggered joints (at 60 deg) and they must be held in close contact with face of

pipes/fittings by means of binding wires / Aluminum bands / seals. Circumferential joints of multilayer insulation should also be staggered by at least 150 mm.

(Refer Drg. No. PE-4-999-169-01).

- 2.7 For the first layer of insulation and in case of multi layer of insulation, mattresses with hexagonal wire netting will be facing on outer side.
- 2.8 Insulation mattresses shall be held in place by fastening over with binding wire. Care should be taken to see that the flexible insulation mattresses are not unduly compressed. The ends of binding wire shall be lightly twisted together, bent over and pressed into the insulation. For mattresses, binding wire shall be used at intervals of 300mm.

In the addition Aluminium bands shall also be provided at 300 mm intervals for diameters greater than 500mm. (Refer Drg No. PE-4-99-169-01.)

- 2.9 Where junctions between bodies of different diameters occur and difference in insulation thickness is specified, the greater thickness is to be continued for a length equal to one diameter of the smaller body and then smoothly tapered to the required smaller thickness over a length equal to two diameters of the small body.
- 2.10 The indicated thickness of insulation are minimum requirement which should be maintained. Any change in the thickness of the insulation should be done only after prior approval of the design engineer.
- 2.11 The day-to-day insulation work should be covered with suitable protective materials to prevent the rain water entry, if same is expected.
- 2.12 The insulation shall be cut to fit the piping O.D / equipment and shall be wrapped on the piping / equipments and held in position with proper support and wires. All the joints should be properly staggered and tightly butted and adjacent edges laced (Refer Drg No. PE-4-999/169/01)
- 2.13 The insulation of valves and flange joints shall be enclosed in a removable jacketing so that it may be removed without disturbing the concerned equipment or piping. The thickness of insulating shall be same as that of the pip line in which these valves and fittings are located. (Refer Drg No. PE-4-999-169-07.)
- 2.14 Steam / Air / Gas leakages in and around the pipes to be insulated with be attended before applying insulation.
- 2.15 In order to provide support to Aluminium cladding, support rings made out of 20 x 3 mm M.S. flats shall be fixed at equal intervals of approximately 850 mm spacing and at every circumferential joints. These rings shall be fixed with 'L'

type lugs and shall be fabricated from 20 x 3 mm M.S flats. To reduce that conductivity through these lugs 20 mm x 3 mm size Ceramic mill board shall be used between rings and lugs (Refer Drg No. PE-4-999-169-04 and PE-4-999-169-13).

- 2.16 Spacing between supporting rings for vertical piping shall be 3 mtrs. Support rings are to be provided only when the vertical height exceeds 3 mtrs. (Refer Drg No. PE-4-999-169-03-and PE-4-999-169-05).
- 2.17 For vertical pipes since support rings is provided at every 3 mtrs interval, only two spacer rings shall be provided in between support rings.
- 2.18 Spacer rings shall be provided at both ends of elbows/bends, valves and flanges pipe having dia more than 89mm.
- 2.19 Wherever the end of hanger clamp assembly protrudes out of the insulation at the bottom suitable box structure are to be provided. Pipe hangers and supports should be covered in such a way that the moisture cannot penetrate into the insulation.
- 2.20 It is very important that sheet metal cladding should be done by a well experienced and competent fabricator. Person doing the job can alter the method of fixing of cladding sheet after consulting the concerned design engineer.
- 2.21 The longitudinal joint in the outer cladding sheet should always be at the lower half of the circumference for horizontal piping so that no rain water enters the insulation through the joints. (Refer Drg No. PE-4-999-169-01).
- 2.22 The joints of outer cladding should be staggered axially.
- 2.23 Inside surface of all Aluminium sheet will have two coats of Bituminous paint applied uniformly.
- 2.24 Aluminium sheets covering on outdoor horizontal pipes will be provided with 3 mm drain hole at the bottom center line at 6 mtr intervals.
- 2.25 The cladding sheet shall provide directly over the insulation/finishing cement (1F APPLICABLE). Suitable flashing and weather proofing shall be provided at all nozzles, manholes and other projections to prevent the entrance of water.
- 2.26 Loose wool can be taken from wool mattresses. Wherever gaps and voids have to be filled.
- 2.27 Sealing compound to be applied on Aluminum cladding sheet joints.

- 2.28 Support rings/spacer rings shall be provided if the insulation thickness > 40mm and pipe diameter > 89mm.
- 2.29 Equipment's name plates shall not be insulated.
- 2.30 Clips made out of sheet be riveted inside the box for insulation of valves and flanges to hold the insulation in box. (Refer Drg No. PE-4-999-169-06).
- 2.31 The insulation local to the inspection points of the critical piping shall be removable.
- 3.00 For Thermal Insulation Material Specification related to the project refer Annexure – 1.

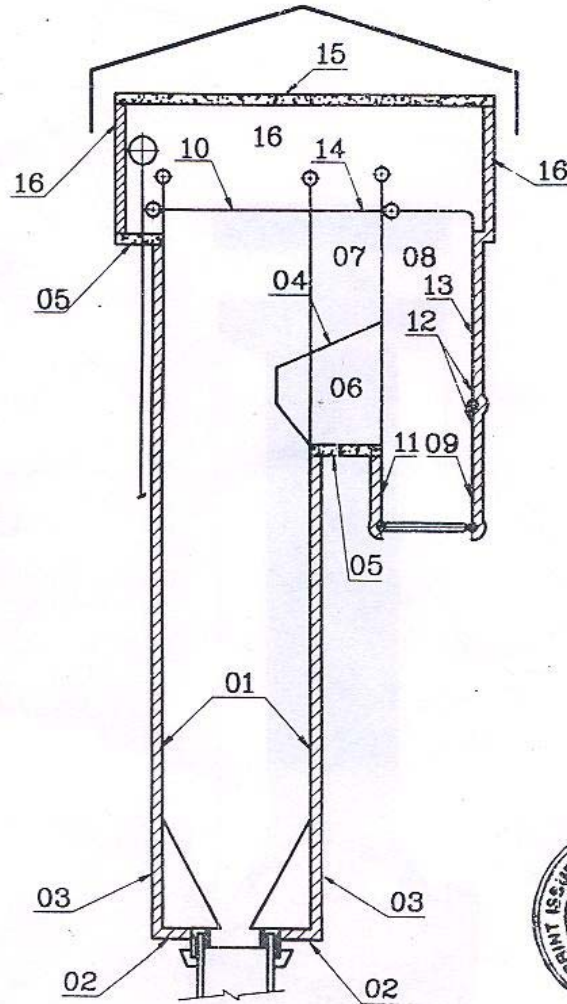
IMPORTANT POINTS TO BE TAKEN CARE DURING APPLICATION

- I) Binding wires for all layers of insulation will be at distance of 300mm.
- ii) In addition Aluminum bands/seals also to be provided at distance of 300 mm for sizes above 500mm.
- iii) Aluminum bands/seals to be provided over aluminum sheets at distance of 500mm.
- iv) Ceramic mill boards to be used between all 'L' type lugs and the support rings.
- v) Inside surface of Aluminum sheets to have 2 coats of bituminous paint applied uniformly.
- vi) Gaps to be properly filled with loose wool taken from mattresses.
- vii) End of hanger clamp assembly protruding out of insulation at the bottom should be suitably boxed with Aluminum sheets.
- viii) Valves to be insulated properly in box structure as given in enclosed drawings.
- ix) Multilayer longitudinal and circumferential joints should be staggered.

ANNEXURE – 1

- 1.0 **Thermal insulating materials shall be per the details given below:-**
- 1.1 **Lightly Bonded Mineral (Rock) wool Mattresses** of density 150 Kg / Cub. Mt with S.S. wire netting will be applied for the first layer of insulation where hot face temperature greater than 400 degree centigrade. For subsequent layers matters of density 150 Kg / Cub. Mtr with G.S. wire netting will be applied.
- 1.2 **Lightly Bonded Mineral (Rock) wool Mattresses** of density 100 Kg/Cub. Mt with G.S. wire netting will be applied for all layers of insulation for host face temperature less than and equal to 400 degree centigrade.
- 2.0 **Binding and lacing wires:** For insulation matters shall be of stainless steel for all insulation interface temperatures.
- 3.0 **Aluminum cladding sheet** shall be provided over the Mattresses ad per details given below.
- | | |
|-----------------------|---|
| 18 SWG (1.22 mm thk.) | For pipes with dia over insulation above 450 MM. |
| 20 SWG (0.91 mm thk.) | For pipes with dia over insulation above 150 MM and less than equal to 450MM. |
| 22 SEG (0.71 mm thk.) | For pipes with dia over insulation less than equal to 150mm. |

SECTION – B

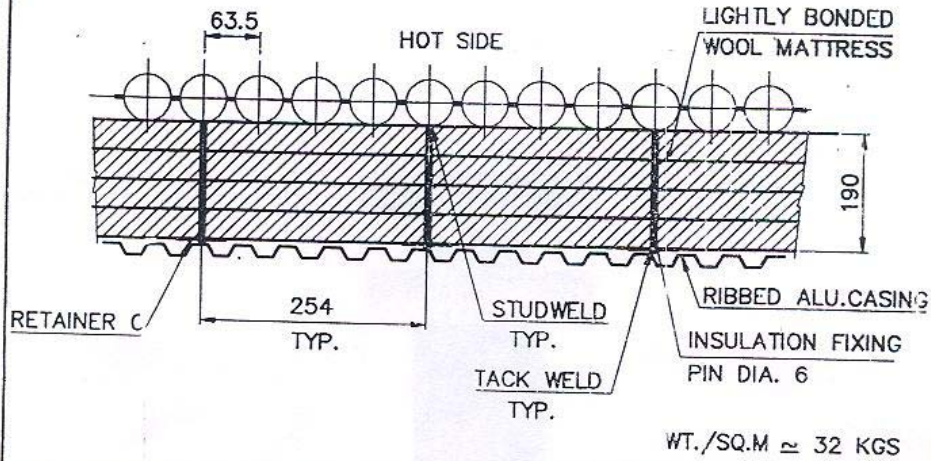


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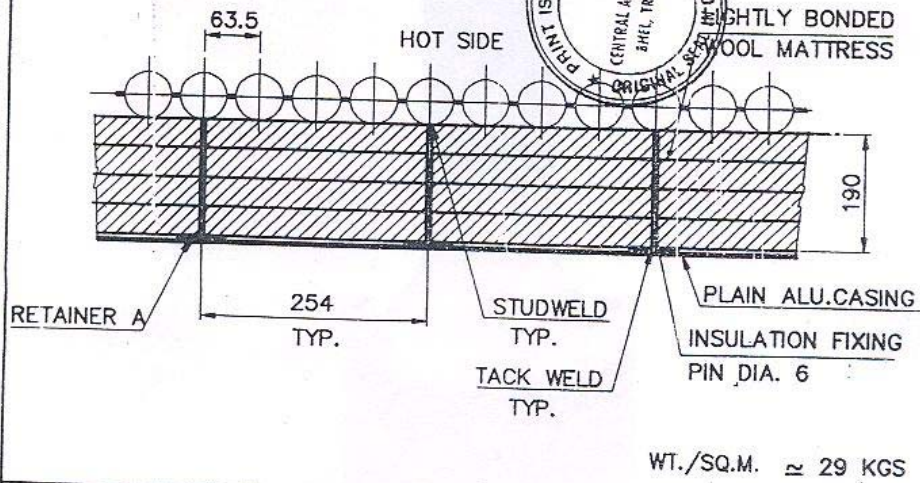
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DETAIL 01

