2x125 MW SURAT LIGNITE THERMAL POWER PROJECT
EXPANSION PROJECT – PHASE –II, UNIT 3 & 4
GUJARAT

VOLUME--II

RCC TWIN FLUE CHIMNEY

SPECIFICATION NO. PE-TS-253-620-C001

BHARAT HEAVY ELECTRICALS LIMITED NEW DELHI

PROJECT TITLE : 2 X 125 TPS

NO. OF UNITS : FOUR UNIT

RATING : 125 MW

LOCATION : SURAT, GUJARAT

PREAMBLE

This Tender document contains three (3) volumes. The bidder shall meet the requirement of all three volumes.

VOLUME – II

This volume is subdivided into following sections:

Section-A: This section outlines the scope of enquiry.

Section-B: This section provides “Project Information”.

Section-C: This section indicates the technical requirements specific to the contract not covered in the section-D.

Section-D: This section comprises of technical specification.

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VOLUME – II

SECTION-A

SCOPE OF WORK

SPECIFICATION NO. PE-253-620-0-0

Scope of Work

1.0.0 **SCOPE**

1.1.1 The work to be done under this specification comprises of construction of two 122M high Reinforced Concrete twin flue steel lined Chimney complete with reinforced concrete raft foundations, R.C shell, liner supporting platforms, steel liners, insulation and provision of other accessories including, external platforms, S.S. minishells, structural steel staircase, fabrication and fixing of flue duct inside the chimney, G.I. discrete strakes, complete interior and Air Aviation Obstruction lighting system, lightning protection and grounding system, M.S. doors for access to the shell, external platforms and inspection of the liners, M.S. ladders, communication system components, embedments for installation of equipments and fixtures and painting both internal and external of the chimney shell as well as of all doors, stairs, ladders and other structural steel items in accordance with this specification and approved drawings,

1.1.2 The tenderer shall make provision to accommodate chimney elevator within the annular space of R.C.C. Shell and all Civil and structural steel works required for erection, testing and commissioning of the elevator shall be in the scope of this work. The tenderer shall provide all necessary openings of required sizes in R.C.C. shell (along with bird screen/louvres wherever applicable) and platforms without any extra cost to the purchaser.

1.1.3 The scope under this specification covers the construction of Two Twin flue Reinforced Concrete Chimney on turnkey basis including providing all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, storage, insurance and all incidental items not herein specifically mentioned but reasonably implied or which may be found necessary for successful completion of the work including contractor's, and where necessary manufacturer's expert supervision in strict compliance with the requirements of this specification and approved construction drawings. The tendered amount shall be for the chimney to be completed in all respect as per this specification for the purpose required.

1.1.4 The successful tenderer shall have to prepare bar bending schedule & schedule of embedments and get the same approved by the Engineer. The detailed fabrication drawings for doors, flue ducts, minishell, ladders, M.S. staircases, hand rails and other fixtures shall also be prepared by the successful tenderer and got approved from the Engineer before undertaking the actual fabrication or erection of construction.
Various drawings/ documents for electrical system/ equipments for chimney (main power distribution, LPs distribution, Aviation lighting distribution, lightning protection & earthing, complete lighting system design calculations, lighting layout and conduit layout etc.) shall be prepared by bidder after award of contract for approval of purchaser/customer/consultant.

1.1.5 The contractor shall prepare, at his own cost, the detailed working drawings showing all details of the formwork staging (adequacy to be supported by design calculations) and other arrangements for the concreting work and submit six copies of the same for the approval of the Engineer-in-Charge /consultants and only on the receipt of the approval of the consultants the work shall be taken up.

2.0.0 **TENDER DRAWINGS**

2.1.1 The following drawing which forms part of Tender Documents are indicative and give overall dimensions, and some other typical details of the work required to be done under this contract. The accessories shown in the drawings are also indicative :

S. NO.	DRG. NO.	TITLE
1.	PE-DG-253-620-C01	GENERAL ARRANGEMENT OF CHIMNEY.

2.1.2 The drawings and specifications furnished are to be considered as explanatory of each other. Should anything appear in one drawing that is not described in the other, no advantage shall be taken of such omission. Should any discrepancies, however, appear, or should any misunderstanding of drawings or as to the dimensions or quality of the materials or the due and improper execution of the works or as to the measurements or quality or valuation of the works executed under this contract or as extra thereupon, the same shall be clarified by the Engineer-in-charge or his authorised representative and his explanation shall be binding upon the contractor. Directions as given by the Engineer-in-charge or his authorised representatives being considered necessary for the proper completion of the work as implied by the specifications and drawings, even though such works and things are not specially shown and described in the said drawings and specifications shall be binding on the contractor. Supplementary dimensions or drawings may be given by the Engineer/Engineer-in-charge in addition to those already given and changes may also be effected in them and the contractor shall have to execute the works on the basis of the supplementary drawings or changed drawings and specifications without any additional claim whatsoever.

3.0.0 **DOCUMENTS MUTUALLY EXPLANATORY AND SECTION C.**

3.1.0 In this volume section C is specifically prepared for this project. Any conflict between the requirements of Section C volume II and those of Section D volume II or any other provisions elsewhere in these documents, the requirements as stipulated in section C shall prevail and will be binding.

3.2.0 **GENERAL**

3.2.1 The overall coordination for all works specified in the scope of work will be the responsibility of the contractor. The contractor shall also provide adequate supervisory personnel for works executed under his Scope of Work.

3.2.2 Any clarification from customer/customer's representative shall have to be furnished by the contractor.

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SECTION-B

PROJECT INFORMATION

1.0	PURCHASER	:	Gujarat Industries Power Co. Ltd. P. O. Petrochemicals – 391 346 District Baroda, India
2.0	CONSULTANT	:	TCE Consulting Engineers Limited 73/1, St. Mark's Road Bangalore – 560 001.
3.0	PROJECT	:	**Surat Lignite Power Plant** 2 x 125MW – Phase II (Expansion Project) Unit No. 3 &4
4.0	LOCATION	:	At a distance of 50 kms from Surat, Village Nani Naroli, Taluk Mangrol, District Surat, Gujarat State, India.
5.0	NEAREST AIRPORT	:	Baroda, Gujarat State
6.0	ROAD APPROACH	:	Accessible by road from which is on Mumbai-Ahmedabad highway. From Surat, the site is around 50 kms.
7.0	NEAREST RAILWAY STATION	:	Surat is on Mumbai-Ahmedabad broad gauge line and located at a distance of 50 kms from the proposed power project site.
8.0	NEAREST PORT	:	Mumbai
9.0	ALTITUDE	:	About 50 m above mean sea level.
10.0	SEISMIC ZONE	:	Zone – III as per Indian Standard IS: 1893 (Current Issue).
11.0	RAINFALL (ANNUAL TOTAL R.O.MEAN)	:	1800 mm (Maximum rainfall occurs during June to September)
12.0	AMBIENT AIR TEMPERATURE		
	(a) Maximum dry bulb	:	45.6 Deg. C.
	(b) Minimum dry bulb	:	4.4 Deg. C.
	(c) Maximum daily average dry bulb	:	37.3 Deg. C
	(d) Reference Temperature for design of electrical equipment / devices	:	(+) 50 Deg. C

13.0 RELATIVE HUMIDITY

(a)	Maximum	:	87%
(b)	Minimum	:	33%
(c)	Average	:	71%
(d)	Relative humidity for design of equipment / devices	:	(+) 100%

14.0 CLIMATIC CONDITION : Hot, humid and dusty.

15.0 TROPICALISATION : All equipment supplied against this specification shall be given tropical and fungicidal treatment in view of the severe climatic conditions prevailing at site as described above.

16.0 WIND DATA

16.1	(a)	Wind load as per IS 875 (Part-3) 1987		
		(i) Basic wind speed	:	44 m/sec.
		(ii) Factor KI	:	1.07
		(iii) Terrain category 1 & the corresponding value of K2	:	1.09
		(iv) Factor K3	:	1.0
	(b)	Prevailing wind direction	:	North – North East and South-West

17.0 **ELECTRICAL**

AUXILIARY POWER SUPPLY

Auxiliary electrical equipment pertaining to this project shall be suitable for operation at the following supply system

(a)	For AC motors above 175 kW	:	6600 V (±10%), 3 phase, 50 Hz, (± 5%) non-effectively earthed neutral.
(b)	For AC motor rated 175 kW and below	:	415V (±10%), 3 phase, 3 wire, 50 Hz, (± 5%) non-effectively earthed
(c)	AC Control and protective device	:	110 V (±10%), 1 phase, 2 wire, 50Hz AC supply with one point earthed.
(d)	For DC motors, control and protective devices	:	220V (±15%), 2 wire, unearthed DC supply from battery / battery charger.
(e)	For lighting fixtures, space heaters, for motors rated above 30 kW and indicators / recorders	:	240V, 1 phase, 2 wire AC 50 Hz with neutral lead effectively earthed.
(f)	For solid state controls and annunciation	:	(+) 24V(+10%), 2 wire, negative earthed DC supply (for instrumentation and control)
(g)	Uninterruptible power supply	:	110V, 1 phase, 50 Hz, AC supply with one lead earthed (for I&C)
(h)	Construction power supply	:	11KV, 3 phase, 3 wire, 50 Hz, AC supply with solidly earthed neutral will be provided at one point from GEB. GIPCL will arrange the connection from GEB at the starting of work.

METEOROLOGICAL DATA

Sl. No.	Particulars		Values
1.	Elevation above mean sea level m	:	50 m
2.	Ambient air temperature	:	
2.1	Maximum dry bulb – Deg. C	:	45.6
2.2	Minimum dry bulb – Deg. C	:	4.4
3.	Relative humidity		
3.1	Maximum %	:	87%
3.2	Minimum %	:	33%
3.3	Average %	:	71%
4.	Annual average rainfall, mm	:	1203.5 mm
5.	Basic wind speed, m/sec.	:	44
6.	Prevailing wind direction	:	North – North East and South-West
7.	Climatic condition	:	Hot, Humid and dusty

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SECTION-C

SPECIFIC TECHNICAL REQUIREMENTS FOR CIVIL WORKS

SPECIFICATION NO. PE-253-620-0-0

1.0 **BRIEF DESCRIPTION**

The Chimney will be twin flue reinforced concrete structure of 122 m height with steel liners. Flue will be made of mild steel, insulated on outer face with resin bonded rock wool insulation. Internal access platforms of structural steel shall be provided. These platforms will be supported on steel beams which would span between simple/restrained supports on the shell. These platforms shall also provide support and restraint to the mild steel flue. The liner above roof level shall be of stainless steel. The platform structure shall be painted for acid and heat protection. External platforms of reinforced concrete or structural steel shall be provided at more or less regular intervals along the height of chimney.

The grade level slab shall be of reinforced concrete with an ironite finish. The chimney shall have a suitable foundation system depending upon soil characteristics.

Apart from aviation warning light, the complete external surface of the wind shield shall be painted in alternate band of red and white colour and in line with aviation requirements, out of which the top 20 metre of paint shall have acid and heat resistant properties and rest of the surface shall be painted with synthetic enamel paint.

The chimney roof slab shall be of reinforced concrete treated for water proofing and protected by a layer of acid resistant tiles laid in acid resistant mortar. Suitable personnel access door and truck entry door shall be provided. A personnel access hatch in the of slab, liner access hatches, rain water drainage system, flue acid drainage, bird screens or louvers on the ventilation openings shall also be provided.

There will be structural steel stairways for access to platforms. Arrangement shall be provided for measuring concentration of particulate matters, Nox & Sox in the flue gas for monitoring and taking necessary measure for pollution control. It will also have necessary arrangement for electrical power supply , distribution boards, socket outlets, power and control cabling raceways system, stair and platform lighting, lightening protection and earthing system.

Stack elevator will be provided to run along inside surface of wind shield.

Galvanised mild steel discrete strakes shall be provided over the required length of the chimney at the top, if found necessary from wind tunnel studies for chimney model.

2.0 APPROACH TO WORK SITE

The contractor shall make his own arrangements at his own cost for the necessary approach roads for transport of materials to site of work. No extra charge will be paid.

3.0 DAMAGES TO THE OTHER STRUCTURE AND PLANT

The contractor shall be totally held responsible for any loss or damages caused by an any act of the contractors, labour or his sub-contractor's labour including but not limited to covered/open blasting to the existing structures and plant or any other structures or plant that may be under construction/erection by any other agency at this site during the entire period covered by this contract along with time extension if any.

Any permission given by the Engineer to the contractor to carry out such work, such as blasting etc. shall not be construed to be waiver of the Contractor's responsibility. In such cases the amount in respect of loss of damage. shall be considered as final and binding on the contractor & shall stand recoverable.

4.0 DE-WATERING

No separate payments for dewatering of sub-soil or surface water if required or removal of slush at any time during construction work including monsoon periods would be made and the rates quoted by the Tenderers for various items under in Vol. III are deemed to be inclusive of cost of such dewatering & removal of slush where necessary.

5.0 FORM WORK

The chimney shell shall be constructed by using slip form technique only. The contractor shall be allowed to use form work as per his own design subject to however that the design shall conform to the most acceptable practice for such type of work and the relevant IS specification. The design shall also be approved by the Engineer-in-charge. The responsibility of form striking period shall rest with contractor subject to however that the same shall not be less than the minimum recommended under the relevant IS specification.

6.0 EMBEDDING FIXTURES IN CONCRETE

6.1 Proper steel templates shall be used for fixing anchor bolts, pipe sleeves etc. to ensure that they - are fixed precisely as per dimensions shown on drawings. Such templates are subject to the - Engineer’s approval.

6.2 The contractor shall exercise great care to ensure that these inserts are accurately held in position and maintained undisturbed during placing and vibrating of concrete and that pipe sleeves do not get filled in with concrete. If found desirable the Engineer may direct the contractor to tie or weld the inserts to the reinforcement to ensure that are maintained undisturbed. All such works shall be done by the contractor at no extra cost.

6.3 The contractor shall ensure that the anchor bolts, inserts etc. are properly protected as under-

a) From weather by approved means such as white lead putty and wrapping them with gunny bag or canvas or by other means as directed by the engineer. However before actual fixing in position the anchors shall be cleaned of all oil and grease and the protruding positions shall again be cleaned and grease after concreting is over.

b) From damage due to movement of contractor's labour staff, materials and equipment and providing suitable guards around them as directed by the Engineer-in- charge.

6.4 In the event of pockets, bolts, pipe sleeves, channels and other inserts not being found in correct position whole work shall be liable to be rejected.

6.5 Removal of bolt hole pockets shall only be done by welding. In no case burning of bolt hole forms shall be permitted on removal of forms, the pockets shall be temporarily plugged by the - hessian cement bags or other method to prevent them from getting filled in with dust debris, concrete etc.

7.0 QUALITY ASSURANCE PLAN

The contractor shall submit Quality Assurance Plan for complete works after awards of contract and shall get for the same approved by employer/owner.

8.6 SUPERVISION BY CUSTOMER OR THEIR CONSULTANT

The owner or his representative may depute their representatives for checking and supervision of important stages of work. The contractor shall be required to provide all facilities for inspection of works by the customer/consultants or their representatives without any cost implication to the employer or Engineer. Any defects in quality of work, or deviations from drawings specifications, pointed out during such inspection shall be made good by the contractor in the same way as pointed out the Engineer without any cost implications.

9.0 SURVEY EQUIPMENT

9.1 The contractor shall have on site a good number of accurate survey instruments such as levels, theodolite, staffs, measuring devices, survey umbrellas, etc. to ensure smooth. progress of work.

10.0 SPECIFICATIONS AND CODES

10.1 All works shall be carried out strictly in accordance with the technical specifications unless otherwise approved by the Engineer in writing. Where not specified in the technical specifications the relevant latest Indian Standards Codes shall be followed.

10.2 Field quality shall be adhered to strictly in accordance with the standards and applicable codes various checks during the process of work at different stages shall be performed according to the checklist. Tests wherever required for these checks shall be conducted by the contractor at his own cost in presence of the Engineer. The record of all such checks shall be jointly signed by the Engineer and the contractor and maintained with the Engineer.

10.3 Any deviations in execution of the works as a result of chances in specifications. contract drawings, inaccurate workmanship, type, size or grade of materials to be used etc shall be first discussed by the contractor with the Engineer at site and feasibility of such non-conformances possible ascertained. The contractor shall initiate the matter by submitting a Non Conformance Request (NCR). The contractor shall not proceed with construction or preparation of drawings or purchase of materials or remedial measures for defective work not conforming to specifications without the approval in writing by Engineer on the NCR submitted by the contractor.

10.4 Proprietary Items: All proprietor, items of materials specified/required as per item description shall be procured from the manufacturers/reputed suppliers only after obtaining the approval of Engineer. Unpriced copies of such order shall be submitted to the Engineer for any follow up action as deemed fit by the Engineer.

11.0 TECHNICAL INSTRUCTIONS

i) The successful tenderer on receipt of letter of intent shall prepare a detailed work programme including items of work within the over all time period allowed and shall submit the same to the Engineer for approval. The drawings as listed in section 'A' are enclosed with the tender documents.

ii) The work has to be taken up immediately on issue of work order/letter of intent/telex and completed within the scheduled time of completion.

iii) The work has to be carried out according to priority that may be fixed by the site Engineer at site.

iv) The materials and workmanship must be of good quality and accepted standards and specifications.

v) All materials for construction are to be procured by the contractor and should conform to relevant I.S. specification.

vi) The site Engineer reserves the right to reject any material not upto the specifications.

vii) Unless specified other otherwise rates quoted under the contractor shall apply for works irrespective of lifts and leads. Rates shall also. include providing scaffolding and its subsequent removal.

viii) After completion of the work the buildings and areas around them should be cleared all rubbish debris etc. and handed over in fit condition for occupation.

12.0 INSULATION

12.1 The heat insulation to be fixed on the inner surface of shell shall be semi-rigid resin bonded fibrous material conforming to IS: 819, or equivalent with a maximum coefficient of thermal conductivity of 0.52 MW/CM/Deg. C at a mean temperature of 100 deg. C. The Insulation material shall have a delivered density of 100 Kg/Cu.M for resin-bonded rock wool or 64 Kg/Cu.M for resin-bonded glass wool. Thickness of the insulation as specified in BOQ 's is the minimum as installed.

12.2 No negative tolerance shall be permitted in the bulk density of insulation. The insulation shall be in the form of slabs wrapped on the inner surface of shell with galvanized wire mesh as specified. The insulation should not be affected by acid and should be free from any impurities which may cause corrosion.

12.3 The insulation should be able to sustain structural vibrations and should not settle under these conditions during erection, construction and operation in any case. The insulation shall also be suitable tied to prevent dislocation under adverse conditions. Care should be taken in the selection of the insulation material to ensure that the material can safely withstand the long term exposure to the maximum flue gas temperature without deterioration or break-down. Slag Wool insulation shall not be acceptable.

12.4 Unbounded wool shall be of Type–I loose, glass wool in conformance with IS: 3690 or Type-I loose rock Wool in conformance With IS: 3677. The insulation shall be packed to achieve a density of 64 Kg/Cu.M in case of glass wool and 100 kg/Cu.M in case of rock Wool. Bonded and unbonded insulation shall be of the same material.

12.5 The insulation material shall be tested for its stipulated characteristics and properties listed in this specification and IS : 8183 and the drawing accordance with the IS: 3144 and IS: 3346 and/or as directed by the Engineer at the Contractor's own cost. The tests shall be conducted in the presence of the Engineer and the reports of such testing shall be submitted to the Engineer before application of the material.

12.6 The insulated material shall be protected against weather at all times from delivery up to completion of work. Insulation material shall not be stacked directly on the ground. The contractor shall provide covered storage for insulation material accessories to the satisfaction of the Engineer.

13.0 CONSTRUCTION

13.1 INSULATION

13.1.1 The fixing details shall be as per specification, approved drawings and the directions of the Engineer.

13.1.2 The insulation shall be provided in more than one layer and the joints staggered. Each layer shall be minimum 25 mm thick.

13.1.3 Particular care shall be taken to ensure that all semi rigid resin bonded fibrous slabs are tightly - butted. The insulation shall be tightly secured to the exterior of the liner or the inner surface or the shell or on and other surface leaving no air gap at the interface

13.1.4 Pins and studs shall be anchored/fixed to the surface receiving insulation at 500 mm centers maximum horizontally and vertically. Pins and studs shall be minimum 10 gauge and plated. These shall be 25 mm longer than the thickness of insulation.An alternative arrangement with anchor fasteners instead of pins can also be made as approved by the engineer incharge.

13.1.5 The insulation shall be impaled on the studs and secured in place with 63 mm round or square metal plated speed washers.

13.1.6 20 gauge galvanized wire netting shall be wrapped continuously over external surface of the

insulation. The wire mesh shall be 25 mm hexagonal conforming to IS: 3150. All joints in the mesh shall be lapped in minimum of 150 mm and tied with 16-gauge soft annealed wire at 300 mm centers. Lacing will not be permitted.

13.1.7 The insulation shall be fixed after painting the inner surface of the shell with acid and heat resistant paint.

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SECTION-C

SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL WORKS

SPECIFICATION NO. PE-253-620-0-0

ELECTRICAL EQUIPMENTS
SPECIFIC TECHNICAL REQUIREMENT
FOR
TWIN FLUE CHIMNEY

SPECIFICATION NO. PE-TS-253-620-0
(5 SHEETS)

1.00 ELECTRICAL SYSTEM

1.01 415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply.

1.02 Ambient temperature for design of all equipment shall be considered as 50 deg. C which is likely to be encountered inside the chimney.

1.03 The distribution boards of chimney shall comprise switch-fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from normal AC distribution board itself. Auto-changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source.

1.04 Dry type isolating transformer of Dy_n connection shall be provided in emergency board to obtain neutral lead, in case 3 phase 3 wire emergency supply is derived from main plant.

1.05 Various platforms shall be illuminated by 70/150W HPSV well glass lighting fixtures. Staircase lighting shall be with 70W HPSV well glass fixtures. Average illuminations level of 150 lux shall be maintained on equipment and 70 lux on platforms/staircases. Lighting system shall be controlled through MCB provided in lighting panel.

1.06 A lighting panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 15A, 240V receptacle shall be provided. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminum wires through galvanized steel conduits.

1.07 Aviations obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA). The type of aviation obstruction lighting system shall be of high intensity aviation obstruction lights having an effective intensity of 4000 to 2,00,000 cd depending upon back ground illuminance. The obstacle lights shall flash simultaneously at a rate between 40 and 60 per minute. The aviation obstruction lighting system shall be of type FTB 205 & FTC 110N of Flash Technology Corporation of USA or equivalent. A minimum of three levels will be provided with aviation obstruction lights and there will be four light units per level. The lowest level should not be lower than 75 meters above the base and vertical spacing of the intermediate levels could vary between 75 and 105 meters. Aviation obstruction lighting shall be complete with lights, photo cell, controller, special cables, etc.

1.08 A temporary aviation obstruction lighting system shall be provided during construction of the chimney.

1.09 Cables from distribution board to lighting panels/receptacles shall be 1100V grade, PVC/XLPE insulated armoured aluminum conductor with a minimum size of 6 mm^2 Cables shall be laid on galvanized sheet steel cable trays. Cables shall be terminated using double compression type cable glands and cable lugs.

1.10 Lightning protection system shall comprise minimum 3 vertical air terminations for each flue liner, horizontal air termination and minimum 4 Nos. of down conductors spaced 90 degrees apart routed all along chimney height and connected to the earthing system. Above ground level, earthing and lightning protection system shall comprise galvanized steel strips. These materials provided at top 12 meters shall have additional coating of 2 mm thick seamless lead cover or it shall be of stainless steel to take care of corrosion. Chimney earthing system shall be inter connected to main plant earthing system.

2.00 ELECTRICAL EQUIPMENT SCOPE

The Bidder's scope of supply, installation, testing and commissioning shall include but not be limited to the following:

2.01 Lighting of chimney as per specification no. PE-DG-253-558-0001 including aviation obstruction lighting system.

2.02 Lightning protection & earthing of chimney as per specification no. PES-509-02A Rev. 0 and PE-DG-XXX-509-0004. Also refer enclosed typical drawing of Lightning Protection and Earthing system.

2.03 <u>Power Distribution Boards</u>:

2.03.1 415 V, 3∅, 4 wire AC distribution board (ACDB) as per specification no. PES-506-05. 415 V, 3∅, 4 wire AC Emergency Lighting distribution board (ELDB) & Lighting panels (LP) as per Specification no. PES-558-01A.

2.04 Power & control cables PVC, armoured, FRLS type 1100 V grade as per specification no. TCE-4549A-H-TPP-01.

2.05 PVC insulated 1100V grade stranded copper conductor lighting wires.

2.06 <u>Aviation obstruction lighting system</u>:

2.06.1 Supply and installation of single obstruction lights with fixtures equivalent to GEC Cat.No. 'ZA750(L) neon' at each platform below 150 m EL complete with all accessories and suitable supporting arrangement to withstand high wind pressure.

2.06.2 Supply and installation of white flashing aviation obstruction lights at different floor levels as per aviation obstruction lighting system conforming to the requirements of the latest Indian Standard IS-4998 & International civil

aviation organisation (ICAO).

2.06.3 Supply and installation of high intensity flashing white light having an effective intensity of 4000 to 200,000 candles depending upon background illuminance at EL(+)150 M and above. The flash frequency shall be 40-60/min.

2.07 The lighting system also includes supply and installation of GS Cable Trays, GI conduits, conduits fitting, weatherproof junction boxes, lead coated flexible conduits (PLICA make), all accessories viz. supports, clamps, mounting structure/brackets etc. to make the installation complete. Supporting structure for the above shall be hot dip galvanised.

2.08 Temporary obstruction lighting system :

2.08.1 Temporary obstruction lighting shall be provided by the bidder during construction as per specification requirements. The fixture shall be equivalent to GEC Cat. No.ZA 750(L) neon, minimum 4 nos. on the upper most part of the chimney.

2.08.2 Power for these lights shall be obtained from the construction power system including cable, cabling & maintenance by bidder.

2.09 Painting and lead coating shall be carried out as per specification requirements.

2.10 Photo Electric light detector along with timer & contactor etc. shall be supplied and installed to monitor the aviation obstruction lighting system.

2.11 Any item or work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be provided by the tenderer without any extra charge.

2.12 All equipment offered shall have suitable provision for termination and connection of power, control and special cables and shall also be complete with cable boxes, double compression nickel-chromium plated brass cable glands (heavy duty type), solderless tinned copper crimping cable lugs etc.

2.13 The size of two nos. down conductors for earthing are 50 x 6 mm GS flat extending at different platforms for electrical equipment earthing. These down conductor are in addition to lightning down conductor.Total four nos. down conductor shall be provided

2.14 Various drawings, data, calculations, test reports, test certificates, operation and maintenance manuals etc. as specified shall be furnished after award of contract for approval of purchaser/customer/consultant.

2.15 Make of equipment/components shall be subject to purchaser/customer/consultant approval after award of contract without any commercial or delivery implications to the purchaser.

2.16 Bidder shall furnish list of recommended spares for 3 years for all electrical

equipments with unit prices.

2.17 Start-up & commissioning spares for electrical equipment shall be supplied on as required basis and cost for the same shall be included in the main equipment cost.

2.18 Bidder shall furnish List of Erection & maintenance tools & tackles with the offer.

2.19 Bidder shall furnish unpriced "Price Schedule" for electrical equipments with the offer.

2.20 All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project electrical information.

2.21 Bidder shall furnish electrical load requirements for normal 415V AC & Emergency 415V AC after award of contract.

2.22 The final technical particulars of various electrical equipment/components/items shall be subject to purchaser/consultant/customer approval after award of contract.

2.23 The detailed Schedule of Equipment is enclosed in the form of Electrical Equipments BOQ.

2.24 Various drawings/ documents for electrical system/ equipments for chimney (main power distribution, LPs distribution, Aviation lighting distribution, lightning protection & earthing, complet lighting system designe calculations, lighting layout and conduit layout etc.) shall be prepared by bidder after award of contract for approval of purchaser/customer/consultant.

3.00 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS

3.01 Power cables for incomer to 415 V AC Distribution Board (ACDB) and AC Emergency Lighting distribution board (ELDB). However, termination of incomer power cables in ACDB & ELDB shall be carried out by bidder. ACDB & ELDB shall be located inside the chimney. Bidder to note that the second incomer to ELDB shall be derived from ACDB by the bidder. Cable glands and lugs shall be supplied by the bidder.

3.02 Cable trench, cable trays/GI pipes up to the boundary limit of the chimney i.e. 3M away from outer shell. Bidder shall coordinate with the purchaser for layout and matching.

4.00 OTHER REQUIREMENTS

4.01 In case of any deviation the bidder shall indicate the same clause by clause in enclosed deviation schedule. In the absence of duly filled in schedules, it will be construed that the offer confirms strictly to the specification.

4.02 Bidder shall furnish duly filled in data sheets (enclosed with specification) for electrical equipments after the award of contract for approval. Technical data sheet of any other electrical equipment if required by the purchaser shall

be furnished to the contractor after award of contract to enable them to furnish the same.

4.03 The bidder shall furnish signed and stamped copy of the specification as a token of acceptance and submit the same along with the technical offer. Further, Quality plan shall be subject to BHEL/customer/consultant approval after award of contract without any commercial or delivery implication. Inspection shall be carried out as per approved Quality Plan approved during detailed engineering.

4.04 Bidder shall furnish details of aviation obstruction lights with catalogues.

4.05 Bidder shall furnish all drawings/data/catalogues as indicated in different electrical equipment specifications along with the offer in sufficient nos. as indicated in the civil part of the specification.

4.06 Bidder shall furnish complete power distribution diagram for chimney.

4.07 The minimum illumination level shall be provided as indicated below :

- Ground Floor, platforms, stairs & landings 70 LUX
- Area of different distribution boards 150 LUX

4.08 In case of any conflict between various sections of the specification, decision of the Purchaser shall be final and binding on the bidder.

VOLUME – II

SECTION-C

SPECIFIC TECHNICAL REQUIREMENTS FOR CHIMNEY ELEVATOR

SPECIFICATION NO. PE-253-620-0-0

1.00.00 **DESIGN AND CONSTRUCTION**

1.01.00 **Stack Elevator - General**

1.01.01 The stack elevator including mechanical and electrical components shall be installed outside/inside Single flue/ multi flue chimney. Since chimney is a free standing structure, deflection of chimney top is expected during the normal operation, so the design of the elevator shall be in such a way that the elevator operation will be safe even with the expected maximum deflection of the chimney structure. The stack elevator shall lift a pay load as indicated against rated load as mentioned in Data sheet-A or its nearest as per manufacturer's present standard in addition to the weight of the car and its accessories and shall travel at a rated speed as indicated in the data sheet-A. Travel of the elevator car, number of landings and levels shall be as per Data sheet-A attached to this section.

1.01.02 Stack elevator mechanical and electrical operating devices and trailing cable shall be designed for operation indoors/out door with dusty and high humidity conditions and shall operate equally well in any ambient temperature encountered in the site conditions. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100^{o}C when the elevator is not operating.

1.01.03 Cage earthing shall be done through trailing cable.

1.01.04 Stack elevator shall be attached to the chimney shell using expansion type anchor bolts drilled in to chimney shell. Elevator shall be capable of operating from the ground floor to the top platform with intermediate stops at all platforms. Landing for elevator parking shall be one (1) metre above the stack ground floor. Suitable concrete/brick steps leading to the landing for entry to cabin shall also be provided,

1.01.05 The stack elevator shall be designed in line with recommendations contained in the latest editions of the applicable codes and standards.

1.02.00 **Equipment Specification**

1.02.01 Enclosures

A three-sided enclosure with one access door shall be provided at graded level. At each platform landing above graded level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high and one coat of epoxy primer coated. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the Cab is at the landing. Doors shall be bi-parting and swinging type.

Base of three-sided enclosure shall be securely anchored to the grade level floor slab using expansion type anchors.

1.02.02 Mast

Mast shall be provided in sections approximately 1.52 m in lengths considering of tubular sections and/or structural shapes welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the concrete chimney walls.

1.02.03 Cab

Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.

Cab floor shall be of skid resistant glass fibre reinforced plywood or approved equal. Cab shall be attached to a framed structure and form integral part with the drive mechanism located atop the cab.

Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.

1.02.04 Buffers

Sufficient numbers of buffers of spring loaded/hydraulic type shall be fitted below the cab. The buffers shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment. The number of buffers shall be so fixed as to ensure proper sharing of impact loads by all of them.

1.02.05 **Drive unit and safety Device**

Drive unit located on the top of the cab shall be complete with Ac squirrel cage induction motor, reduction gear, drive pinion and an over speed governor. Drive unit shall incorporate an electric disc brake and an external manual brake release. The brake on the electric motor will be of the electromagnetic single disc self-adjusting type with the mechanical compression spring being held off by the electromagnet.

The hoist shall be provided with a centrifugal brake to prevent accidental tripping of safety device when the cage shall be taken to the ground by gravity in case of power failure.

1.02.05 Power and Control

All electrical components furnished with the elevator shall be completely wired, energised and checked. Necessary power distribution arrangement shall be provided by the contractor to feed the electrical power to the elevator.

All electrical control devices shall be in enclosures. Equipment furnished

shall also include the following:

a) Momentary contact push button for raise lower control.

b) Reversing combination motor starter with a moulded case circuit breaker for the motor. Starter shall be equipped with three thermal overload relays for motor protection. Operating handle for the combination starter circuit breaker shall be accessible from inside the cab and shall also serve as an emergency stop switch.

c) Electrical and mechanical interlocks on cab access door and landing level enclosure doors.

d) Over travel protection, emergency stop push button, over speed governors.

e) All electrical and mechanical interlocks on cab access door and landing level enclosure doors, phase reversal protection shall be provided.

f) An alarm push button shall be provided in the cage connected to a battery-operated alarm at the elevator base. Simultaneous alarm shall also sound at the plant control room in the event of any fault in the stack elevator for which one potential free contact shall be provided in each elevator for audiovisual alarm in PCR for “Stack Elevator fault” indication.

g) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.

h) Continuous duty electric torque motor recoil cable reels as required to maintain electrical power service to all elevator electrical components throughout the limits of travel.

i) One auxiliary panel shall be furnished and mounted on the grade level enclosure. Panel shall be equipped with a main ‘ON-OFF’ isolating switch, main contactor, relays, control transformer and fuses, tone frequency transfer, terminal blocks and all other accessories required for normal operation of the elevator.

j) One main control panel shall be furnished and mounted on the top of the cab. Panel shall be equipped with necessary, equipped like rectifier, battery, charger, tone frequency receiver, contactors, MCBs, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.

k) Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling. Degree of protection of the control cabinets shall be IP-52 as per IS:2147. Control cabinets shall be provided with hinged door(s) with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets, louvers, when provided, shall have screeners and filters. The screens shall be of fine wire mesh made of brass or GI wire. Suitable cable gland plate shall be supplied fitted on to this gland plate. All cable glands shall be screwed on type and made of brass.

l) Each motor to be controlled from the control cabinet shall be provided

with 3 pole isolating switch. HRC fuses, contactors of AC4 duty class with thermal overload relays with single phasing preventer and other equipment required for satisfactory control motor. The isolating switch and contractor shall be rated at least 20% more than the connected motor full load current. Motors of 0.2 KW and above shall be rated for 415 V 3 Phase and below 0.2 KW will be 240 V single phase supply.

m) The controllers and resistors for motors shall conform to IS-8544 (latest edition) and IS-2959 (latest edition) and shall be continuously rated for 150% full load current of the motor. Switches shall be hand operated, air breaker heavy duty, quick make, quick break type conforming to IS-4064. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal / abnormal conditions such as full load, overload, locked rotor, short circuit. The incoming power supply isolating switch shall be inter-locked with the control cabinet door so as to prevent opening of the door when the switch is closed. Device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

n) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 KA. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive without danger of contact with live metal.

o) Contractor shall provide dry type transformers with class B insulation for control power supply, lighting and space heating. Control supply will be 240 V AC. Transformer for control supply shall be provided with a control tap at 110 V, which will be earthed. Power and control supply to individual drives and users shall be distributed with separate isolating switches and primary and secondary fuses.

p) All push buttons shall be of push to actuate type having 2 “NO” and 2 “NC” self reset contacts. They shall be provided with integral escutcheon on plate engraved with their functions. Push button contacts shall be rated for 5 Amp at 415 V AC and 1 Amp. Inductive breaking at 250 V, DC. Mushroom type emergency push button to open the main contactor shall be provided in the operator’s cabin and two on the bridge platform within easy reach indicating lamps shall be of the filament type and low watt consumption lamps shall be provided with series resistors.

q) Strip type space heaters of adequate capacity shall be provided inside in each cabinet.

r) Control cabinets shall be supplied completely wired. All wiring shall be carried out with 650 V grade PVC insulated, stranded conductors. Power circuits shall be wired with stranded aluminum conductors of adequate sizes to suit the rated circuit shall be wired with stranded copper conductors of sizes not small than 1.5 Sq.mm. Control circuits shall be isolated from power circuits.

s) Cab shall be controlled by a semi-automatic floor selection control system. Cab shall be furnished with 240 Volt grounding type receptacle, emergency alarm push button with a normally open contact rated 0.5 ampere at 220 VDC volts, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab

main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Cable guides shall be installed at every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level and the main control panel on the cab. Will be provided with the tone frequency receiver. However control and interlocks from the landings shall be connected to the auxiliary panels located at ground level through fixed armoured cables. The power and control cables and training power cables shall be FRLS type.

s) Each landing assembly shall include a limit switch for door interlock and push button control station installed and wired to a landing junction box.

t) Cable trolley with cable guides for recoil of cable on to cable reel to maintain electrical power service to all elevator components through out the limits of travel.

u) Contractor shall furnish, install, and connect a system equipment ground to the Owner's existing chimney ground system. System equipment ground shall electrically connect panels and junction boxes, which contain electrical devices, motors, and elevator platforms and support structure. Raceway system shall not be considered as an equipment ground.

v) All enclosures containing electrical devices shall be provided with 240 Volt, single-phase space heaters with adjustable thermostat control.

w) All power cables and race way shall be furnished and installed by the Contractor for interconnection of the main control panel, auxiliary panel and landing junction boxes etc. Conductors included in the cable shall be as required to energise all electrical equipment furnished with the elevator. Transmission of alarm signals is done by means of tone frequency equipment. Hence communication conductors are not required.

6.03.07 Electric Motor

Elevator drive motor shall be squirrel-cage induction type designed and fabricated to conform to the requirements indicated below.