SHEET 02 OF 09



DETAIL 02

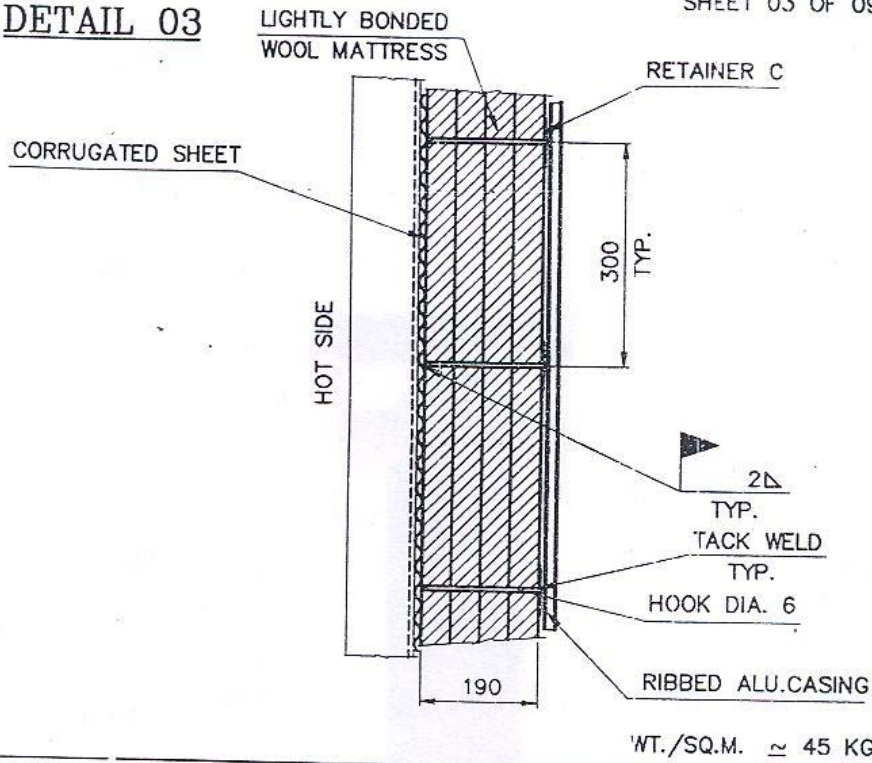


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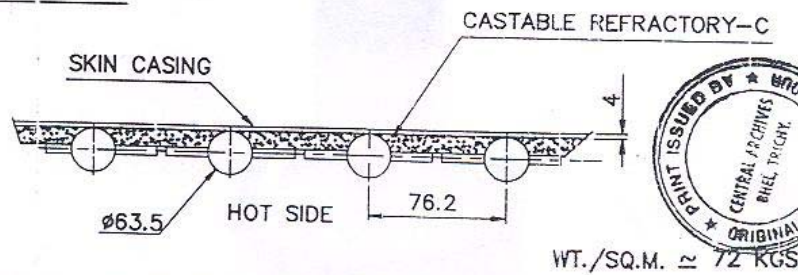
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DETAIL 03

SHEET 03 OF 09



DETAIL 04

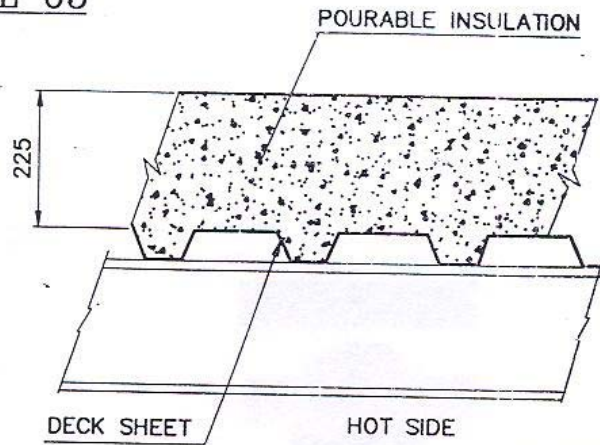


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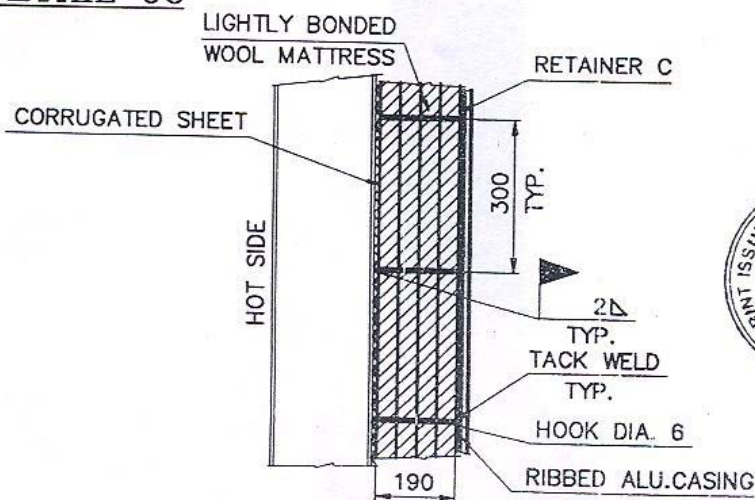
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SHEET 04 OF 09



WT./SQ.M $\approx$ 193 KGS

DETAIL 06



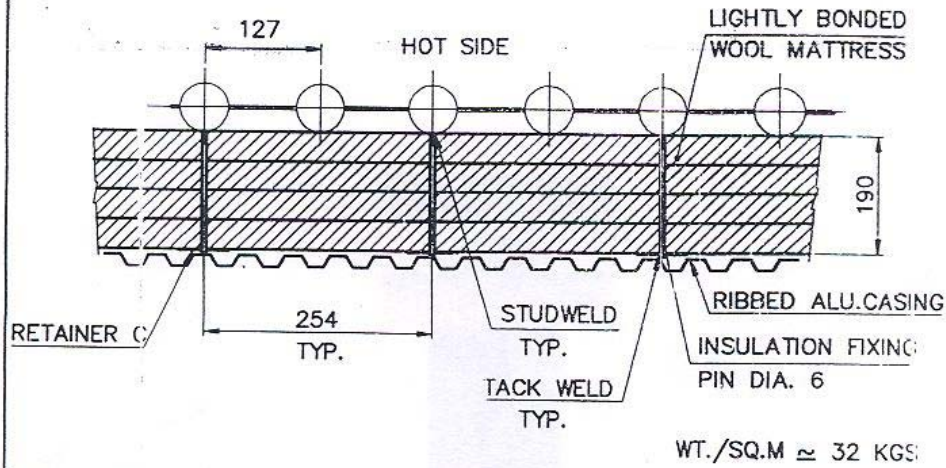
WT./SQ.M $\approx$ 45 KGS

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	APPD	C.G.S			
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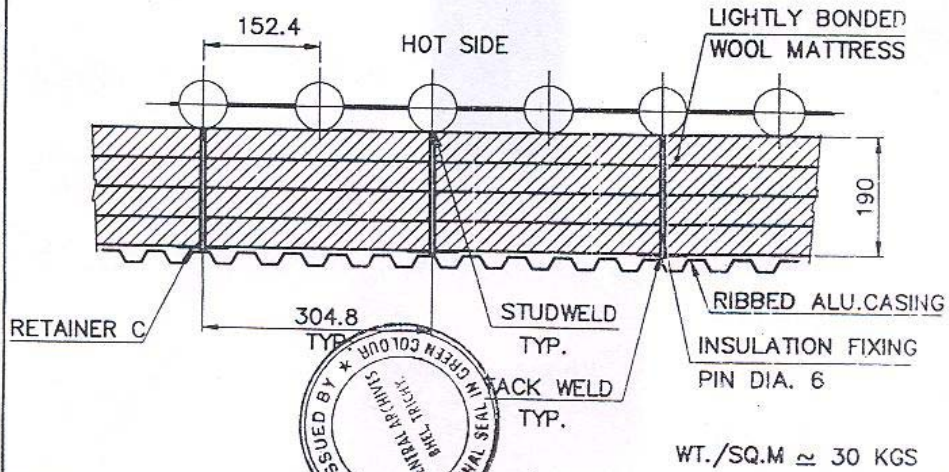
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DETAIL 07