Motor shall be designed for operation at the required speed: 415 Volts, 3 phase, 50 hertz. And shall be suitable for full voltage starting, S4 duty class as per IS-4722 with CDF of 25% and maximum number of 120 starts per hour in 55 Deg. C ambient temperature. Motor shall be tested at the factory to determine that it is free from electrical or mechanical defects.

6.03.08 Raceway

a) **General**

Complete raceway system for the elevator shall be furnished and installed in accordance with this section and the Contractor's shop drawings as reviewed and accepted by the Engineer-in-Charge. The Contractor shall provide drawings for acceptance showing the routing of conduit and wiring for the control circuits associated with the elevator.

Raceway system is defined to include conduit and all related materials and devices required to support, secure and provide a complete system for support and protection of electrical cable and wiring.

b)**Materials**

Raceway shall be rigid galvanized steel conduit, provided in accordance with IS-1653 (latest edition).

Steel conduit, couplings, and elbows shall be hot-dip galvanized rigid mild steel. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. Thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage. Flexible conduits shall be plastic jacketed, liquid tight galvanized steel.

Galvanised iron or galvanized cast steel fittings shall be used with galvanized steel conduit. Fittings installed outdoors or in damp locations shall be sealed and gasketted. Outdoor fittings shall be of heavy cast construction.

6.03.09 **PVC Insulated FRLS Cable**

a) Materials

Electrical part of this specification shall be referred for FRLS cable. Unless specified otherwise, Contractor shall submit to the Engineer-in-Charge four copies of the manufacturer's test report on each cable furnished. Conductor accessories including terminal materials like glands, lugs etc. makers, tying materials and cable support shall be furnished and installed. Wire termination materials for conductors 10 Sq. mm and larger shall be pressure or bolted type. Terminals for conductors smaller than 10 Sq. mm shall be an insulated pressure connection in the shape of a ring.

b) **Installation**

Power and control cable shall be routed as required by the drawings. Cables pulled into the wrong conduit or cut too short shall be replaced. Cables removed from one conduit shall not be installed in another conduit.

6.03.10 **Earthing**

a) **General**

Earthing system furnished and installed and include a complete earthing system for the elevator. Earthing equipment and materials shall be furnished and installed in accordance with the reference codes and standards these specification and the contractor's shop drawings as reviewed and accepted by the Engineer-in-Charge.

b) **Materials**

The earthing of all electrical items being supplied by the Bidder shall be in his scope. For earthing the various equipment, conductor sizes shall be as listed below:

i)	MCCs Motor above 90 KW	:	50 x 6 Sq.mm G.I. flat
ii)	Motors above 30 KW, upto 75 KW and lighting panel/ control panels/auxiliary panels	:	25 x 6 Sq. mm G.I. flat
iii)	Motor above 5 KW upto 30 KW	:	25 x 3 mm G.I. flat
iv)	Motors upto 5 KW and misc. Small item like conduits, Junction boxes etc.	:	8 SWG GI wire

Data Sheet–A

1	Designation	:	Rack and Pinion type Stack Elevator
2	Type of loading	:	Passenger-cum-goods
3	Quantity :	:	One No.
4	Carrying Capacity	:	400 Kg
5	Operating Speed	:	40 m/min (Approx)
6	Dimension of lift and lift well/cut out	:	As per requirement (Bidder to furnish)
7	No. of landings	:	5 (Five)
8	Total vertical travel	:	To suit the chimney height of 122 m
9	Electrical power supply system	:	415 V, 3 ph, 4 wire, 50 Hz
10	Other accessories	:	As required

SECTION-D

VOLUME II
Specification for Civil, Structural and Architectural Works

SPECIFICATION NO. PE-253-620-0-0

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SUB-SECTION: D-I
Earthwork in excavation & backfilling

C O N T E N T

SUB-SECTION – D I
EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work To Be Provided For By The Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:

a) Furnish all labour, supervision services including as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of soils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for strong or explosives required for blasting work to be carried out under the scope of this tender.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed

IS-3764	Indian Standard for Safety Code for Excavation work
IS-1200 (Part-I)	Indian Standard Method of Measurement of building, & Civil Engineering work, Part-I: Earthwork.
IS-4701	Indian Standard Code of Practice for earthwork on Canals.

2.04.00 Conformity with Designs

The Contractor is to carry out the work as per the drawings, which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 Materials to be used

2.05.01 General

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for back-filling shall be excavated from approved locations and levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

2.06.00 Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials, and equipment used. The quality control operation shall include but not be limited to the following items of work.

a) Lines, Levels and Grades	i) Periodic surveys
	ii)Establishment of markers, boards etc.
b) Back-filling	i) Checking the quality of fill material
	ii) Checking moisture content of the backfill.
	iii) Checking the degree of compaction

3.00.00 EXECUTION

3.01.00 Setting out

Within 15 days of award of Contract, the Contractor will create and submit to the Engineer, detailed drawings of the excavation work as Proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shoring, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers will be fixed at interval prescribed by the Engineer and checked by the Engineer and certified by him after whom the Contractor will proceed with the work. It should be noted that this checking by the Engineer prior to start of the work will in no wav absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, necessary, free of cost to the owner in case any errors are noticed in the Contractor's work at any stage.

3.02.00 Clearing and Grubbing, etc.

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked Felling of trees shall include taking out roots. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked property at the worksite in a manner as directed by the Engineer.

3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. The Contractor, in each individual case, shall obtain prior approval of the Engineer for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal etc. This approval, however, shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders, if any, projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the work/workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services, and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion, which was originally sound and safe. Any materials not requiring removal as contemplated in the work, which is in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm - above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, the excess depth shall be filled up to the required level with cement concrete not leaner than 1:4:8 ordinary concrete or richer as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those over cuts which are unavoidable will be made up by ordinary cement concrete 1:4:8 or richer as directed by the Engineer. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.03.02 Excavation in Ordinary soil, hard soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the Engineer will check the work thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started.

All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Owner and the Contractor shall duly preserve the same to the satisfaction of the owner and from time to e deliver the same to such person or persons as owner may from time to time authorize or appoint to receive the same.

3.03.03 Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including literate formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging, or any other approved method.

3.03.04 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The Contractor shall ensure that these rules/regulations are strictly adhere to. The following instruction, wherever found in variance with the above rules/regulations, shall be considered as superseded by the above rules/regulations.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

The Contractor shall obtain licence from the District Authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected upto date. The Contractor shall purchase the explosives, fuses, detonators etc. only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The Engineer or his authorized representative shall have the access to check the Contractor's store of explosives and his accounts.

It shall be the full responsibility of the Contractor to transport the explosives as and when required for work in a safe manner to the work spot.

The Contractor shall acquaint himself with all the applicable laws and regulations concerning storing, handling and the use of explosives. All such laws, regulations and rules etc. as were current from time to time shall be binding upon the Contractor.

The provisions detailed in this are supplementary to the above laws, rules and regulations etc. and are applicable except where they conflict with the afore-mentioned laws etc. from time to time. Further, the Engineer may issue modifications, alterations and new instructions from time to time. The Contractor shall comply with the same without these being made a cause for any claim.

Materials

All materials such as explosives, detonators fuses tamping materials etc. that are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used.

The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds per inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist, damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.

The detonators used shall be capable of giving an effective blasting of the explosives, moist and damaged detonators shall be discarded.

b) Storage of Explosive

The current Explosive Rules shall govern storage of explosives; Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90 m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexes adjoining the magazine provided that their number does not exceed 25,000 and that the annexes is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexes and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives, which appear to be in a damaged or dangerous condition, are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No. Smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

Persons entering the magazine must put on the magazine shoes, which shall be provided at the magazine for this purpose and should be careful

* Not to put their feet on the clean floor unless they have the magazine shoes on.
* Not to allow the magazine shoes to touch the ground outside the clean floor.

* Not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall before entering the magazine dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine, on each occasion if it is opened for the receipt, delivery, or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives, which have been issued and returned to the magazine, are to be issued first: otherwise those, which have been longest in store, are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or neither thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

c) Carriage of explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, marked lights; steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

d) Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading stemming shot holes. Only one cartridge at a time shall be inserted and gently passed hole with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed

inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate Cordtex, connecting wire or string.

The authorized shot firer himself shall make all connections. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short-circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a-time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh whole not less than 600 mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

When blasting is conducted in the neighborhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light charge of explosives.

Adequate safety precautions as per building byelaws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.03.05 Disposal

The excavated spoils will be disposed of in any or all the following manners

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date-during execution of the Contract.

c) i) By either spreading, Or

ii) Spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

3.03.06 Disposal of surplus

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately.

3.03.07 Protection

The Contractor shall notify the Engineer as soon as the excavation is expected to be completed within a day so that he may inspect it at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval by the Engineer. Excavated material shall be placed beyond 1.5 meters from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered and/or lower the subsoil water level to 300 mm below the founding level until the construction of foundation structure and backfilling are complete in all respects.

Sumps made for dewatering must be kept clear of the foundations. The Engineer shall approve Method of pumping but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

3.03.09 Timber Shoring

Timber Shoring made out of approved quality of timber shall be "close" or the Engineer shall determine ‘open’ type, depending on the nature of soil and the depth of pit or trench and the type of timbering. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering' the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacings, cross strutted with wooden struts or as directed by the Engineer. The length of the wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit, The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall-not be damaged during the removal of the timber, No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

b) Open Timbering

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer in all other respects specification for close timbering shall apply to open timbering.

3.04.00 Treatment of Slips

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, beams, shoring, and control of ground water should cause no slips to occur. If however slips still occur the same shall be removed by him.

3.05.00 Back-filling

3.05.01 General

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary "tacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, where sand filling is required, the sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.05.02 Filling and Compaction in Pits and Trenches all-round Structures

As soon as the work in foundations has been accepted the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to the satisfaction of the Engineer. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimize the moisture

content.

3.05.03 Plinth Filling

The plinth shall be filled with -earth in layers not exceeding 250 mm in loose thickness, watered and compacted with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.05.04 Filling in Trenches for Water Pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of excavation of trenches in rock, the filling upto a depth of- 300 mm or the- diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm nixed with fine material as available to fill up the voids, watered, rammed, and compacted.

3.05.05 Filling in Disposal Area

Surplus material from excavation, which is not required for backfilling, will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the

Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.06.00 Approaches and Fencing

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project, sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.07.00 Lighting

Full-scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer over excavation of the sides will be made good by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 Back-filling

The degree of compaction required will be as per the stipulation laid down in IS-4701 and the actual method of measuring the compaction achieved will be as decided by the Engineer. The work of back filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Details of Equipment proposed to be used for excavation, backfilling, and compaction have to be submitted along with the tender.

5.02.00 After Award

After award of the Contract the successful tenderer shall submit the following for approval and adoption:

a) Within 15 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

   The Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimizing temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

VOLUME: II

SECTION-D
SUB-SECTION: D-II

CEMENT CONCRETE (PLAIN & REINFORCED)

C 0 N T E N T S

VOLUME: II

SECTION: D-II

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of, work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate is Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment tools and plants, transportations, etc. required for the work.

b) Prepare detailed drawings and Bar Sending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per Clauses 2.01.00 (g) & 3.04.00 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.Design mix is to be established within 45 days from the date of LOI.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as

directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved proforma, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the name Pour Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed, as the Contractor on approved proforma will prepare “Progress Cards”. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Generally cement shall be ordinary Portland cement conforming to IS: 269. In special cases, Rapid Hardening Portland Cement, Low Heat Cement, High Strength ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Normally potable water is found to be suitable. Generally, IS-3550 will be followed for routine tests. In case of doubt, the acceptance test for water shall be as per IS: 3025, and Table-I of IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall

be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete or air entraining admixtures, dosage to be adjusted to maintain air contents within esirable limits.

b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water: Impurities tests.

d) Cement: Tests to satisfy relevant IS Specifications.

e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints materials: Locations of joints, water stops and filler dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to he used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M10 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates. Should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS: 456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition if values given in the tables shown herein below are different from those mentioned in IS: 456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE-1
STRENGTH REQUIREMENT OF CONCRETE

Grade of concrete	Specific Characteristic Compressive strength of 15 cm Cubes at 28 days conducted in accordance with IS: 516 (All values in N/Sq.mm)
M 10	10
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40

TABLE -I I

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1.8.5	1:7.4	1:8.0
Medium slump 50-100 mm	0.4	1:3.5	1:3.8	1.3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE: I - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0.

NOTE: 2 - It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water-cement ratios, which may be required to be used in mass concrete, work only.

NOTE: 3 - The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per Table-2 of IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.0 MINIMUM CEMENT CONTENT

The minimum cement content for each grade of concrete shall be shown as shown below:

FOR DIFFERENT GRADES OF CONCRETE

Grade of Concrete	Minimum Cement Content/Cu.M of Finished Concrete
M - 15	280 Kg
M - 20	300 Kg
M - 25	365 Kg
M - 30	400 Kg
M – 35	410 Kg

The minimum cement contents mentioned above are for average conditions and for 20 mm size aggregate. For 40 mm size aggregate the cement content may be reduced. In case the cement content can be reduced due to continuous and consistent favorable conditions, on account of better quality of cement control, or by the addition of suitable plasticizers/super-plasticizers, then the Engineer may instruct lower cement content, and the Contractor shall abide by the stipulations laid down hereunder:

a) The Contractor shall design the mixes for higher strength over and above those specified in Table-I under Clause 3.4, for the various grades of concrete and different slump requirements as per IS: 10262.

b) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

c) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

d) The Engineer will always have the unquestionable right to revise the

minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-3 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 19 & 20 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criterion, the former shall be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in Table No. IV.6

In general the water cement ratio between 0.4 and 0.45 will be desirable to

satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use melamine-based plasticizer.

TABLE-IV

MAXIMUM PERMISSIBLE WATER/CEMENT RATIOS FROM DURABILITY CONSIDERATIONS FOR DIFFERENT TYPES OF STRUCTURES AND DEGREES OF EXPOSURE USING ORDINARY PORTLAND CEMENT

Type of Structure	Exposure Conditions					
	Severe wide range of temperature. Frequent alterations of freezing or arid and thawing (use Air Entrained concrete only)			Mild Temperature rarely below freezing or rainy		
	At the water line or within the range of fluctuating water level or spray.			At the water line or within the range of fluctuating water level or spray.		
	In Air	In Fresh water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Air	In Fresh water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Thin sections such as railings kerbs, sills ledges, ornamental or Architectural concrete reinforce concrete piles, pipes and all sections with less than 25 mm concrete cover to reinforcement.	0.49	0.44	0.40	0.53	0.49	0.40
Moderate sections such as Retaining Walls, abutments, piers, girders, beams	0.53	0.49	0.40	*	0.53	0.44
Exterior portions of						

heavy mass sections.	0.58	0.49	0.44	*	0.53	0.44
Concrete deposited by Tremie under water	-	0.44	0.44	-	0.44	0.44
Concrete slabs laid on ground	0.53	-	-	*	-	-
Concrete which will later be protected by enclosure or backfill but which may be exposed to freezing & thawing for several years before such protection is offered.	0.53	-	-	*	-	-
Concrete protected from the water, interiors of buildings, concrete below ground, which is free from sulphate attacks.	*			*		

Note: * Water/cement ratios should be selected on basis of strength and workability requirements.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V
LIMITS OF CONSISTENCY

Slump in mm with

Degree of workability	Standard Cone as per IS:1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure With heavy compaction equipments, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures With congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 6 of IS: 456 shall be carried out.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space - 12 mm

Reinforced concrete
Except foundation - 20 mm

Ordinary Plain concrete and Reinforced

concrete foundations - 40 mm

Mass concrete - 80 mm

Mass concrete in very large structure - 150 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, inspite of all precautions, segregations do occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be r and consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed

and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the

loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

9) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out

defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or

such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his

supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules with working drawings showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. Six prints of the final drawings & schedules with one reproducible print shall be submitted by the contractor for record and distribution.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebendinq can be done only if approved by the Engineer. Reinforcing bars

shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Splicing of reinforcement shall normally be done by lapping. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete

blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 4.5°C or below during the placing and curing period, the work shall conform to the requirement of Clause 13 of IS: 4S6 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 13 of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centering and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically

permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross-braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the formwork at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and

countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in .the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified in the drawing:

a) **Ordinary:** These shall be used in places where ordinary surface finish is

required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose

fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

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iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall

be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly leveled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength - 55 to 60 N/Sq.mm

Flexural strength - 5 to 30 N/sq.mm

Tensile strength - 15 N/Sq.mm (approx.)

Bonding strength to concrete - 3 N/Sq.mm (approx.)

Bonding strength to steel - 20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to

Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be- taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and

cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to

vii) above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out by the Contractor without any expense to the Owner. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the owner or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS: 3025 & IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS: 456. To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 and as mentioned in clause 3.8 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with Clause 15 of IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made

good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 14.5 of IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 15 of IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 16 of IS: 456.

5.04.00 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results falls below the required strength, as per 'Load Test on Parts of Structures'. Clause 16.5 of IS: 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, the Contractor free of cost to the Owner as are necessary to make the structure adequately strong shall make such changes.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 16.5 of IS: 456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by

the Contractor to the satisfaction of the Engineer.

6.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS : 73 - Indian Standard Specification for Paving Bitumen

IS : 216 - Indian Standard Specification for Coal Tar Pitch

IS : 69 - Indian Standard Specification for ordinary, and Low Heat Portland Cement

IS : 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS : 455 - Indian Standard Specification for Slag Cement

IS : 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS : 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS : 1139 - Indian Standard specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for Concrete Reinforcement

IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS : 1200 - Indian Standard Specification for Method of Part-II Measurement of Cement Concrete Works.

IS : 1200 - Indian Standard Specification for Method of Part-V Measurement of Formwork

IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement

IS : 1566 - Indian Standard Specification-for Methods of Sampling and Analysis of concrete

IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS : 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers

IS : 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS : 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS : 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS : 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS : 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS : 2645 - Integral cement water proofing compound

IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS : 2751 - Code of Practice for Welding of Mild

Steel Bars used for Reinforced Concrete Construction

IS : 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS : 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS : 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS : 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS : 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS : 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS : 3590 - Indian Standard Specification for Load Bearing Light Weight Concrete Blocks

IS : 3696 - Safety Code for Scaffolding and Ladders

IS : 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS : 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement

IS : 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS : 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS : 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS : 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS : 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS : 4926 - Indian Standard Specification for Ready Mixed Concrete

IS : 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS : 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS : 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS : 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys

IS : 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS : 5513 - Indian Standard Specification for vicat Apparatus

IS : 5515 - Indian Standard Specification for Compaction Factor Apparatus

IS : 5751 - Indian Standard Specification for Precast Concrete Coping Blocks

IS : S816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders

IS : 5891 - Indian Standard Specification for Hand operated Concrete Mixers

IS : 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS : 6909 - Indian Standard Specification for Supersulphated Cement

IS : 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators

IS : 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures

IS : 7242 - Indian Standard Specification for Concrete Spreaders

IS : 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete

IS : 7251 - Indian Standard Specification for Concrete Finishers

IS : 7320 - Indian Standard Specification for Concrete Slump Test Apparatus

IS : 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting

IS : 7969 - Safety Code for Storage and Handling of Building Materials

IS : 8041E- Indian Standard Specification for Rapid Hardening Portland cement

IS : 8112 - Indian Standard Specification for high strength Ordinary Portland Cement

IS : 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance

IS : 8989 - Safety Code for Erection of Concrete Framed Structures

IS : 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens

IS : 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction

IS : 9103 - Indian Standard Specification for Admixtures for Concrete

IS : 10262 - Recommended Guidelines for Concrete Mix Design

VOLUME-II

SECTION-D
SUB-SECTION: D-III
FABRICATION OF STRUCTURAL STEEL WORK

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FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification

and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering

IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and

Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS *:* 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high

tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367 : Technical supply conditions for threaded fasteners.

ii) IS: 1608 : Method for tensile testing of steel products other than sheet, strip, wire and tube.

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide - Zinc Chromate Priming.

2.06.00 Storage of material

2.06.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored

in separate gunny bags or compartments according to diameter, length, and quality.

2.06.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel : Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.08.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not b limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also

their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved

methods, shall not exceed 600°C.

3.01.03 Cutting

Cutting shall be affected by shearing, cropping, or sawing. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted

before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1065°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any protrusion of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before

and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will

ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with

such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3.07.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in

the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twie, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION,TESTING,ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blow-holes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.06 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on

Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

VOLUME: II

SECTION - D

SUB-SECTION: D-IV
ERECTION OF STRUCTURAL STEELWORK

C 0 N T E N T

SUB-SECTION – D XVIII

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the

Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and

sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.

No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times	Bolt length exceeding 8 times	Remarks

dia or 200 mm	dia or 200 mm	
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more

		than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses or than 10mm	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span greater whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Girders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion	At the time of setting of the expansion gaps, due	

gaps — regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

VOLUME: II

SECTION: D

SUB-SECTION: D-V

REINFORCED CONCRETE CHIMNEY

C 0 N T E N T

SECTION-V

REINFORCED CONCRETE CHIMNEY

1.00.00 SCOPE

This section covers plain and reinforced cement concrete work, lining and insulation work, miscellaneous steel and metal work, painting and protective treatment work, stack elevator, lightening protection system and aviation obstruction lighting system connected with construction of RCC Chimney.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following:

a) Furnish all labour, supervision, services, insurance, material, power, fuel, Forms, templates, supports, scaffolding, tools, plants, construction, equipment, approaches, transportation etc. required for the entire work.

b) Design and prepare working drawings for formworks, scaffoldings, supports, staging etc.

c) Prepare as per approved schedule, detailed drawings for R.C. work in shell, hopper, platforms and ground floor and bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.

d) Prepare detailed fabrication and erection marking drawings for steel and metal- works.

e) Prepare detailed shop drawings for various inserts, anchors, sleeves, frames, templates, anchor bolts etc. showing relative locations of their installations.
As decided by the Engineer, some or all of the drawings schedules prepared under items b) to e) above will have to be submitted for approval.

f) Prepare and submit for approval the detailed schemes for operations like material handling, placement of concrete etc. and for items like approaches, services etc.

g) Design and submit for approval the mix proportions for concrete to be adopted on job.

h) Furnish samples and submit for approval the results of tests for various properties of the following materials:
i) Ingredients of concrete, ii) Concrete, iii) Metal work components, (iv) acid proof bricks, (v) fire bricks, (vi) Castable refractories, vii) insulation material, (viii) Paints, (ix) Electrical items.

i) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

j) Produce if directed by the engineer, a guarantee, approved Performa, for satisfactory performance, for a specified period as considered reasonable by the engineer, of material manufactured by specialist firms.

2.02.00 Work by others

No work under this specification will be provided for by agency other than the Contractor for this Contract unless specified mentioned otherwise in the Contract.

2.03.00 Codes and Standards

All works under this Section, unless specified otherwise, conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, along with those mentioned there in. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the engineer, shall be followed. Specifications shall mean Codes, Criteria etc. of BIS:

IS: 6 Moderate heat duty fireclay refractories, Group-A.

IS: 104 Ready mixed paint, brushing**,** zinc chrome, priming.

IS: 158 Ready mixed paint, brushing, bituminous, black, lead free, acid, alkaline water and heat resisting for general purposes.

IS: 269 Ordinary, and low heat Portland cement.

IS: 383 Coarse and fine aggregates from natural sources for concrete.

IS: 432 Mild steel and medium tensile steel bars.

IS: 456 Code of practice for plain and reinforced concrete.

IS: 516 Methods of test for strength of concrete.

IS: 732 Code of practice for electrical wiring Installations (System voltage not exceeding 650 Volts).

IS: 800 Code of practice for general construction in steel.

IS: 808 Rolled steel beam, channel & angle sections.

IS: 813 Scheme of symbols for welding.

IS: 814 Covered electrodes for metal arc welding of structural steel.

IS: 816 Code of practice for use of metal arc welding for general construction in mild steel.

IS: 817 Code of practice for training & testing of metal arc welders.

IS: 818 Code of practice for safety and health requirements in electric and gas wielding and cutting operations.

IS: 822 Code of Procedure for inspection of welds.

IS: 1139 Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars concrete reinforcements.

IS: 1161 Steel tubes for structural purposes.

IS: 1199 Methods of sampling and analysis of concrete.

IS: 1200 Methods of measurement of building works.

IS: 1239 Mild steel tubes.(Part-I)

IS: 1367 Technical supply conditions for threaded fasteners.

IS: 1526 Sizes and shapes for firebricks (230 m. series).

IS: 1554 Cables.

IS: 1566 Hard-drawn steel wire fabric for concrete reinforcement

IS: 1608 Methods for tensile testing of steel products.

IS: 1730 Dimensions for steel flats, sheet and strip for structural and general engineering purposes.

IS: 1731 Dimensions for steel flats for structural and general engineering purposes.

IS: 1786 High Strength Deformed steel Bars and wires for concrete Reinforcement.

IS: 1791 Batch type concrete mixers.

IS: 1893 Criteria for Earthquake Resistant Design of Structures.

IS: 1977 Structural steel (ordinary quality).

IS: 2062 Steel for general structural purposes.

IS: 2074 Ready mixed paint, red oxide - zinc chrome priming.

IS: 2309 Code of practice for the protection of the buildings & allied structures against lightning.

IS: 2386 (Part-:I) Methods of test for aggregates for concrete. Particle size and shape.

IS: 2386 (Part-:II) Estimation of deleterious materials & organic impurities.

IS: 2386 (Part-.:III) Specific gravity, density, voids, absorption & bulking.

IS: 2386 (Part-IV) Mechanical properties.

IS: 2386 (Part-V) Soundness.

IS: 2386 (Part-VI) Measuring mortar making properties of fine aggregates

IS: 2386 (Part-VII) Alkali aggregate reactivity.

IS: 2386 (Part-VIII) Petrographic examination.

IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement.

IS: 2505 Concrete vibrators, immersion type.

IS: 2506 Screed board concrete vibrators.

IS: 2633 Methods of testing uniformity of coating on zinc coated articles.

IS: 2722 Portable swing weighbatchers for concrete (single and double bucket type).

IS: 2750 Steel scaffoldings.

IS: 2751 Code of practice for welding of mild steel bars used for reinforced concrete

construction.

IS:3025 Methods of sampling and test (Physical and Chemical) for water used in industry.

IS: 3043 Code of Earthing.

IS: 3144 Methods of Test for mineral wool thermal insulation material.

IS: 3346 Method for the determination of thermal conductivity of thermal insulation materials (two guarded hot plate - method).

IS: 3495 (Part-I to IV) Method of test for clay building bricks.

IS: 3550 Methods of test for routine control for water used in industry.

IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete.

IS: 3677 Unbonded rock and slag wool for thermal insulation.

IS: 4014 (Part- III) Code of practice for steel tubular scaffolding.

IS: 4031 Method of physical tests for hydraulic cement.

IS: 4634 Method for testing performance of batch type concrete mixers.

IS: 4687 Gland racking asbestos.

IS: 4860 Acid-resistant bricks.

IS: 4990 Plywood for concrete shuttering work.

IS: 4998 (Part-I) Criteria for design of reinforced concrete chimneys.

IS: 5410 Cement paint, colour as required.

IS: 5445 Long fluted machine reamers with Morse taper shanks.

IS: 5495 Sizes and shapes for Firebrick (300 mm and higher series).

IS: 8112 High strength ordinary Portland cement.

IS: 8163 Bonded Mineral Wool.

IS: 9595 Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels.

IS: 10262 Recommended guidelines for concrete mix design.

CP326 British standard - Protection of structures against lightning.

NEPA NO. 78 Code of protection against lightning.

Draft Code of Practice for the protection of buildings against lightning - 1954 of Institution of Engineers (India).

The Indian Electricity Rules.

The requirements of Department of Civil Aviation, Govt. of India.

2.04.00 Conformity with drawings and specifications:

The Contractor shall carry out all the work in strict accordance with the approved drawings stamped ‘Released for Construction' and specification issued to him. Prior to concreting, the Contractor shall prepare a check list on a set format involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer, No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For steelwork and metal work, the Contractor shall, design all connections, inserts and scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials, whether to be incorporated in the work or to be used temporarily for the construction shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.05.02 Cement

Portland Cement shall be as per the requirements laid down in IS: 8112.

2.05.03 Coarse Aggregate

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS: 383 or IS: 515 and shall be washed clean, if necessary. The maximum size of coarse agreement for chimneys shall be 20 mm downgrade unless otherwise stated (vide serial 5(b) of clause 3.3.6). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.05.04 Fine Aggregate

Fine aggregate shall be river or pit sand free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading within the limits of one of the three grades, mentioned in the relevant IS Specifications.

2.05.05 Water

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, and organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer, at no extra cost to the Owner.

2.05.06 Reinforcement

Mild steel, or Medium or High Tensile steel deformed bars specified for reinforcement shall conform the latest relevant specifications and shall be of tested quality under IS certification Scheme. The reinforcement shall be free from any oil, foreign material or mild rust scales.

2.05.07 Structural Steel

All steel materials to be used in construction of Chimney ladder, hand rails, flue opening frame, access door frame, doors shutters etc. shall comply with IS: 2062, IS: 1239, IS: 1367, IS: 1608 and with other relevant IS specifications.

2.05.08 Paints

Paints to be used for shop coat of fabricated steel shall conform to IS: 2074. Paint for treatment of outside face chimney with Cement waterproof paint shall conform to IS: 5410.

2.05.09 Fire Bricks, Acid Resistant Bricks and Castable Refractories

Fire Bricks and acid resisting bricks for internal lining of chimney shall conform to IS: 6 Group-A, and IS: 4860 class II respectively. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractories properties similar to Firebricks conforming to IS: 6, Group-A and working temperature shall be upto 1350 Deq.C.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material which is deteriorated or is damaged or is otherwise considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the contractor dues.

2.06.02 Cement

Contractor shall store cement in watertight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The floors of stores shall be at least 30 cm above G.L. Deteriorated cement shall be removed immediately from the site. Not more than ten bags of

cement shall be stacked one above the other. A suitable passage shall be provided for Engineer's inspection of stacked cement.

2.06.03 Aggregate

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.06.04 Reinforcement

Reinforcement shall, be stored preferably under Cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.06.05 Steel, Metal and Fittings

All steel metal and fittings to be used for fabrication and erection, shall be stored section wise and lengthwise in separate stacks off around, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.06.06 Paints

Paints shall be stored under cover, in airtight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in airtight containers.

2.06.07 Bricks

Bricks shall be stored in systematic stacks for ease of handling and counting. While unloading the bricks from trucks, they shall be stacked right, away and shall not be dumped in a heap.

2.06.08 Insulation material

Insulation materials like mineral wool, asbestos ropes etc. shall be stored in packing boxes, under covered sheds, their coming in contact with objectionable matter.

2.06.09 Electrical Items

All electrical items shall be stored properly under covered watertight shed so that they do not come in contact with moisture or cement dust.

2.07.00 Quality Control

Contractor shall establish and maintain different quality of work and materials as may be directed by Engineer to assure compliance with to the contract requirement and submit to the Engineer records of the same. The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall be limited to the following items of work :

a) Cement : Test to satisfy relevant IS Specifications.

b) Aggregate : Physical, Chemical & Mineralogical qualities, grading, moisture contents and impurities.

c) Water : Impurities Test.

d) Reinforcement : Material tests or certificates to satisfy relevant IS Specification.

e) Structural Steel : Material tests or certificate lo satisfy relevant IS Specification.

f) Bricks : Compressive strength, water absorption, efflorescence, warpage.

g) Fire Bricks : Cold crushing strength, alumina content & water absorption test, density test, thermal-conductivity test.

h) Acid Resistant bricks/tiles : Compressive and tensile strength, acid resistance and water absorption test.

i) Mortar : Compressive and tensile strength, adhesion and acid resistance test.

j) Insulation : Thermal conductivity, density, heat and acid resistance.

3.00.00 EXECUTION

3.01.00 Concrete

3.01.01 Trial Mix, Grades of Concrete

Before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum, proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables:

i) Strength requirements of concrete: Table-2 of IS: 456-2000.

ii.) Concrete Mix Proportion: Table-9 of IS: 456-2000.

iii) Minimum cement content/Cum of finished concrete shall be 325 Kg, 360 Kg, 420 Kg. & 500 Kg for Grades M15, M20, M25 and M30 respectively unless otherwise stated (vide serial 5(c) of clause 3.3.6).

iv) Limit of consistency: Refer Table in Item 3.1.4 of this specification.

V) Cement/Total Aggregate Ratio: As per the following table on the subsequent leaf.

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER-CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIO

Water/	Ratio by weight of cement	Ratio by weight of cement to

Workability	Cement. to gravel aggregate Ratio		crushed stone aggregate	
		20 mm size	38 mm size	20 mm size	38 mm size
Very Low	0.4	1:4.8	1:5.3	1:4.5	1:5
Slump	0.5	1:7.2	1:7.7	1:6.5	1:7.4
0-25 mm	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low	0.4	1:3.9	1: 4. 5	1:3.5	1:4
slump	0.5	1:5.5	1:6.7	1: 5	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7
25-50mm	0.7	1:8	1:8.5	1:7.4	1:8
Medium	0.4	1:3.5	1:3.8	1:3.1	1:3.6
slump	0.5	1:4.8	1:5.7	1: 4.2	1:5
50-100mm	0.6	1:6	1:7.3	1:5.2	1:6.2
Low	0.4	1:3.2	1:3. 5	1:2.9	1:3.3
slump	0.5	1:4.4	1:5.2	1: 3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
100-175mm	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE-1:

Notwithstanding anything mentioned above, the cement /Total aggregate ratio is not to be increased beyond 1:9.

It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water-cement ratios which may be required be used in mass concrete work only.

NOTE-2:

The Above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty eight days. The making of the Cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant chance in the

quality of any the ingredient for concrete, at the discretion of the Engineer. All cost for trial mixes and tests shall be borne by the Contractor and shall be included in the contract price.

3.01.02 Batching of concrete

For controlled concrete, only weigh batching shall be allowed. Weight batcher using an approved make of weigh batcher shall batch all concrete ingredients, except water. The batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.01.03 Mixing of Concrete

Materials for concrete shall be emptied in rotation into the mixer when all-the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes or at least for forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The Fixer shall be thoroughly cleaned to the satisfaction of the Engineer, before different quality of concrete is put through the mixer and also at the end of day's work.

3.01.04 Workability of Concrete

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork, and around the reinforcement and embedment, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm to 40 mm slump in chimney works shall be adopted subject to Engineer's approval unless stated otherwise (vide be serial 1(d) of clause no. 3.3.6). The usual limits of consistent for various types of structure are given on the following leaf:

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with standard concrete		Use for which concrete is suitable
	Min	Max.	
Very Low	0	15	Large mass concrete with

			Heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Mediurn	35	65	Deep and wide RCC congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

NOTE:

The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, Cement Shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test, in accordance with IS: 1199 shall be carried out.

3.01.05 Placing and Compaction of Concrete

Concreting shall proceed in a manner directed by Engineer, for concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall decide the Engineer. The concrete shall be placed in the forms gently and not dropped from a height, which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tanning or rodding by hand in thecorners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown those in use.

3.01.06 Curing of Concrete

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered canvas etc. immediately after stripping of forms; and curing shall be continued for a period of not less than 14 days reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor's curing.

3.01.07 Construction Joints

When slip form method is not adopted for concreting the chimney shell upto top of flue ducts operating, one full ring lift shall be completed in a day’s pour. Before the formwork for the following pour starts the horizontal surface of the chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleared and washed again and covered with 1:2 sand cement slurry before fresh concrete placed. The horizontal constructed joints shall be so arranged and made that they are regular and neat. No vertical joints shall be allowed.

The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters .The Contractor shall submit to the Engineer, any proposal of providing joints to facilitate his work for the study Engineer well in advance.

3.01.08 Ordinary Concrete

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS: 456-2000.

3.02.00 Reinforcement

3.02.01 Bending of Reinforcement

All bars shall be carefully and accurately bent by the Contractor in accordance with approved drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS: 2502.

3.02.02 Placing

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the Engineer shall be provided. Laps shall be staggered and too many laps shall be avoided.

3.02.03 Fixing of Reinforcement

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

3.03.00 Forms

3.03.01 Design and Material of formwork

The shuttering for the chimney shell shall be either steel formwork or steel framed plywood formwork of adequate thickness, proper surface texture and with requisite supports and battens to produce a shell surface which will be even, smooth and of uniform curvature and batter as per Drawing and free from all blemishes.

The Contractor shall be responsible for designing the formwork along with its supports etc. Contractor shall obtain the approval of the Engineer for the design of forms, before assembling them. Of the Engineer does not relieve the Contractor of this responsibility to ensure the soundness of formwork vibrations.

3.03.02 Installation of Formwork

All formwork shall be set to plumb and to line and level or curvature or batter as per drawing. All shutters shall be adequately supported, to the satisfaction of the Engineer, to prevent deflection under dead weight of concrete, imposed load of workmen, materials and plant and to withstand.

No joint in any props shall be allowed. The joints in formwork shall be watertight. Surface of formwork shall be oiled with approved quality mould oil which shall not strain the surface the steel.

3.03.03 Tolerance

The formwork shall be so made as to produce a finished concrete true to shape, levels, plumb and dimensions as shown the drawings, subject to the following tolerances, otherwise specified.

a) Out of plumb between two consecutive lifts : 3 mm
b) Errors in level : 3 mm
c) Errors in sectional dimensions : 5 mm
d) Out of plumb in general : 1 in 1000 of height subjected to a maximum of 200 mm

However, the Contractor shall aim at improving upon this figure. Should the limitations exceed, the Contractor shall, if directed by the Engineer, demolish that portion of work and recast at his own cost to the complete satisfaction of the Engineer. No tolerance shall be allowed between the two Consecutive places of the formwork either radially or vertically placed.

3.03.04 Stripping of formwork

Unless otherwise permitted in writing by the Engineer, the minimum period of keeping formwork in position after the completion of pouring of concrete shall conform to relevant clause of IS:456. For the chimney shell the stripping time shall be 48 hours minimum.

Formwork shall be so arranged as to permit removal without jarring or damaging the concrete. Immediately after stripping of formwork, the Engineer shall be informed by the contractor. The Contractor shall ensure that the site is cleared of stripped shuttering nails or any other material, which might hinder the inspection, so that the Engineer can inspect the concrete surface.

3.03.05 Re-use of formwork

Before re-use, all forms shall be thoroughly scraped, cleaned, examined, repaired, and treated with mould oil as specification here in before. Formwork, declared unfit or unserviceable, by Engineer, shall not be used or reused.