SHEET 05 OF 09



DETAIL 08

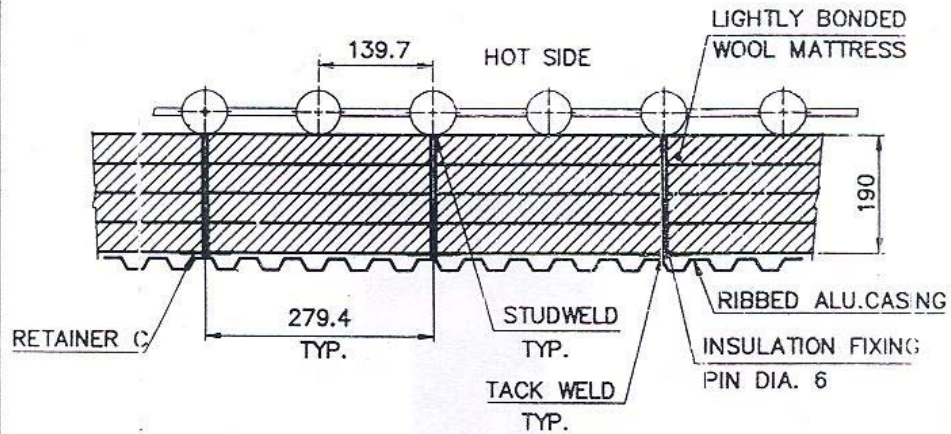


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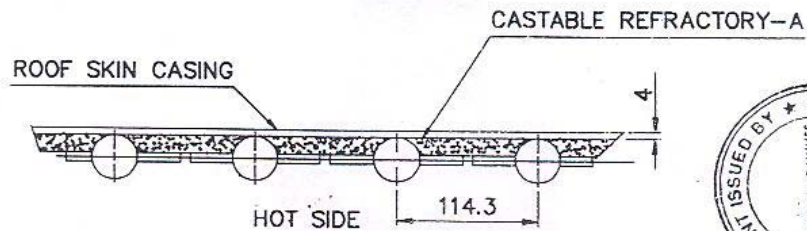
DETAIL 09

SHEET 06 OF 09



WT./SQ.M $\approx$ 30 KGS

DETAIL 10



WT./SQ.M $\approx$ 75 KGS

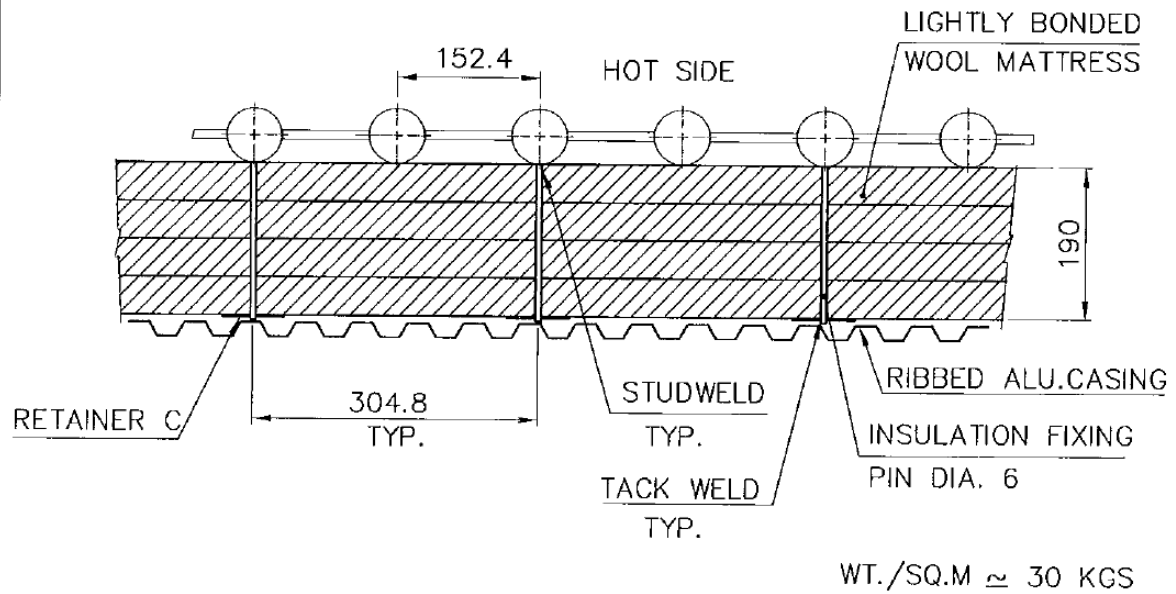


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	APPD	C.G.S			

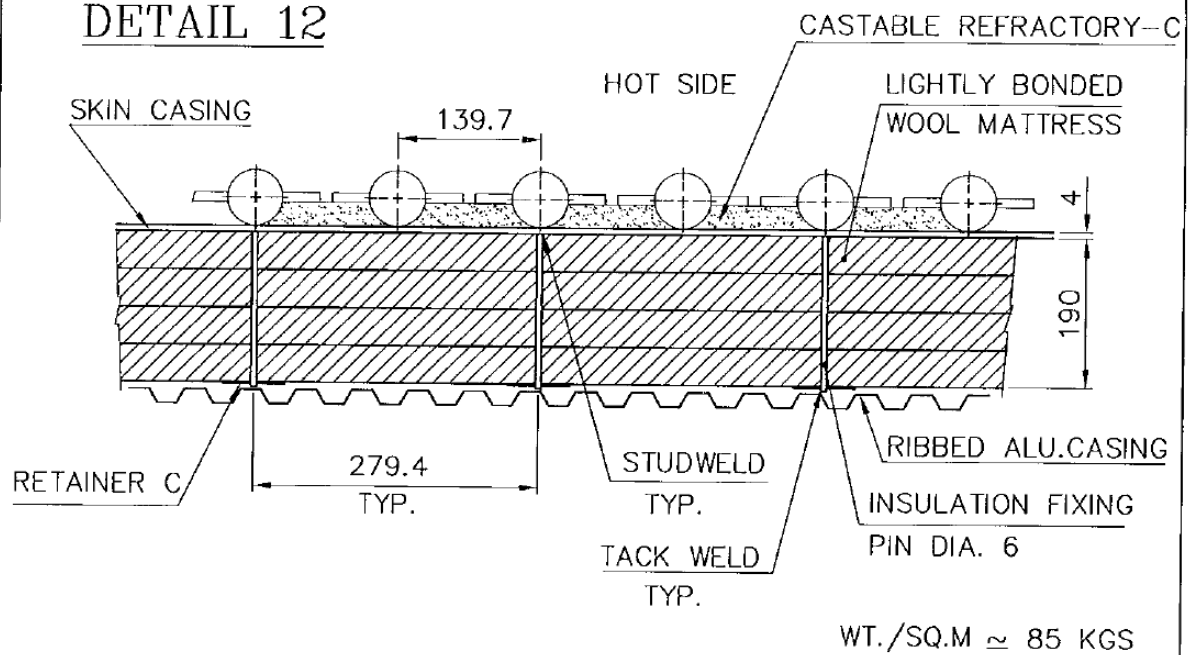
CTS001384-0

DETAIL 11

SHEET 07 OF 09



DETAIL 12



INSULATION

DRN	C.S
CHD	C.G.S
APPD	C.G.S

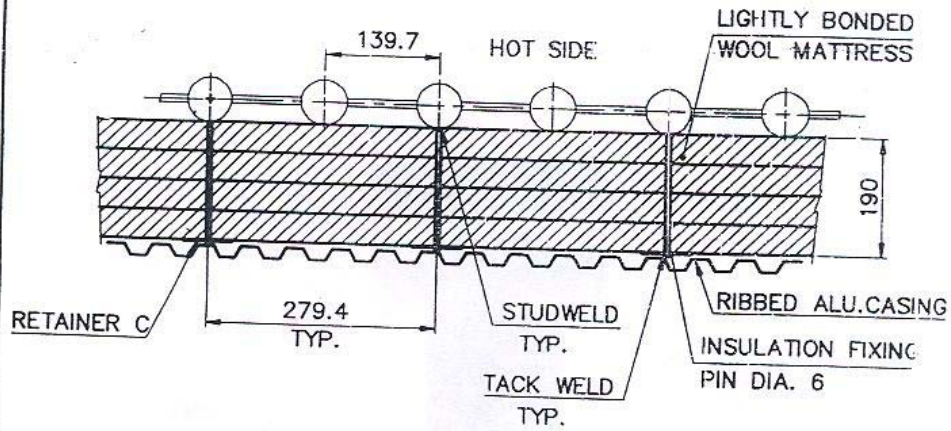
DRG.NO.

4-00-215-08557 00

REV.NO.

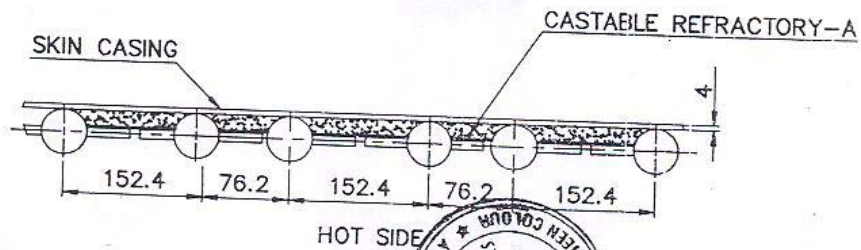
DETAIL 13

SHEET 08 OF 09



WT./SQ.M $\approx$ 30 KGS

DETAIL 14



WT./SQ.M. $\approx$ 75 KGS

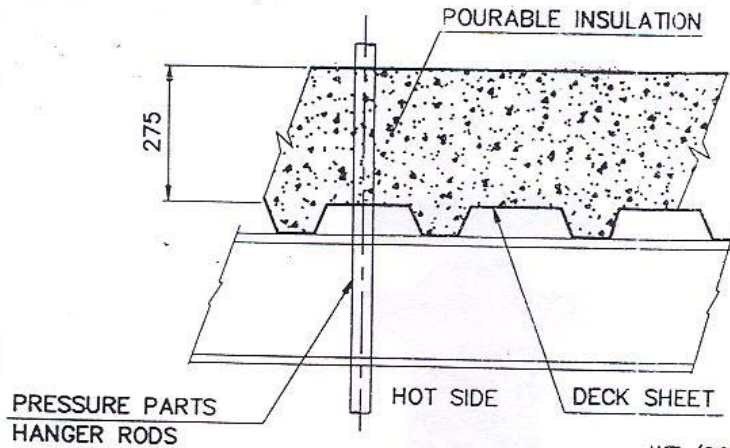
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	CHD	C.G.S			
	APPD	C.G.S			