3.03.06 Construction by slip-form Method

The Contractor, if it is convenient to him, may use jump form upto top of flue duct opening, but above that level, slip form construction shall be sed. Types of slip form, proposed should be in indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the opffer to guarantee workability of the scheme both from execution time and safety point of view.

The Tenderer should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Owner at the time of submitting Tender. This statement shall include the following items:

i) Type and description of slip-form equipment and its accessories.

ii) Design of scaffolding and staging.

iii) Description of materials including admixtures to be used for construction.

iV) Manpower planning, construction spaces required, standby arrangements.

v) Rate of slip forming.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality assurance programme.

viii) Method of transportation of material.

ix) Method of curinq and rectification of defects.

x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

Not withstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by tenders for slip form method of construction.

1. Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps are advisable:

   a) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete coat of epoxy paint.

   b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum sloping of shuttering is 100 mm per hour.

   c) Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant IS Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.

   d) Mix design also should be so done that it has a slump of 150 mm at the point where concrete is Placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum slump should not drop down to zero in less than 45 minutes. Suitable retarding agent and plasticizer approved manufacture may be added in mix to achieve purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used. The admixtures shall be used strictly as per manufacturer's specification.

   Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40 Deg.C.

2. Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes

interval. One person should exclusively be assigned this work together with rectifying any defect.

3. Every endeavour has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken :

   b) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

   c) Loading on slip-form truss/yokes has to be fairly equal.

   c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5mm all-round.

4. For tapered walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.

5. In designing the mix following, aspects should be borne in mind :

   a) Cement used should have initial setting time not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm.per gram.

   b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

   c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 kg. per Cu.M of concrete.

   d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/sq. mm.

e) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes.

6. Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation.

7. It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights.
   In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a standby pump for effective utilization of the system.

8. If Slipforming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

9. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.
   It is desirable that jacking system, based on which the entire slipform system works, should consist of jacks 3 Tonne/ 6 Tonne capacity and a hydraulic pump with necessary pipe connections.
   Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading of jacks consequent failure resulting in twist of the formwork.
   Jacking rods should be of 25 mm diameter for 3 Tonne jacks and 32 mm diameter for 6 Tonne jacks.

10. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.

11. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

12. For effective utility of this technique following areas need careful attentions at the very conceptual stage :

a) Detailed quality assurance programme.

b) Advance Planning and preparations

c) Arrangement for on site supervision and adequate access facilities.

13. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

14. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcements. Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system.

15. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc.

16. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete. For movement of personnel supervising the work a separate hoist must be arranged for.

17. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform.

18. Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

19. Proper telecommunication system has to be established between the personnel working on top of Chimney and control room below.

20. A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for quick feedback results.
Apart from using plumb bobs, level and theodolite instruments for survey purpose, arrangement should also be kept for lasers.

21. In case of interruption in the course of slipping of formwork following measures should be taken :

a) Provision of a key and additional reinforcement at the junction of new and old concrete.

b) Slipform system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

e) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.

22. It is preferable to suspend the construction work under high wind condition.

23. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slipform technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

24. Operation of slipform method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

25. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer. Safety measures as listed below must be adhered to but should not be limited to only these

:

a) Safety helmets and belts to be provided to all supervising staff and workers.

b) Safety nets to be provided as instructed by Engineer.

c) Hand railing and toe guard to be provided around all openings and platforms.

d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

e) Passenger hoist must have multiple ropes.

f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure. Emergency standby generator must be kept ready during the entire period of slipform method of construction.

g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

26. Permissible construction tolerances should be limited to the following :

Variation in wall thickness	:	(-) 5mm, (+)25mm.
Variation from Design Diameter	:	(±) 25mm or (±) 12.5mm per 3 m diameter whichever is less, but in no case more than (±) 75mm.
Out of Plumb in General	:	1 in 1000 of height subject to a maximum of 200mm.

3.04.00 **Chimney Steel and Metal Work**

3.04.01 General

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.

3.04.02 Fabrication

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:652. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat, the

temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length, based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burrs shall be removed with power driven hand grinder. Bolt holes shall net be formed by a gas cutting torch.

3.04.03 Assembly

Riveting, bolting and welding shall be carried cut as per requirements laid down in IS:800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection . Each steel piece shall bear erection marking, written in paint.

3.04.04 Painting

A coat of shop painting shall be applied do all steel and metal work, unless stated otherwise. All steel ladder, platforms, balconies, hand railing, frames, doors etc. which are specified for painting snail be painted first with two coats of red oxide zinc chromate paint conforming to IS: 2074 and then with two coats of Synthetic enamel paint (as per IS: 2932 & 2933) or aluminium paint (as per IS: 2339) of approved quality or acid resisting paints as specified in approved drawing or elsewhere.

Total dry-film thickness of Paints provided on metal structures shall be 190 microns minimum.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer’s literature and samples shall be submitted to the Engineer, for his approval, before bulk purchase is made.

The metal Surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

3.04.04 Galvanizing

All steel including threaded bolts, nuts and washers, unless specified otherwise in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS: 2629 – Recommended practice for Hot Dip galvanizing of Iron and Steel.

All members to be galvanized shall be cleaned thoroughly, to the Satisfaction of the engineer by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown. of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

3.04.06 Erection

Erection of structural members shall be done as per requirement of IS: 800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contract. Proper Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor.

3.05.00 Insulation and Protective Treatment

3.05.01 Acid and Heat Resistant Paint

The entire internal surface, including corbels, and about five meters at top of the external surface of the concrete shall including the top platform shall be painted with acid and heat resistant paint. The paint material shall be impregnated bituminous paint conforming to IS 158. Its heat resisting qualities shall be as specified for Type–I (i) of IS:158. Three coats of paint shall be applied over a primer coat which shall consist of a thinned coat of the same paint. The total dry film thickness (DFT) of paint shall be not less than 150 microns.

The top external surface of the concrete shall, below the top black band, shall be painted in alternate bands of colours :- signal red and bright white. The painting system shall comprise one coat of cement primer `Bison' of M/S Berger paints or an approved equivalent and three coats of water proof cement paint conforming to IS :5410. The balance external surface of the windshield shall be

painted with minimum three coats of waterproof cement paint for Cement-grey colour Conforming to IS 5410.

All painting shall be done as per the paint manufacturer's recommendations and the relevant Indian standards.

3.05.02 Insulation

Rock wool for thermal insulation shall conform to IS: 3677. The packed density of the wool shall be within the range of 175 to 200 Kg/Cum and the coefficient of thermal conductivity shall conform to the requirement of IS:3677 at a mean temperature of 150 Deg.C.
Over the concrete surface of the ash collecting hopper at the bottom of chimney flue, 75 mm. thick vermiculite concrete shall be laid to act as thermal insulation. Vermiculite concrete shall be made by mixing exfoliated vermiculite, Portland cement and water. It shall have a density of 210 Kg/Cu.m. The vermiculite aggregate size shall be maximum 6mm. The mix shall be 1 part cement and 8 parts vermiculite by volume. Over this layer of vermiculite concrete. 75mm thick acid proof brick lining shall be made.

3.06.00 Steel Liner (Flue)

3.06.01 General

3.06.02 Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting platform.

The liner shall be of corrosion resistant steel of minimum 8 mm thick or mild steel minimum 10 mm thick. Top 10 m length or length equal to 2 times flue diameter whichever is larger shall be provided in stainless steel grade SS 316L for the liner. The liner shall be primarily suspended from the top, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between.

3.06.03 The lining / stiffeners shall be fabricated from corrosion resistant steel type"COR-TEN B" or mild steel having an ultimate tensile strength of not less than 410 N/sq.mm and conforming to the requirement of IS:2062 (Grade-A) unless noted.

3.06.04 The portion of liner with stainless steel shall be provided with a grade of steel conforming with the requirements of AISI type 316L.

3.06.05 The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluroelastomeric fabric expansion compensator.

3.06.06 Fabrication

3.06.07 The CONTRACTOR shall establish a full fledged fabrication shop at site including proper cutting, bending, welding, testing and proper handling facilities. Complete fabrication shall be carried out at site.

3.06.08 The individual cans of the liners shall be joined together by butt welding internally allround for full strength after connecting the flanged portion of the cans with high tensile steel threaded fasteners conforming to IS:1367. It shall be ensured that the joints are accessible from internal platform during erection to facilitate welding.

3.06.09 The CONTRACTOR shall arrange inspection of welds in the presence of BHEL's representative as described below.

3.06.10 100% of the welds shall be subjected to visual inspection to detect visual imperfection.

3.06.11 At least 10% fillet welds shall be subjected to Dye penetration tests (DPT) at random.

3.06.12 100% of the root welds for butt welding shall be subjected to DPT after back gouging.

3.06.13 10% of butt welds chosen at random shall be subjected to radiographic / ultrasonic tests. All welding / weld testing procedure shall in general follow AWS standards.

3.06.14 **Erection**

3.06.15 CONTRACTOR shall submit to the BHEL the scheme for erection of the steel flues, erection equipment to be deployed, equipment and accessories complete for approval. CONTRACTOR shall make sure that there are adequate spares for the erection equipments and at no cost will a delay be permitted due to inferior or faulty erection equipment.

3.06.16 CONTRACTOR shall furnish necessary details such as number of jacks he proposes to use, their supporting arrangement, collars, rod hangers, high tensile steel cables/rods to lift or suspend the flue, temporary staging arrangement and fixing details. The capacity of the jacks, cables etc. shall be double the actual load proposed to be lifted / borne by them.

3.06.17 It is suggested that the liner be installed in heights of approximately 45 m. This height is indicated so as to facilitate welding at each access platform level. The top portion of liner is first installed at ground level, hoisted and placed on the support platform. After ensuring that this portion is well supported, the second set of linear is erected at ground level, hoisted and

welded to the already placed linear portion and so on. This would enable requirement of jacks and cables of smaller capacity and easier handling.

3.06.18 CONTRACTOR shall ensure that deviations shall not exceed the specified tolerances spelt out herein below for fabrication and erection of steel flues. The permissible deviations from the true form are as under:

3.06.19 Internal diameter shall not differ from the true or design diameter by more than +20mm in the horizontal plane.

3.06.20 Horizontal centre of any section shall not deviate more than 12 mm from the shell vertical centre line in any 15 m height and never more than 1:2500 of height plus 12 mm at any level considered.

3.06.21 Locally, the variation of the bent plates from true circular form (flat spots) should not exceed the plate thickness. All measurement/ checking shall be done by a segmental circular template having the design radius and a chord length of 0.15 times the design radius.

3.07.00 Lightning Protection System

3.07.01 General

The lightning protection system to be installed on the chimney by the contractor shall be strictly as per specification and shall satisfy the following requirements.

3.07.02 Air Terminals

The chimney shall be provided with pointed air terminals uniformly distributed alone the top rim of shall. The projected length of the air terminals above the top of shell shall not be less than 1000 mm. The air terminals shall be made of lead coated solid copper rods having a minimum diameter of 20 mm. The air terminals shall be secured to the top of chimney by at least two fasteners of substantial construction to withstand high wind pressure acting in the area commensurate with the height involved. All the air terminals shall be electrically connected together by means of a band of 75x6 mm. galvanized steel flat which shall from a close loop 600 mm. below the top of the shell. Each segment for the cast iron cap of the chimney shall be connected to this galvanized steel flat band on top of the chimney by means of bolted connections.

3.07.03 Down Conductors

There will be two separate system of vertical down conductors of 5Ox6 mm flats spaced uniformly. One system, envisaged for lightning protection, will have two numbers of down starting from the top encircling band leading to the ground.

the other system, envisaged for earthing of platforms/ ladders etc. on the stack, will also have ground conductors originating below the platforms and leading to ground Galvanised steel 50x6 mm. flat bands shall be provided below each platform. These bands shall be connected to each ground conductor. No part of the down conductor system for lightning protection shall have electrical contact with hand rails of platform, cage ladder and encircling band ring forming the earthing system.

The connections of the galvanized steel down conductors to the copper air terminals shall be brazed and connection to the nearest grounding grid at the bottom shall be are welded. Connection between any two Galvanized steel flats/bands shall be made by are welding. The ground grid for chimney shall be connected to the power house ground grid at least at two points.

The galvanized steel flat encircling bands shall be supported at an interval of maximum 600 mm. and the vertical down conductors shall be supported at an interval of approx. 2500 mm. The fasteners shall be of same grade of material as the conductors and have to be galvanized. The conductor shall be laid straight and sharp bends shall be avoided as far as practicable. A suitable bolted test piece shall be provided at each down conductor at a convenient height near the bottom of the chimney.

At all supports, the portion embedded inside the chimney shell concrete shall not touch the reinforcement bars and shall be duly insulated from them.

3.07.04 Bonding

All exposed metallic parts of the chimney shall be bonded to the ground conductor. Such parts shall include ladders, balconies, conduits, etc. If the metal has considerable length, it shall be bonded at each end. If. the metallic components are composed of electrically discontinuous parts, each part shall be bonded to the ground conductors. The bond shall have a minimum cross sectional area equal to that of the ground conductor.

3.07.05 Joints

The joints in the lightning/ground shall be kept to a minimum and there shall be no joint in the underground portions of conductors. All joints, except those for the air terminals shall be done by arc welding process. Overlapping of the conductors at straight joints shall not be less than 150mm. The bolted joint of the test piece shall be covered with thick coating of bituminous paint after successful testing. The

connections between the down, conductors/short piece (of 50 x 6mm. galvanized - steel flat) and the copper air terminals shall be brass brazed as shown in the drawing (with the help of brass rods, manufactured by Indian Oxygen Limited (Silos or Ruptum 14) or equivalent.

3.09.05 Painting and Lead Coating

All welded joints with galvanized steel shall be provided with cold galvanizing paint. Other accessories necessary for lightning protection as well as brackets, supports and other items of obstruction lighting installations, shall be painted with two coats of Red Oxide priming paint and one coat of Aluminium finishing paint. The Red Oxide paint shall be applied on the down conductors and bands before installation and the Aluminium paint coating shall be applied after the installation is over. The copper air terminals, conductors, fasteners and other accessories upto the top encircling band shall have a continuous lead covering of about 2 mm. thickness, for protection against corrosion due to gases and weather.

3.10.0 Sampling Port

Sampling ports of minimum 0.1 m. dia shall be provided in the Chimney to maintain records of emission. Minimum length of port shall be 0.5 m. measured from inside face of the lining to the outside end of the port. The port shall be provided with industrial flange capped when not in use. Location of port shall be at least two times the top diameter below the stack exit and at least eight time the stack diameter above the last obstruction. A working platform of minimum 1 Sq.m. area with safeguard rail shall be suitably provided one meter below sampling port along with access ladder, if required. There shall be no obstructions within 1 m. horizontal radius on platform beneath ports. A power source of 220 V, 15A single phase 50 Hz AC shall be located on the platform. There shall be two ports 90 Deg. apart when stack dia. less than 3 m. plus port length and 4 ports when stack dia. is more than 3 m. plus port length.

3.11.00 Mechanical Items

Stack Elevator shall conform to the specification furnished elsewhere in this specification.

4.00.00 Testing and Acceptance Criteria

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specification and as supplemented herein for the following items or any other item as may be required by the Engineer, at his own cost. The contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to

him, the original test results in triplicate. within seven days after the completion of the test.

4.02.00 Cement

Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the manufacturer / supplier for carrying out the tests for fineness (by hand sieving), setting time, compress strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard.

4.05.00 Concrete

The Contractor shall take cubes for works test as per requirement laid down in.IS:516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS:456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement, of IS:456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild. Such demolishing and rebuilding shall be carried out by the Contractor at his own cost.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following technical information are required with the tender :

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used. All details as per clause no. 3.3.6 to be submitted for slip form method proposed to be used.

e) Proposal for lifting of men and material in constructing the chimney.

5.02.0 After Award

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.02.01 Programme of execution and requirement of materials

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving month wise requirement of materials.

The master programme may have to be reviewed end updated by the Contractor Quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.

5.02.02 Samples

Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, free of cost, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.

5.02.03 Design Mix

Design mix as per details of this specification giving proportions of ingredients. sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work.

5.02.04 Detail Drawings

Following items shall be provided by the Contractor which are to be approved by the Owner.

a) Detail drawings and designs of form work including scaffolding to be used. Detail drawings snowing all the arrangements for slip form technique

including methods for reducing internal diameter and providing required slopes on outer diameter.

b) Detail drawings and bar bending schedules for concrete components.

c) Shop drawings for steel and metal work, including inserts etc.

d) Detail drawings for templates and temporary supports for embedment.

5.02.05 Reports

Following Test Reports shall be furnished by the Contractor:

a) Mill Test Report for cement and reinforcing steel.

b) Inspection Report of formwork and reinforcement.

c) Reports of tests of various material and concrete.

d) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship

SECTION-D

VOLUME II
Specification for Electrical Works

GENERAL TECHNICAL REQUIREMENTS
OF
LIGHTNING PROTECTION OF CHIMNEY

SPECIFICATION NO. PES-509-02A

1.0 GENERAL

1.1 This section includes the design, fabrication, supply, installation and testing of Lightning Protection system for the Chimney(s). The requirements of this specification shall be complied with in relation to the requirements set out in Data Sheet-A & Section-C.

1.2 The contractor's scope, besides material supply shall include complete installation of Lightning Protection System, protective coating application, and testing of the system. All materials, consumables, erection equipment etc. as required for the completion of installation and testing facilities shall be supplied.

2.0 CODES & STANDARDS

2.1 The latest revisions of the following codes & standards shall be applicable:

IS:2309 Code of practice for protection of buildings & allied structures against lightning.

IS:3043 Code of Practice for earthing

IS:4759 Hot-dipped galvanised coating on structural steel

IS:2629 Recommended practice for Hot-dipped galvanising for Iron & Steel.

IS:2633 Methods of Testing Uniformity of Coating on zinc-coated Articles.

IS:1731 Dimensions for Steel flats for structural & General Engineering Purposes.

IS:1752 Electroplated Coatings of Cadmium on Iron & Steel

Indian Electricity Rules, 1956,

Indian Electricity Act, 1960.

IS:4990(Part-I) Criteria for Design of Reinforced concrete Chimney.

3.0 DESIGN REQUIREMENTS

3.1 Lightning Protection system for the chimney shall consist of air-termination network comprising requisite number of vertical copper rods, 20mm in dia, projecting at least 1000mm above the top of the chimney and the flues, spaced uniformly along the top periphery of the outer shell of the Chimney and that of the flues. A ring of 75x6mm GI strip shall be laid along the top periphery of the flues and the Chimney, forming the

annular horizontal air terminations. The vertical air terminations shall be electrically connected (Brazed) to the horizontal air terminations, the vertical termination of the flues and those of the Chimney to the horizontal termination of the Chimney. The vertical terminations shall be spaced not more than 3m apart from each other.

3.2 The air terminations shall be secured to the top of Chimney top by an arrangement of substantially strong construction to withstand high wind pressure prevalent in the area commensurate with the height involved. All materials for the securing arrangement shall be of the same grade as the conductors and must be galvanised. The vertical air terminals at the top of the shell shall also be secured to the guard ring at the top of the shell.

3.3 A minimum of two numbers of equally spaced conductors, each consisting of 50x6mm GI strip, shall be brought down from their connecting points on the annular rings at the top of the Chimney/flues. The down-conductors originating at the top of the flues shall be brought down along the walls of the flues and electrically connected (welded) to the annular ring at the top of the outer shell of the Chimney. The down conductors (minimum two numbers) from the chimney top shall be brought down to the bottom of the Chimney all along the exterior Chimney wall.

3.4 A test link of copper black/phosphor bronze gunmetal bolted to the conductor for the purpose of isolation & testing shall be provided on each down conductor 1000mm above ground level.

3.5 Down conductors shall be cleated to the wall at an interval of 1500mm all along the length of the Chimney.

3.6 Down conductors near ground level shall be protected against mechanical injuries by means of wood-moulding or non-metallic cover. A removable cover of the same material shall be provided over the test- link for easy access.

3.7 The connection between the downconductor from the test link onwards upto an annular ring of galvanised steel running around the entire periphery of the chimney bottom shall be provided through risers which shall be of 40mm dia MS rods.

3.8 The risers shall be terminated on the annular ring of 40mm dia MS rod running around the periphery of the chimney buried 1 metre deep in the ground and clearing all foundation by at least 2 metres.

3.9 From the termination points of the downconductors on to this underground ring, mild steel rods shall terminate at test pits complete with test-links and electrodes.

3.10 The test pits at para 3.9 shall in turn be connected to the main earthmat of the power house through 40mm dia MS rod.

3.11 All joints, except for testing purposes, shall be welded type lap joints with an overlap of 100mm. The welding shall be complete around the joint and not tack welded. Electric arc welding shall be used for all joints.

3.12 After welding, two coats of anti-corrosive (red-oxide) paint followed by a coat of bituminous paint shall be applied to each joint.

3.13 The 40mm dia MS rods shall be protected against corrosion by applying a coat of barium chromate paint and two coats of bitumen below the test link.

3.14 The complete lightning protection system arrangement including air-terminations, conductors, connections, fittings etc. and materials located on the exterior within 10m from the top of the chimney shall have lead coating of 2.0mm thickness.

3.15 All exposed metal structures such as hand rails, platforms, ladders/stairs shall be connected to the downconductors through earthing band rings, of 50x6mm GI strip located 2000mm above each platform. Ladders and platforms shall be bonded together for electrical continuity. A strip of 25x3mm GI shall be used for connection between equipment and earthing band rings. Similarly, all lighting fixtures shall be earthed.

3.16 Temporary lightning protection system shall have to be provided and maintained during the construction of chimney or till final lightning protection system is installed by the contractor free of cost and in line with IS:4998(Part-I).

3.17 For general reference and guidance, Below Ground Earthing Typical Details drg.no. PE-DG-XXX-509-0004 & drg.no.PE-DG-XXX-509-003 may be used.

4.0 GALVANISING

4.1 All steel strips and materials requiring galvanisation shall be hot-dip galvanised according the IS:2629 & IS:4759. Galvanising shall be done at a place where galvanising and testing facilities conforming to the relevant Indian Standards exist. The galvanising shall be smooth, clean, uniform, continuous & free from acid spots. The thickness of zinc deposit at any spot shall not be less than 75 microns. The purchaser reserves the right to measure the thickness of zinc deposit and reject any component which shows thickness of zinc at any location less than 75 microns. Should the galvanising of the sample be found defective, the entire batch of the steel will have to be re-galvanised at the seller's cost.

4.2 All nuts, bolts and washers, wherever used, shall be cadmium coated or zinc passivated, the thickness of plating conforming to the relevant Indian Standards.

5.0 INSPECTION & TESTING

5.1 The following stages of manufacture/installation shall be stage inspected by purchaser or his duly authorised representative:

5.1.1 Inspection of all material such as vertical air terminals, steel strips, electrodes, test links including hardware items such as bolts, nuts etc.

5.1.2 Inspection of manufacturing processes such as shearing, punching, beinding, welding, galvanising, painting etc.

5.1.3 Inspection of installation procedures

The actual inspection will be carried out as per the agreed Quality Plan.

5.2 TESTING

5.2.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to relevant standards and that such tests are adequate to

demonstrate that the equipment shall comply with the requirements of this specification.

5.2.2 The tolerance in dimensions shall be in accordance with appropriate Indian Standards.

5.2.3 Forged steel below 10mm thick is subject to Magnetic Particle Testing.

6.0 DRAWINGS, DATA & DOCUMENTS

6.1 Data sheet-A of this specification gives the details of materials to be used for the Lightning Protection system for Chimney.

6.2 The tenderer shall submit his design(s) and drawings for Direct stroke Lightning Protection System of Chimneys for purchaser's evaluation/scrutiny and approval.

6.3 The contractor shall furnish his design(s) and installation drawings for approval.

6.4 The contractor shall furnish the requisite number of prints & RTF's of all drawings as specified elsewhere in this specification.

6.5 The site modifications/deviations shall be marked on the latest revision of the drawings & submitted as 'As Built' drawings to the purchaser after completion of installation.

6.6 Tenderer shall submit all filled up schedules as per Volume-III.

6.7 The tenderer shall submit reports on Type tests & Special tests conducted on lightning protection materials & accessories.

7.0 COMPLETENESS

7.1 The offer for supply and erection shall be complete in all respects & shall include all materials, tools and appliances, whether specified or not, required for the completion of the job.

7.2 Supply/arrangements of all accessories and material etc. shall be the responsibility of the contractor.

SPECIFIC TECHNICAL REQUIREMENTS

MATERIALS & SIZES

The following are the minimum sizes of material to be used for lightning protection system:

S.No.	Material	Minimum Size
1.	COPPER RODS (Lead Coated)(for vertical air Terminations projecting 1000mm above the Chimney/ flues)	20mm dia
2.	GI STRIP (for annular horizontal band ring at the top of the Chimney/flues)	75x6mm
3.	GI STRIP (for downconductor)	50x6mm
4.	GI STRIP (for earthing band ring each platform)	50x6mm
5.	MS ROD (for risers)	40mm dia
6.	TEST LINK	compatible with size at Sl.No.3 & 5 above
7.	MS ROD (for annular ring buried 1 metre in the ground around the chimney)	40mm dia
8.	MS ROD (for electrodes) with Test Pits	40mm dia
9.	MS ROD (for connection between test pit and customer's earthmat)	40mm dia
10.	GI STRIP/WIRE (for connection between equipment and earthing band rings)	25x3mm/As required

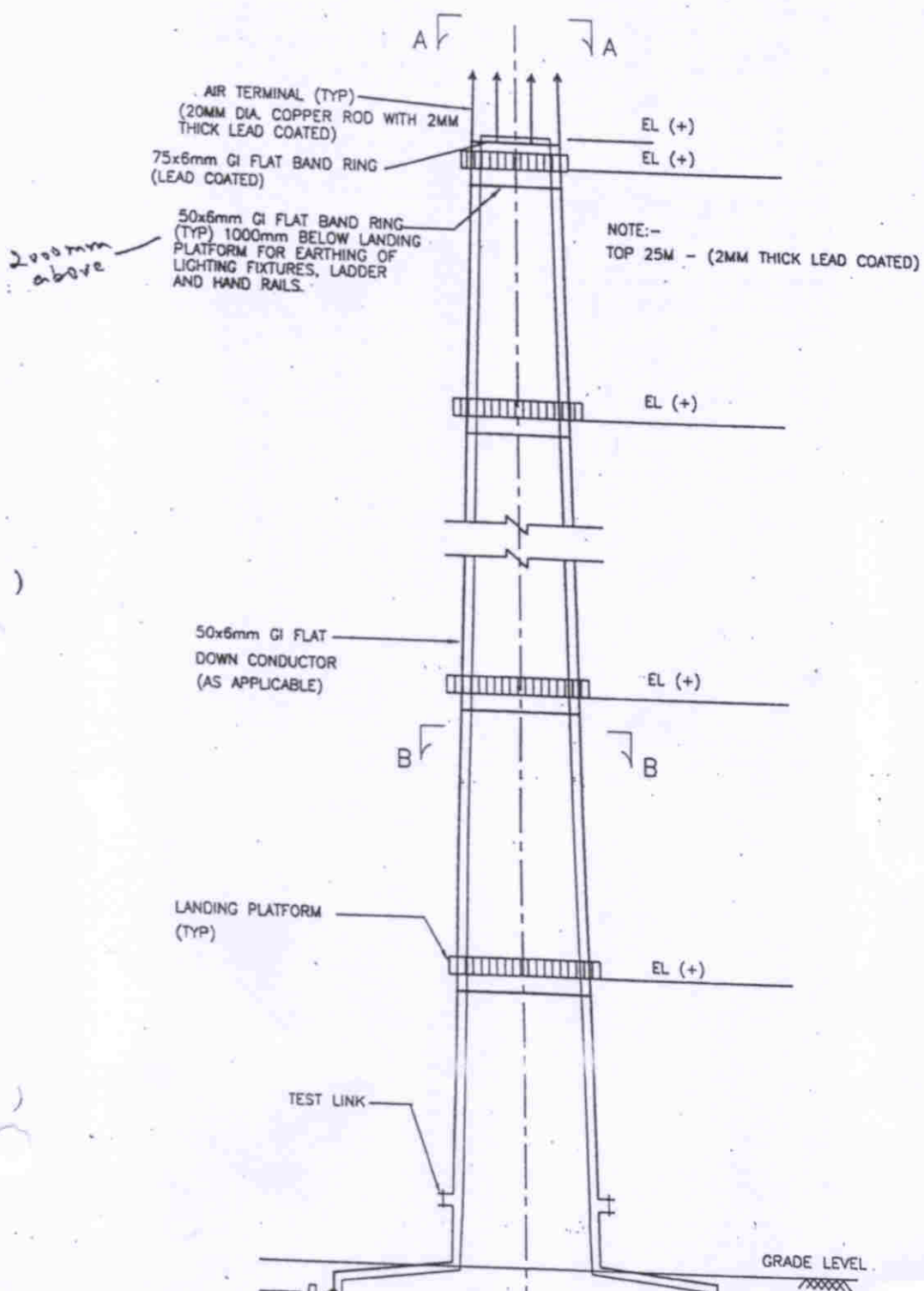
1.0 GUARANTEED TECHNICAL PARTICULARS:

The tenderer shall fill up and submit the following technical particulars:

1.01	Name of Manufacturer		:
1.02	Place and country of Manufacture		:
1.03	Standards applicable		:
	i/	For materials & sizes	:
	ii/	For galvanisation/Electroplated coating	:
	iii/	For testing uniformity of Galvanization	:
	iv/	For code of practice	:
	v/	For hexagonal bolts, nuts washers	:
	vi/	For welding	:
1.04	Thickness of galvanizing on steel		:
1.05	Thickness of Electriplated coatings		:
1.06	Thickness of Lend coating on copper		:
1.07	Materials and sizes offered		:
	i/	Below ground conductor	:
	ii/	Electrodes	:
	iii/	Risers	:
	iv/	Down Conductors	:
	v/	Air terminations (Vertical)	:
	vi/	Air termination (Horizontal)	:
	vii/	Test Pits	:
	viii/	Test Links	:

1.08 Whether all type test certificates furnished

1.09 Whether all schedules of Vol.III filled up and submitted.

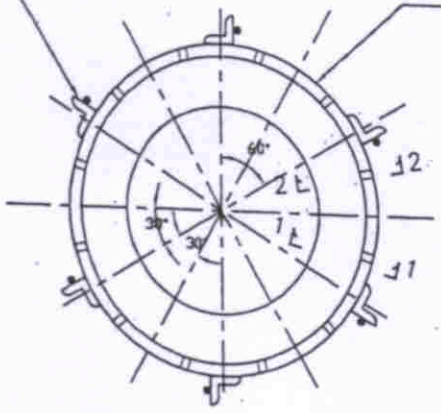


CHIMNEY (ELEVATION)

BHEL	[illegible]	LIGHTNING PROTN. OF CHIMN
	BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003
		SHEET 1 OF 4 REV. 00

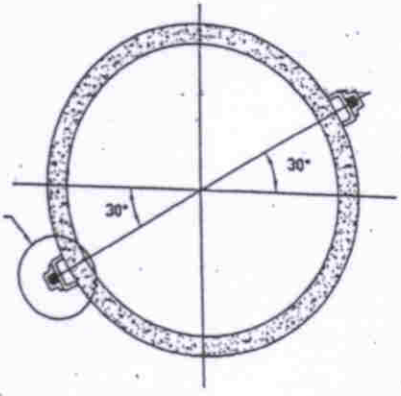
AIR TERMINAL (TYP)
(20MM DIA. COPPER
ROD WITH 2MM THICK
LEAD COATING)

75X6 G.I. FLAT BAND
RING-LEAD COATED
(HORIZONTAL AIR
TERMINATION)



SECTION A-A

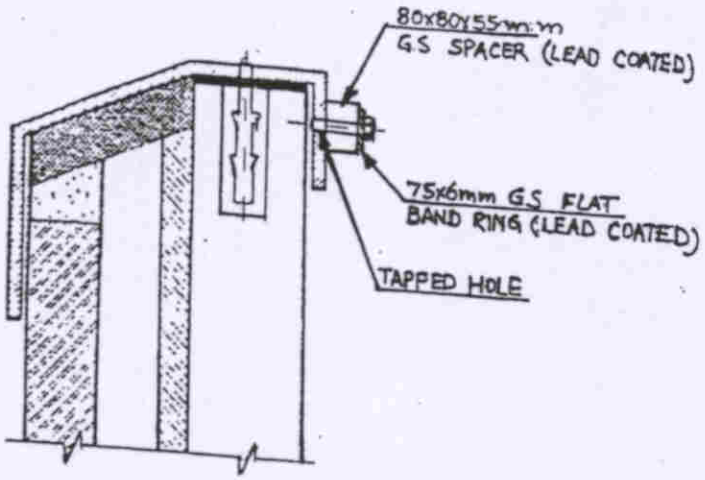
SEE DETAIL-'Y'



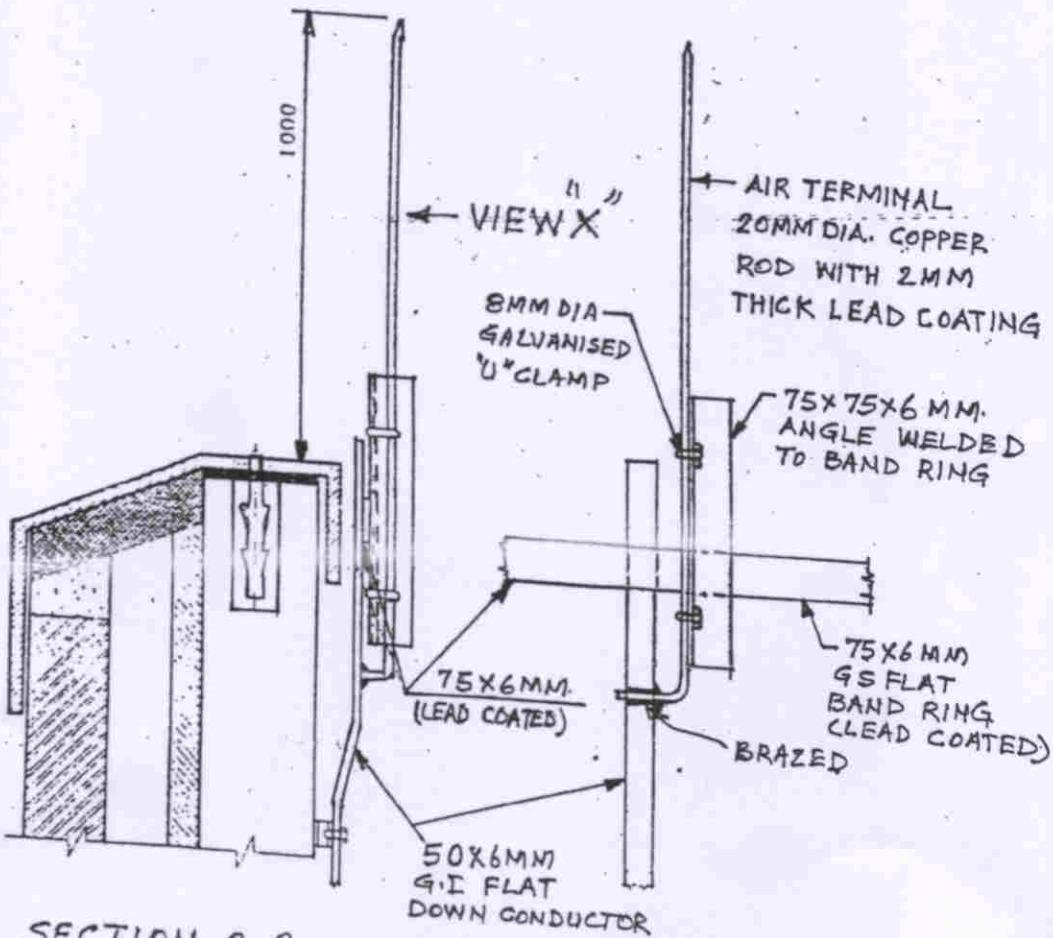
SECTION B-B

NOTE:-
TOP 25M OF CHIMNEY SHALL HAVE A LEAD COATING OF 2MM THICKNESS.