CTS001384-0



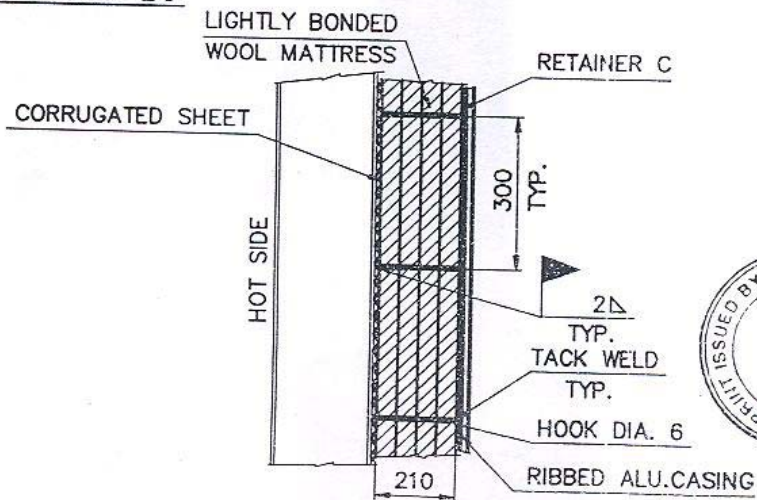
DETAIL 15

SHEET 09 OF 09



WT./SQ.M $\approx$ 233 KGS

DETAIL 16



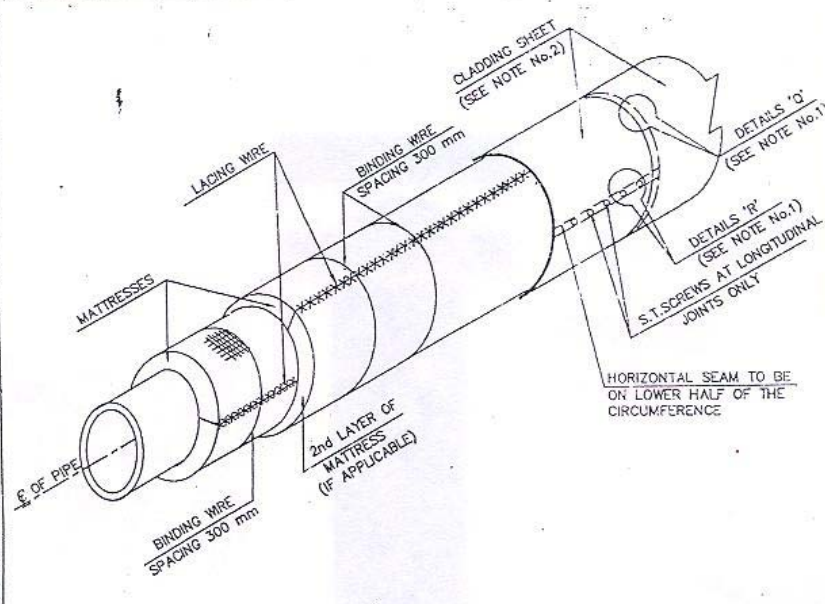
WT./SQ.M $\approx$ 46 KGS

INSULATION	DRN	C.S	DRG.NO.	REV.NO.
	CHD	C.G.S		
	APPD	C.G.S		
			4-00-215-08559	00

CTS001284.0

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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)			
REV.	DATE	ALTERED	CHECKED
JOB NO.		STANDARD	



NOTES: -

1. FOR DETAILS 'Q' AND 'R' REFER DRG No. PE-4-999-169-12
2. FOR SHEET SUPPORT REFER DRG No. PE-4-999-169-04
3. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".
4. IN ADDITION TO BINDING WIRE ALUMINIUM BANDS TO BE PROVIDED FOR DIAMETERS > 500 MM.

MATERIALS REQUIRED: -

1. MATTRESSES
2. BANDS AND SEALS
3. CLADDING SHEET
4. S.T.SCREWS
5. SEALING COMPOUND
6. LACING WIRE
7. BINDING WIRE

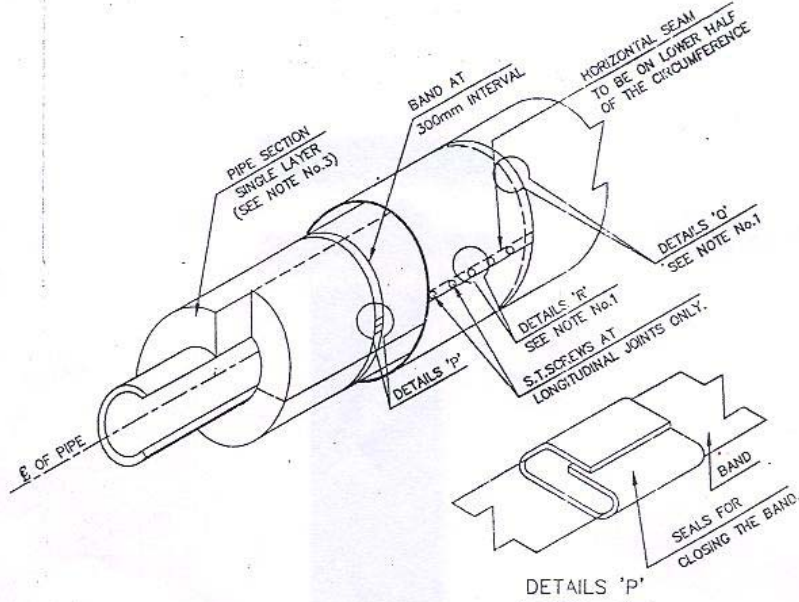
		BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NEW DELHI	
DEPT. MP	CODE M	SCALE N.T.S.	WEIGHT (KG.)
TITLE: INSULATION APPLICATION (HORIZONTAL PIPES WITH MATTRESSES)		REF. TO ASSY. DRG	ITEM
DRN	NAME S.C.S.	SIGN	DATE
DESN	S.C.S.	9.6.97	
CHD	D.B.S.	9.6.97	
APPD	S.K.J.	11.6.97	
CARD CODE	DRAWING NO. PE-4-999-169-01		
SHEET 1 OF 1		REV. 00	

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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED

JOB NO. STANDARD



NOTES: -

1. FOR DETAILS 'Q' AND 'R' REFER DRG. No. PE-4-999-169-12
2. FOR CLADDING SHEET SUPPORT REFER DRG. No. PE-4-999-169-04
3. 2nd & 3rd LAYER IF ANY SHALL BE OF MATTRESSES.
4. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS"

MATERIALS REQUIRED: -

1. PIPE SECTIONS
2. BANDS AND SEAL
3. CLADDING SHEET
4. S.T. SCREWS
5. SEALING COMPOUND



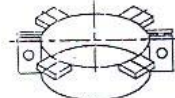
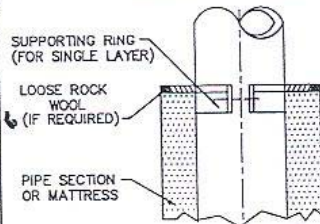
BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT. MPL	CODE M	SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG.	ITEM																
TITLE: - INSULATION APPLICATION (HORIZONTAL PIPES WITH PIPE SECTION)				<table border="1"> <tr> <td>DRN</td> <td>NAME</td> <td>SIGN</td> <td>DATE</td> </tr> <tr> <td>DESN</td> <td>S.C.S.</td> <td>[Signature]</td> <td>6.6.97</td> </tr> <tr> <td>CHD</td> <td>D.B.S.</td> <td>[Signature]</td> <td>7.6.97</td> </tr> <tr> <td>APPD</td> <td>S.K.J.</td> <td>[Signature]</td> <td>11.6.97</td> </tr> </table>	DRN	NAME	SIGN	DATE	DESN	S.C.S.	[Signature]	6.6.97	CHD	D.B.S.	[Signature]	7.6.97	APPD	S.K.J.	[Signature]	11.6.97	
DRN	NAME	SIGN	DATE																		
DESN	S.C.S.	[Signature]	6.6.97																		
CHD	D.B.S.	[Signature]	7.6.97																		
APPD	S.K.J.	[Signature]	11.6.97																		
CARD CODE			DRAWING NO. PE-4-999-169-02																		
SHEET 1 OF 1			REV. 00																		

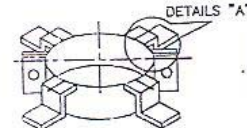
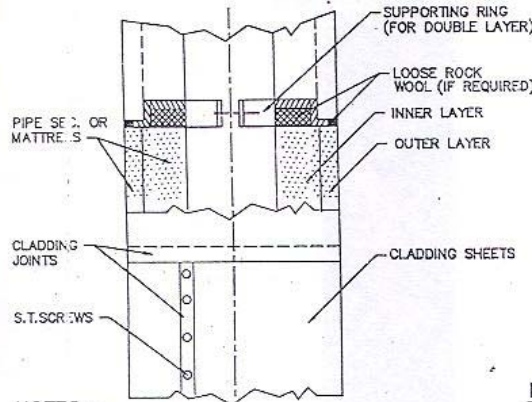
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

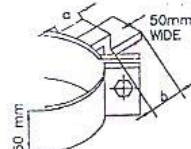
REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED
JOB NO. STANDARD					



SUPPORT RING
(FOR SINGLE LAYER)



SUPPORT RING
(FOR DOUBLE LAYER)



DETAIL 'A'

NOTES:-

1. LENGTH 'a' & 'b' TO BE 12 TO 50mm LESS THAN SPECIFIED INSULATION THICKNESS.
2. SUPPORT RING TO BE FABRICATED OUT OF MS FLATS/STRAPS.
3. SUPPORT RING REQUIRED FOR PIPE 80 NB & LARGER IF INSULATION THICKNESS LARGER THAN 30mm.
4. SUPPORT RINGS REQUIRED FOR MATTRESS ONLY.
5. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS"

MATERIALS REQUIRED:-

1. FLATS/STRAPS
2. MATTRESSES/PIPE SECTIONS
3. CLADDING SHEET
4. NUTS AND BOLTS
5. SELF TAPPING SCREWS
6. SEALING COMPOUND
7. SUPPORT RINGS (FOR MATTRESSES ONLY)

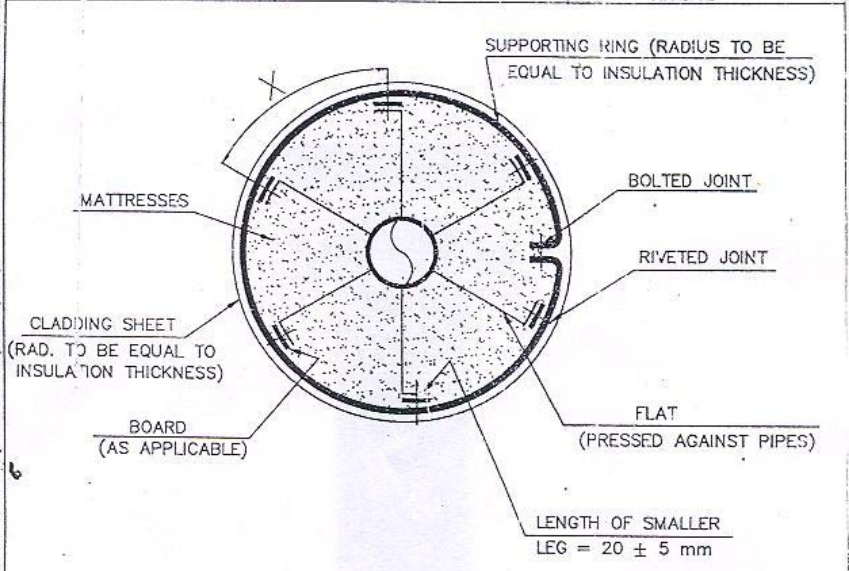


BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	(KG.)		
TITLE:- INSULATION APPLICATION (VERTICAL PIPING)					
CARD CODE		DRAWING NO. PE-4-999-169-03			
SHEET 1 OF 1		REV. 00			

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REV. DATE		REV. DATE		JOB NO.		STANDARD	
ALTERED		ALTERED					
CHECKED		CHECKED					



X = 150 mm TO 200 mm SO THAT NUMBER OF WEBS IS EVEN NUMBER

MATERIAL REQUIRED:-

1. FLATS
2. RIVETS
3. BOLTS AND NUTS
4. BOARD

NOTE:-

1. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NEW DELHI							
DEPT. MPL	CODE M		SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM	
TITLE:- INSULATION APPLICATION (CLADDING SHEET, SUPPORT RING FOR HOR. PIPE O.D>114.3mm & HOR. EQUIPMENTS)					DRN S.C.S. DESN S.C.S. CHD D.B.S. APP'D S.K.J.	NAME S.C.S. SIGN [Signature] DATE 9.6.92	DATE 9.6.92
CARD CODE				DRAWING NO. PE-4-999-169-01			
SHEET 1 OF 1				REV. 00			

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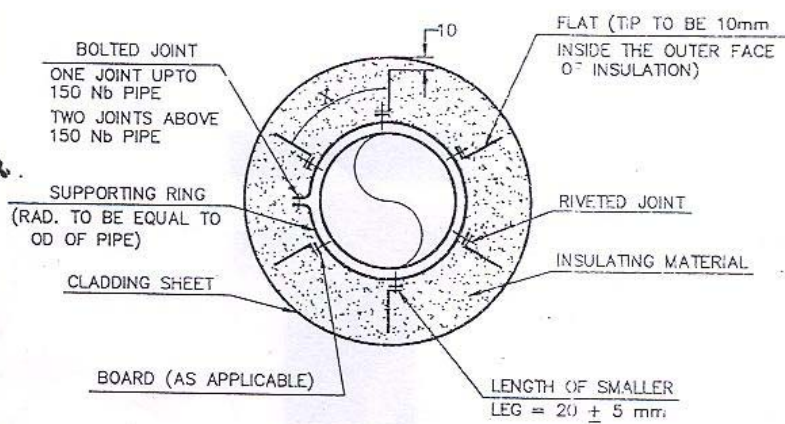
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FIRST ANGLE PROJECTION OF ALL DIMENSIONS ARE IN MM

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED

JCB NO. STANDARD

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X = 150 mm TO 200 mm SO THAT NUMBER OF WEBS IS EVEN NUMBER
MATERIAL REQUIRED:-

1. FLATS
2. RIVETS
3. BOLTS AND NUTS
4. BOARD

NOTES:-

1. INSULATION DETAILS ON VERTICAL PIPING SHALL BE SAME AS PER FOR HORIZONTAL PIPES.
2. SPACING BETWEEN SUPPORTING RINGS SHALL BE 3 Mtrs.
3. FOR INSULATION OF END OF VERTICAL EQUIPMENTS REFER DRG. No. PE-4-999-169-09.
4. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS."
5. FLATS/RINGS OF REQUIRED LENGTH/DIA SHALL BE MADE BY ERECTING AGENCY AT SITE FROM MS FLATS/STRAPS.

		BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NEW DELHI																				
DEPT.	CODE	SCALE	N.T.S.	WEIGHT (KGS)	REF. TO ASSY. DRG	ITEM																
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DRN	NAME	SIGN	DATE																			
DESN	S.C.S.	[Signature]	9.6.97																			
CHK	D.B.S.	[Signature]	9.6.97																			
APPD	S.X.J.	[Signature]	11.6.97																			
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SHEET 1 OF 1		REV. 00																				

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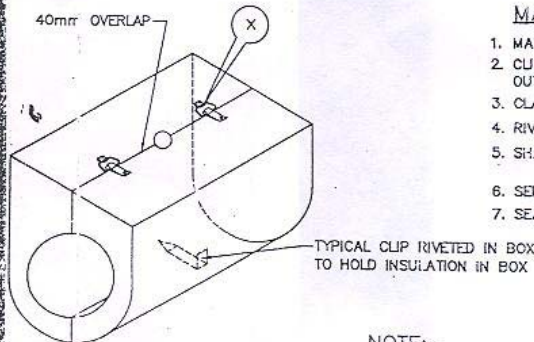
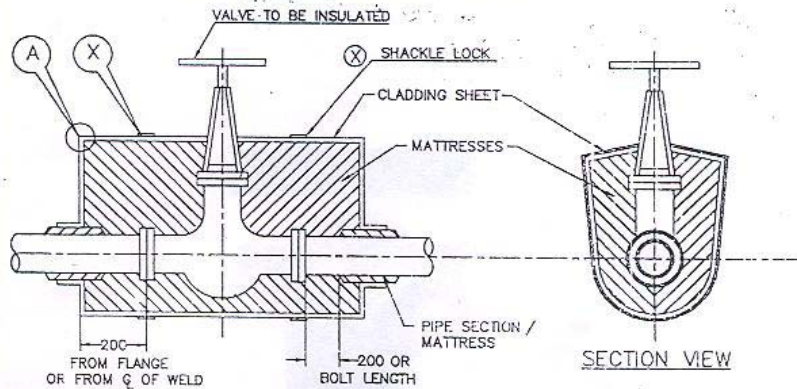
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED
JOB NO. STANDARD					



MATERIALS REQUIRED: -

1. MATTRESSES
2. CLIPS OF SHACKLE LOCKS FABRICATED OUT OF CLADDING SHEET
3. CLADDING SHEET
4. RIVETS
5. SHACKLE LOCKS CONNECTING BUCKLES.
(REF. DRG. PE-4-999-169-10)
6. SELF TAPPING SCREWS
7. SEALING COMPOUND.

NOTE:-

1. FOR DETAIL A & X REFER DRG No. PE-4-999-169-10
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

ASSEMBLED VALVE BOX



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT. MPL	CODE M	SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
TITLE: - INSULATION APPLICATION (VALVES)				DRN NAME S.C.S.	DATE 5.6.97
				DESIGN S.C.S.	DATE 5.6.97
				CHD D.B.S.	DATE 11.6.97
				APPD S.K.J.	
CARD CODE		DRAWING NO. PE-4-999-169-06			
		SHEET 1 OF 1 REV. 00			

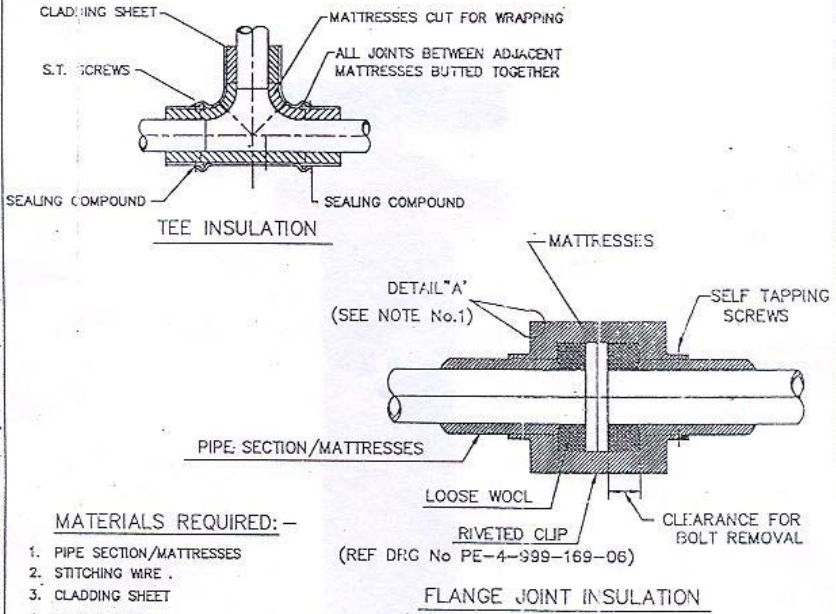
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REV.	DATE	ALTERED	REV.	DATE	ALTERED
6		CHECKED			CHECKED

JOB NO.	STANDARD
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MATERIALS REQUIRED:-

1. PIPE SECTION/MATTRESSES
2. STITCHING WIRE
3. CLADDING SHEET
4. BINDING WIRE
5. SELF TAPPING SCREWS
6. SEALING COMPOUND

(REF DRG No PE-4-999-169-06)