BHEL	[illegible]	
	BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003
		SHEET 2 OF 4 — REV. 00



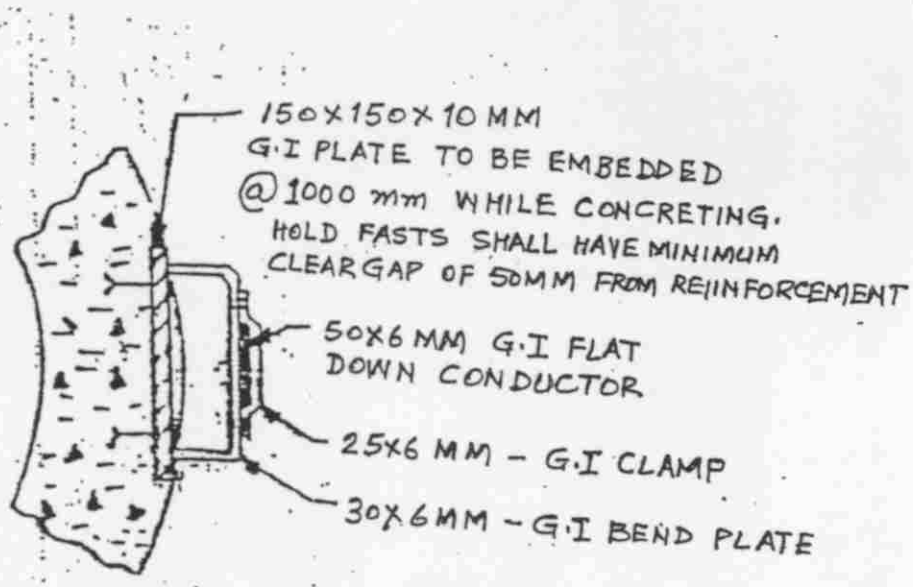
SECTION 1-1



SECTION 2-2

VIEW- "X"

BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003	
	SHEET 3 OF 4	REV. 00



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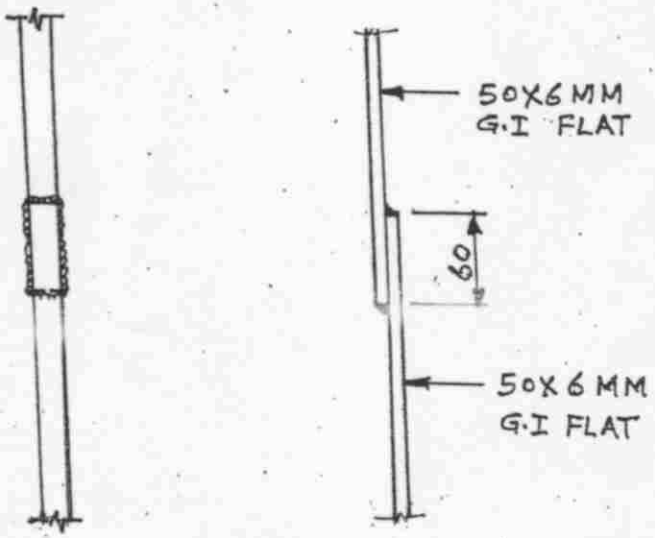


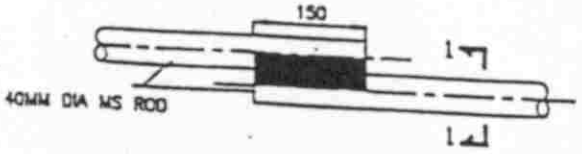
TYPICAL WELDED JOINT

BHEL		
BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003	
	SHEET 4 OF 4	REV. 00

BELOW GROUND EARTHING
TYPICAL DETAILS

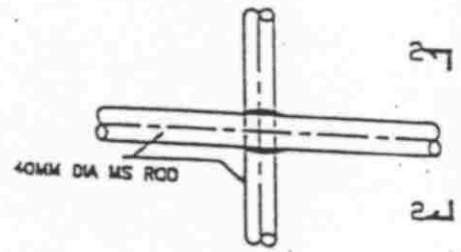
DRG. NO. PE-DG-~~XXX~~-509-0004

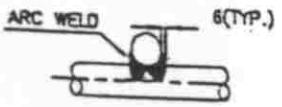
LAP JOINT



SECTION 1-1

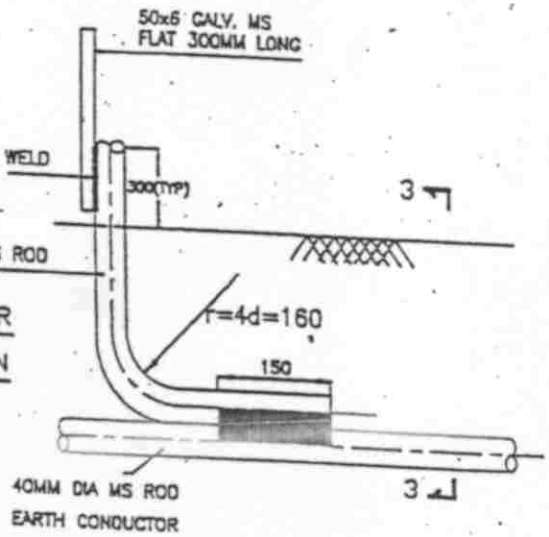
CROSS JOINT

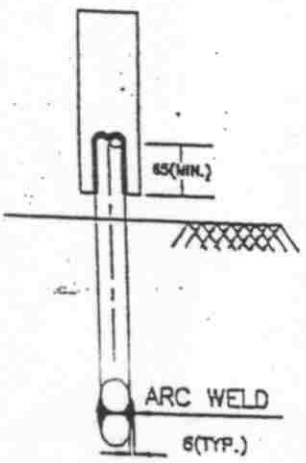




SECTION 2-2

LAP JOINT FOR RISER/COLUMN EARTHING





SECTION 3-3

WELDED JOINTS

NOTES :-

ALL DIMENSIONS ARE IN MM.

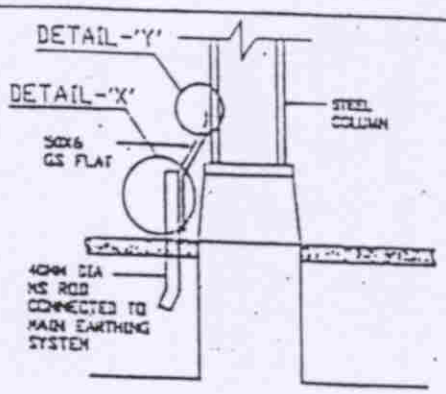
BHEL

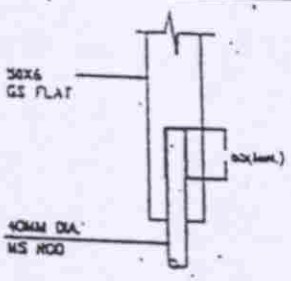
BELOW GROUND EARTHING TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-XXX-509-0004

SHEET 2 OF 8





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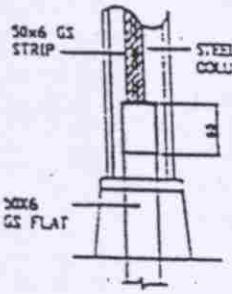
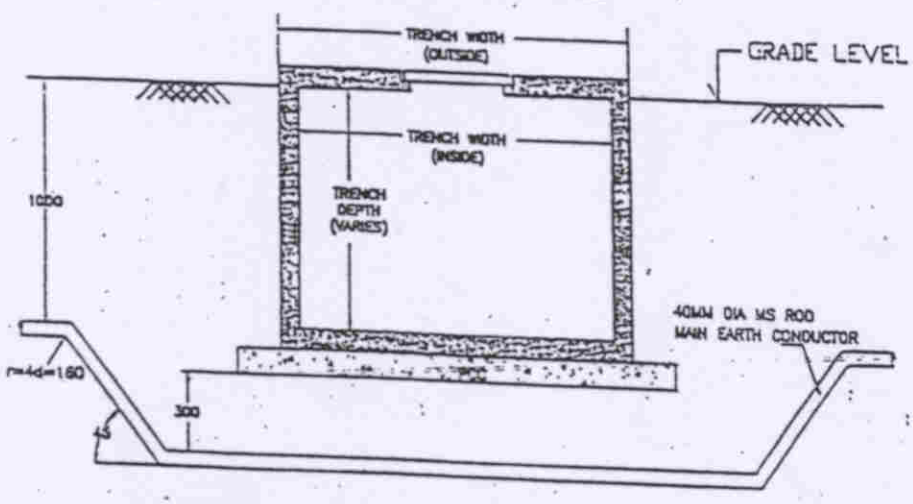
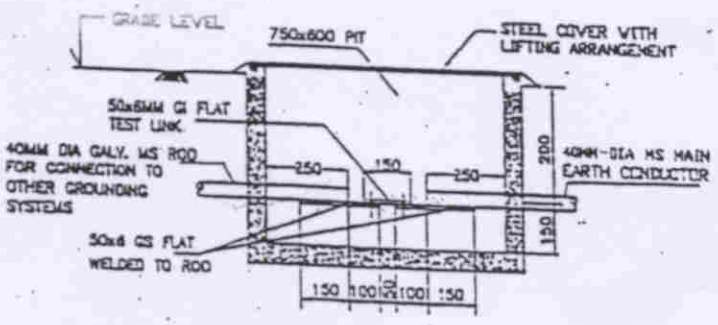


DETAIL-'Y'

COLUMN EARTHING



TRENCH CROSSING



Concrete cover

TEST-LINK

(PROVIDED FOR CONNECTION BETWEEN VARIOUS GROUNDING SYSTEMS)

NOTES :-

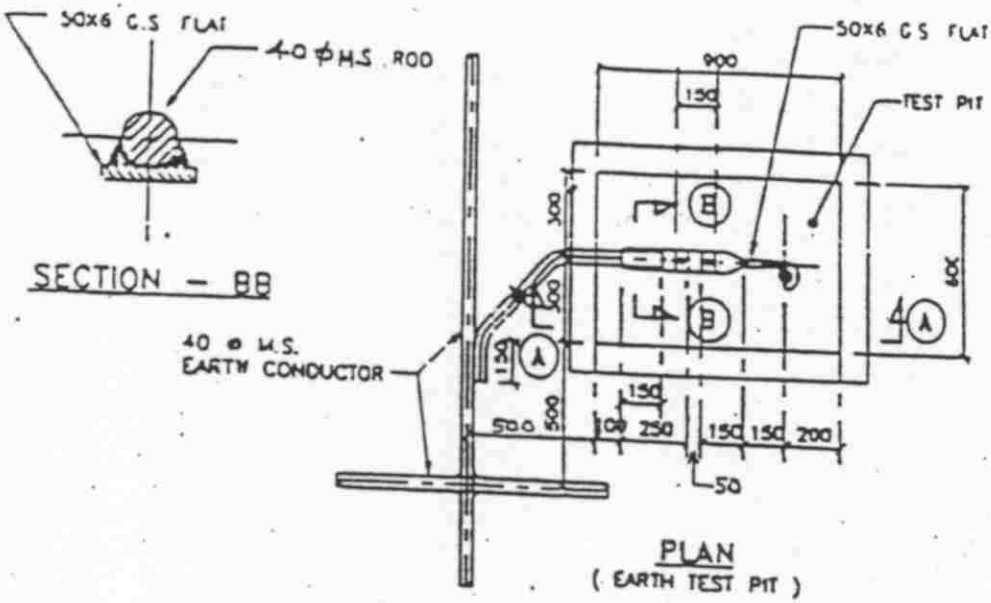
ALL DIMENSIONS ARE IN MM.

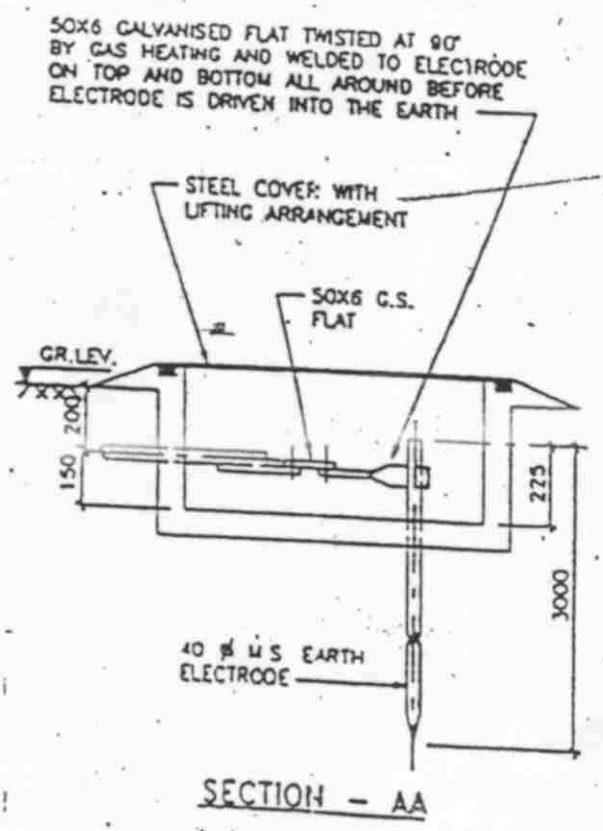
BHEL DRAWING No.

PE-DG-XXX-503-0004

BELOW GROUND EARTHING TYPICAL DETAILS

SHEET 3 OF 8



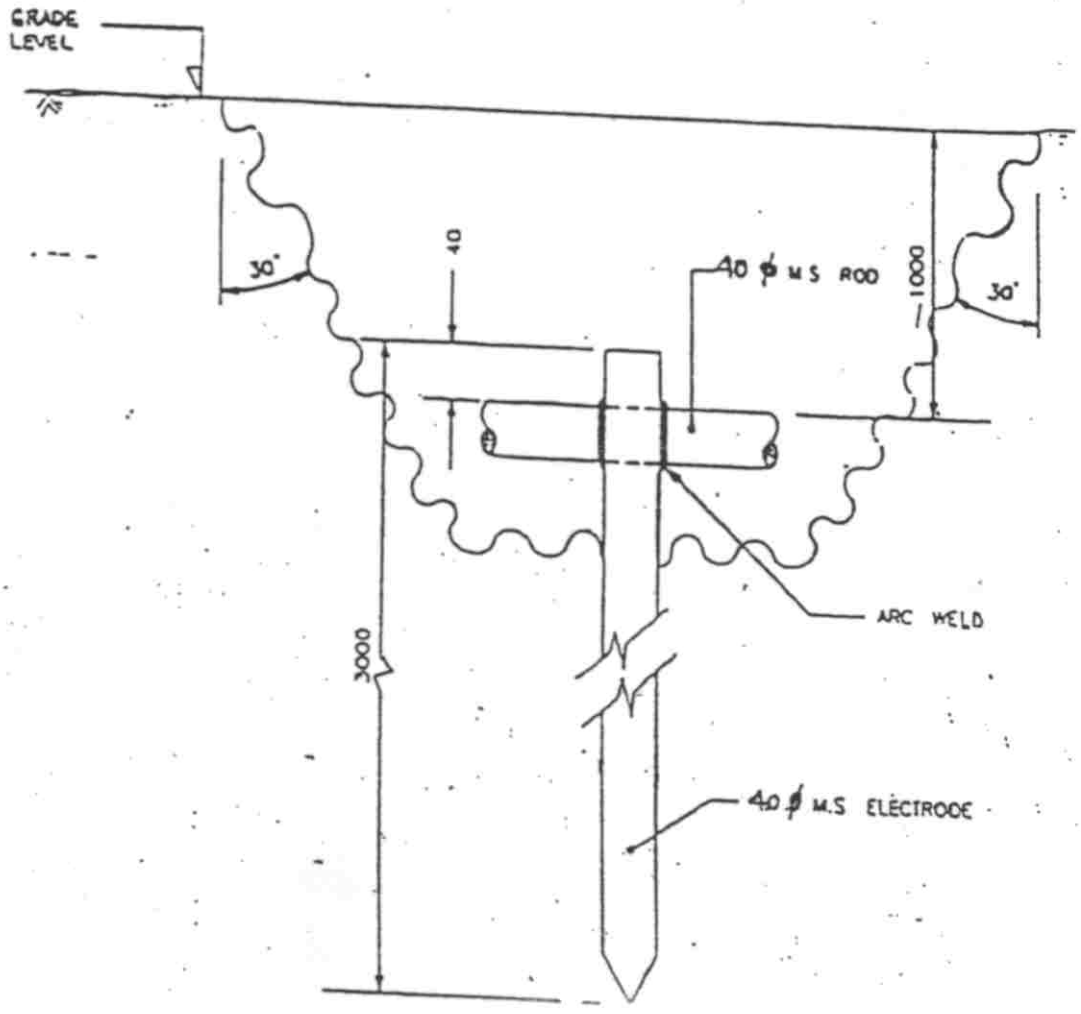


NOTE: ALL DIMENSIONS ARE IN MM.

75

SIPUS PM BHEL	BELOW GROUND EARTHING TYPICAL DETAILS	BHEL DRAWING No. PE-DG-XXX-509-0004
		SHEET 4 OF 8

124



GROUND ELECTRODE

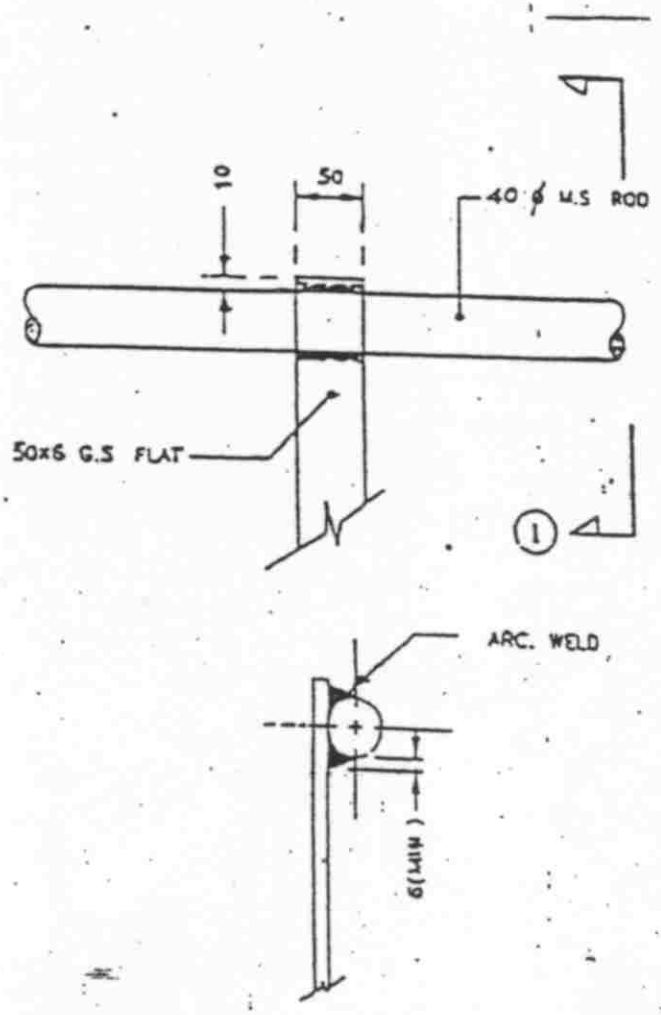
NOTE:-

1. ALL DIMENSIONS ARE IN MM.

BELOW GROUND EARTHING
TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-~~XXX~~509-0004



SECTION – (1)

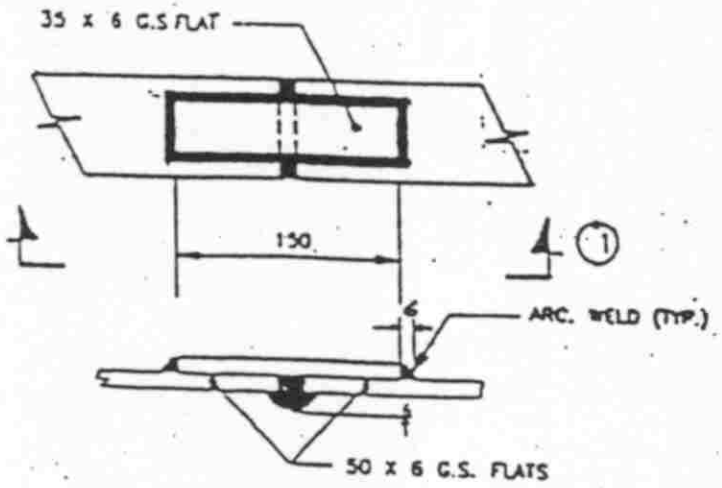
CROSS JOINT
BETWEEN M.S. ROD & G.S FLAT

NOTE:-
1. ALL DIMENSIONS ARE IN MM.

BHEL DRAWING No.

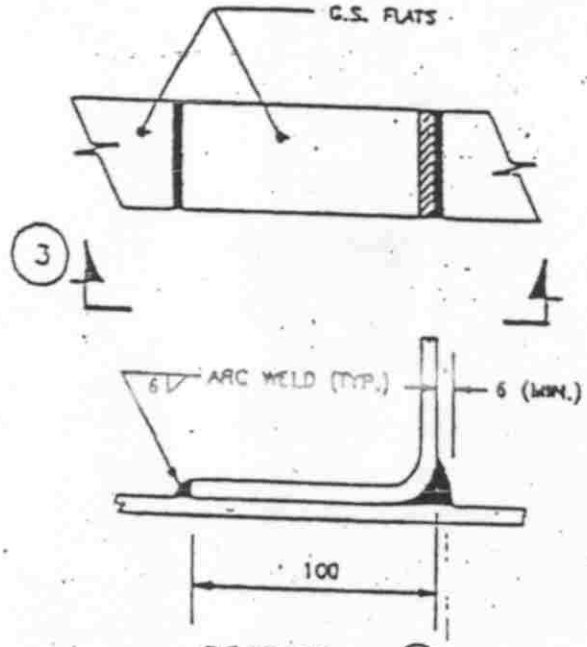
PE-DG-XXX509-0004

BELOW GROUND EARTHING TYPICAL DETAILS



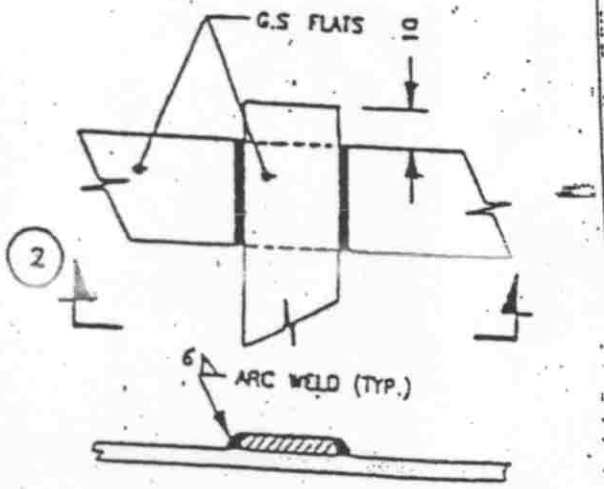
SECTION – (1)

LAP JOINT
BETWEEN G. S. FLATS



SECTION – (3)

ANGULAR JOINT
BETWEEN G. S. FLATS



SECTION – (2)

CROSS JOINT
BETWEEN G. S. FLATS

BELOW GROUND EARTHING
TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-~~XXX~~-509-0004

NOTES:-

1. WELDING OF GALVANISED FLAT/MS RODS SHALL BE CARRIED OUT AS FOLLOWS:
   a) CLEANING OF WELD AREA WITH WIRE BRUSH.
   b) REMOVAL OF GALVANISATION COATING IN THE WELD AREA.
   c) WELDING OF CONDUCTORS AS PER DETAILS SHOWN IN THIS DRAWING BY ELECTRIC ARC WELDING PROCESS USING LOW HYDROGEN CONTENT WELDING ELECTRODES.
   d) NATURAL COOLING OF WELDED JOINT.
2. EARTH CONDUCTOR SHALL BE ROUTED BELOW ROADS/ TRENCHES WITH MINIMUM CLEARANCE OF 300MM.
3. CIVIL DETAILS OF EARTH PITS/ TEST PITS ARE INDICATIVE. ACTUAL DETAILS SHALL BE SHOWN IN CIVIL DRAWINGS.
4. MINIMUM DEPTH OF BURIAL OF EARTH CONDUCTOR SHALL BE 1000 MM.

NOTES :-

ALL DIMENSIONS ARE IN MM.

भारत हेवी इलेक्ट्रिकल्स लिमिटेड / BHEL	BELOW GROUND EARTHING TYPICAL DETAILS	BHEL DRAWING No. PE-DG-XXX-509-0004
		SHEET 8 OF 8

GENERAL TECHNICAL REQUIREMENTS

OF

CHIMNEY LIGHTING

SPECIFICATION NO. PES-558-03 REV-01

1.0 **GENERAL**

1.1 This specification covers the following :

- Engineering of lighting system including the associated power distribution system for chimney.
- Design, manufacture, supply, storage at site, testing of all necessary equipment such as lighting luminaries, lamps, wires, conduits, wiring accessories and any other equipment and material as would be found necessary for the satisfactory execution/ completion of the job.
- Erection, testing and commissioning of the lighting system for chimney.
- Temporary warning lights shall be provided during the course of work for heights above 45m free of cost.

2.0 **CODES & STANDARDS**

2.1 Unless otherwise specified, the following codes & standards are applicable. In all cases latest revision of codes shall be referred to.

Indian Standards	Title
IS 418	Tungsten flament general service electric lamps.
IS 732	Code of practice for electric wiring installation (system voltage not exceeding 650 V)
IS 5133 (Part-I)	Boxes for enclosure of electrical accessories steel & cast iron boxes.
IS 9537	Hot dip galvanised conduit.
IS 1913	General Safety requirements for electric lighting fitting.
IS 1947	Specification for flood lights.
IS 9900	High pressure mercury Vapour Lamp.
IS 3043	Code of practice for earthing.
IS 9974	High pressure sodium vapour Lamps.

IS 3528 Water proof electric lighting fitting.

IS 694 PVC insulated cables for working voltages up to & including 1100 V.

Indian Electricity Rules -1956.
International Civil Aviation Code.

3.0 DESIGN REQUIREMENTS

3.1 Lighting luminaries

3.1.1 Twin obstruction luminaire for aviation lighting shall be used having aluminium alloy casting body with separate galleries to take two specially designed red prismatic glass domes to give a symmetrical light distribution with maximum intensity 10 degrees above horizontal. Two porcelain Bayonet caplamp holders for 100 watt incandescent lamps shall be provided. Approved weather proof paint shall be provided.

3.1.2 Alternatively Neon lamp type Luminaire shall also be quoted.

3.1.3 The obstruction lights shall be fixed lights, red in colour, having an intensity sufficient to ensure conspiquity considering the intensity of adjacent lights and general level of illumination against which they would normally be viewed. In no case, the intensity shall be less than 10 candles of red lights.

3.1.4 Flood light shall be outdoor type consisting of light weight die cast aluminium alloy housing, heat resistant and toughened glass cover with synthetic rubber gasket, reflector and mounting bracket. The luminaries shall be suitable for 1x250 W High pressure Mercury Vapour lamp (HPMV) with suitable lamp holder, ballast, power factor improvement capacitor, mounting box for accessories and connector block & fuses duly pra-wired.

3.1.5 Alternatively flood lights with 150 W High Pressure sodium vapaur lamp (HPSV) HPSV lamp shall be provided with external igniters and rapid restart facility.

3.2 Arrangement of lights

3.2.1 The number and arrangement of lights at each platform to be provided shall be such that the obstruction is indicated from every angle in azimuth. Number of obstruction luminaire at each platform shall not be less than four.

3.2.2 The lights shall be placed between 1.5 metres and 3 metres below the top of chimney.

3.2.3 When the top of the chimney is more than 45metres above the level of the surrounding ground, intermiate lights shall be provided for each additional 45metres or fraction thereof.

3.2.4 Four (4) Nos. flood lights shall be provided at the lowest platform of chimney for illuminating the surrounding of chimney.

3.3 **Power Distribution Scheme**

3.3.1 Lighting system load shall be supplied from A.C. Emergency lighting board. From the outgoing of A.C. ELDB, PVC armoured cable of suitable size shall emanate for feeding supply to lighting panel for chimney.

3.3.2 The contractor shall install lighting panel to be supplied by the purchaser.

3.3.4 A.C. ELDB shall be supplied & erected by the purchaser. Inter-connecting power cable between A.C. ELDB and lighting panel shall be supplied and installed by the purchaser. However, necessary provision shall be made by the chimney vendor in his civil works near the chimney for installation of above cable.

3.4 **Method of wiring**

3.4.1 From A.C. ELDB to lighting panel for chimney 650/1100 V grade, PVC insulated, PVC sheathed, armoured cable of aluminium conductor shall be installed. From lighting panel further distribution to lighting luminaries shall be done with 650 V/1100V grade, Single core ,stranded copper conductor, PVC insulated, unsheathed wires of minimum 4mm sq in conduits fixed on the chimney wall.

3.4.2 Each circuit from lighting panel shall be taken in a separate conduit.

3.4.3 The minimum acceptable copper conductor size for connecting lighting fixtures shall be 4 sq.mm. or more depending upon the voltage drop consideration.

3.4.4 Minimum conductor size shall be such that the voltage drop to the farthest lighting point shall not exceed 2.5% of 240 V.

3.4.5 The aviation obstruction lights/flood lights shall be balanced on all the three phases to the extent possible.

3.5. **Conduits**

3.5.1 Conduits (Heavy gauge) & junction boxes, shall be hot dip galvanised type as per relevant IS. No conduit less than 20mm diameter shall be used. Junction boxes/pull boxes shall be made from 1.6mm thick galvanised sheet steel and shall incorporate terminal block for termination of incoming and outgoing cables. Junction boxes to be used outdoor shall be weather proof type with gasket conforming to degree of protection IP 55.

3.5.2 Conduit accessories/ fittings shall be as per relevant IS.

3.6 **Earthing**

A separate G.I. wire of 14 SWG shall be used for earthing the lighting fittings, lighting panels as per IE Rules & IS 3403. The contractor shall connect this earthing system to main earthing mat provided by the purchaser . Main earthing mat shall be located near the chimney.

3.7 For other general reqts. of Lighting design, refer to (w enclosed "Lighting Notes & Details" (Dg No. PE-DG-XXX-558-0004).

4.0 **TESTING & INSPECTION**

4.1 Standard quality plan (QP) for lighting system is enclosed in VOL III. Bidder to confirm compliance to this quality plan by signing every page of it.

4.2 All equipment shall comply with the type and routine tests as prescribed in the relevant standards. Certificates of type tests shall be furnished with the tender. The vendor shall furnish certified test reports for all routine tests before the equipment is dispatched.

4.3 Test at Site: The vendor, in the presence of the customer shall subject the installation to the following tests.

a) Insulation resistance test.

b) Testing of earth continuity path connections.

c) Complete operational tests on the whole of the installation.

4.4 Field quality plan (FQP) for quality checks to be observed at site during erection, testing & commissioning shall also be furnished by vendor alongwith offer as per standard BHEL format.

5.0 SPARE PARTS

Recommended list of spares for commissioning and for operation and maintenance of the lighting system for a period specified in data sheet -A shall be furnished. The vendor shall furnish separate price and list of the same. Unit rates shall also be furnished in addition to total price.

6.0 GUARANTEED PERFORMANCE REQUIREMENTS

The vendor shall guarantee satisfactory performance of equipment supplied under all conditions & requirement as laid down by this specification.

7.0 DRAWINGS & DATA

7.1 Drawings & data to be furnished with the offer

a) Filled in Data Sheet B.

b) Technical leaflets of luminaires offered.

7.2 Drawings & data to be furnished after award of contract

a) Design calculation for luminaries.

b) Design calculation for selection of lighting wires.

c) Lighting Layout plan showing lighting fixtures, conduit routing, conduit Size, cable size etc.

d) Fixing and mounting details of luminaires, conduits, junction boxes etc.

e) Test certificates for all equipment .

f) General arrangement drawing of equipment supplied.

g) Manufacturer catalogues/literature.

h) Field quality plan

i) As built drawings

8.0 OPERATION AND MAINTENANCE MANUAL

Operation and maintenance manual shall contain the followings :

a) Technical Data Sheet.

b) Instruction for maintenance for various lighting equipment.

FORM No. PEM - 0000-0

	TITLE	SPECIFICATION NO. PE
BHEL	DATA SHEET A CHIMNEY LIGHTING	VOLUME II B SECTION A REV. NO. 0 DATE SHEET 1 OF 1

1.0	**Details of Supply System**		
	a) Rated voltage	:	415 V ± 10%.
	b) Rated frequency	:	50 Hz ± 5%
	c) Combined voltage and frequency variation	:	10% (Absolute)
	d) System fault level at rated voltage	:	50 kA for 0.25 sec.
	e) LV System grounding	:	Solidly
	f) Design ambient temp.	:	50°C
2.0	Type of conduit mounting	:	Surface Mounting
3.0	Type of obstruction light	:	i) GEC ZA 750(L) NEON ii) High intensity flashing white light having intensity > 200 candles & flashing freq. 40-60/min.
4.0	Type of Flood light	:	→ 250 W HPSV lamps
5.0	Source for power	:	Normal AC & Emergency AC
6.0	Junction boxes	:	Weather-proof, Galvanised steel
7.0	Main earthing mat details	:	MS Rod 40 mm dia
8.0	No. of years for which O&M spares required	:	3 years

	TITLE	SPECIFICATION NO.
BHEL	DATA SHEET - B CHIMNEY LIGHTING	VOLUME III
		SHEET 1 OF 2

FORM No. PEM - 6019 B-0

INSTRUCTIONS FOR BHEL

1. In the ... 'SPECIFICATION NO.' the specification number for th... ject shall be entered by DE b... e issue for an enquiry. The standard specification number sha... not be entered.

1.0 **CONDUIT**

a) Make :

b) Size :

c) Material :

d) Applicable Standard :

2.0 Applicable Standard for Conduit accessories and fittings :

3.0 **JUNCTION BOX**
(for each type & size)

a) Make :

b) Type :

c) Material :

d) Degree of protection of enclosure :

e) Applicable Standard

4.0 **LIGHTING WIRES**

a) Make :

b) Type :

c) Conductor material :

d) Size :

e) Voltage grade :

f) Applicable Standard :

Name of Bidder / Vendor				Project
Revision Number	0	1	2	3
Signature of Bidder / Vendor / Authorised Representative				
Date				

	TITLE	DATA SHEET - B CHIMNEY LIGHTING	SPECIFICATION NO. VOLUME III SHEET 2 OF 2

5.0 **LUMINARIES**

a) Make :

b) Type :

c) Type of lamp holder :

d) Applicable Standard :

6.0 **LAMPS**

a) Make :

b) Type :

c) Wattage :

d) Nominal lamp voltage :

e) Light output :

f) Applicable Standard :

Name of Bidder / Vendor				Project	
Revision Number	0	1	2	3	
Signature of Bidder / Vendor / Authorised Representative					BIDDER'S SEAL
Date					

FORM No. PEM - 6019 B-0

1. In the "SPECIFICATION NO." the specification number for the DE being issue for an enquiry. The standard specification number shall not be entered.

FOR BHEL

1.0 **CONDUIT**
(for each type & size)

a) Make :

b) Type :

c) Size :

d) Applicable Standard :

2.0 **JUNCTION BOX**
(for each type & size)

a) Make :

b) Material :

c) Size :

d) Degree of protection of enclosure :

e) Applicable Standard :

3.0 **LIGHTING WIRES**

a) Make :

b) Type :

c) Voltage grade :

d) Applicable Standard :

e) Continuous current rating at design ambient :

f) Conductor

i. Material :

Form No. PEM - 6018B-0

ii. Nominal cross sectional area :

iii. No. & Diameter: of wires

g) **Insulation**

i. Composition of insulation :

ii. Thickness of insulation :

iii. Tolerance on thickness of insulation :

h) Colour scheme for identification of wires :

4.0 **LUMINARIES**
(for each type)

a) Make :

b) Type :

c) Type of lamp holder :

d) Capacitor rating :

e) Weight of luminaires :

f) Applicable Standards :

5.0 **LAMPS**

a) Make :

b) Type :

c) Wattage :

INSTRUCTIONS FOR BHEL ... "SPECIFICATION NO." the specification number for ... issue for an enquiry. The standard specification number ... ject shall be entered by ... ll not be entered.

Form No. PEM - 60188-0

d) Nominal lamp voltage :

e) Light output (lumen) :

f) Life of lamp :

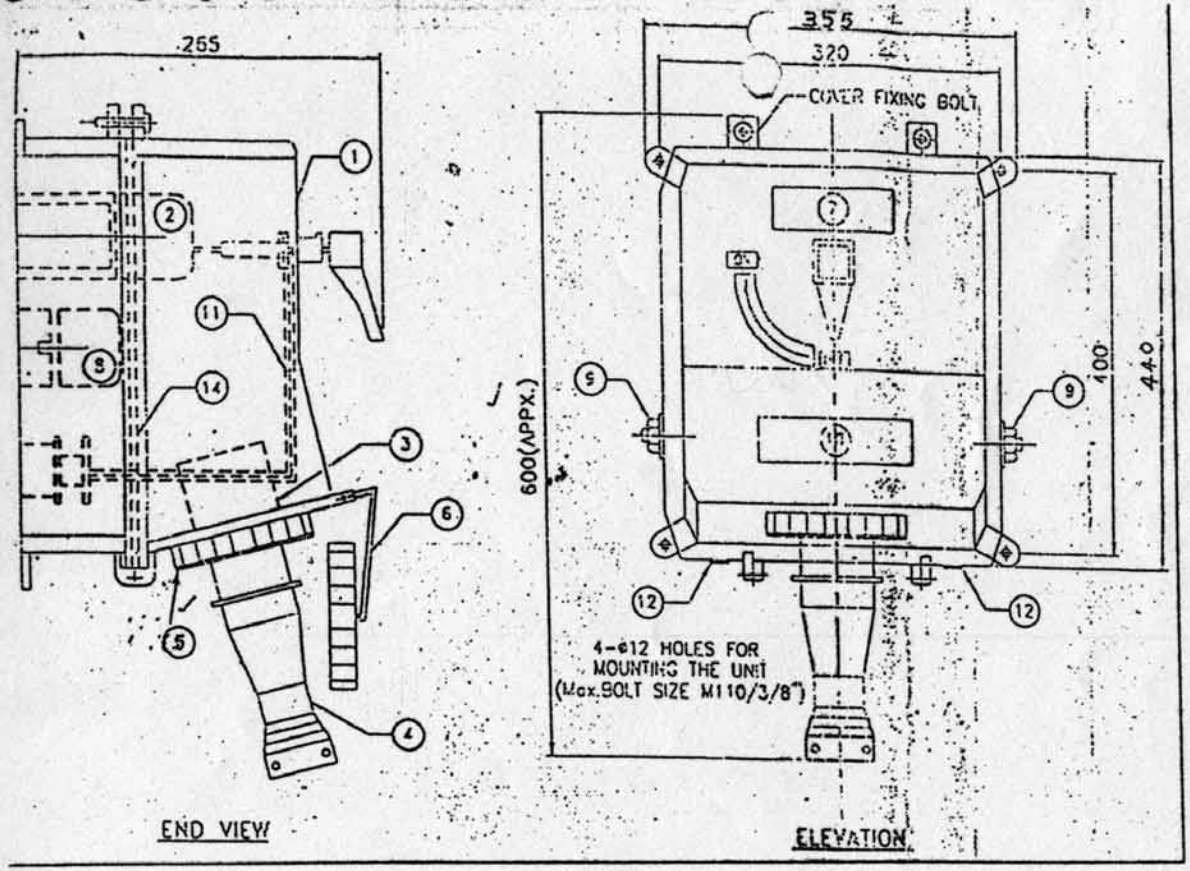
g) Applicable Standard :

...ct shall be entered by
...e entered.

...olumn 'SPECIFICATION NO.' the specification number for
...ssue for an enquiry. The standard specification number

INSTRUCTIONS FOR BHEL

Name of Bidder / Vendor				Project
Revision Number	0	1	2	3
Signature of Bidder / Vendor / Authorised Representative				

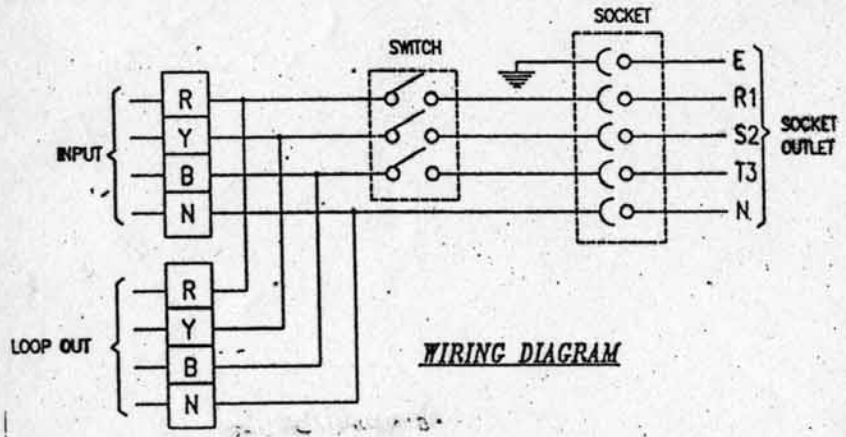


SPECIFICATION

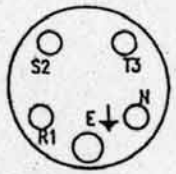
1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
5] PLUG RING
6] SPRING LOADED COVER FOR SOCKET OUTLET
7] NAME PLATE
8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRAGEMENT TO TERMINATE 3.5Cx50 sq.mm STUD TYPE BEST & CROMPTON MAKE
9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT,NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
10] CAUTION STACKER
11] MECHANICAL INTERLOCKING ARRANGEMENT
12] DETACHABLE GLAND PLATE O TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mM. CABLES.