NOTE:-

1. FOR DETAIL "A" REFER DRG No. PE-4-999-169-10
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS."

		BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NEW DELHI			
DEPT. MPL	CODE M	SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
TITLE:- INSULATION APPLICATION (TEES AND FLANGE JOINTS)			DRN	NAME S.C.S.	SIGN
			DESN	S.C.S.	DATE
			CHD	D.B.S.	9.6.97
			APPD	S.K.J.	7.6.97
			4.6.97		
CARD CODE		DRAWING NO. PE-4-999-169-07			
		SHEET 1 OF 1 REV. 00			

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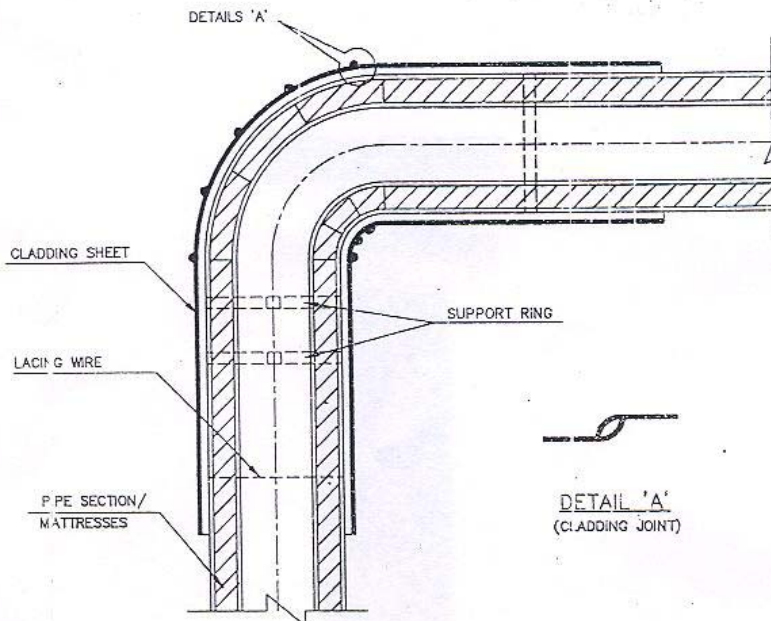
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED

JOB NO. STANDARD



MATERIALS REQUIRED:-

1. MATTRESSES
2. PIPE SECTION (IF APPLICABLE)
3. LACING WIRE
4. CLADDING SHEET
5. BINDING WIRE
6. SELF TAPPING SCREWS
7. SEALING COMPOUND

NOTES:-

1. TWO SELF TAPPING SCREWS TO BE USED FOR EACH SHEET SEGMENT AT INNER SIDE OF BEND.
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS."



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT. MPL	CODE M		SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
TITLE:- INSULATION APPLICATION (ELBOWS & BENDS SIZE EXCEEDING 150mm)					DRN NAME S.C.S.	SIGN DATE
					DESIGN S.C.S.	9.6.97
					CHKD D.B.S.	9.6.97
					APPD S.K.J.	11.6.97
CARD CODE				DRAWING NO. PE-4-999-169-08		
—				SHEET 1 OF 1 REV. 00		

D8

A4

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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)																					
REV.	DATE	ALTERED	REV.	DATE	ALTERED																
		CHECKED			CHECKED																
					JOB NO. STANDARD																
NOTES:- 1. STRAPS/BANDS CUT FROM SHEET, WITH SEAL SHALL BE USED OVER FINAL LAYER AT 300mm INTERVALS. 2. INSULATION OF HOR. EQPTS. SHALL BE AS FOR HOR. PIPES. REFER DRG No. PE-4-999-169-01 & PE-4-999-169-02 3. FOR CLADDING SHEET SUPPORT REF. DRG. No. PE-4-999-169-04. 4. FOR INSULATION SUPPORT REF. DRG. No. PE-4-999-169-05. 5. INSULATION OF ENDS OF HOR. EQPTS. SHALL BE SIMILAR TO THIS DRG. 6. WELDING TO EQUIPMENT NOT PERMITTED. 7. FOR GEN. INF. ON APPLICATION OF INSULATION REF. DOC. "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING & EQPTS".																					
MATERIALS REQUIRED:- 1. FLATS 2. MATTRESSES 3. BINDING WIRE 4. LACING WIRE 5. CLADDING SHEET 6. GLASS FABRIC/BOARDS (AS APPLICABLE) 7. RIVETS 8. SELF TAPPING SCREWS 9. SEALING COMPOUND 10. STRAPS/BANDS																					
BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NEW DELHI																					
DEPT. MPL	CODE M	SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM																
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DRN	NAME	SIGN	DATE																		
DESN	S.C.S.	<i>[Signature]</i>	9.6.77																		
CHD	D.B.S.	<i>[Signature]</i>	9.6.77																		
APPD	S.K.U.	<i>[Signature]</i>	11.6.77																		
INSULATION APPLICATION (EQUIPMENT)			CARD CODE DRAWING NO. PE-4-999-169-09 SHEET 1 OF 1 REV. 00																		

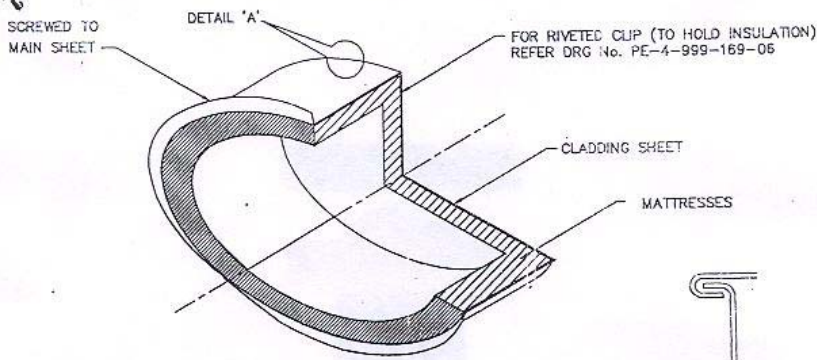
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED

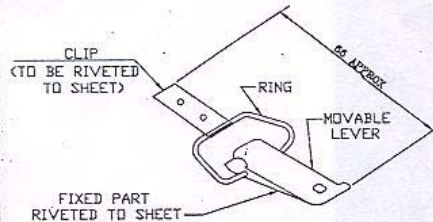
JOB NO. STANDARD

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INSULATING COVER FOR MAN HOLE

DETAILS 'A'
(LOCKING OF SHEETS)



G.I. SHACKLE LOCK CONNECTING BUCKLE

DETAILS 'X'

MATERIAL REQUIRED:-
(MAN HOLE)

1. MATTRESSES
2. CLADDING SHEET
3. SELF TAPPING SCREWS
4. RIVETS
5. CLIPS (TO BE MADE AT SITE)
6. SEALING COMPOUND

MATERIAL REQUIRED:-

(FOR SHACKLE LOCK)

1. CLIP (MADE FROM CLADDING SHT.)
2. RIVETS

NOTES:-

1. FOR GENERAL INFORMATION ON APPLICATION INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT. MPL	CODE M		SCALE N.T.S.	WEIGHT (KG.) —	REF. TO ASS'Y. DRG —	ITEM
TITLE: —						
INSULATION APPLICATION						
(FABRICATED HEAT INSULATING COVER FOR MAN-HOLE)						
DRN	NAME	SIGN	DATE			
DESN	S.C.S.		9.6.97			
CHD	D.B.S.		9.6.97			
APPD	S.K.J.		9.6.97			
CARD CODE	DRAWING NO.					
—	PE-4-999-169-10					
SHEET: 1 OF 1		REV. 00				

DLO

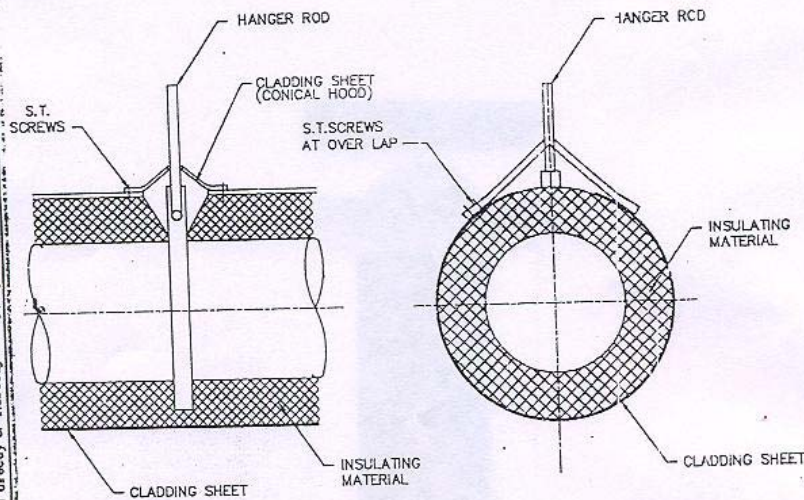
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
01	10.5.82	CHECKED			CHECKED
NOTE 2 ADDED.					

JOB NO. STANDARD

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It must not be used directly or indirectly in any way detrimental to the interest of the company.

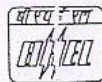


MATERIALS REQUIRED: -

1. MATTRESSES/PIPE SECTIONS
2. CLADDING SHEET
3. SELF TAPPING SCREWS
4. SEALING COMPOUND

NOTES:-

1. OR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".
2. WHEREVER THE END OF CLAMP PROTRUDES OUT OF INSULATION AT THE BOTTOM, SUITABLE BOX STRUCTURE TO BE PROVIDED MADE OF ALUMINIUM.



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

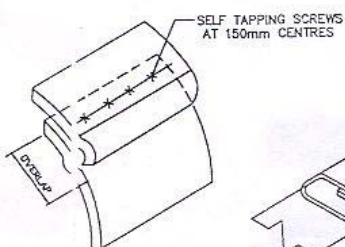
DEPT. MPL	CODE M	SCALE N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM 4
TITLE: - INSULATION APPLICATION (METAL FLASHING ON HANGER ROD PROTRUSION)			DRN S.C.S.	NAME S.C.S.	SGN 0
			DESN S.C.S.	NAME S.C.S.	DATE 5.6.82
			CHO D.B.S.	NAME D.B.S.	DATE 6.6.82
			APPO S.K.J.	NAME S.K.J.	DATE 11.6.82
CARD CODE		DRAWING NO. PE-4-999-189-11			
—		SHEET 1 OF 1 REV. 00			

DLL

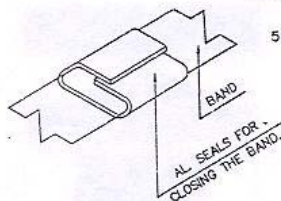
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FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

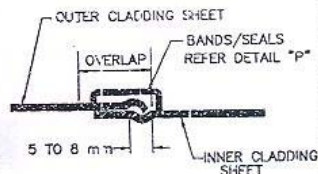
REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED
JOB NO. STANDARD					



****DETAIL 'R'**
(LONGITUDINAL JOINT)



DETAIL 'P'



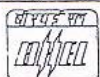
***DETAIL 'Q'**
(CIRCUMFERENTIAL JOINT)

1. JOINTS TO BE MADE AT 45° FROM BOTTOM
2. JOINTS TO BE ON LOWER HALF OF THE CIRCUMFERENCE FOR HORIZONTAL PIPES AND EQUIPMENTS.
3. SEALING COMPOUND WILL BE USED ON ALL LONGITUDINAL JOINTS.

1. TELESCOPIC SLIDING JOINTS SHALL HAVE 5 TO 8mm SPACING.
 2. THE OVERLAPING OF TELESCOPIC JOINTS SHALL BE AS BELOW:--
- | CIRCUMFERENCE OF SHEET (mm) | LONGITUDINAL OVERLAP (mm) |
|-----------------------------|---------------------------|
| < 400 | 30 |
| 401 - 500 | 40 |
| > 500 | 50 |
3. TELESCOPIC JOINT SHALL BE PLAIN.

NOTE: -

1. ALL JOINTS NEAR OIL PIPING TO HAVE SEALING COMPOUND.
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	N.T.S.	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M					
TITLE: -					DRN	NAME
INSULATION APPLICATION (DETAILS OF "P", "Q" AND "R")					DESN	S.C.S.
					CHD	D.H.S.
					APPD	S.K.J.
					SIGN	DATE
						9.8.92
						9.8.92
						11.6.92
CARD CODE					DRAWING NO.	
					PE-4-999-169-12	
					SHEET 1 OF 1	REV. 00

D/12

A4

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L-11

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHECKED			CHECKED

JOB NO. STANDARD

MATERIALS REQUIRED:-

1. FLATS
2. MATTRESSES
3. CLADDING SHEET
4. BOARD
5. RIVETS
6. SELF TAPPING SCREWS
7. SEALING COMPOUND
8. BOLTS & NUTS.

DETAILS OF LUGS:

PIPE	Nb(mm)	No. OF LUGS
1.	33 - 150	4
2.	200 - 300	6
3.	350 - 450	8
4.	500 - 600	10

NOTES:-

1. FOR DETAILS 'Q' AND 'R' REFER DRG No. PE-4-999-169-12
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING & EQUIPMENTS".

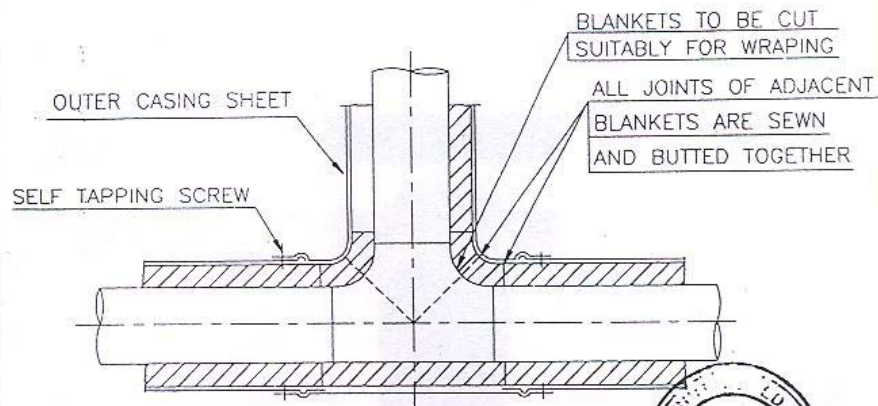
BHARAT HEAVY ELECTRICALS LIMITED
 POWER SECTOR
 PROJECTS ENGINEERING MANAGEMENT
 NEW DELHI

DEPT. MPL	CODE M		SCALE N.T.S	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM																
TITLE:- INSULATION APPLICATION (SUPPORT RING FOR PIPE O.D. > 168.3mm)																						
			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">DRN</td> <td style="width: 10%;">NAME</td> <td style="width: 10%;">SIGN</td> <td style="width: 10%;">DATE</td> </tr> <tr> <td>DES</td> <td>S.C.S.</td> <td><i>[Signature]</i></td> <td>7.6.77</td> </tr> <tr> <td>CHD</td> <td>D.B.S.</td> <td><i>[Signature]</i></td> <td>7.6.77</td> </tr> <tr> <td>APPD</td> <td>S.K.J.</td> <td></td> <td></td> </tr> </table>				DRN	NAME	SIGN	DATE	DES	S.C.S.	<i>[Signature]</i>	7.6.77	CHD	D.B.S.	<i>[Signature]</i>	7.6.77	APPD	S.K.J.		
DRN	NAME	SIGN	DATE																			
DES	S.C.S.	<i>[Signature]</i>	7.6.77																			
CHD	D.B.S.	<i>[Signature]</i>	7.6.77																			
APPD	S.K.J.																					
			CARD CODE: — DRAWING NO. PE-4-999-169-13 SHEET 1 OF 1 REV. 00																			

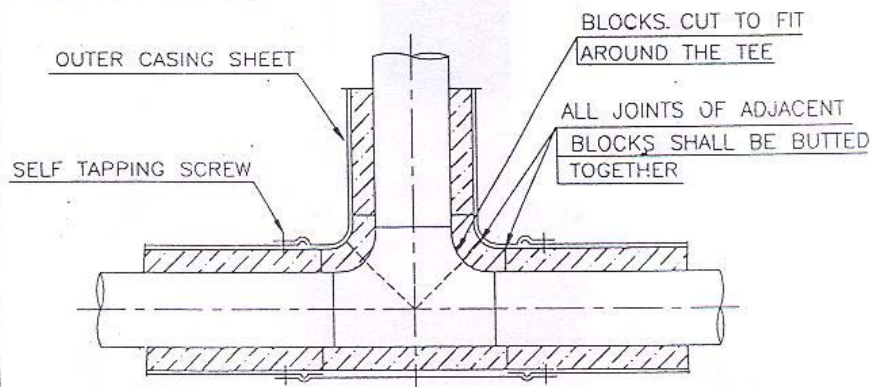
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TEE INSULATION



TEE INSULATION
(WITH WOOL MATTRESS)



TEE INSULATION
(WITH CALCIUM SILICATE)

INSULATION	PREPARED	A.R. JOTHIRUNATHAN	SIGNATURE	DATE	DRAWING NO.	REV.
	CHECKED	K. KALIRAJAN		04.12.03	4-00-235-08546	
	APPROVED	C. GUNASEKARAN				



ELBOW INSULATION

ALL JOINTS BETWEEN ADJACENT
BLANKETS SHALL BE SEWN
AND BUTTED TOGETHER

SELF TAPPING SCREW

BLANKETS CUT FOR
WRAPPING AROUND
THE ELBOW

ALL SHEETS AT
JOINTS TO OVERLAP
BY 40 MM

OUTER CASING SHEET

WITH WOOL MATTRESS

ALL JOINTS BETWEEN
ADJACENT BLOCKS SHALL
BE BUTTED TOGETHER

SELF TAPPING SCREW

BLOCKS CUT TO FIT
AROUND THE ELBOW

ALL SHEETS AT
JOINTS TO OVERLAP
BY 40 MM

OUTER CASING SHEET



WITH CALCIUM SILICATE

INSULATION

PREPARED	A. JOTHIBOURNATHAN
CHECKED	K. KALIRAJAN
APPROVED	C. GUNASEKARAN

SIGNATURE

DATE

04.12.03

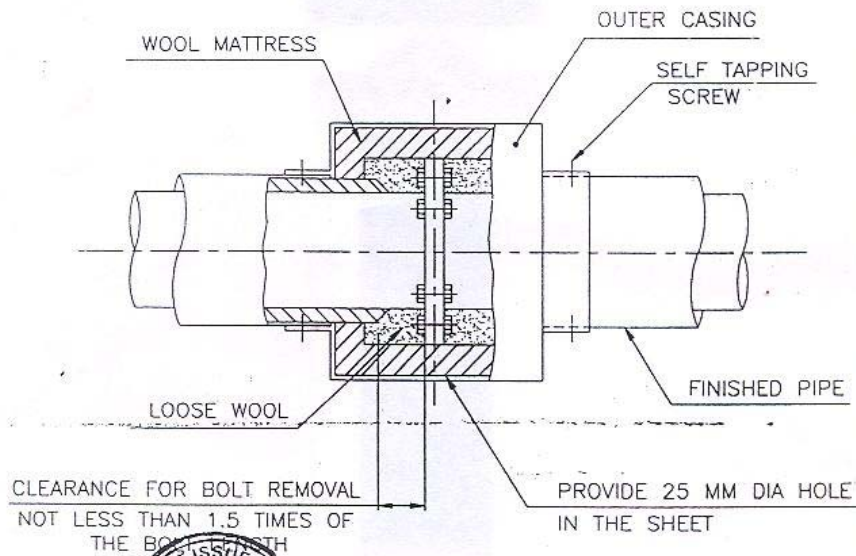
DRAWING NO :