NOTES

1] ALL DIMENSION ARE IM MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 2.5 sq.mm. CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
7] SUITABLE CABLE GRIP SHALL BE PROVIDED



WIRING DIAGRAM



SHOWING TERMINAL POSITION

COLOUR CODED SLEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEXIBLE
R PHASE – RED COLOUR
Y PHASE – YELLOW COLOUR
B PHASE – BLUE COLOUR
NEATRAL – BLACK COLOUR

1230-001-29PE-PVE-B-073

CHIMNEY LIGHTING SPECIFICATION

REV	DATE	DESCRIPTION
01		
02		

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT
NEW DELHI

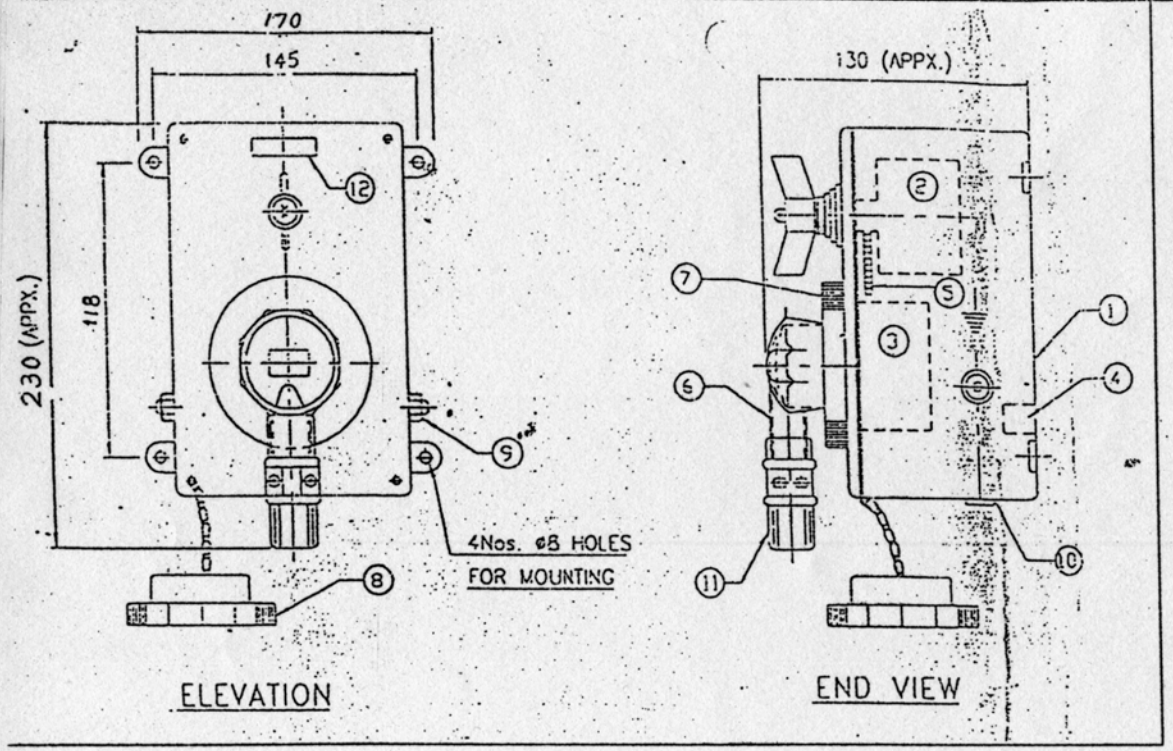
bajaj electricals limited MUMBAI
Engineering & Projects Division.

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

TITLE GENERAL ARRANGEMENT DWG FOR 63 A FULLY INTERLOCKED SWITCHED PLUG 63 AMPS 415 VOLTS [TYPE RC]

DWG. NO. EPBU-03-PS005-04-073 REV 0

SHT. 1 OF 1



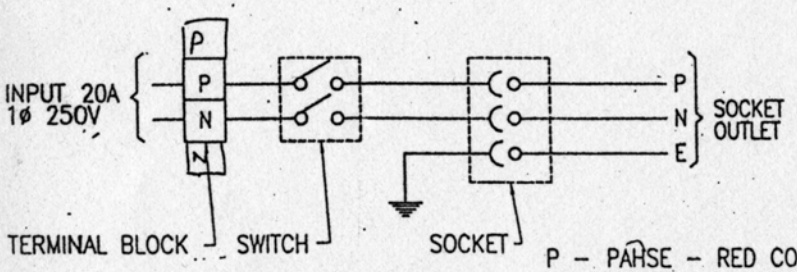
SPECIFICATION

1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 – RECOM MAKE
3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
4] BAKELITE STUD TYPE 2 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
5] MECHANICAL INTERLOCKING SYSTEM
6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
7] THREADED PLUG LOCKING RING
8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
9] EARTHING TERMINAL 2 Nos. – M6 SIZE
10] CABLE ENTRY 25mm DIA – 2Nos.
11] PVC CABLE GRIP
12] NAME PLATE

NOTES

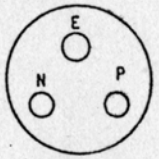
1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWDER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
6] 2 Nos. CABLE ENTRY AT BOTTOM

CHIMNEY LIGHTING SPECIFICATION.



WIRING DIAGRAM
(FOR SINGLE PHASE UNIT)

P – PHASE – RED COLOUR
N – NEUTRAL – BLACK COLOUR
E – GREEN COLOUR.



VIEW ON SOCKET
PLUG REMOVED

REV	DATE	DESCRIPTION
01		
02		

1230-001-29PE-PVC-B-070

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT

bajaj electricals limited MUMBAI
Engineering & Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	IS	AP	30.05.03	PE-V0-200-558-E070

TITLE GENERAL ARRANGEMENT DWG FOR FULLY INTERLOCKED SWITCHED PLUG 20 AMPS, 250 VOLTS [TYPE RA]

DWG. NO. EPBU-03-PS005-04-070 REV 0

SHT. 1 OF 1

LIGHTING NOTES AND DETAILS

SPECIFICATION NO. PES-558-0004

1. These lighting notes and details shall be read and construed in conjunction with the Illumination Layout and drawings.

2. Except specifically approved by site office, installation of exposed conduits, mounting of lighting fixtures etc. shall be taken up only after all other services such as Piping, Air Ducting, Cable Tray/Busduct Hanger, Structural Bracings etc. in a particular area have been installed.

3. The Contractor shall develop final conduit/cable routing based on fixture location and other site conditions.

4. Unless otherwise shown, the mounting heights of lighting fixtures and accessories shall be generally as follows :

a)	i) Low-Bay Lighting Fixtures in general indoor Areas of Industrial plants.		3500 mm from bottom to finished floor
	ii) Medium Bay Type Fixtures.	:	3500 to less than 8000 mm from bottom to finished floor
	iii) High Bay Type Fixtures	:	8000 mm and above from Bottom to finished floor
b)	Bracket lights over door Openings	:	300 mm bottom of Fixture Above top of opening
c)	In Boiler Platforms	:	Pendant below Boiler Platforms or with Brackets from Hand-Rail 3000mm above platform.
d)	Receptacles -		
	i) In control room/office	:	450 mm from finished floor to centre
	ii) Elsewhere	:	900 mm from finished floor to centre
e)	Local Switches	:	1500 mm from finished floor to centre
f)	Lighting Panels	:	1800 mm from finished floor to top

5. Unless otherwise noted,all lighting fixtures shall be fed from respective lighting panels. Normal AC lighting panels will be fed from Main lighting distribution boards (MLDB). Emergency AC lighting panels will be fed from Emergency Main lighting distribution boards (ELDB). DC Emrgency lighting distribution boards (DCELDB) will be fed from MLDB and Main DC distribution boards.

6. All outdoor lighting fixtures, unless it is fed from time switch controlled lighting panel shall be provided with outdoor type local switches.

7. Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in the from of switch or fuse.

8. All exposed conduit runs in battery room, chemical feed station area, water treatment building etc. shall be suitably painted with acid/alkaly proof paints.

9. The entire metallic conduit system whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

10. Lighting fixtures shall not be suspended directly from junction box in the main conduit run.

11. Separate conduits shall be used for wiring lighting circuits of different lighting distribution system such as normal AC lighting/emergency AC lighting/emergency DC lighting/low voltage lighting.

12. A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers and different batteries (D.C. Source) shall not be run through same conduit and junction boxes.

13. Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

14. Wires/cable shall be spliced only at junction boxes with ring-tongue lugs or approved equal.

15. For cable/wire numbering, PVC sleeve with cable/wire Tag number of different colour code shall be used.

16. For roads/outdoor areas, main runs from street/area lighting panels shall be by means of AYWY cables, directly buried in ground with proper protection as per details shown or through duct bank.

17. When buried cables cross road/railway track, additional protection to be provided in from of hume/G.I. Pipe.

18. Flame proof installations shall be carried out with Flame proof conduits, flame proof accessories and junction boxes.

19. Unless otherwise noted, the minimum size of cables, wires, conduits, junction boxes shall be as below :

A) CABLES

i) From main lighting distribution Boards to 400 V normal AC lighting panels : 1x3-1/2C, 95 Sq.mm AL PVC

ii) From emergency lighting Dist. Boards (EMLDB) to 400 V emergency AC lighting Panels : 1x3-1/2C, 95 Sq.mm AL PVC

iii) From main lighting Dist. Boards (MLDB) TO 400V AC/ 220V DC emergency Lighting distribution board (DCELDB) : 1x3-1/2C, 95 Sq.mm AL PVC

iv) From 220V main DC dist. Boards to 400V AC/220V DC emergency lighting distribution board (DCELDB) : 2 x 4C, 35 Sq.mm Al. PVC

v) From PMCC/MCC/DB to 100A, 3 Phase Receptacles : 1 x 3-1/2C, 95 Sq.mm.AL PVC

vi) From 400 normal AC street/ Area lighting panels to street lighting pole Junction Box : 1x4C, 35 Sq.mm Al.PVC

vii) From PMCC/MCC/DB to 63A, 3 Phase Receptacles : 1 x 4C, 35 Sq.mm Al PVC

B. WIRES

Wires shall be PVC insulated, 650V grade and of following sizes :

i) From lighting panels to Junction Boxes : 1C, 10 Sq.mm AL (Stranded)

ii) From Junction Boxes to Lighting Fixtures : 1C, 2.5 Sq.mm Cu.

iii) From Junction Boxes to Flood light Fixtures : 2 x 2.5 Sq.mm, 1C, Cu

iv) From lighting Panels to 230V AC 5/15A, 1 Phase Receptacles & 24V AC.supply Modules type M4 : 1C, 10 Sq.mm AL.(Stranded)

v) From 24V A.C. supply Modules to 230 V A.C. 5A Receptacles : 1c, 10 Sq.mm AL.(Stranded)

C. CONDUITS

All conduits shall be of galvanised steel of following minimum sizes :

CABLE SIZE		CONDUIT. SIZE					
		20MM	25MM	32MM	40MM	50MM	
i)	10 Sq.mm AL	.	2	5	7	8	) Maximum No.of Conductors Admissible for Conduit
ii)	2.5 Sq.mm CU	3	5	9	.	.	)

0. JUNCTION BOXES

	CONDUIT SIZE (MM)	JUNCTION BOX SIZE (MM) 4-WAY	3-WAY	STRAIGHT THROUGH	90°
i)	20 / 25	150x150x100	150x100x100	88 Ø	88 Ø
ii)	32 / 40	254x200x127	254x200x127	150x150x100	
iii)	50	254x200x127	254x200x127	254x200x127	

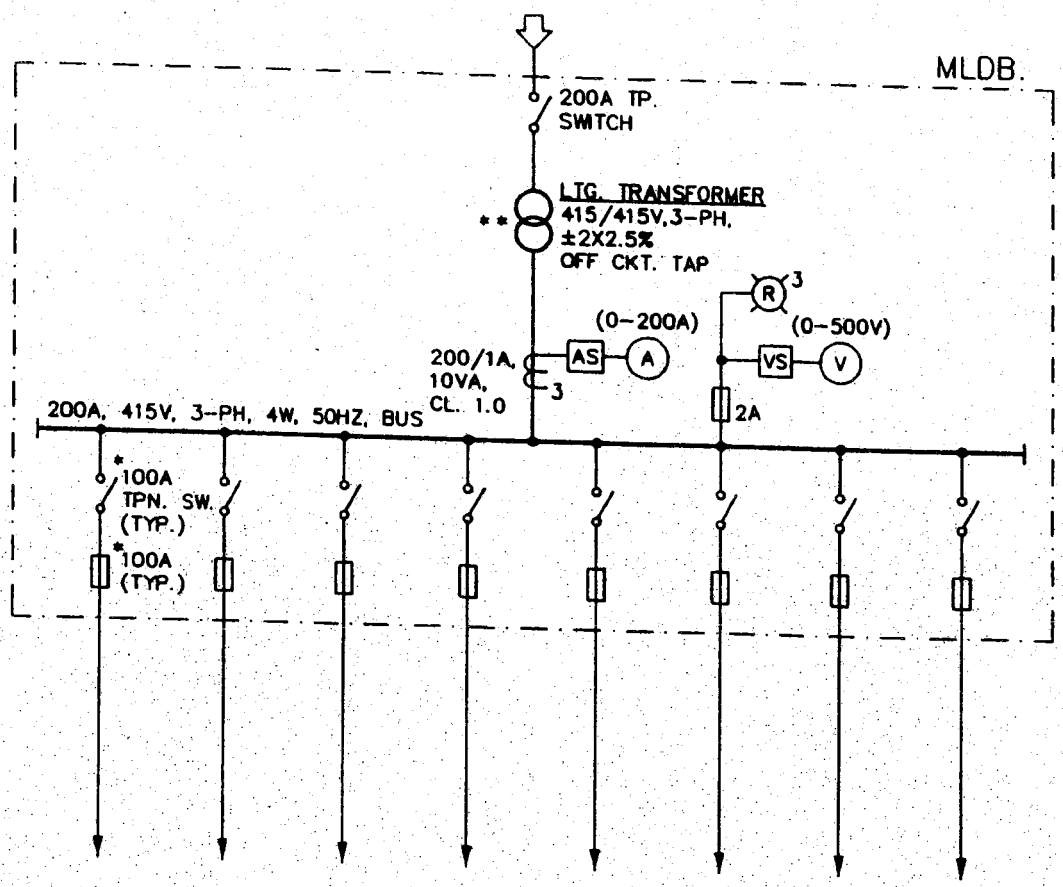
20. All lighting panels/distribution boards, junction boxes, receptacles, Fixtures, Conduits, etc. shall be grounded in compliance with the provision of I.E. rule and as detailed below :

i)	Lighting Panels	:	35 x 6 MM G.S. Flat
ii)	Distribution Boards	:	50 x 6 MM G.S. Flat
iii)	Power Receptacles, Junction Boxes etc.	:	12 SWG G.I. Wire
iv)	Lighting fixtures, switches, conduits etc.	:	16 SWG, G.I. wire.
v)	Street Light Poles and Towers for Floodlighting	:	25 x 3 MM G.S. Flat

21. A continuous ground conductor of 16 SWG G.I. wire shall run along each conduit run and bonded to it every 600 MM.

22. The electrical installation work shall met the requirements of Indian Electricity Rules, relevant IS codes of practice and safety codes, all as ammended upto date. In addition, other rules or regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

23. Typical details of lighting fixtures, other lighting system components and their mounting arrangement as shown herein are for general guidance only, The type no. of some make has been refered in the various drawings. Only to indicate desired appearance, construction features and performance of the fixture.The contractor has to design the same fulfilling the requirement of the specification.



SLD : MAIN LIGHTING DISTRIBUTION BOARD

NOTE :-

* ALL OUTGOING SW/FUSE RATINGS SHALL BE SAME

** TRANSFORMER RATING AND %Z SHALL BE SO SELECTED THAT THE FAULT LEVEL SHALL BE WITHIN AVAILABLE MCB.

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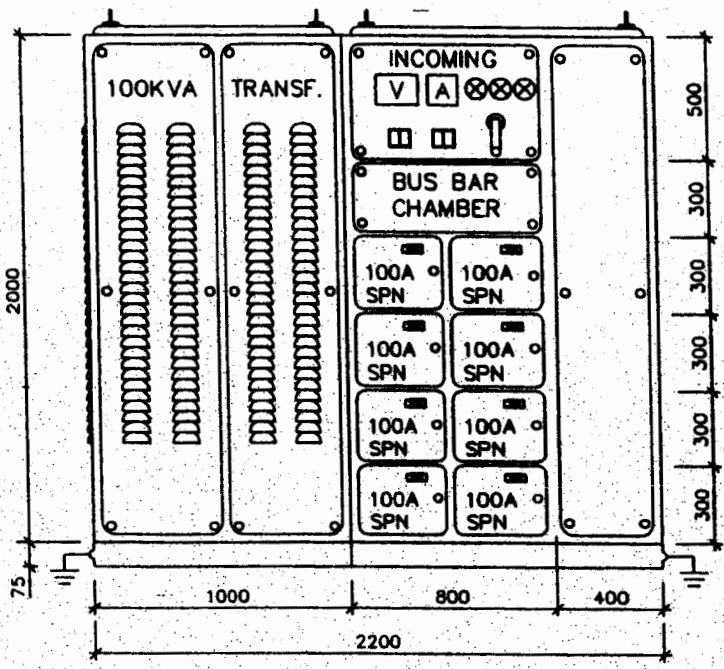
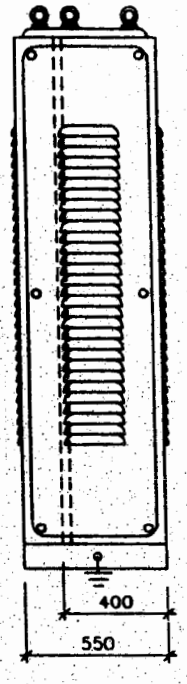
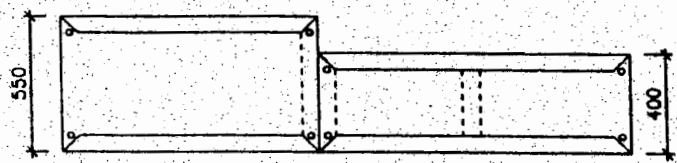


FRONT VIEW



SIDE VIEW



FOUNDATION PLAN

GENERAL ARRANGEMENT MAIN LIGHTING DISTRIBUTION BOARD

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LIGHTING NOTES & DETAILS

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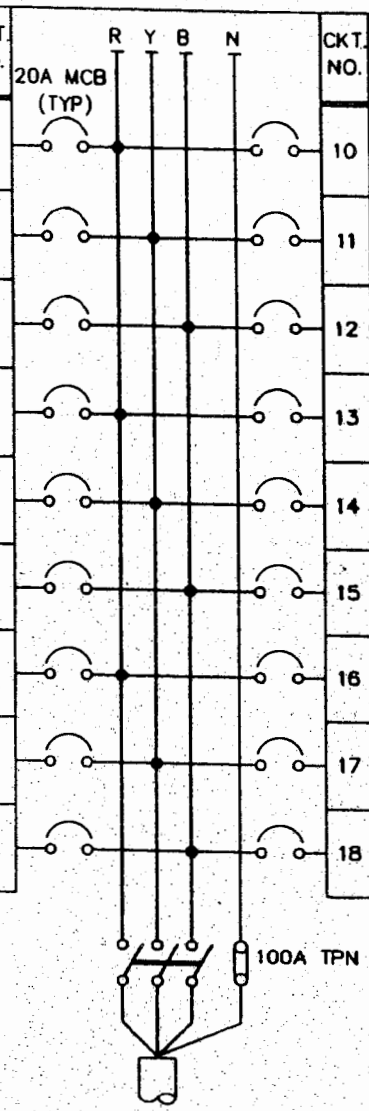
LOCATION	NO.& TYPE OF FIXTURE	LOAD (WATT)	CKT. NO.	CKT. NO.	LOAD (WATT)	NO.& TYPE OF FIXTURE	LOCATION
			1	10			
			2	11			
			3	12			
			4	13			
			5	14			
			6	15			
			7	16			
			8	17			
			9	18			



3-LINE DIAGRAM : LIGHTING PANEL

बीएचई एल

LIGHTING NOTES & DETAILS

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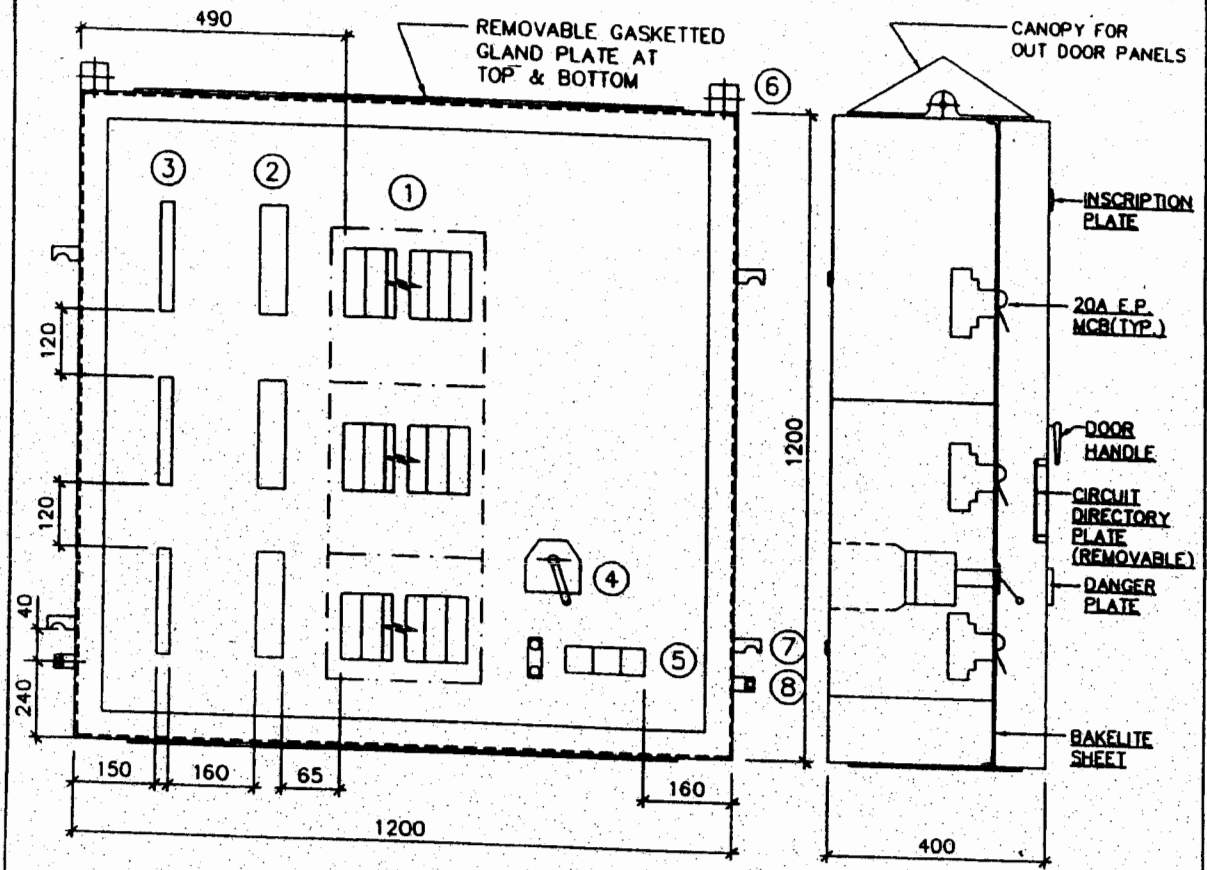
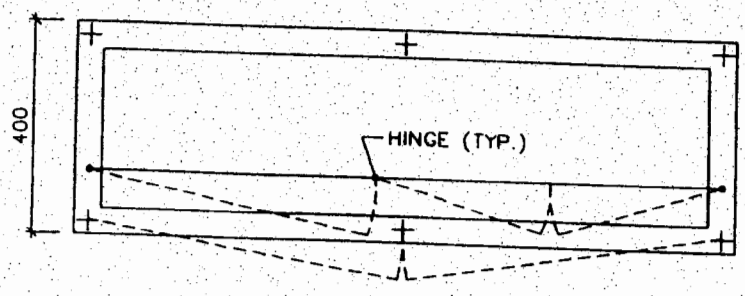


FRONT VIEW
(DOOR REMOVED)

SECTIONAL SIDE VIEW



FOUNDATION PLAN

LEGEND :

1. MINIATURE CKT. BKR.
2. PHASE TERMINALS STRIP
3. NEUTRAL BUS WITH NUT, BOLT & WASHER
4. ISOLATOR
5. TERMINAL BLOCK
6. LIFTING LUG
7. FIXING LUG
8. EARTHING STUD WITH NUTS

GENERAL ARRANGEMENT
LIGHTING PANEL

बी एच ई एल

LIGHTING NOTES & DETAILS

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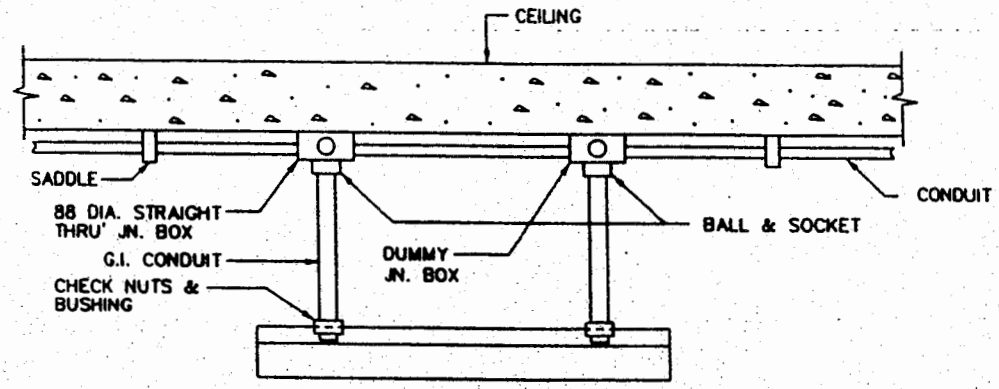
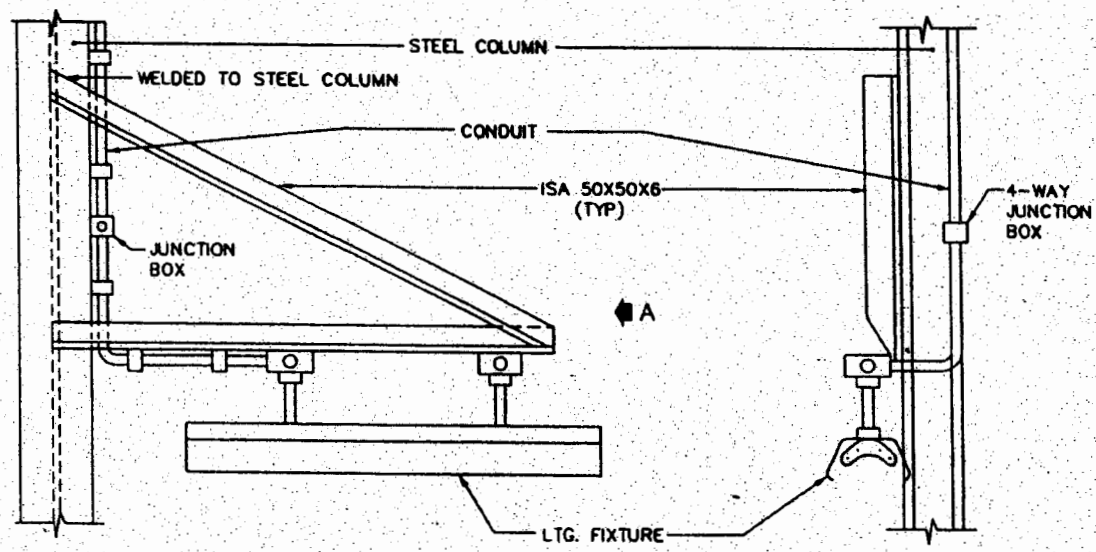


CEILING MOUNTING
TYPE - DA



CANTILEVER MOUNTING
TYPE-DB

VIEW-A

FIXTURE SIMILAR TO PHILIPS: TKC-24/236 OR EQUIV. WITH 2X36W FLUORESCENT LAMP SUITABLE FOR 230V A.C.

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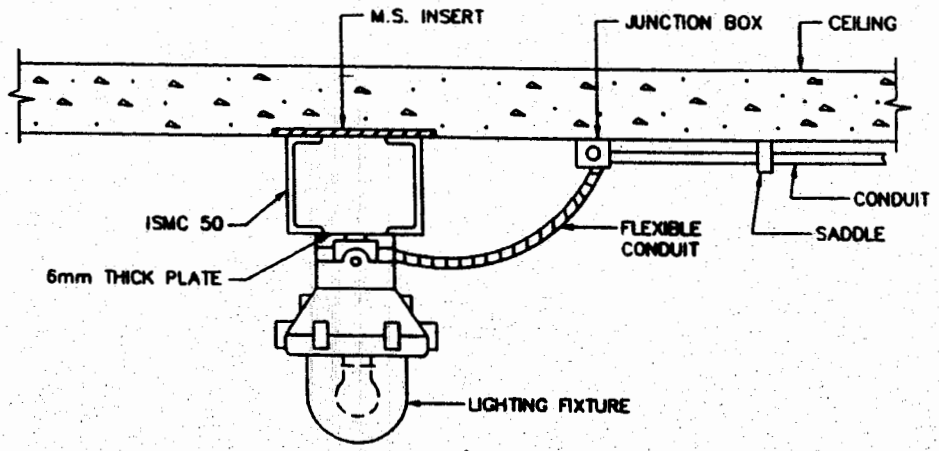
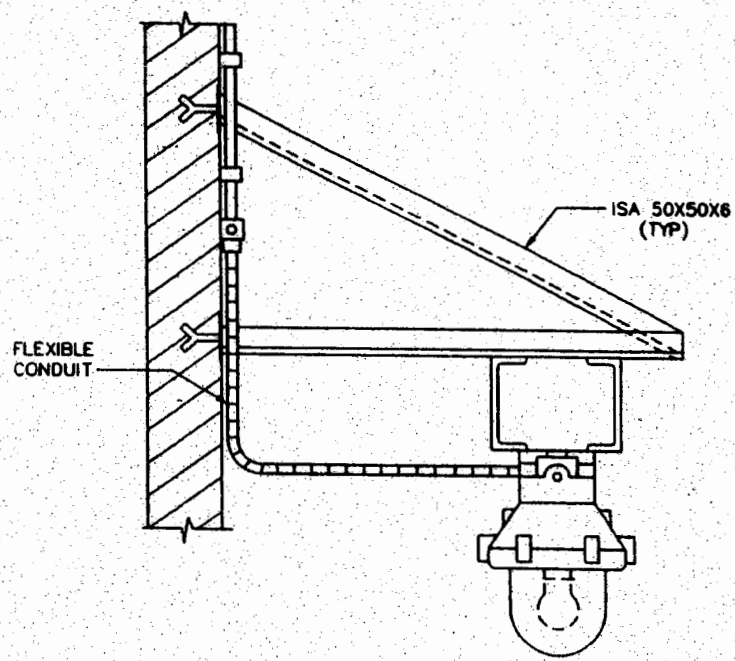


CEILING MOUNTING



WALL MOUNTING

NOTE:

WHEN USED WITH MV LAMPS THE CONTROL GEAR MUST BE HOUSED IN AN APPROVED FLAME PROOF ENCLOSURE OR ALTERNATELY LOCATED OUTSIDE THE DEFINED HAZARDOUS AREA.

FIXTURE SIMILAR TO GENELEC: 65007 OR EQUIVALENT WITH 1X125W HPMV LAMP SUITABLE FOR 230V A.C.SUPPLY

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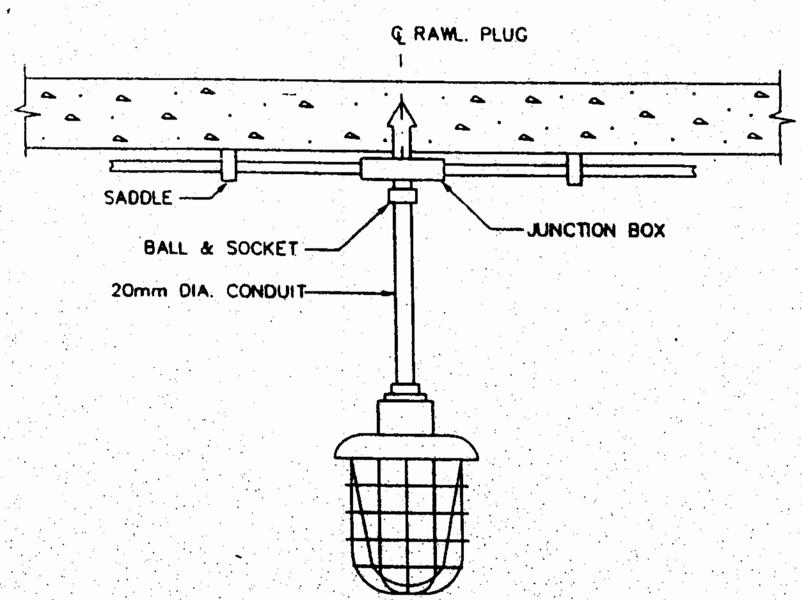
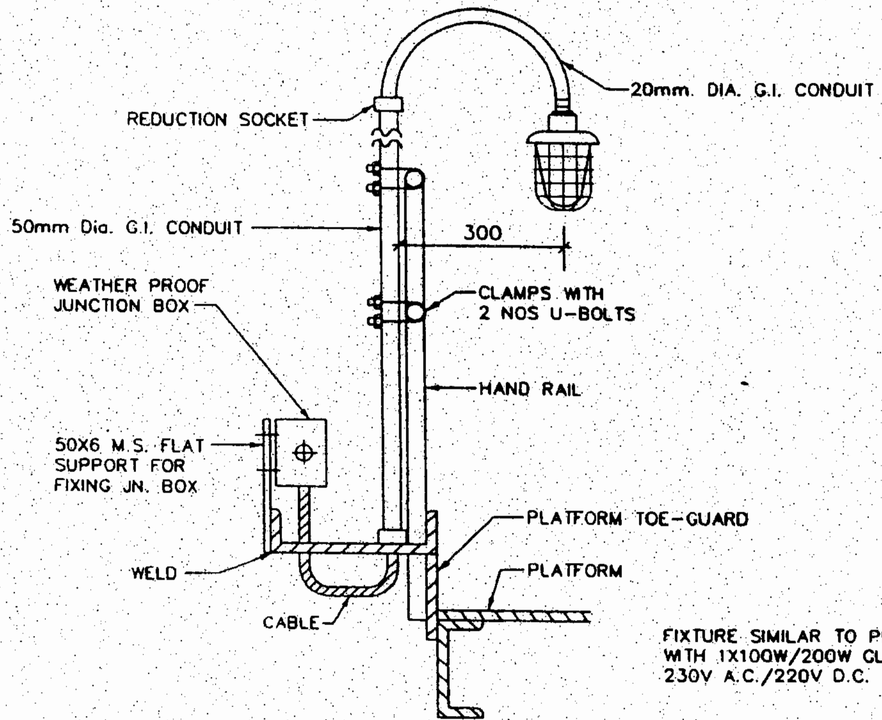