4-00-235-08547

REV



FLANGE INSULATION



NOTE:—

1. WHEREEVER THE FLANGES ARE ENVISAGED FOR DISMANTLING, THIS TYPICAL ARRANGEMENT IS TO BE FOLLOWED.

INSULATION

PREPARED A.R. JOTHI GURUNATHAN
CHECKED K. KALIRAJAN
APPROVED C. GUNASEKARAN

SIGNATURE

DATE
04.12.03

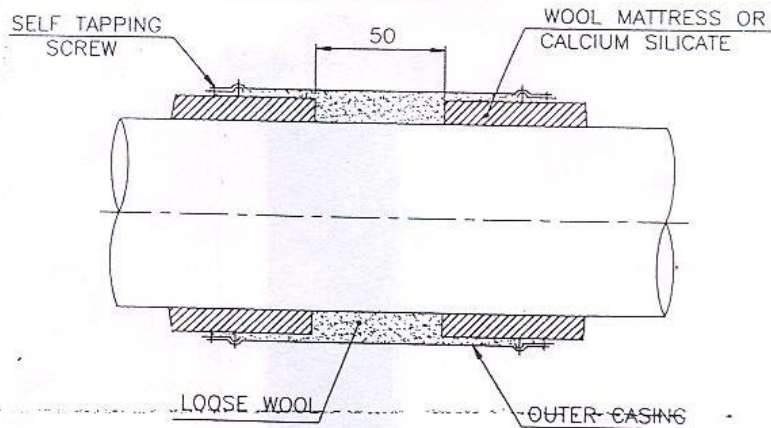
DRAWING NO. :

4-00-235-08548

REV



EXPANSION JOINT FOR PIPES



NOTE:-

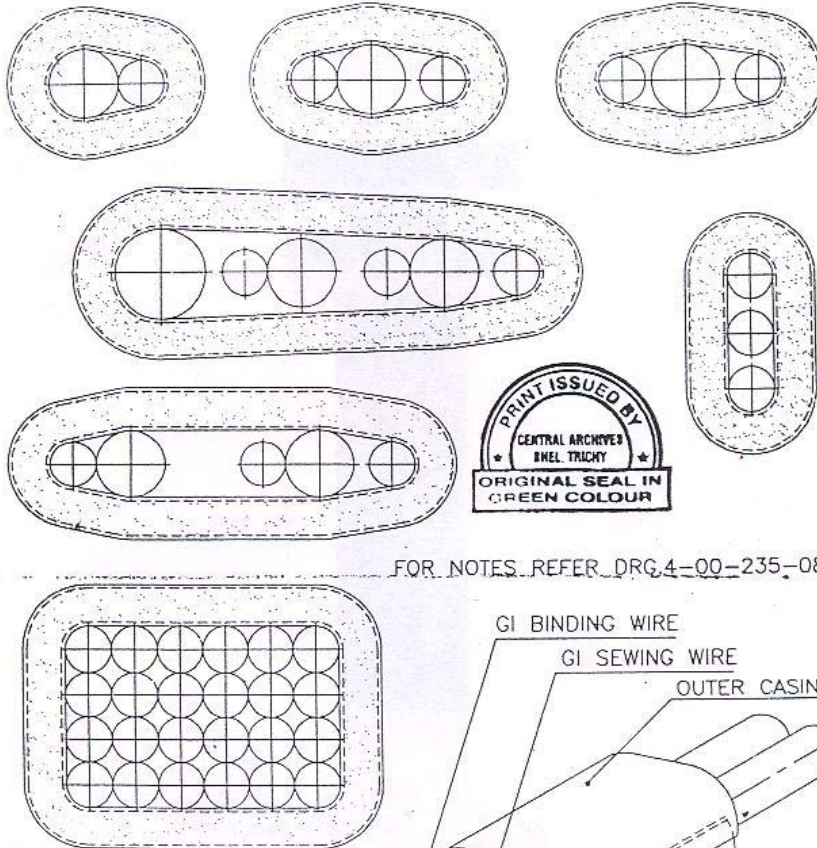
1. THIS ARRANGEMENT IS APPLICABLE FOR BOTH HORIZONTAL AND VERTICAL PIPE LINES, AT EVERY 5 METRES.
2. WHEN THE OPERATING TEMPERATURE IS BELOW 230°C, EXPANSION JOINTS ARE NOT REQUIRED.
3. FOR PIPES, WHERE THE FLOW IS ONLY INTERMITTANT, EXPANSION JOINTS ARE NOT REQUIRED.



INSULATION	PREPARED	A. JOITHI GURUNATHAN	SIGNATURE	DATE	04.12.03	DRAWING NO : 4-00-235-08549	REV
	CHECKED	K. KALIRAJAN					
	APPROVED	C. GUNASEKARAN					



BUNCH INSULATION



FOR NOTES REFER DRG. 4-00-235-08541.

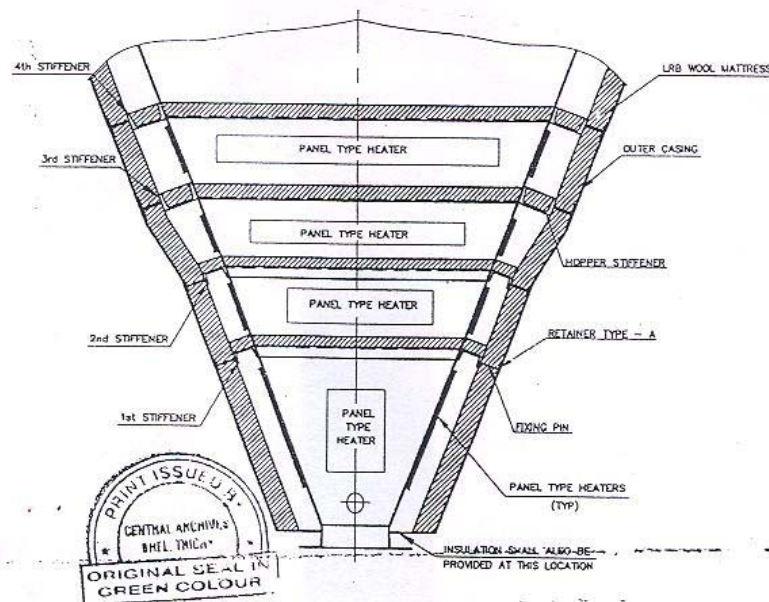
INSULATION	PREPARED	A.R. JOTHIRUNATHAN	SIGNATURE	DATE	DRAWING NO.	REV
	CHECKED	K. KALIRAJAN				
	APPROVED	C. GUNASEKARAN				

4-00-235-08550

THE INFO. ON THIS DOCUMENT IS THE PROPERTY OF BHEL.
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IN ANY WAY DETRIMENTAL TO THE INTEREST OF BHEL.

REV	DATE	ALTERED : A.R.J.
01	01.10.05	CHD & APPD : C.G.S
DRAWING ALTERED		

FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299



NOTE:

01. THE INSULATION SHOWN IS FOR TYPICAL PANEL HEATER HOPPERS. THIS IS TO BE FOLLOWED WHERE EVER PANEL TYPE HEATERS ARE ENVISAGED.
02. INSULATION FIXING PINS AND RETAINERS SHOULD NOT FOUL WITH THE PANEL HEATERS.
03. FOR OTHER INSULATION DETAILS, REFER DRG. 1-00-235-06654.

		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		DRN A.R.J.	SIGNATURE 	DATE 20.09.05
355-056				CHD C.G.S		22.09.05
APPD C.G.S				22.09.05		
DEPT L&I	ALL DIMENSIONS ARE IN MM	PROJECTION 	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	
CODE 123				DRAWING NO : 4-00-235-08702		
TITLE HOPPER INSULATION DETAIL FOR PANEL TYPE HEATERS				REV 01		

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PROFORMA OF BANK GUARANTEE FOR EARNEST MONEY

(On non-Judicial paper of appropriate value)

Bank Guarantee No.....

Date.....

To
(Employer's Name and Address)

.....

Dear Sirs,

In accordance with the terms and conditions of your Invitation for Bids / Notice Inviting Tender No.....¹(Tender Conditions) M/s.....
..... having its registered office at ²
(hereinafter referred to as the 'Tenderer'), is submitting its bid for the work of..... for.....³(name of the Employer) at ⁴. The Tender Conditions provide that the Tenderer shall pay a sum of Rs..... as Earnest Money Deposit in the form therein mentioned. The form of payment of Earnest Money Deposit includes Bank Guarantee executed by a Scheduled Bank.

In lieu of the stipulations contained in the aforesaid Tender Conditions that an irrevocable and unconditional Bank Guarantee against Earnest Money Deposit for an amount of ⁵ is required to be submitted by the Tenderer as a condition precedent for participation in the said Tender and the Tenderer having approached us for giving the said Guarantee,

we, the(Name & address of the Bank) having our Head Office at(hereinafter referred to as the Bank) being the Guarantor under this Guarantee, hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer without any demur, merely on your first demand any sum or sums of Rs. ⁵ without any reservation, protest, and recourse and without the beneficiary needing to prove or demonstrate reasons for its such demand. Any such demand made by the 'Employer' shall be conclusive and binding on us irrespective of any dispute or difference raised by the Tenderer.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment hereunder and the Tenderer shall have no claim against us for making such payment.

We Bank further agree that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to

TECHNICAL CONDITIONS OF CONTRACT (TCC)

vary any of the terms and conditions of the said Tender or to extend the time of submission of bids from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said Tenderer and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Tenderer or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Tenderer or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Tenderer and notwithstanding any security or other guarantee that the Employer may have in relation to the Tenderer's liabilities.

This Guarantee shall be irrevocable and shall remain in force upto and including ⁶ and shall be extended from time to time for such period as may be desired by the Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms hereof. However, unless a demand or claim under this Guarantee is made on us in writing on or before the ⁷ we shall be discharged from all liabilities under this Guarantee.

We, ... Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.

Notwithstanding anything to the contrary contained hereinabove:

- a) The liability of the Bank under this Guarantee shall not exceed ⁵.....
- b) This Guarantee shall be valid up to ⁶
- c) Unless the Bank is served a written claim or demand on or before ⁷ all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

Date.....

Place of Issue.....

¹ Details of the Invitation to Bid / Notice Inviting Tender

TECHNICAL CONDITIONS OF CONTRACT (TCC)

² *Name and Address of the Tenderer*

³ *Details of the Work*

⁴ *Name and Address of BHEL Unit / Division / Region*

⁵ *BG Amount in words and Figures*

⁶ *Validity Date : Shall be minimum six months*

⁷ *Date of Expiry of Claim Period shall be minimum of 60 days after the validity date of Bank Guarantee.*