PENDANT/CEILING MOUNTING : TYPE-CA



FIXTURE SIMILAR TO PHILIPS NDC22 OR EQUIV. WITH 1X100W/200W GLS LAMP SUITABLE FOR 230V A.C./220V D.C. SUPPLY

PLATFORM MOUNTING : TYPE-CB

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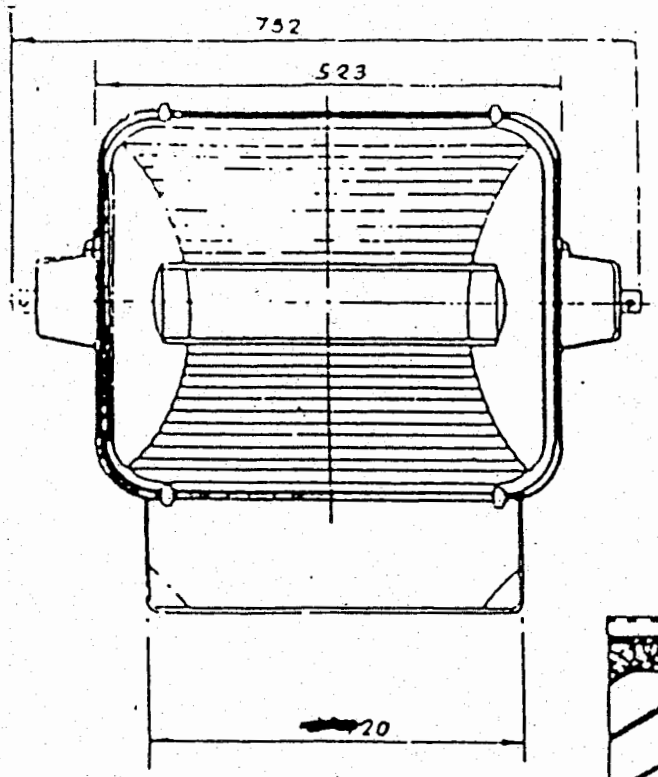
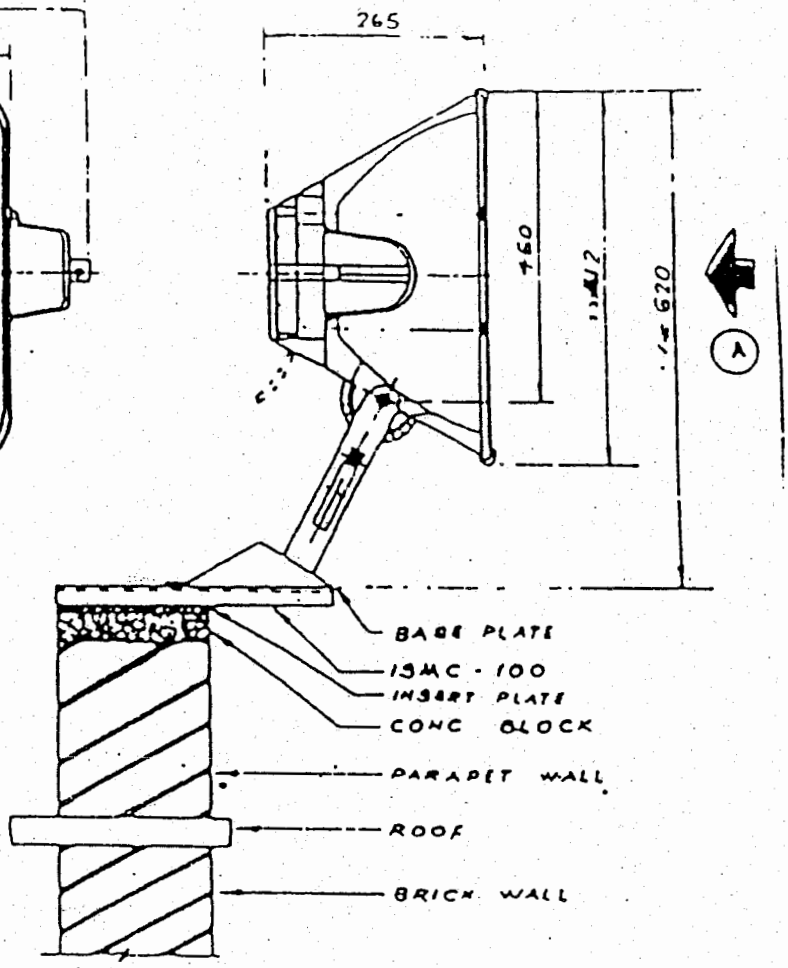
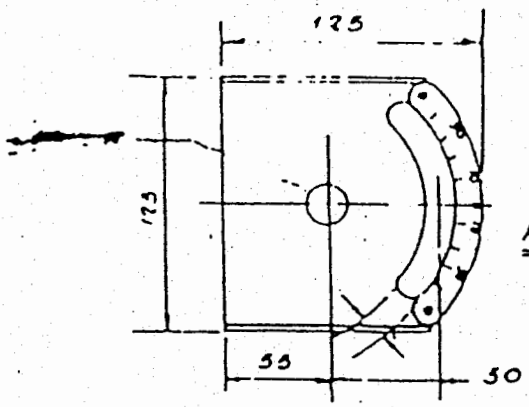


VIEW - A



TYPICAL MOUNTING ARRANGEMENT OF FLOOD LIGHT FIXTURE ON THE ROOF



BASE PLATE

LIGHTING NOTES & DETAILS MOUNTING OF FLOOD LIGHT FIXTURE	DRG. No. PE-DG-253-558-0001
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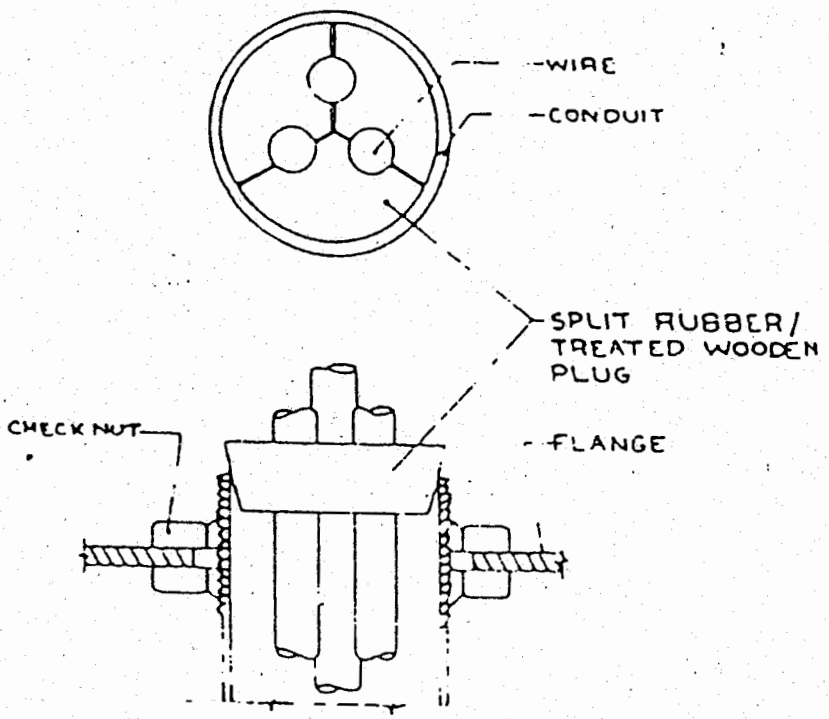

CLAMPING OF WIRES
IN CONDUIT VERTICAL RUN

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LIGHTING NOTES & DETAILS

DRG. No.
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0

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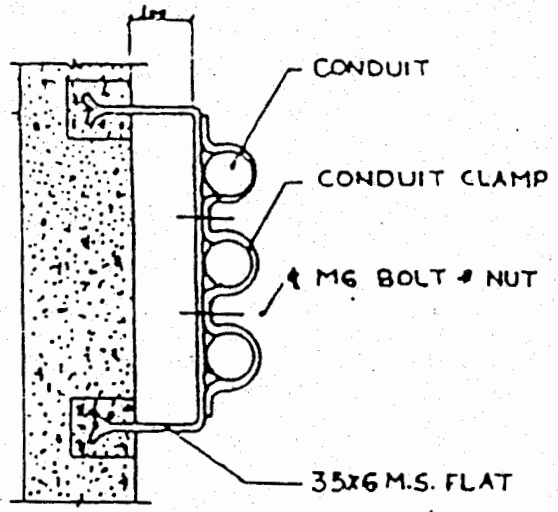
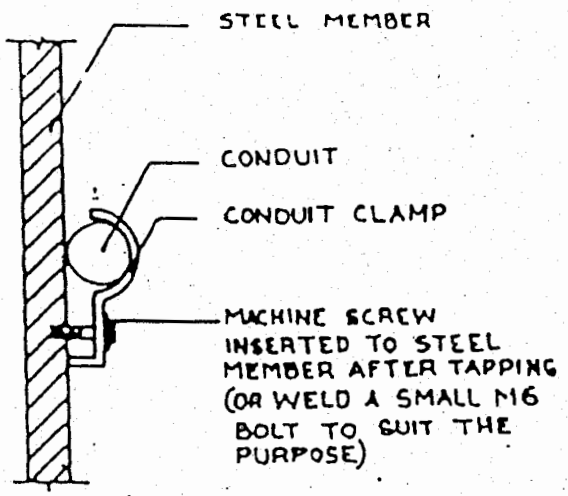
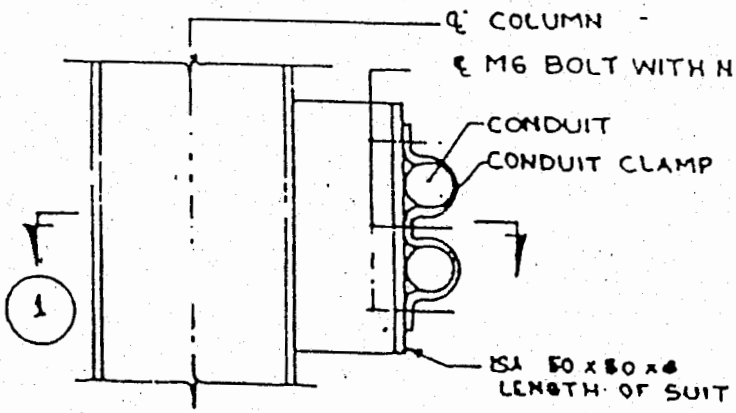


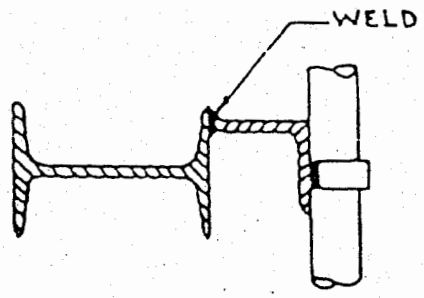
GROUP OF CONDUITS RUN ON CONCRETE SURFACE



SINGLE CONDUIT RUN ON STEEL MEMBER



ELEVATION



SECTION — (1)

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-A

बीएचईएल	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-253-558-0001
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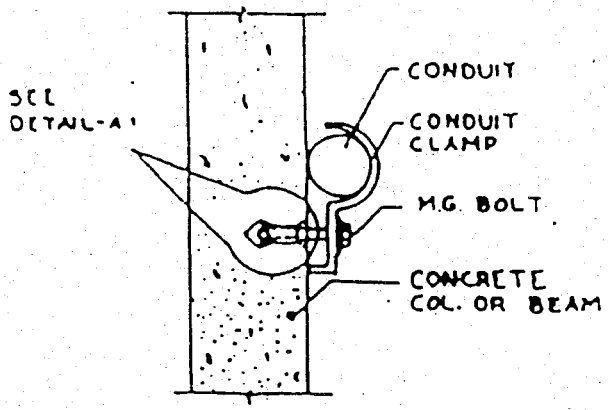
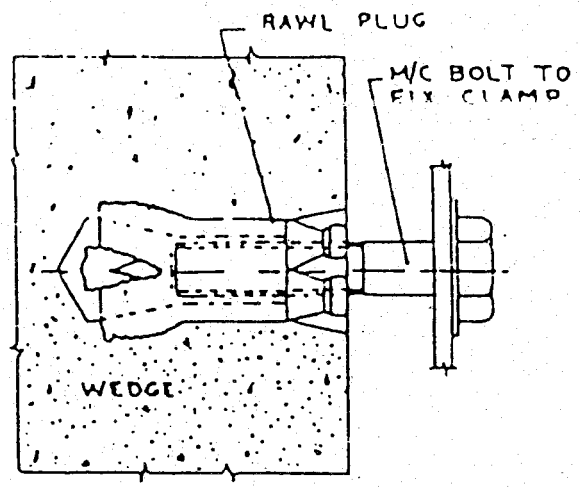
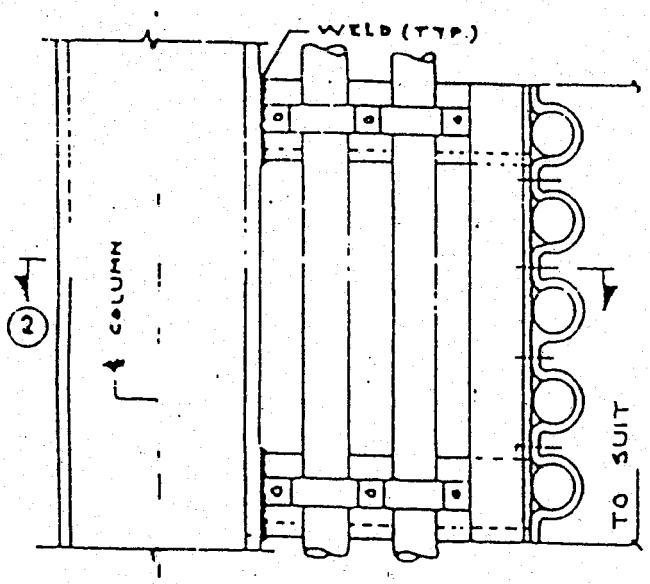


SINGLE CONDUIT RUN ON CONCRETE SURFACE

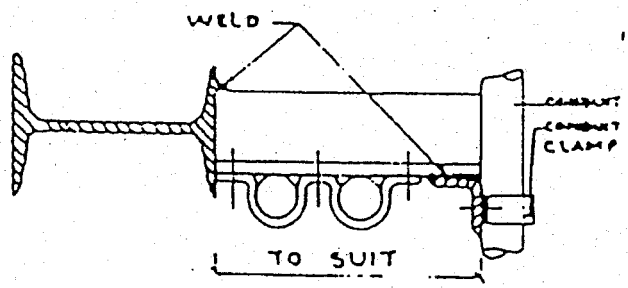


DETAIL - A



ELEVATION

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-B



SECTION-(2)

बीएचईएल BHEL	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-253-558-0001
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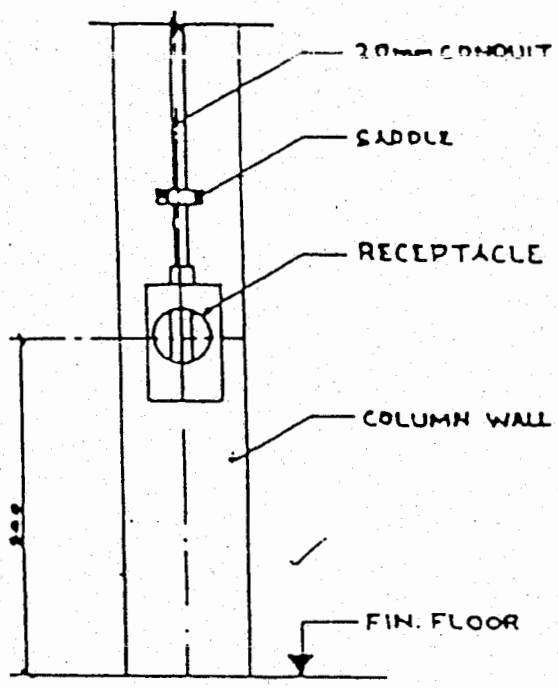
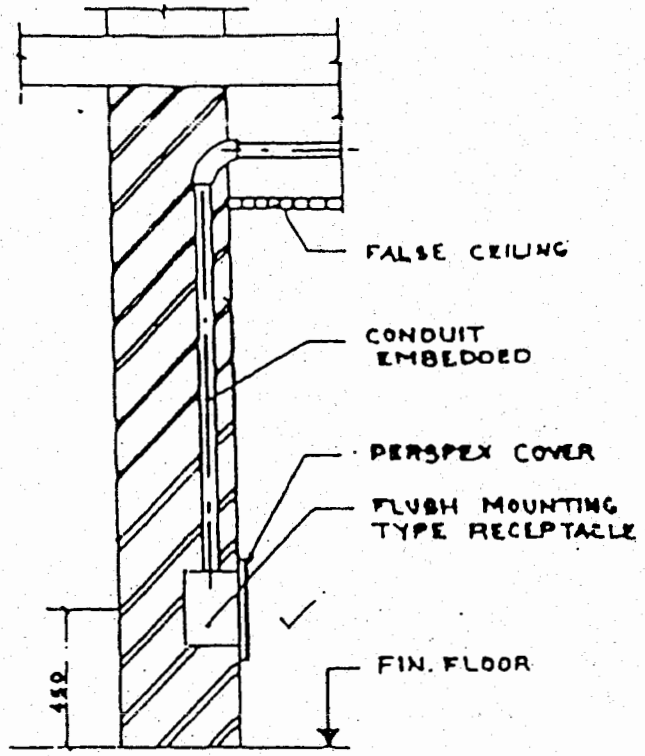


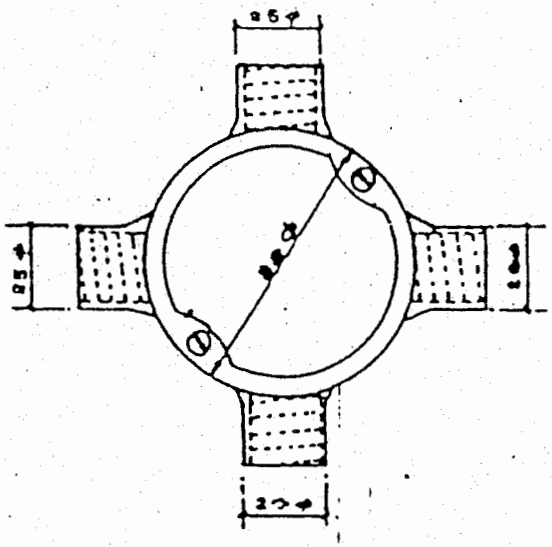
RECEPTACLE – TYPE 'RB'

(STRUCTURE MOUNTING)



RECEPTACLE – TYPE 'RA'

(WALL MOUNTING)



JUNCTION BOX ROUND (TYP.)

LIGHTING NOTES & DETAILS	DRG. No. PE-DG-253-558-0001
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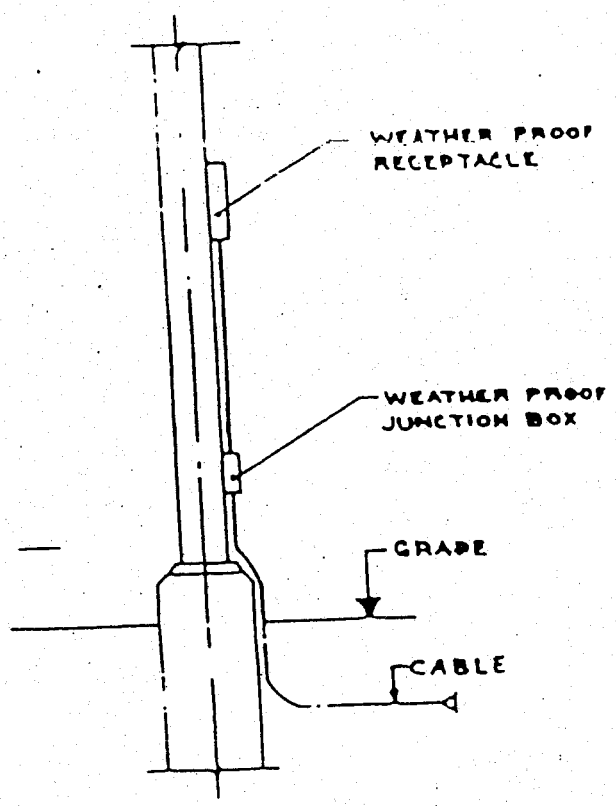
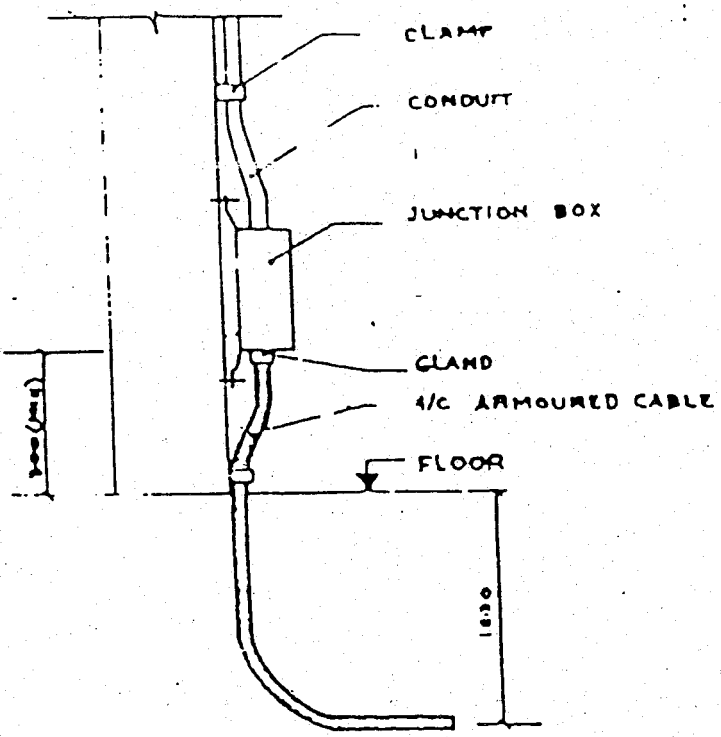
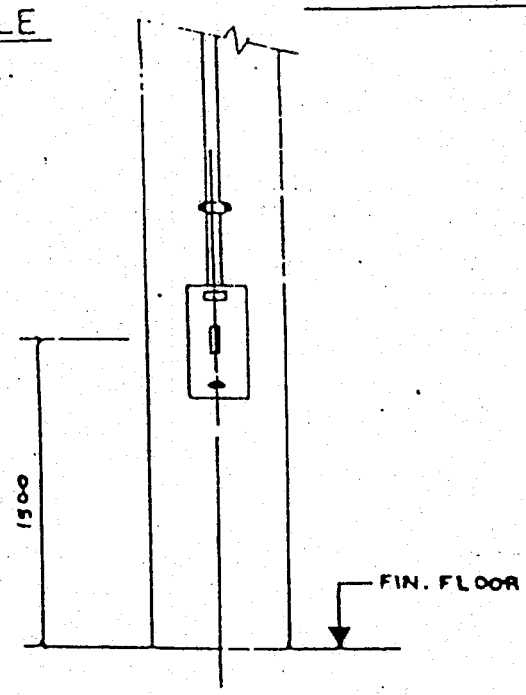


OUTDOOR RECEPTACLE



JUNCTION BOX
MOUNTING (TYP.)



SWITCH ON COLUMN

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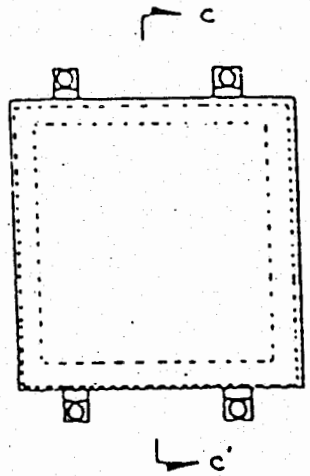
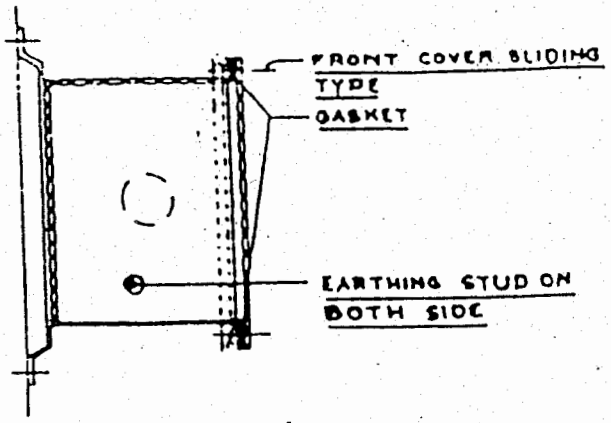
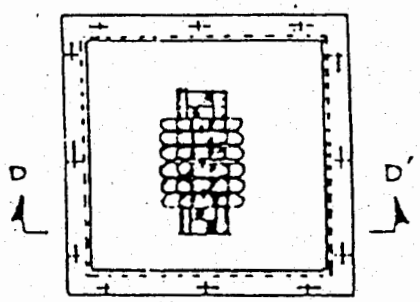


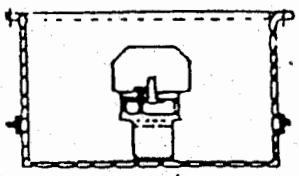
TYP. FIXING DETAIL OF JUNCTION BOX



SECTION : C - C'



JUNCTION BOX (TYP.) FRONT VIEW



SECTION : D - D'

LIGHTING NOTES & DETAILS	DRG. No. PE-DG-253-558-0001
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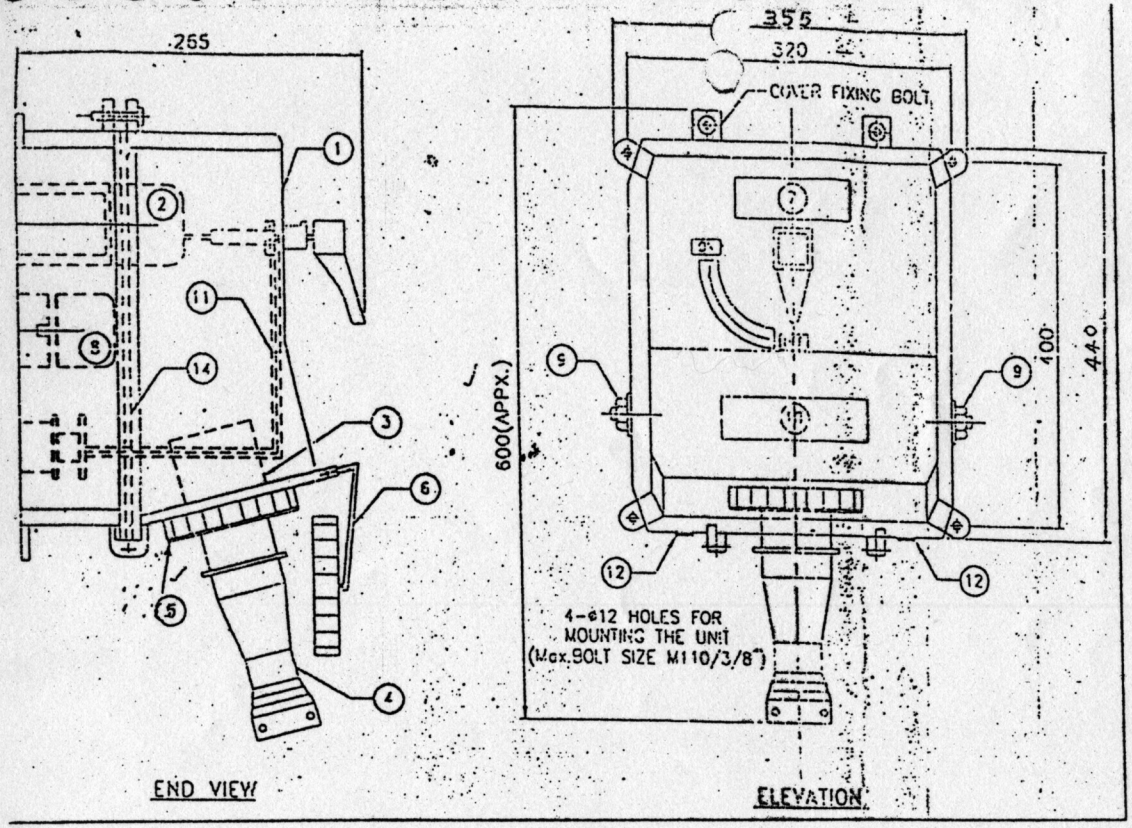
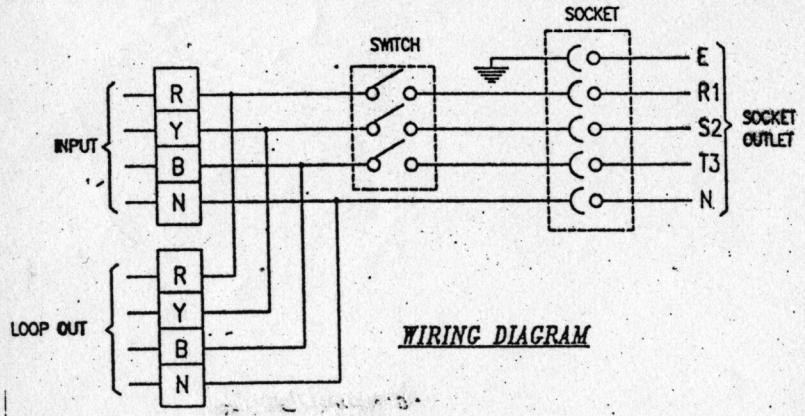


SPECIFICATION

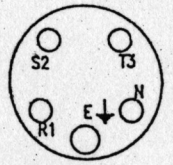
1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
5] PLUG RING
6] SPRING LOADED COVER FOR SOCKET OUTLET
7] NAME PLATE
8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRAGEMENT TO TERMINATE 3.5Cx50 sq.mm STUD TYPE BEST & CROMPTON MAKE
9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT,NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
10] CAUTION STACKER
11] MECHANICAL INTERLOCKING ARRANGEMENT
12] DETACHABLE GLAND PLATE O TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mM. CABLES.

NOTES

1] ALL DIMENSION ARE IM MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 16 25 sq.mm. CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
7] SUITABLE CABLE GRIP SHALL BE PROVIDED



WIRING DIAGRAM



SHOWING TERMINAL POSITION

COLOUR CODED SLEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEIBLE
R PHASE – RED COLOUR
Y PHASE – YELLOW COLOUR
B PHASE – BLUE COLOUR
NEATRAL – BLACK COLOUR

CHIMNEY LIGHTING SPECIFICATION

REV	DATE	DESCRIPTION
01		
02		

1230-001-29PE-PVE-B-073

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT
NEW DELHI

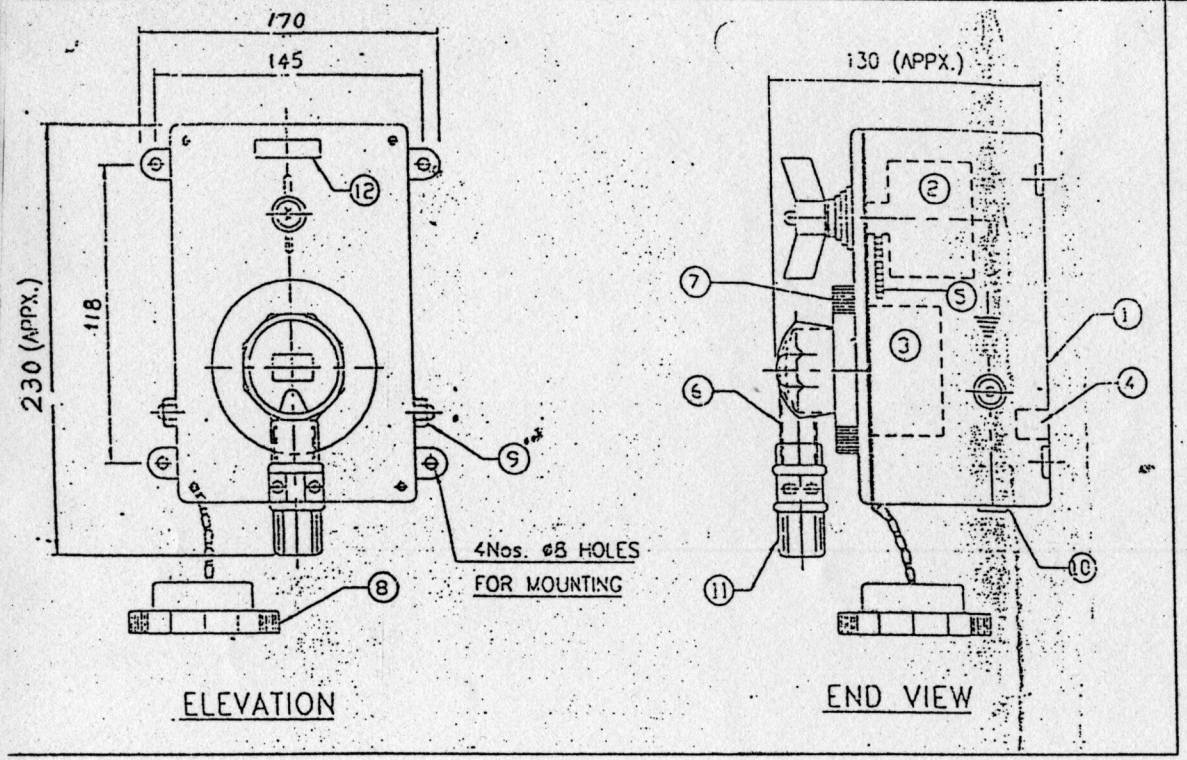
bajaj electricals limited MUMBAI
Engineering & Projects Division.

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

TITLE GENERAL ARRANGEMENT DWG FOR 63 A FULLY INTERLOCKED SWITCHED PLUG 63 AMPS 415 VOLTS [TYPE RC]

DWG. NO. EPBU-03-PS005-04-073 REV. 0

SHT. 1 OF 1



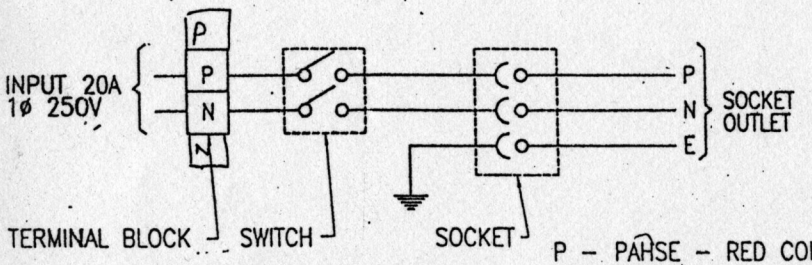
SPECIFICATION

1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 – RECOM MAKE
3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
4] BAKELITE STUD TYPE 2 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
5] MECHANICAL INTERLOCKING SYSTEM
6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
7] THREADED PLUG LOCKING RING
8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
9] EARTHING TERMINAL 2 Nos. – M6 SIZE
10] CABLE ENTRY 25mm DIA – 2Nos.
11] PVC CABLE GRIP
12] NAME PLATE

NOTES

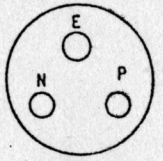
1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWDER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN ~~NOT~~ BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
6] 2 Nos. CABLE ENTRY AT BOTTOM

CHIMNEY LIGHTING SPECIFICATION.



WIRING DIAGRAM
(FOR SINGLE PHASE UNIT)

P – PHASE – RED COLOUR
N – NEUTRAL – BLACK COLOUR
E – GREEN COLOUR.



VIEW ON SOCKET PLUG REMOVED

1230-061-298E-PVG-B-070

REV	DATE	DESCRIPTION
01		
02		

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT

bajaj electricals limited MUMBAI
Engineering & Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBU	IS	AP	30.06.03	PE-V0-200-558-E070

TITLE GENERAL ARRANGEMENT DWG FOR FULLY INTERLOCKED SWITCHED PLUG 20 AMPS, 250 VOLTS [TYPE RA]

DWG. NO. EPBU-03-PS005-04-070 REV 0

SHT. 1 OF 1

FORM No. PEM 6041–0

QUALITY PLAN

CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER	
BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE	
SHEET 1 OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	CABLES & WIRES	1. SURFACE DEFECTS	MA	VISUAL	SAMPLE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3/2	2	1	TO BE PROCURED FROM APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	–DO–	–DO–	–DO–	3/2	2	1	
		3. TYPE TESTS	CR	ELEC. TESTS	ONE/TYPE & SIZE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	TEST CERT.	3	2	1	
		4.ACCEP–TANCE TESTS	MA	–DO–	SAMPLING	–DO–	–DO–	–DO–	3	2	1	
		5. ROUTINE TESTS	MA	–DO–	100%	–DO–	–DO–	–DO–	3	–	2,1	
		6. FRLS PROPS.	CR	FRLS TESTS	SAMPLES	BHEL SPEC.	BHEL SPEC.	–DO–	3	2	1	
2.0	JUNCTION BOXES, LIGHTING PANELS AND DISTRIBUTION BOARDS											
2.1	JUNCTION BOXES	1.DIMENSIONS	MA	MEASUREMENTS	100%	BHEL DRG.	BHEL DRG.	INSP. REPORT	3	–	2	COMPONENTS TO BE OF APPROVED MAKE.
		2.PAINT SHADE/ THICKNESS	MA	VISUAL / MEAS.	SAMPLE	BHEL SPEC./DRG.	BHELSPEC./DRG.	–DO–	3	–	2	
		3.HV / IR / HV	MA	ELECT. TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	–DO–	3	–	2	
		4.DEGREE OF PROTECTION	MA	TESTS	1/SIZE	IS:2147	IS:2147	TEST CERT.	–	–	2,1	
		5.SPECIAL TESTS IF ANY, EXPLOSION PROOF ETC.	MA	–DO–	–DO–	IS:2148	IS:2148	–DO–	–	–	2,1	
2.2	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS	1. DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DRG.	BHEL DRG.	INSPT. REPORT	3	2,1	–	COMPONENTS TO BE OF APPROVED MAKE.

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE
	SHEET 2 OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
		2. PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	–DO–	BHEL SPEC./DRG.	BHEL SPEC./DRG.	INSPT. REPORT	3	2,1	–	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/SIZE	BHEL SPEC./ RELEVANT IS	BHEL SPEC./ RELEVANT IS	TEST CERTF.	–	–	2,1	
		4.PERFORMANCE TESTS	MA	ELEC.	100%	BHEL SPEC.	BHEL SPEC.	INSPT. REPORT	3	2,1	–	BHEL SHALL WITNESS ON RANDOM ONE SAMPLE, THOUGH EACH ITEM SHALL BE CHECKED BY THE MANUFACTURER.
		5.HV/IR/HV	MA	ELEC.	100%	2.5 KV AC FOR 1 MINUTE	2.5 KV AC FOR 1 MINUTE	–DO–	3	2,1	–	–DO–
		6. TEMP. RISE TEST (FOR COM–PLETE ASSEMBL–ED LDB)	MA	ELEC.	1/RATING	BHEL SPEC.	BHEL SPEC.	–DO–	3	2	1	
3.0	TUNGSTEN FILAMENT LAMPS, TUBULAR FLUORESCENT LAMPS, H.P. MERCURY VAPOUR LAMPS,SODIUM VAPOUR LAMPS,BALLASTS, LUMINAIRES	1. – ACCEPTANCE TESTS	MA	TESTS	SAMPLE	BHEL SPEC./ RELEVANT IS	BHEL SPEC./ RELEVANT IS	TEST CERTF.	3,2	–	1	

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE
	SHEET OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
4.0	CONDUITS	1. MATERIAL	MA	VISUAL, MECH. AND CHEMICAL	AS PER SPEC./ IS : 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		2. DIMENSIONS	MA	MEASUREMENT	AS PER SPEC./ IS : 9537	IS:9537	IS:9537	–DO–	3	2	1	
		3. OTHER TESTS	MA	TESTS	AS PER SPEC./ IS:9537,	AS PER SPEC./ IS:9537,	IS:9537,	–DO–	3	2	1	
5.0	ELECTRIC POLES											
5.1	MATERIAL	1. CHEMICAL COMP.	MA	CHEM. ANALYSIS	SAMPLE	IS:2713, IS:228 & IS:1894	IS:2713 IS:228 & IS:1894	–DO–	3/2	–	2,1	
		2. PHYSICAL PROP.	MA	PHYS. TESTS	–DO–	–DO–	–DO–	–DO–	3/2	–	2,1	
5.2	FINAL INSPECTION	1. WORK–MANSHIP & FINISH	MA	VISUAL & MEAS.	SAMPLES	BHEL DRG./IS:2713	BHEL DRG./IS:2713	–DO–	3/2	2,1	–	
		2. DIMENSIONS	MA	–DO–	–DO–	–DO–	–DO–	–DO–	3/2	2,1	–	
		3. WEIGHT	MA	–DO–	–DO–	–DO–	–DO–	–DO–	3/2	2,1	–	
		4. TESTS AS PER IS:2713	MA	–DO–	–DO–	IS:2713	IS:2713	–DO–	3/2	2,1	–	

NOTE : IN CASE TYPE TEST CERTIFICATE FOR DEGREE OFPROTECTION /EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB.

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

1.00.00 **CODES AND STANDARDS** IS:1554, IS:7098, IEC:502, IS:6380, IS:9968

2.00.00 **TYPE** All cable shall be Flame retardent low smoke type

3.00.00 **RATING** As per requirement specified in General Electrical Requirements.

4.00.00 **OPERATIONAL REQUIREMENTS**

All cables shall be suitable for high ambient, high humid tropical Indian climatic conditions. All cables shall be designed to withstand the mechanical, electrical and thermal stresses under the foreseen steady state and transient/fault conditions, and shall be suitable for the proposed method of installation.

5.00.00 **DESIGN AND CONSTRUCTIONAL FEATURES**

5.01.00 Parameters of the cables are as follows :

Particulars	Power cables		Control cables	Trailing cables
	XLPE	PVC		
a) Conductor				
i) Material	Stranded Aluminium		Stranded plain annealed copper	Tinned copper of class 5 of IS:8130
ii) Size	As required, but Min. 6 sq.mm size.		As required, but min. 1.5 sq.mm. size.	As required, but min. 1.5 sq.mm. size.
iii) Shape	Circular/ sector shaped. Circular only for HT cables	Circular/ sector shaped		
b) Main Insulation				
i) Material	XLPE	PVC	PVC	Heat resistant elastomeric compound based on Ethylene Propyline Rubber (EPR)

Particulars	Power cables		Control cables	Trailing cables
	XLPE	PVC		
ii) Continuous withstand temperature (deg.C)	90	70 / 70	90	
iii) Short circuit withstand temperature (deg.C)	250	160 / 160	250	
iv) Colour identification	As per relevant codes and standards			
c) Inner Sheath	All armoured and multicore unarmoured cables have distinct extruded inner sheath			
i) Material	PVC	PVC	PVC	Heat resistant elastomeric compound.
ii) Colour	Black	Black	Black	Black
d) Armour, wherever provided				
i) Material	Aluminium wire for single core cable and GS wire/flat for multi-core cables as per relevant IS. Minimum Coverage of 90%		GS wire/flat as per relevant IS. Min. coverage of 90%.	Nylon cord reinforcemenet
ii) Breaking load of joint	95% of normal armour		95% of normal armour	
e) Outer sheath	All power & control cable shall have extruded outer sheath.			
i) Material (Polyethelene based halogen free material not acceptable)	PVC	PVC	PVC	Heat resistant, oil resistant & flame retardant heavy duty elastomeric compound

Particulars		Power cables		Control cables	Trailing cables
		XLPE	PVC		
ii)	Colour	Black	Black	Grey	Black
iii)	Marking	- Cable size & voltage grade (by embossing) - Word "FRLS" @ 5m (by embossing) - Sequential marking @1m		Same as for Power Cables	Same as for Power Cables

f)	FRLS properties on outer sheath	Oxygen Index : Acid gas generation: Smoke density rating:	Min. 29 (As per ASTMD 2863) Max. 20% (As per IEC754-I) 60% (As per ASTMD 2843)
g)	Flamability test on all types of cables	As per Swedish chimney test F3 as per SEN 4241475 As per IEC 332 Part-3 (Category B)	

5.01.02 **HT cables**

For HT cables conductor screen and insulation screen shall be of extruded semi-conducting compound and shall be applied alongwith XLPE insulation in a single operation by triple extrusion process. Method of curing for 11kV/6.6kV cables shall be "Dry curing/gas curing/steam curing" whereas for 33KV cables it shall be "Dry/Gas curing". 11kV/6.6kV cables shall be provided with copper metallic screen suitable for carrying allowable earth fault current for 2 secs. All other voltage grade HT cables shall be provided with copper metallic screen suitable for carrying earth fault current as per E0. For single core armoured cables, the armouring shall constitute the metallic part of screening.

5.01.03 LT Cables of size 150 sq.mm. and above shall be with XLPE insulation.

5.01.04 **Core identification**

For cables having more than five (5) cores, each core shall be identified by number marking. However, for cables upto five (5) cores, the same shall be by colour as per IS.

5.01.05 **Armouring**

Cables buried direct in ground and cables in switchyard shall be armoured.

Clause No.	POWER AND CONTROL CABLES		
		..... (Bidder's Name)	
	POWER AND CONTROL CABLES (Use separate sheet for each type and size of cables)		
1.00.00	Make	.....	.....
1.02.00	Country of Manufacturer	.....	.....
1.03.00	Type & designation	.....	.....
1.04.00	Applicable standard	.....	.....
1.05.00	Cable size & no. of cores	.....	.....
1.06.00	Rated voltage	.....	.....
1.07.00	Catalogue attached as Annexure No.	.....	.....
1.08.00	Continuous current rating for max. conductor temperature	.....	.....
	a) When laid in air at an ambient temperature of 50 deg. C	.....	.....
	b) When buried in soil having thermal resistivity of 150 deg.C cm/n at a depth of 1000 mm at ground ambient temperature of 40 deg. C	.....	.....
1.09.00	Short circuit withstand capacity and duration for	.....	.....
	a) Conductor	.....	.....
	b) Screen	.....	.....
	c) Armour	.....	.....
1.10.00	Conductor	.....	.....
	a) Material	.....	.....
	b) Nominal cross section area in sq. mm	.....	.....

Clause No.	POWER AND CONTROL CABLES		
		..... (Bidder's Name)	
	c) Shape of conductor	.....	.....
	d) DC resistance at 20°C	.....	.....
1.11.00	Insulation		
	a) Material	.....	.....
	b) Nominal thickness (in mm)	.....	.....
	c) Type of curing (for XLPE)	.....	.....
1.12.00	Metallic screen (wherever applicable)		
	a) Material	.....	.....
	b) Type	.....	.....
	c) Rating KA, Sec		
1.13.00	Material & Type of Inner sheath	.....	.....
1.14.00	Armour material & shape	.....	.....
1.15.00	Outer sheath material & type	.....	.....
1.16.00	Over all dia of cable (in mm)	.....	.....
1.17.00	Guaranteed value of minimum oxygen index of outer sheath	.....	.....
1.18.00	Maximum acid-gas generation by weight (%) of outer sheath	.....	.....
1.19.00	Smoke Density rating of outer sheath	.....	.....

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 1 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	PVC COMPOUND (FOR INSULATION- AND SHEATH)	1. PHYSICAL PRO- PERTIES	MA	PHYS TESTS	SAM- PLE	IS:5831/ BHEL SPEC- IFICATION	IS:5831/ BHEL SPEC IFICATION	LOG BOOK /TEST CERT	3/2	-	2	
		2. ELEC. PROPER- TIES	MA	ELEC TEST	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3.MAKE & TYPE	MA	VISUAL	100 %	PLANT STD.	PLANT STD.	DO	2	-	-	
1.2	GALVANIZED STEEL WIRE / STRIP	1. PHY. AND ELEC PROPERTIES	MA	PHY. ELEC.TESTS	SAM-* PLE	IS:3975, BHEL SPEC	IS:3975 BHEL SPEC	-DO-	3/2	-	2	* SAMPLE FROM EACH BATCH / LOT
		2. DIMENSION	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. GALVANIZAT- ION QUALITY	MA	GALV. TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
1.3	COPPER / ALUMINIUM RODS / WIRES	1. PHYSICAL PROERTIES.	MA	PHY.TESTS	-DO-	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	-DO-	3/2	-	2	
		2.CHEM COMPOS- ITION & PURITY	MA	CHEM ANALYSIS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. ELECTRICAL PROPERTIES	MA	ELECTRICAL TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		4. DIMENSION	MA	MEASURMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 2 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	WIRE DRAWING, TINNING AND ANNEALING	1. PHYSICAL, ELECT. FINISH & DIMEN.	CR	PHY. & ELECT-TESTS VISUAL, MEAS.	SAMPLE	BHEL SPEC., IS-8130	BHEL SPEC., IS-8130	LOG BOOK	2	-	1	
		2. CHEMICAL TEST FOR TINNING	CR	CHEMICAL TEST	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.2	STRANDING OF WIRES	1. NO. OF WIRES	MA	COUNTING	SAMPLE	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	LOG BOOK	2	-	-	
		2 SEQUENCE,LAY LENGTH AND DIRECTION	MA	VISUAL, MEAS	-DO-	-DO-	-DO-	-DO-	2	-	-	
		3. SURFACE FINISH	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. DIMENSION	MA	MEASURE-MENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.3	CORE - INSULATION (NO REPAIR PERMITTED)	1 SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BULGING, BURNT PARTICLES LUMPS, CUTS & SCRATCHES	-DO-	2	-	1	
		2. INSULATION THICKNESS	CR	MEASUREMENT	SAMPLE	APPD.DATA SHT. IS : 1554	APPD.DATA SHT. IS : 1554	-DO-	2	-	-	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 3 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3. CONCENTRI-CITY. #	CR	MEASUREMENT	SAMPLE	MFR. STD. ./APPD. DATA SHEET.	MFR. STD. /APPD. DATA SHEET.	-DO-	2	-	1	# TO BE CHECKED AT STARTING & FINISH END OF EXTRUDED LENGTH
		4. DIA OVER INS-ULATION	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		5. SPARK TEST OR WATER IMMERSION TEST	CR	ELECTRICAL	100%	MFR. STD.	MFR. STD.	-DO-	2	-	1	
		6. CORE IDENTIF-ICATION.	MA	VISUAL	100%	IS:1554	IS:1554	-DO-	2	-	-	
2.4	CORE - LAYING	1.DIA OVER LAID UP CORE	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		2.SEQUENCE OF LAY, LAY LENGTH & DIRECTION UP CORE	MA	VISUAL & MEAS.	SAMPLE	MFR. STD/ RELEVANT IS	MFR. STD/ RELEVANT IS	LOG BOOK	2	-	-	
2.5	INNER SHEATH EXTRUSION	1. SURFACE FINISH	MA	VISUAL	100%	–	FREE FROM BULGING,BURNT PARTICLES, LUMPS CUTS & SCRATCHES	-DO-	2	-	-	
		2. SHEATH THICKNESS	MA	MEASUREMENT	SAMPLE	IS:5831 & DATA SHEET IS-1554	IS:5831 & DATA SHEET IS-1554	-DO-	2	-	-	
		3. DIA OVER INN-ER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.6	ARMOURING	1. NO. OF WIRES/ STRIPS	MA	COUNTING	AT THE START OF THE PROCESS	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554	-DO-	2	-	-	
		2. LAY DIRECTION	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 4 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3. LAY LENGTH	MA	VISUAL, MEAS.	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. COVERAGE	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
		5. DIA OVER - ARMOURING	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.7	OUTER SHEATH EXTRUSION	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BUL-GING, BURNT PA-RTICLES, LUMPS CUTS & SCRATC-HES.	LOG BOOK	2	-	-	
		2. SHEATH THICK-NESS	MA	MEASUREMENT	SAMPLE	IS:5831 & IS-1554 DATA SHEET	IS:5831 & IS-1554 DATA SHEET	-DO-	2	-	-	
		3.DIA OVER OUT-ER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. MARKING	MA	VISUAL	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	-	SEQUENTIAL MARKING SHALL BE DONE BY PRINTING.
2.8	FINISHED CABLE	1. ROUTINE TEST	CR	ELEC. & MEAS.	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	1	
		2.TYPE AND FRLS TESTS	CR	ELEC. PHY & MEAS	SAMPLE *	-DO-/APPD. DATA SHEET.	-DO-/APPD.DATA SHEET.	-DO-	2	-	1	*ONE DRUM / SIZE / LOT
3.0	FINAL INSPECTION	1. FINISH & LENGTH	MA	VISUAL	(SEE REMARK)	BHEL SPEC. IS: 1554	FREE FROM BULGING,BURNT PARTICLES LUMPS CUTS & SCRATC-HES.	-DO-	2	1	-	ONE DRUM EACH FOR POWER AND CONTROL CABLES IN A LOT

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 5 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		2. DIMENSION	MA	MEASUREMENT	AS PER IS	APPD.DATA SHEET. IS:1554 IS:10810	APPD.DATA SHEET. IS:1554 IS:10810	-DO-	2	1	-	
		3. ARMOURING-COVERAGE NO.OF WIRES /STRIPS	MA	VISUAL & MEAS.	AS PER IS	-DO-	-DO-	-DO-	2	1	-	
		4.MARKING/COL-OUR CODING	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	1	-	
		5 ACCEPTANCE TESTS	CR	PHY. & ELECT. TESTS	-D0-	-DO-	-DO-	-DO-	2	1		
		6. TYPE & FRLS TESTS	CR	MEASUREMENT	(SEE REMARK)	BHEL SPEC. , APPD. DATA SHEET	BHEL SPEC. APPD. DATA SHEET	-DO-	2	1	-	TYPE TEST SHELL BE WITNESSED ON ONE SAMPLE PER TYPE (POWER / CONTROL) OF EVERY LOT.

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 6 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11

NOTES:

A) JOINTS IN WIRES SHALL BE AS PERMITTED BY IS/BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME
B) NO REPAIR OF CORE INSULATION FERMITTED.
C) CABLE ENDS SHALL BE SEALED AS PER BHEL SPECIFICATION.
D) PURCHASER SHALL HAVE RIGHT TO WITNESS THE SPARK TEST AT CORE STAGE.
E) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDOR'S Q.C. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER.
F) FILLERS / DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION.
G) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES, THE SAME SHALL BE AS PER VENDOR'S SAMPLING PLAN.
H) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION.

LEGEND :– P – PERFORMER : W–WITNESSER : V – VERIFYER:
1–BHEL/BHEL'S CUSTOMER : 2– VENDOR : 3–SUB VENDOR

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

	TITLE	SPECIFICATION NO. PES-506-05
		VOLUME II B
		SECTION D
		REV NO. 0 DATE 11.02.2002
		SHEET 1 OF 1

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not an exact copy

GENERAL TECHNICAL REQUIREMENTS
OF
415 V AC DISTRIBUTION BOARD

SPECIFICATION NO. PES-506-05

(7 SHEETS)

1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch of AC Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

2.0 STANDARDS

Major standards which shall be followed are listed below. Other applicable standards for any component, if not covered in the listed standards, shall also be followed.

IS:375	Marking& arrangement for swgr. busbars, main connections & aux. Wiring
IS:4064	Air-break switches, disconnectors switch-disconnectors & fuse combination units
IS:2147	Degree of protection provided by enclosures
IS:8623	Factory built assemblies of switchgear & controlgear

3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL REQUIREMENTS

ACDBs shall be of single front contruction having a continuous line-up of vertical sections housing switch-fuse modules only. ACDBs shall have duplicate incomers and a bus-section.In-cubicle rating of incomer and bus-section switches shall be identical to the associated busbar rating.Outgoing feeders shall be such so as to ensure uniform loading on each section DB.

ACDBs shall be indoor, air insulated, metal-clad and fixed type suitable for floor mounting.It shall conform to the degree of protection IP:54. Panels shall be fabricated from minimum 2mm thick CRCA sheet steel.

DB shall be front wired and front connected. They shall be fully compartmentalised with metal insulating partitions between compartments. Working height shall be limited between 450mm and 1800mm from floor level.

All instruments, switches etc. mounted on the front face of the panels shall be of flush type.

Each panel shall be provided with internal illumination lamp operated by door switch, space heater and switchfuse unit and plug socket with switch for hand lamp.

DBs shall be supplied with base frame made out of structural steel sections along with all necessary mounting hardware required for bolting/welding the base frames to the foundation.

3.2 BUSBARS & CONNECTIONS

Busbars shall be sized to carry continuously the total running load of the ACDB plus a 20% margin. The minimum clearance in air between phases and between phases and

earth for entire run of horizontal and vertical busbars shall be 25mm. Horizontal and vertical busbars and bus connections shall be of high conductivity copper/ aluminium alloy. Maximum temperature shall be limited to 90 deg C.

3.3 PANEL WIRING

All panels shall be fully wired at the factory to ensure proper functioning of all control, protection and interlock schemes. All wiring for external connection shall be brought to terminal blocks and numbered.

Panel wiring shall be carried out with flexible heat resistant 650V grade, PVC insulated stranded copper wire of minimum 2.5sq.mm cross-section.

Solderless compression /clamp type connection shall be used for wire terminals. Wiring shall be continuous between terminals without splicing. Each wire shall be identified at both ends with permanent markers having wire numbers as per approved wiring drawings.

Terminal blocks shall be box clamp type with marking strip. Not more than two wires shall be connected to one terminal. Spare terminals equal in number to 20% of active terminals shall be furnished.

3.4 GROUNDING

A copper ground bus, sized to carry maximum short circuit current shall run along the entire length of panel structure and shall have terminal connection at each end for connection to station ground grid (50x6 mm GI flat).

3.5 NAME PLATE

Name plates of approved design shall be furnished on each panel and for each instrument or device mounted on panel.

The material shall be lanucoid or approved equal 3mm thick with white letters on black background.

Name plates shall be held by self tapping screws. Name plates size shall be minimum 20x75mm for instruments devices and 40x50mm for panels.

4.0 SWITCHGEAR COMPONENTS

4.1 SWITCHES

Switches shall be triple/double pole air break type.

The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON & OFF position.

The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position . Means shall be provided for releasing the interlock at any time.

Switches shall be capable of withstanding the through fault current of back up fuse.

Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of three can be closed at a time.

4.2 FUSES

Fuses shall be HRC, preferably link type with a minimum interrupting capacity equal to short circuit current of the LV system.

Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

The fuse on incoming feeder wherever provided shall be chosen to provide discrimination with outgoing feeder fuses.

4.3 METERS & METER SELECTOR SWITCHES

All indicating instruments (96x96mm) shall be switchboard types with 250deg. Scale, antiglare glass and accuracy class of ±2% full scale. Each meter shall have zero adjuster on the front.

Meter selector switches shall be maintained contact, stay-put type with knob handle. Voltmeter selector switches shall be four position type.

5.0 PAINTING

All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).

6.0 TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

	TITLE	SPECIFICATION NO.
BHEL	415 V AC DISTRIBUTION BOARD (DATA SHEET – A)	VOLUME II B SECTION D REV NO. DATE SHEET 1 OF 1

1.0	GENERAL		
1.1	Type	:	Fixed Type
1.2	Service	:	Indoor
1.3	Enclosure	:	IP-54
2.0	SYSTEM		
2.1	Voltage	:	415 V±10%
2.2	Phase	:	3
2.3	Frequency	:	50Hz±5%
2.4	System	:	Solidly grounded
3.0	RATED CURRENT AT 50 DEG.C		
31.	Busbar	:	to be decided by tenderer
3.2	Switches	:	to be decided by tenderer
4.0	SHORT CIRCUIT RATING		
4.1	Interrupting	:	50kA
4.2	Short time for 1sec.	:	50kA
5.0	INSULATION LEVEL	:	2.5kV for 1min

	TITLE	SPECIFICATION NO.
	415 V AC DISTRIBUTION BOARD	VOLUME II B
		SECTION D
	DATA SHEET C/B	REV NO. / DATE
		SHEET 1 OF 3

1.0 EQUIPMENT

1.1 Make :

1.2 Type :

1.3 Reference Standard :

1.4 Construction

a/ Degree of protection :

b/ Sheet metal thickness (mm):

c/ Floor channel sills vibration damping pads & kick plate furnished

1.5 Whether all equipment are flush: Mounted

1.6 Name plate

a/ Material :

b/ Thickness :

c/ Size for

-Equipment :

-Panels :

1.7 Internal illumination

a/ Volt :

b/ Watt :

c/ Door switch controlled :

1.8 Space Heater :

a/ Volt :

b/ Watt :

c/ Thermostat controlled :

1.9 Plug Socket :

a/ Type :

b/ Rating :

1.10 Type & rating of isolating Switch-fuse units for incoming AC supply

1.11 Internal Wiring :

a/ Wire type :

b/ Voltage grade :

c/ Conductor material :

d/ Conductor size for :

-Current control circuit :

-Voltage circuit :

1.12 Terminal Block

a/ Make :

b/ Type :

c/ 20% spare terminals furnished

1.13 Ground Bus

a/ Material

b/ Size

1.14 Painting

a/ Type of finish

b/ Colour shade

2.0 SWITCHES

2.1 Make

2.2 Type

2.3 Reference standard

2.4 Breaking current at 415V AC

3.0 FUSE

3.1 Make

3.2 Type

3.3	Reference standard
3.4	Rupturing capacity (kA rms)
3.5	Cont. current at 50deg.C ambient and within cubicle (Amp.)
3.6	Cut-off currents (kA peak)
3.7	Whether fuse characteristics furnished
4.0	METER SELECTOR SWITCH
4.1	Make
4.2	Type
4.3	Reference standard
4.4	Contact rating
	a/ Make & continuous (Amp.)
	b/ Break inductive (Amp.)
5.0	INDICATING INSTRUMENT
5.1	Make
5.2	Type
5.3	Reference Standard
5.4	Type of movement
5.5	Accuracy class
5.6	Scale in degrees
5.7	VA barden

GENERAL TECHNICAL REQUIREMENTS

OF

LIGHTING DISTRIBUTION BOARD
&
LIGHTING PANEL

SPECIFICATION NO. PES-559-01A

1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch, installation & commissioning of AC Lighting Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

2.0 STANDARDS

Unless specified otherwise, the latest revisions of standards, codes and other applicable statutory rules and regulations specified in Annexure-I of Data Sheet A are applicable and shall be referred to.

3.0 Light Distribution Boards (LDBs)

3.1 General Requirements

3.1.1 LDBs shall be totally enclosed, modular in construction, indoor type and suitable for electrical system data as specified in Data Sheet A. The LDB shall be free standing type suitable for installation on cable trenches / floor.

3.1.2 LDBs shall be constructed from CRCA sheet and structural sections. Sheet thickness for load bearing members shall be 2.0 mm and that for non-load bearing members shall be 1.6 mm, unless specified otherwise in Data Sheet A. The design and construction of LDBs shall ensure adequate rigidity.

3.1.3 Vertical cable chambers / alleys of adequate width but not less than 250 mm shall be provided for incoming / outgoing cables of each panel.

3.1.4 LDBs shall have only one operational front. Door shall be provided at the front of each module to give full access to all the components.

3.1.5 LDBs shall consist of dust and vermin proof cubicles without the use of louvers (except the transformer compartment, where applicable).

3.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door, cover edges and cutout edges for pushbutton, lamps etc. for protection against dust. The door when closed, shall compress the gasket uniformly.

3.1.7 Cutout edges for instruments, relays etc. shall have sufficient overlap surface to minimize the dust entry. The arrangement for the front mounting of switch handles shall render the LDB reasonably dust free such that the normal operations are not affected.

3.1.8 Degree of protection for completed LDBs (Distribution Board) shall be IP:52 unless mentioned otherwise in Data Sheet A.

3.1.9 The LDBs shall be designed to prevent contact with live parts both within the modules and in the cable alley.

3.1.10 The ratings of all components shown in the enclosed drawings are indicative only. The bidder shall be responsible to check and coordinate the MCB characteristic with back up fuses etc. provided. Any change in size / ratings of components required for final arrangement may be complied with and provided by the vendor at no extra cost.

3.1.11 All equipment shall be constructed of non-hygroscopic and non-inflammable materials.

3.1.12 All components mounted in the LDBs shall be accessible and shall not impede access to wiring or terminals. All faults except busbar fault which may occur within any individual unit shall be confined within that unit only and shall not cause shutdown of any section of the board other than the affected unit itself. Maintenance and inspection shall be possible in any individual unit without affecting other units.

3.1.13 Incoming unit shall comprise of either switch-fuse / composite fuse-switch unit or MCCB as per scheme / Data Sheet A. Outgoing units shall be a switch-fuse / composite fuse-switch unit / MCB.

3.1.14 The rated continuous current of the equipment and components shall be as given in the schemes. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.

3.1.15 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module.

3.1.16 Defeat interlock shall be provided for the units comprising of switch or moulded case circuit breaker as a means of isolation device, such that it is possible to open the door with device ON. It shall not be possible to close the door till the interlock has been reinstated.

3.1.17 Each LDB shall be fitted with base frame made of angle or channel.

3.1.18 All fixing nuts and bolts together with grounding bolts shall be provided.

3.1.19 Lifting lugs shall be provided for each shipping section of LDB. Removal of such lugs or hooks shall leave no opening in the LDB.

3.2 LDBs with transformers (Additional Features)

3.2.1 The lighting distribution board shall be arranged in two adjacent but separate compartments, one compartment for the lighting transformer and the other for the incoming & outgoing feeders etc.

3.2.2 The transformer shall be mounted on the base channel and it shall be possible to easily remove the transformer from the cubicle after opening the door. Necessary portable ramp made of mild steel shall be supplied along with each LDB.

3.2.3 Independent gasketted hinged door with operating handle shall be provided for access to transformer & its taps. Operating handle shall have built-in key locking arrangement.

3.2.4 Suitable ventilation arrangement for the transformer compartment to dissipate the heat of the transformer shall be provided. The arrangement shall be in the form of louvers and the same shall be provided with galvanized wire mesh with dust catchers on the inside.

3.2.5 The degree of protection for transformer compartment shall be IP:42 unless mentioned otherwise in Data Sheet A.

3.2.6 Connections between transformer secondary terminals and the busbars shall be made by using PVC insulated flexible copper cables or busbars.

3.2.7 Warning plate shall be provided on transformer enclosure. The inscription of warning plate shall be as given below:

- DO NOT OPEN DOORS WHEN ENERGISED

- KEEP TAPS AT SAME POSITION FOR ALL PHASES

3.2.8 Transformer enclosure shall be provided with a danger plate.

3.3 Lighting Transformer

3.3.1 Lighting transformer, where specified shall form an integral part of lighting distribution board.

3.3.2 Lighting transformer shall be dry type, natural air cooled and suitable for mounting inside the lighting distribution board. Transformer shall be non-encapsulated type, unless specified otherwise in Data Sheet A.

3.3.3 Rating of transformer shall be 50 kVA as per type of LDB.

3.3.4 Voltage rating shall be given in Data Sheet A.

3.3.5 Percentage impedance shall be 3% for 50kVA and 4% for 100 kVA transformers, unless specified otherwise in Data Sheet A.

3.3.6 Off circuit tap changers/links shall be provided for $\pm$ 5% in steps of 2.5%.

3.3.7 Transformer winding insulation shall be class “F” or better.

3.3.8 Transformer shall be of vector group Dynl.

3.3.9 Winding shall be of copper material maximum winding temperature at full load and under site conditions shall not exceed 120 Deg. C.

3.3.10 Transformer shall be suitable for cable connections on the primary side and flexible cable or busbar connectin on the secondary side.

3.3.11 The secondary neutral of the transformer shall be brought out for getting a grounded 4 wire supply system.

3.3.12 The transformer neutral shall be brought outside the LDB for earthing. The neutral busbar shall be insulated from the LDB enclosure.

3.3.13 Transformer shall be provided with the rollers, pulling holes, lifting lugs, jacking positions etc.

3.4 Busbars, Connections and Joints

3.4.1 Busbars shall be made of aluminium grade E 91E or high conductivity copper (ETC), Busbar material shall generally be aluminium unless mentioned otherwise in Data Sheet A.

3.4.2 Busbars shall be supported on non-hygroscopic and non-inflammable insulators of material such as glass reinforced moulded plastic material, epoxy cast resin etc. Separate supports shall be provided for each phase of the busbars, Insulation level of neutral busbar shall be same as that of phase busbars.

3.4.3 Busbars shall be contained in a separate vermin-proof compartment within the LDB and shall have bolted sheet steel covers for providing suitable access.

3.4.4 Busbar clearances in the air shall be as per applicable standard for 500V, 3 phase system.

3.4.5 Temperature of busbars, droppers and connections shall not exceed 90 Deg. C for an ambient of 50 Deg. C while carrying maximum continuous current.

3.4.6 The busbar, busbar connections and supports shall have sufficient strength to withstand thermal and electromechanical stresses produced by the specified short circuit level of the system.

3.4.7 Busbars (including neutral busbar) shall be capable of carrying the short-time current specified in Data Sheet A. The duration of short-time current shall be 1 sec unless mentioned otherwise in Data Sheet A. For the specified current and duration, there shall be no damage to the equipment.

3.4.8 The neutral bus shall be rated same as phase bus.

3.4.9 Main busbars and connections shall be prominently marked and displaced for standard sequence counting from rear to front top to bottom, or left to right as viewed from the switching device operating mechanism side.

3.4.10 Busbars and connections shall be provided with colour coded PVD sleeves. All live parts shall be properly shrouded with insulating material.

3.4.11 Earth busbar shall be provided separately. Material of earth busbar shall be GI unless mentioned otherwise in Data Sheet A.

3.4.12 Busbar Joints

a) Busbar and tap off joints shall be bolted type.

b) Busbars shall be thoroughly cleaned before jointing. Suitable contact greae shall be applied to remove oxide film just before jointing.

c) For copper busbars, the connecting portion shall be tinned or silver plated.

3.5 Wiring and Terminals

3.5.1 All internal wiring for connections to remote equipment shall be brought to terminal boards. Spare contacts of devices shall also be wired upto terminal board as per schemes. Wires shall not be jointed or teed-off except at terminal points.

3.5.2 Wiring shall be made by 1000 volt grade three / seven strand PVC insulated copper wire having a cross-sectional area of not less that 1.5 sq.mm. All connections from CT leads upto instruments, terminals shall be made by copper wires of minimum 2.5 sq.mm. size.

3.5.3 All wiring shall be made with the Colour Codes specified below:

a) 3 phase AC Connections

Phase 1 (R)	Red
Phase 2 (Y)	Yellow
Phase 1 (B)	Blue
Neutral	Black

b) 1 phase AC Connections

Phase	Red/ Yellow / Blue (as per associated circuit)
Neutral	Black

c) DC Connections

Positive	While
Negative	Grey

d) Earth Connection Green

3.5.4 Where wiring passes from one compartment to another, the aperture shall be 'Bushed' to prevent damage to wires against sheet metal edges. Bushes may comprise of good quality rubber/ PVC grommets.

3.5.5 Every wire end shall be fitted with numbered ferrules of white or yellow colour having glossy finish with identification number engraved in black, Ferrules shall be made of moisture and oil resisting insulating material. Ferrules shall be or interlocked type or tight fitting type. Ferrules shall be so fitted that they will not get detached, when the wire is removed from the terminal.

3.5.6 System of marking of wiring shall be as per applicable standard.

3.5.7 All wires used internally shall have crimped on tinned copper lugs for terminations.

3.5.8 Terminal boards shall be stud type with insulating barriers of adequate height.

3.5.9 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal.

3.5.10 Terminal boards shall be mounted vertically or in the horizontal rows and properly spaced to have clean wiring arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked near the terminal boards.

3.6 Controls

The controls shall be provided as per purchaser's requirements covered in the specification and control schemes.

3.7 Switch Fuse Units

3.7.1 These units shall preferably comprise of switches having integral fuses, called composite units. Alternatively, combination units of separate switch and fuse may also be acceptable.

3.7.2 These units shall be provided for general purpose i.e. incoming or outgoing units.

3.7.3 The units shall be of the air break air insulated type and designed to ensure safety to operating personnel.

3.7.4 Composite units shall have integral fuses i.e. fuse carrier with fuse link (fuse link forming the moving contact). The design shall ensure that the moving contact is not live when switch is open i.e. in OFF position, so as to facilitate removal of fuse.

3.7.5 The switch shall be capable making and carrying the system prospective fault current, but limited in magnitude and duration by the cut off characteristics of the largest HRC fuse link that may be fitted to that unit.

3.7.6 The fixed contact shall be so shrouded that maintenance of the unit can be carried out in safety with the busbars live.

3.7.7 Where one isolating switch is used as the incoming device, the incoming side fixed contacts shall be shrouded to ensure that maintenance can be carried out with the remote fuse and switch closed.

3.7.8 Composite switch-fuse or the combination of switch and fuse shall meet the requirements of its components as follows:

3.7.9 Isolating Switch

a) Switches shall be air-break, quick make, quick break heavy duty type conforming to applicable standard.

b) All switches shall have visible ON / OFF position indication and shall be padlockable in any (ON /OFF) position.

c) Switches shall be door interlocked such that it shall not be possible to gain access to inside the unit unless the isolating switch is in OFF position.

d) The switches shall be suitable for independent manual operation.

e) The switch contacts shall be of silver alloy or silver plated copper and springs of non corrosive material.

f) Inter-phase barriers shall be provided to prevent possibilities of phase to phase fault in the switch. The switch shall also be shrouded from all sides to prevent access to live parts on the switch after opening the unit door. The barriers and shrouding shall extend upto the height of switch to fully enclose both side terminals of the device. The arrangement shall permit easy maintenance.

3.7.10 High Rupturing Capacity (HRC) Fuses

a) The fuse serving as the short-circuit protective device in isolating fuse-switch units shall be of HRC cartridge, current limiting and plug-in non-deteriorating type.

b) The fuse carriers shall be easily withdrawable for replacement of fuse, Insulated fuse pullers shall be provided where fuses are not mounted in insulating carriers to remove and replace fuses in live conditions.

c) Fuses shall preferably be fitted with a device to indicate operation (i.e. when the fuse has blown).

d) Live terminals of fuse bases shall be shrouded to prevent contact with personnel where fuse links are not mounted in carriers and are directly plugged into the fuse base. Inter-phase barriers extending throughout the length of the fuse base shall be provided to prevent inter-phase short circuit. They shall be shrouded from all sides to prevent accidental contact.

e) Fuse carriers and bases shall be of good quality moulded insulating material. Porcelain fuse bases and carriers will not be accepted.

3.8 Cable Terminations

3.8.1 All cable, either incoming or outgoing to the LDB, shall be terminated in a cable chamber. For each panel, there shall be a cable chamber on the side. The door of cable chamber should open or be locked with the help of a tool. Unless stated otherwise in Data Sheet A, all cables shall enter from the bottom.

3.8.2 Removable undrilled gland plates of sheet steel shall be provided in the cable chamber for entry of cables. Minimum thickness of gland plate shall be 3mm. The gland plate shall be of adequate size for connecting requisite number of cable glands for power and control cables.

3.8.3 Heavy duty bolt-on termination tinned copper lugs of compression type shall be used in for power cable termination.

3.8.4 For supporting and clamping of cable cores at regular interval in cable alleys, suitable slotted angle upto the respective terminal blocks shall be provided.

3.8.5 The supply of tinned copper cable lugs for power cables from part the supply of equipment.

3.9 Earthing

3.9.1 An earth busbar of adequate size of galvanized MS shall be provided at the bottom for the entire length of the LDB.

3.9.2 Every metal part other than those forming parts of an electrical circuit shall connected to the earth bus by means of high conductivity copper wire of size not less than 2.5 sq. mm cross-sectional area.

3.9.3 Doors shall have a flexible copper wire for earth connection to fixed unit.

3.9.4 Each LDB shall be fitted with two earthing studs located in accessible position on sides for connection of internal earth busbar to the external earthing connection.

3.9.5 Earth busbar shall be brought outside LDB for making external connections.

3.10 Type of LDBs

The LDBs shall be of following type:

a) LDB-H (n) - AC LDB with 100 kVA transformer

b) LDB-F (n) - AC LDB with 50 kVA transformer

c) LDB-N (n) - AC LDB with no transformer

d) LDB-D (n) - DC LDB

NOTE: (n) indicates number of outgoing feeders.

3.10.1 AC LDBs (LDB-H, LDB-F, LDB-N)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams:

a) One lighting transformer (LDB-H & LDB-F)
LIGHTING SYSTEM

b) One incomer of TP / TPN switch-fuse unit or MCCB / MCCB with neutral link as per Data Sheet A. It shall be provided on the primary side of transformer for LDB type LDB-H & LDB-F.

c) Set of busbars with 3 phase and neutral.

d) TPN switchfuse units for each outgoing circuit.

e) Three indicating lamps with fuses for indicating bus supply ON.

f) CT operated ammeter with selector switch.

g) VT operated voltmeter with selector switch.

h) Power & control terminals, earth-stud, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

3.10.2 DC LDBs (LDB-D)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams:;

a) One incomer of two pole switch-fuse unit.

b) Two pole DC contactor on the incoming circuit for changeover to DC in case of AC normal supply failure.

c) One under voltage relay of suitable range, if specified in Data Sheet A.

d) One ON delay timer.

e) One test push button.

f) Set of busbars for positive and negative.

g) Two pole switch-fuse units / MCB for outgoing feeders.

h) Two indicating lamps with fuses for indicating but supply ON.

i) Power & control terminals, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

4.0 LIGHTING PANELS (LPs)

4.1 General Requirements of Lighting Panels

4.1.1. LPs shall be totally enclosed, suitable for electrical system data as specified ind Data Sheet A.

4.1.2 Panels shall be suitable for indoor / outdoor application as per Data Sheet A and BOQ. Outdoor panels shall have a sloping canopy.

4.1.3 LPs shall be constructed from CRCA sheet. Sheet thickness shall be 2.0mm, unless mentioned otherwise in Data Sheet A. The construction of LPs shall ensure adequate rigidity.

4.1.4 All components of the LP shall be fully mounted inside the panel, LPs shall have only one operational front. Door shall be provided to give full access to all the components. Door shall have padlocking arrangement.

4.1.5 LPs shall consist of dust and vermin proof cubicles without the use of louvers.

4.16 Good quality synthetic rubber / neoprene gaskets shall be put around the door. The door when closed, shall compress the gasket uniformity.

4.17 Unless mentioned otherwise in Data Sheet A, degree of protection for completed LPs shall be IP:52 for indoor LPs and IP:55 (with weather-proof protection & canopy) for outdoor LPs.

4.1.8 The LPs shall be designed to prevent contact with live parts when the front door is open.

4.1.9 All busbars (phase, neutral, positive, negative as applicable) within a panel shall be of the same size.

4.1.10 All control wiring inside the panels shall be carried out with 1100 V grade, PVC insulated flexible copper wire of 2.5 sq.mm size.

4.1.11 The rated continuous current of the equipment and components

4.1.12 Each LP shall be fitted with MS. Mounting brackets.

4.1.13 Panel shall be suitable for top / bottom cable / conduit entires. However, outdoor LPs shall have bottom cable / conduit entry. Removable undrilled undrilled gland plate of sheet steel shall be provided for entry of cables. Minimum thickness of gland plate shall be 3 mm. The gland plate shall be of adequate size having knock-outs for requisite number cable connections. Gland plate shall be provided with gasket.

4.1.14 The lighting panel shall be complete with copper busbars, and shall incorporate switch fuse or MCB on the incoming side, single pole miniature circuit breakers (MCBs) for AC outgoing circuits and double pole MCBs for DC outgoing circuits. Number of outgoing circuits shall be as per BOQ.

4.1.15 Each lighting panel shall be fitting with two GI earth studs located in accessible position on the outside of the panel on opposite sides.

4.1.16 All metal parts of the panel except current carrying parts shall be bonded together electrically to the earthing stud.

4.1.17 Each panel shall be fitted with phase barriers of fireproof insulating material in such a manner that it is not readily possible for personnel to touch the phase busbars.

Insulating sheet shall be fitted around the MCBs such that only the surface and toggle of the MCBs are available on the front.

4.1.18 The supply of cable lugs for power and control cable connections forms part the supply of equipment.

4.1.19 Each panel shall be provided with a circuit directory plate with inscriptions neatly typed and laminated fitted on the inside of door.

4.2 Type of Lighting Panels

a)	LP-A (n)	-	AC	Lighting Panel
b)	LP-D (n)	-	DC	Lighting Panel
c)	LP-F (n)	-	Fancy	Lighting Panel (Decorative)
d)	LP-V (n)	-	Aviation	Lighting Panel

NOTE: (n) indicates number of outgoing circuits.

4.3 AC Lighting Panel (LP-A)

4.3.1 LPs shall be provided with TPN switch as incomer.

4.3.2 Requisite number of single pole MCBs shall be provided for outgoing circuits.

4.3.3 Separate neutral shall be available at terminal block for each outgoing circuit.

4.3.4 Construction of AC Normal and AC Emergency panels shall be same.

4.4 DC Lighting Panels (LP-D)

4.4.1 LPs shall be provided with double pole switch as incomer.

4.4.2 Requisite number of double pole MCBs shall be provided for outgoing circuits.

4.5 Decorative Type Lighting Panels (LP-F)

4.5.1 Decorative lighting panels shall be designed for use in areas like administrative building, service building, canteen, residential premises etc.

4.5.2 Thickness of sheet steel shall be as per manufacturer’s practice.

4.5.3 LPs shall be of tone colour with elegant finish.

4.5.4 LPs shall be provided with TPN switch as incomer and requisite number of MCBs shall be provided for outgoing circuits.

4.5.5 LPs shall be suitable for either surface or flush mounting as per Data Sheet A and BOQ. Flush mounted panels shall have the collared door suitable for matching with the wall.

4.5.6 Lighting Panels may be provided with transparent acrylic cover for operation of MCBs, if asked for in Data Sheet A.

4.5.7 LPs shall be provided with knockouts on the top, bottom and sides.

4.6 Aviation Lighting Panel (LP_V)

4.6.1 Aviation Lighting Panels shall be provided for feeding power supply to Aviation obstruction luminaries.

4.6.2 Each Aviation Lighting Panel shall comprise of the following:

a) One TPN door interlocked switch-use unit. Interlock defeat feature shall also be provided.

b) Three pole AC Contactor

c) 00-24 hrs timer and a photo-electric switch for automatic switching of contactor

d) Three phase & neutral busbars

e) Single pole or three pole MCBs for each outgoing circuit as per Data Sheet A

f) Two lamps for bus supply ON & OFF indications

g) Complete wiring arrangement as per control scheme.

h) Auto-Manual selector switch

i) ON push button

j) OFF push button

k) Photo switch

4.6.3 Switching ON and switching OFF shall be through both 00-24 hrs timer and light sensor in automatic mode.

4.6.4 One number light sensor in weather proof enclosure having IP:55 degree of protection shall be supplied loose along with each SLP.

4.6.5 Internal power wiring shall be done with PVC insulated Cu wire of suitable size. All control wiring inside the panel shall be carried out with 1100 V grade, PVC insulated flexible copper wires.

5.0 Guaranteed Performance Requirements

5.1 The vendor shall guarantee satisfactory performance of the equipment under all conditions and requirement as laid down by this specification.

5.2 For the general requirements of performance guarantees refer to other parts of the specification.

6.0 PAINTING

(All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).

7.0 TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

1.0 SYSTEM DESIGN DATA

1.1	Design Ambient		:	50 Deg.C
1.2	Relative humidity		:	
	a)	Average	:	As per project synopsis
	b)	Maximum	:	-do-
1.3	Details of Operating parameters			
	a)	AC Supply		
		i. Rated voltage	:	415 V
		ii. Rated frequency	:	50 Hz
		iii. Voltage variation (Permissible)	:	± 10 %
		iv. Frequency variation (Premissible)	:	± 5 %
		v. Combined voltage & Frequency variation (sum of absolutes permissible)	:	10%
		vi. System fault level At rated voltage	:	50 kA for 0.25 sec.
		vii. System grounding	:	Solidly
	b)	DC Supply		Not applicable
		i. Rated voltage	:	V
		ii. Voltage variation (Permissible)	:	%
		iii. System fault level at rated voltage	:	
	c)	AC Emergency luminaries as per percentage of total luminaries	:	Not applicable %
2.0	APPLICABLE STANDARDS		:	As per Annexure I

3.0	LIGHTING DISTRIBUTION BOARDS			
3.1	Sheet thickness	:	2.0	mm
3.2	Degree of protection	:		
	a) Main panel	:	IP 54	
	b) Transformer cubicle	:	IP 33	
3.3	Type of Incomer	:	Switch-Fuse	
3.4	Type of Outgoing Feeders	:	Switch-Fuse	
3.5	Voltage rating of transformer	:	415 V	
3.6	Whether transformer is encapsulated:		No	
3.7	Transformer impedance			
	a) 100 kVA	:	-	%
	b) 50 kVA	:	4.0	%
3.8	Bus bar material	:	Aluminium	
3.9	Earth busbar material	:	GI (50X6 mm)	
3.10	Cable entry	:	Bottom	
3.11	Whether under voltage relay required in DC LDB	:	Not applicable	
4.0	LIGHTING PANEL			
4.1	Application	:	Both Indoor & outdoor	
4.2	Sheet thickness	:	2.0	mm
4.3	Degree of protection			
	a) Indoor	:	IP : 54	
	b) Outdoor	:	IP : 55 (weather-proof protection with canopy)	
4.4	Type of Incomer	:	Switch-Fuse	
4.5	No. of poles for Aviation lighting panel MCBs	:	1 / 3	

4.6	Type of mounting of decorative lighting panel		:	Not applicable	
4.7	Whether decorative lighting panel required with acrylic panel		:	Not applicable	
5.0	LABELING		:	As per specification	
6.0	PAINTING		:		
6.1	Shade (as per IS:5)				
				Interior	Exterior
	a)	LDBs	:	Glossy white	631 of IS:5
	b)	LPs	:	-do-	-do-
6.2	FINISH				
	a)	Interior	:	Semi-glossy	
	b)	Exterior	:	Semi-glossy	
6.3	Paint thickness (min.)		:	50 microns	
7.0	MAKE OF COMPONENTS		:	Shall be subject to BHEL approval	

	TITLE	SPECIFICATION NO.
BHEL	LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL (DATA SHEET – B)	VOLUME II B SECTION D REV NO. DATE SHEET 1 OF 4

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

1.2 Details of Operating parameters

a) AC Supply

i. Rated voltage : V

ii. Rated frequency : Hz

iii. Voltage variation (Permissible) : %

iv. Frequency variation (Permissible) : %

v. Combined voltage & frequency variation (sum of absolutes permissible) : %

vi. System fault level at rated voltage :

b) DC Supply

i. Rated voltage : V

ii. Voltage variation (Permissible) : %

iii. System fault level at rated voltage :

2.0 APPLICABLE STANDARDS : As per Annexure I

3.0 Lighting Distribution Boards

3.1 Sheet thickness : mm

3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

3.3	Type of Incomer	:	[ ] MCCB [ ] Switch-Fuse
3.4	Type of Outgoing Feeders	:	[ ] Switch-Fuse [ ] MCB
3.5	Bus bar material	:	[ ] Aluminium [ ] Copper
3.6	Cable entry	:	[ ] Bottom [ ] Top
3.7	Whether under voltage relay required in DC LDB	:	[ ] Yes [ ] No
3.8	Range of time delay relay	:	
3.9	Whether hinged door with locking facility provided	:	[ ] Yes [ ] No
3.10	Whether earth busbar provided	:	[ ] Yes [ ] No
3.11	Earth busbar material	:	[ ] GI [ ] Copper
3.12	Fault current and duration	:	kA
3.13	Lighting Transformer		
a)	kVA Rating(s)	:	50 100
b)	Type of cooling	:	
c)	Rated current		
i.	Primary	:	Amp.
ii.	Secondary	:	Amp.
d)	Rated voltage		
i.	Primary	:	Volts
ii.	Secondary	:	Volts
e)	Rated frequency	:	Hz
f)	No. of phases	:	
g)	Temperature rise above ambient in winding by resistance	:	^{o}C

h)	Vector Group	:		
i)	Tap changer			
	i. Type	:		
	ii. Range	:		
	iii. No. of taps	:		
	iv. Voltage of each tap	:		
j)	Type of ventilation arrangement provided for transformer enclosure	:		
k)	Iron loss at 50 Hz and 100% rated voltage	:		kW
l)	Regulation at full load and at 75 ^{o}C and 0.8 p.f. lagging	:		
m)	Copper loss at rated load and 75 ^{o}C	:		kW
n)	Impedance at rated current, frequency and at 75 ^{o}C	:		
o)	Winding conductor material	:		
p)	Whether transformer is encapsulated	:	[ ] Yes [ ] No	
q)	Insulation class	:		
r)	Weight	:		kg

4.0	Lighting Panel		
4.1	Application	:	[ ] Indoor [ ] Outdoor [ ] Both
4.2	Sheet thickness	:	mm
4.3	Degree of protection		
a)	Indoor	:	IP :

	b) Outdoor	:	IP :
4.4	Type of Incomer	:	[ ] Switch-Fuse [ ] MCB
4.5	MCB type for street lighting panel.	:	[ ] 1 pole [ ] 3 pole
4.6	Busbar material	:	
4.7	Whether hinged door with with locking facility provided	:	[ ] Yes [ ] No
4.8	Whether earthing studs provided	:	[ ] Yes [ ] No

5.0 LABELING

	Requirement of specification complied with	:	[ ] Yes [ ] No

6.0 PAINTING

6.1 Shade (as per IS:5)

			Interior	Exterior
	a) LDBs	:		
	b) LPs	:		

6.2 Finish

	a) Interior	:	[ ] Matt [ ] Semi-glossy
	b) Exterior	:	[ ] Semi-glossy [ ] Full-glossy

6.3 Paint thickness (min.) : microns

7.0 O&M SPARES

7.1	Duration for which O&M spares considered	:	years

	TITLE	SPECIFICATION NO.
	LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL (DATA SHEET – C)	VOLUME II B
		SECTION D
		REV NO. / DATE
		SHEET 1 OF 5

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

1.2 Details of Operating parameters

a) AC Supply

i. Rated voltage : V

ii. Rated frequency : Hz

iii. Voltage variation (Permissible) : %

iv. Frequency variation (Permissible) : %

v. Combined voltage & frequency variation (sum of absolutes permissible) : %

vi. System fault level at rated voltage :

b) DC Supply

i. Rated voltage : V

ii. Voltage variation (Permissible) : %

iii. System fault level at rated voltage :

2.0 APPLICABLE STANDARDS : As per Annexure I

3.0 LIGHTING DISTRIBUTION BOARDS

3.1 Sheet thickness : mm

3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

3.3 Type of Incomer : [ ] MCCB

			[ ] Switch-Fuse
3.4	Type of Outgoing Feeders	:	[ ] Switch-Fuse [ ] MCB
3.5	Bus bar material	:	[ ] Aluminium [ ] Copper
3.6	Cable entry	:	[ ] Bottom [ ] Top
3.7	Whether under voltage relay required in DC LDB	:	[ ] Yes [ ] No
3.8	Range of time delay relay	:	
3.9	Whether hinged door with locking facility provided	:	[ ] Yes [ ] No
3.10	Whether earth busbar provided	:	[ ] Yes [ ] No
3.11	Earth busbar material	:	[ ] GI [ ] Copper
3.12	Fault current and duration	:	kA
3.13	Lighting Transformer		
a)	kVA Rating(s)	:	50 100
b)	Type of cooling	:	
c)	Rated current		
i.	Primary	:	Amp.
ii.	Secondary	:	Amp.
d)	Rated voltage		
i.	Primary	:	Volts
ii.	Secondary	:	Volts
e)	Rated frequency	:	Hz
f)	No. of phases	:	
g)	Temperature rise above ambient in winding by resistance	:	^{o}C
h)	Vector Group	:	

i) Tap changer

i. Type :

ii. Range :

iii. No. of taps :

iv. Voltage of each tap :

j) Type of ventilation arrangement provided for transformer enclosure :

k) Iron loss at 50 Hz and 100% rated voltage : kW

l) Regulation at full load and at 75 ^{o}C and 0.8 p.f. lagging :

m) Copper loss at rated load and 75 ^{o}C : kW

n) Impedance at rated current, frequency and at 75 ^{o}C :

o) Winding conductor material :

p) Whether transformer is encapsulated : [ ] Yes [ ] No

q) Insulation class :

r) Weight : kg

4.0 LIGHTING PANEL

4.1 Application : [ ] Indoor [ ] Outdoor [ ] Both

4.2 Sheet thickness : mm

4.3 Degree of protection

a) Indoor : IP :

b) Outdoor : IP :

4.4	Type of Incomer	:	[ ] Switch-Fuse [ ] MCB
4.5	MCB type for street lighting panel.	:	[ ] 1 pole [ ] 3 pole
4.6	Busbar material	:	
4.7	Whether hinged door with with locking facility provided	:	[ ] Yes [ ] No
4.8	Whether earthing studs provided	:	[ ] Yes [ ] No

5.0 LABELING

Requirement of specification complied with	:	[ ] Yes [ ] No

6.0 PAINTING

6.1 Shade (as per IS:5)

		Interior	Exterior
a)	LDBs	:	
b)	LPs	:	

6.2 FINISH

a)	Interior	:	[ ] Matt [ ] Semi-glossy
b)	Exterior	:	[ ] Semi-glossy [ ] Full-glossy

6.3 Paint thickness (min.) : microns

7.0 MAKE

EQUIPMENT	MAKE	TYPE DESIGNATION OF MANUFACTURER
7.1 LDBs		
a) AC		
b) DC		

7.2 LPs

a) AC

b) DC

c) Decorative

d) Street Lighting

8.0 QUANTITY VARIATION (Limited to the value of the contract)

a) Till the "Engineering" is complete : %

b) Till the "Erection" is complete : %

9.0 O&M SPARES

9.1 Duration for which O&M spares considered : years

10.0 DOCUMENTATION

Whether following enclosed :

a) General Arrangement drawings of all types of LDBs : [ ] Yes [ ] No

b) General Arrangement drawing of Lighting Transformer : [ ] Yes [ ] No

c) Bar chart of activities of manufacture, testing, inspection and dispatch : [ ] Yes [ ] No

The above documents shall be submitted in the form of Annexure- A to Annexure - C in the exact order listed above along with this Data Sheet C duly filled up.

	TITLE	SPECIFICATION NO.	
BHEL	LIGHTNING PROTECTION OF CHIMNEY (SUPPLY & INSTALLATION)	VOLUME	II B
		SECTION	D
	DATA SHEET – C (TO BE SUBMITTED BY SUCCESSFUL BIDDER)	REV NO.	DATE
		SHEET 1 OF 1	

1.0 Name of manufacturer :

2.0 Place & country of manufacture :

3.0 Standards applicable :

- i/ For materials & sizes :
- ii/ For galvanisation/Electroplated coating :
- iii/ For testing uniformity of Galvanization :
- iv/ For code of practice :
- v/ For temporary lightning protection during construction :

4.0 Thickness of galvanizing on steel (microns) :

5.0 Thickness of Electroplated coatings (microns) :

6.0 Thickness of Lead coating on copper (mm) :

7.0 Materials and sizes offered :

- i/ Below ground annular ring conductor :
- ii/ Electrodes :
- iii/ Below ground interconnection conductor :
- iv/ Down Conductors :
- v/ Vertical air terminations :
- vi/ Horizontal air termination :
- vii/ Test Pit :
- viii/ Earthing band ring (above landing platform) :
- ix/ Test Link :
- x/ Conductor for equipment earthing :

ANNEXURE-I

LIST OF APPLICABLE STANDARDS

Illumination

1.	Code of practice for interior illumination	[ ] IS 3646 [ ]
2.	Code of practice for industrial lighting	[ ] IS 6665 [ ]
3.	Code of practice for design of electrical street lighting installations	[ ] IS 1944 [ ]

Luminaires

4.	General and safety requirement for electric lighting fittings	[ ] IS 1913 [ ]
5.	Luminaires	[ ] IS 10322 [ ]
6.	Industrial lighting fittings with metal reflector	[ ] IS 1777 [ ]
7.	Industrial lighting fittings with plastic reflectors	[ ] IS 3287 [ ]
8.	Decorative lighting outfits	[ ] IS 5077 [ ]
9.	Water proof electric lighting fittings	[ ] IS 3528 [ ]
10.	Water tight electric lighting fittings	[ ] IS 3553 [ ]
11.	Dust proof electric lighting fittings	[ ] IS 4012 [ ]
12.	Dust tight electric lighting fittings	[ ] IS 4013 [ ]
13.	Flameproof electric ltg. fittings well glass & bulk head types	[ ] IS 2206 [ ]
14.	Electric lighting fittings for division 2 areas	[ ] IS 8224 [ ]

Lamps

15.	Electric lamps, tungsten filament general service	[ ] IS 418 [ ]
16.	Tubular fluorescent lamps for general lighting service	[ ] IS 2418 [ ]
17.	High pressure mercury vapour lamps	[ ] IS 9900 [ ]
18.	High pressure sodium vapour lamps	[ ] IS 9974 [ ]

Luminaire Components

19.	Ballast for fluorescent lamps for switch start circuits	[ ] IS 1534 [ ]
20.	Ballast for high pressure mercury vapour lamps	[ ] IS 6616 [ ]
21.	Capacitors for electric discharge lamps (fluorescent and MV)	[ ] IS 1569 [ ]
22.	Bi-pin lamp holders for tubular fluorescent lamps	[ ] IS 3223 [ ]
23.	Methods of measurment of lamp cap temp. rise	[ ] IS 8913 [ ]
24.	Starters for fluorescent lamps	[ ] IS 2215 [ ]
25.	Holders for starters for tubular fluorescent lamps	[ ] IS 3324 [ ]
26.	Cast acrylic sheets for use in luminaires	[ ] IS 7569 [ ]

Assembled Equipment and Components

27.	General requirements for swgr. and control gear for voltage not exceeding 1000 V AC or 1200 V DC	[ ] IS 4237 [ ]
28.	Code of practice for selection, installation & maintenance of switchegear & control gear	[ ] IS 10118 [ ]
29.	Flame proof enclosures for electrical apparatus	[ ] IS 2148 [ ]

30.	Classification of hazardous areas for electrical installations	[ ] IS 5572 [ ]
31.	Degree of protection provided by enclosures for LV switchgear & control gear	[ ] IS 2147 [ ]
32.	Dry type transformers	[ ] IS 11171 [ ]
33.	Air break switches, disconnector etc. and fuse combinations units	[ ] IS 4064 [ ]
34.	Miniature air break circuit breaker for voltages not exceeding 1000 V	[ ] IS 8828 [ ]
35.	Low voltage Fuses	[ ] IS 9224 [ ]
36.	Contactors for voltags not exceeding 1000 V AC or 1200V DC	[ ] IS 2959 [ ]
37.	Indicator lamps (visual)	[ ] IS 1901 [ ]

Poles, Sockets and Other Miscellaneous

38.	Tubular steel poles for over head power lines	[ ] IS 2713 [ ]
39.	Three pin plugs and sockets	[ ] IS 1293 [ ]
40.	Switch socket outlets (non-interlocking)	[ ] IS 4615 [ ]
41.	Interlocking switch socket outlet	[ ] IS 4160 [ ]
42.	Structural steel (Standard quality)	[ ] IS 226 [ ]
43.	Danger notice plates	[ ] IS 2551 [ ]
44.	Boxes for enclosure of electric accessories steel & cast iron boxes	[ ] IS 5133 [ ]
45.	Code of practice for general construction in steel	[ ] IS 800 [ ]

46.	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes	[ ] IS 5082 [ ]
47.	Code of practice for phosphating of iron and steel	[ ] IS 6005 [ ]
48.	Colour for ready mixed paints & enamels	[ ] IS 5 [ ]
49.	Recommended practice for hot dip galvanising of iron & steel	[ ] IS 2629 [ ]
50.	Method of testing uniformity of coating on zinc coated articles	[ ] IS 2603 [ ]

1.0 CABLES

1.1 H T CABLES

System cables shall be 6.6kV (UE) grade suitable for use in medium resistance earthed system, stranded & compacted aluminium conductor, extruded semi conducting screen over conductor, XLPE insulated, semi-conducting followed by copper tape screened, extruded PVC Type ST – 2 inner sheathed, overall PVC Type ST – 2 FRLS outer sheathed, conforming to IS 7097 (Part II), IEC-502 for constructional details and tests.

1.2 L T POWER CABLES

LV Power Cable shall be 1100 V grade, single / multi core, armoured, stranded aluminium conductor, PVC type-A insulated, with PVC inner sheath and outer sheath made of FRLS PVC compound, overall PVC ST-1 FRLS, generally conforming to IS 1554 Part-I. The cables used for DC system shall be of single core type. In case cables are used between LV side of transformer and 415V switchgear incomer and tie between two switchgear / MCC, the cables may be 1100 V grade XLPE insulated. All other details shall be same as that of 6.6 kV XLPE cables. Minimum conductor cross section of power cables shall be 6-sq. mm for aluminium cables.

1.3 CONTROL CABLES

Control cables shall be 1100V grade, multi core, minimum 2.5 sq. mm cross section, stranded copper conductor having minimum 7 strands, PVC type-A insulated, PVC type ST-1 inner sheathed / galvanised steel wire armoured, overall PVC type ST1 FRLS outer sheathed generally conforming to IS1554 Part-I. In situations where accuracy of measurement or voltage drop in control circuit warrants, higher cross sections as required shall be used.

1.4 LIGHTING WIRES

1100V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS-694-1990 / IEC-227 Part 1 to 5 (1979) / IEEE-719 (1971). Minimum cross section of copper wires shall be 2.5 sq. mm for lighting circuits and 4 sq. mm for receptacle circuits.

1.5 TRAILING POWER AND CONTROL CABLES FOR MOBILE EQUIPMENT.

6.6 kV (UE) and 1100V-(E) grade power & control flexible trailing, annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed and shall have conductor screen of rubber. Cables shall conform to IS requirements and any other applicable standards.

2.0 CABLE PROPERTIES

2.1 All single core power cables will have wire / strip armouring of aluminium, whereas multi core power cable will have galvanised steel wire / strip armouring.

2.2 The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.

2.3 The outer sheath of FRLS PVC compound shall meet the following performance requirements:

(a) The critical oxygen index value shall be minimum 29 when tested at 27$\pm$ 2^0C as per ASTM-D-2763-77 and the temperature index shall be minimum 250^0C at oxygen index value of 21 when tested as per NES-715.

(b) The maximum acid gas generation as determined by titration method shall be less than 20% by weight when tested as per IEC-754-1 (1994).

(c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2743-7 (1977).

(d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53377.

2.4 The finished cable shall pass the flammability test as per IEC-322-1 (1993) and IEEE-3733. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475 (1977).

2.5 Cables for devices mounted on or near hot surfaces of Steam Generators, Turbine Generators, Main steam etc will have heat resistance type outer sheath.

3.0 DESIGN CRITERIA FOR CABLE SIZING

3.1 POWER CABLES

Power cable sizes shall be selected on the following basis :

3.1.1 Power cables shall carry the full load current of the circuit continuously under site conditions considering the condition listed below: :-

- Ambient designs temperature 50 deg. C.
- Maximum allowable temperature under normal full load condition and under short circuit condition based on material selected (XLPE/PVC).
- Maximum short circuit fault current as specified in relevant section.
- Ambient temperature for underground cables, 40 deg. C.
- De-rating factors:(a). Cable laid in air - 0.7 (b) Cable laid in ground touching each other – 0.6.

3.1.2 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for 6600V motor feeders and transformer feeders having high-set instantaneous protection shall be 0.16 sec., whereas tie between two 415V switchgear and any two 6600V switchgear shall be 0.5 sec, and for incomers and tie feeders 1.0 sec.

3.1.3 For 6600V motors controlled by vacuum contactors with back-up HRC fuses, the minimum cross-section of cables shall be based on the cut-off current of the fuses and its fusing time.

3.1.4 For the cables to 415V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time.

3.1.5 Voltage drop from transformer secondary to motor terminals during starting of motors will be limited to the following values :

(i) For all motors except BFP – 15% of the rated voltage.
(ii) For BFP motors – 20% of the rated voltage.
(iii) For LV motors – 15% of the rated voltage.

3.1.6 Voltage drop in feeder cables shall be limited to 3% during full load running condition. Voltage drop from transformer secondary to motor terminals during full load running of motors will be limited to 5 % of rated voltage.

3.1.6 For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described in Clause 1.2 above.

3.1.7 DC System Cables:-

1100 V grade, single or two cores cables as specified in LT power cables will be used. Only Single core cables will be used from batteries/ battery chargers to main DCDB, between main Distribution Board, from main Distribution Board to sub distribution board, main DC supply to various system cabinets/panels, Switchgears etc and for critical auxiliaries such as Emergency Lube & Lifting oil pump, seal oil & control oil pumps etc.

3.2 CONTROL CABLES

3.2.1 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and 4.0 sq. mm cables shall be used for connection of CTs and PTs to the load. In case 2.5 sq. mm conductor impose unacceptably high burden on CTs, 4.0-sq. mm conductor shall be used. The conductor material shall be copper.

3.2.2 Voltage transformer leads shall be checked for voltage drop which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5 sq. mm conductors exceed this value, higher conductor sizes shall be used.

3.2.3 The multi-core cables shall have 2 to 4 nos. cores on spare. The grouping of cables for critical application shall be avoided.

4.0 CABLE TERMINATIONS

4.1 All 6.6kV termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for a short circuit value as specified in clause 3.1.2 above. Weather proof Double compression type cable glands and heavy duty , tinned , long barrel copper lugs shall be used for termination.

4.2 All 1100V termination for XLPE/PVC power cables and control cables shall be by Double compression weather proof type cable

glands and heavy duty, tinned, long barrel copper lugs shall be used for termination.

5.0 CABLE JOINTS

Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable types having a short circuit with stand capacity value as specified in clause 3.1.2 above. Lugs shall be heavy duty, tinned copper, long barrel. All cable glands shall be double compression, weather proof.

6.0 CABLE CARRIER SYSTEM

6.1 The cable carrier system shall be designed considering the following :

(a) Facility for easy laying of cables.
(b) Access to maintenance.
(c) Neat and aesthetic appearance.
(d) Safety of equipment & personnel.
(e) Ground water seepage.
(f) Drainage system for oil and water.

6.2 Cables shall be laid in prefabricated ladder / perforated type trays and in conduits. Also joint markers shall be provided at each joint. The cable trays shall be laid vertical only in boiler, ESP, Limestone area, Lignite area and ash handling area.

6.3 Cable trays and supporting structures in chemically corrosive area like battery room and water treatment plant shall be mild steel painted trays finished with chlorinated rubber based paint/epoxy paint.

6.4 Cable trenches will be avoided to the extent possible inside Fuel oil pump house, water treatment plants, Boiler & ESP areas where possibility of oil and water collection exists.

6.5 No direct underground burial cables shall be laid except lighting tower, street lighting. For some exceptional case like isolated individual equipments it shall be allowed after GIPCL approval.

7.0 CABLE INSTALLATION AND ACCESSORIES

7.1 All material and accessories required for cable installation like cable trays, tray covers, support steel, etc., shall be hot dip

galvanized and conduits/pipes shall also be hot dip galvanized. The racks/trays, conduits/pipes, trenches required to route the cables to individual equipment shall be supplied and installed by the CONTRACTOR.

7.2 Separate trays shall be provided for HV Power/LV Power (AC&DC)/Control & Instrumentation cables.

7.3 After laying all the cables, CONTRACTOR shall dress all cables by clamping at every metre, so that the cables are securely held and aesthetically good.

7.4 Cable trays shall be avoided very close to the pipes carrying high temperature steam. When they are inevitable, it shall be laid after OWNER approval and suitable insulation material shall be provided between the cable trays and pipes.

7.5 Wherever cables have to be laid to top of cooling tower and different elevations of chimney, the cables shall be laid in conduits embedded in concrete. The number of conduits shall be subject to Purchaser's approval considering different conduits for different phases / application.

7.6 6.6 kV cables shall be laid only in one layer. 1100 V cables up to 120-sq. mm. can be laid in two layers. Control and Instrumentation cables can be laid in three layers.

7.7 One spare conduit shall be provided for cable of center / outer drive in clarifier.

7.8 No cable trenches shall be allowed in Boiler, ESP and lignite handling system.

7.9 Power and control cables for critical / emergency drives / equipment like DC EOP / JOP shall be kept away and routed in separate cable trays

7.10 Cable shall not be laid inside lignite conveyor gallery, shall be outside gallery with suitable maintenance platforms. Further, in case of lignite screen house and crusher house, cable shall be laid outside the building through out the height and necessary platforms shall be provided outside for maintenance and approach.

7.11 Cable routing on stacker reclaimer machine should be such that the trays should be laid above the walkways and cable race should not be erected below boom. Wherever any cable has to cross

conveyor, the crossing should take place above the conveyor either above the cross over ladder or by providing separate plate form.

7.12 Contractor shall make all effort to provide one nos. ACDB in stacker reclaimer machine at Slewing plate form to feed all the drives installed at Slewing structure and above that. The incoming supply can be derived from LT MCC at machine. This is required to reduce number of cables through undercarriage and subsequent failure of cables.

8.0 CABLE TRAYS AND COVERS

8. 1 Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 12 gauge (2.5 mm thick) mild steel sheets. Cable tray covers shall be provided for all cable trays and raceways. The cable tray accessories like trays, elbows, bends, etc., shall be fabricated and galvanized before bringing to site. Cable tray covers shall be fabricated from 16 gauge (1.7 mm thick) MS sheets. All the sheet steel shall be hot dip galvanized.

8.2 1100 V rated cables of sizes 120-sq. mm and above shall be laid in single layer. Single core cables used for 3-phase AC power circuits shall be laid in Trefoil form with suitable PVC aluminum clamps to hold the cables.

8.3. The sizing of cable trays from TG building to other areas shall consider para 9.2 above an additionally to avoid crowding and criss crossing of cables, especially in boiler area where vertical risers are to be provided for various power, control and instrumentation cables to higher elevations of boiler.

8.4. Separate cable trays shall be provided for fire alarm/fighting, DC system cables communication system cables to avoid damage to these cables during a fire in other cables.

8.5. Slotted angles shall not be used for cabling. In all locations smaller size cable trays of 50 mm / 100 mm wide shall be used for one or two cables.

9.0 FIRE-PROOF SEALING OF CABLE PENETRATION

Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another,

between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to the following requirements:

(a) FPSS shall have a fire rating of two hours.

(b) The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'.

(c) The FPSS will also conform to the in-combustibility test carried out in accordance with IS: 3144-1992.

(d) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.

(e) FPSS shall have life of 25 years.

10.0 **FIRE BREAK**

10.1 Fire break shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of two hours.

10.3 Fire break shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with fire breaks. Fire coating shall be provided on entire length of cables in lignite handling system.

10.4 When pipe sleeves are provided for cables from outdoor areas to indoor areas, the pipe opening at the outdoor side shall be sealed by fire proof sealing material which is also continuously water proof. The indoor side of the pipe opening shall also be sealed by continuous fire proof sealing materials. The duct banks in outdoor areas also need to be sealed by water poof seals. It is necessary to explore possibility of applying waterproof coating on fireproof sealing.

11.0 TESTS

All routine tests and FRLS tests as per relevant standard shall be performed on each size of cable. If same size is supplied in different

lots, inspection shall be done for each lot. If same cable is supplied by different agencies, test shall be carried out on cables supplied by each agency. These tests shall be carried out as per relevant standards as applicable.

Routine and acceptance test shall be carried out on FPSS.

Sr. No.	Description	unit	Client specification	Bidders specifications
1.00	Name of manufacturer		*	
1.10	Conductor No. core x Size Form- circular/segmented Effective cross sectional area sq. mm		*	
1.2	Whether cores identification numbers for cables with 5 cores and above to be provided		Yes	
1.3	Whether incremental running lengths are marked on cable		Yes	
1.4	Finished cable a) Diameter under armour in mm b) Diameter over armour in mm c) Overall diameter in mm		*	
1.5	Cable drums a) Whether cable drums confirm to IS : 10417 b) Length of cables in drum & tolerance c) Weight of cable drum without cables d) Weight of cable drum with cables e) Type of end sealing		*	
1.6	FRLS /FS cables a) Critical oxygen index value at 250 deg C when tested for temperature index test as per ASTM-D-2763		Ref. Clause 2.3	

	b) Total acid gas generation by weight when tested as per IEC – 754-1 in % c) Percentage of light transmission under fire for assessment of smoke generation when tested as per ASTM – D – 2743 d) Will the cables offered against this specification pass the flammability tests as per 1) Class – F3 – Swedish standard S5-424- 1475 2) IEC 332 – 1 3) IEC 331 - 1			
1.7	maximum dielectric loss of cable per KM at normal voltage and frequency	Watt/km	*	
1.7	Short circuit capability for 1 Sec (HT & LT Power Cable)	kA rms	Minimum 40 kA and shall be in line with requirements of the switchgear and protection.	
1.9	Maximum dielectric stress at core screen	KV/cm	*	
1.10	Max. overall diameter of cables	mm	*	

NOTE	'*' indicated above shall be filled by CONTRACTOR.
	'**' CONTRACTOR shall furnish the data after placement of order.

1.0 EARTHING SYSTEM

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

2.0 DESIGN CRITERIA

2.1 The earthing conductor shall be designed for carry highest fault level of the electrical switchgears except IPBD (minimum 40 kA) for duration of 1 second.

2.2 The ambient temperature and allowable maximum temperature rise for steel welded joints shall be considered as 50 deg. Cent and 50 deg. Cent. Respectively.

The earthing and Lightning protection shall be designed on the basis of following codes and standards:-

(a) IS –3043-1987- Code of practice for safety earthing.

(b) IS- 2309- 1989 – Code of practice for protection of building and allied structures against lightning.

(c) IEE-80-1986 - Guide for safety in Alternating Current Sub Station grounding.

(d) Indian Electricity rules.

The CONTRACTOR shall undertake the soil resistivity measurements at site and select suitable type of conductors.

2.3 Size of Conductors

(a) **Main Earthing Conductors**

The earthing conductor sizes shall be calculated as per the following formulae.

$$\frac{I_f}{A} = K\frac{1}{\sqrt{t}}$$

A = Cross-section area in sq. mm

I_f = Maximum a.c. rms ground fault current amperes.

t = Operating times of the protective device to disconnect the faulty circuit, in secs.

K = Factor depending on the earthing conductor, the insulation and other parts, and the initial and final temperature.

The factor "K" is determined by the formula

$$K = Qc\frac{(B+20)}{P20}Log_e\frac{(B+\phi t)}{(B+\phi 1)}$$

P20 = Electrical resistivity of conductor material at 20 deg. C (ohm-m).

Qc = Volumetric heat capacity of conductor material (J/deg.C/cu.m).

B = Reciprocal of temperature co-efficient of resistivity at 0 deg. C for the conductor.

$\phi 1$ = Initial temperature of conductor, (deg.C).

ϕt = Final temperature of conductor, (deg. C) depending on the type of joints.

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

Resistivity of soil Ohm-Meter		Reduction in thickness / diameter, mm
> 0	<10	8.0
>10	<25	7.0
>25	<50	5.5
>50	<75	4.5
>75	<100	3.0
>100		1.5

2.4 Rod Electrodes

Galvanized steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits, electrodes shall be heavy-duty type (Class – C) GI pipes of suitable diameter with perforations. Electrodes installed in the test

pits will have disconnecting facilities. The size of GI pipe shall be of minimum 3m length, 40-mm dia and of thickness 1.2 mm. All earthing electrodes (rods and pipes) shall be in RCC chamber with disconnecting links.

2.5 **Equipment Earthing Leads**

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043 and also with a view to minimize the number of sizes and per clause no 6.0 to 9.0. Earthing connection to all equipment shall be through disconnecting type link.

2.6 **Conductors for lightning protection system**

The size of conductors for lightning protection system shall be decided based on mechanical strength.

3.0 **General**

3.1.1 Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

3.1.2 Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

3.1.3 All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

3.2 Earthing Conductor Layout in Switchyard/ Transformeryard

3.2.1 Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

3.2.2 The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80. The aging effect of conductor shall also be taken into consideration

while arriving at the maximum permissible step and touch potentials.

3.2.3 Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 1000-mm. This shall be connected to the switchyard-earthing grid.

3.2.4 An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.

3.2.5 Each earth leads of all Generator & transformer neutral shall be directly connected to separate treated pit pipe electrodes with disconnection link in RCC chamber which in turn will be connected to station grid. One earth leads of all EMVT /CVT/PT neutral shall be directly connected to rod electrodes with disconnection link in RCC chamber and other lead shall be connected to station grid. Earth leads of all Lightning arrestor shall be directly connected to two separate treated pit pipe electrodes with disconnection link in RCC chamber. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

3.3 Earthing Conductors Inside Building

3.3.1 Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover.

3.3.2 In case, the building has more than one floor, each floor shall be provided with earth grid as discussed earlier. Floor earthing grids shall be interconnected.

3.3.3 Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.

3.3.4 Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

3.3.5 Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.

3.3.6 Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

3.3.7 Earthing grid design shall be done in such a manner that the grid resistance is less than 0.20 ohm.

4.0 EARTHING SYSTEM INSTALLATION

4.1 The spacing between two electrodes shall be atleast equivalent to twice the length of the electrode.

4.2 Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.

4.3 The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.

4.4 When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall sealed after installation.

4.5 The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.

4.6 Metallic conduits and pipes shall not be used as earth continuity conductor.

4.7 Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.

4.8 Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc..

4.9 Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.

4.10 Connection between the equipment earth lead and the grid conductor shall be necessarily joined by a flexible conductor of adequate size by bolting the same with GI nuts, bolts and washers. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

4.11 The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.

4.12 All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

4.13 In areas where chemicals are used like chlorination room, alum dosing area, etc., the earthing strip shall be provided along the cable trays (above ground) to avoid damage.

4.14 Embedded earthing system shall be specified in boiler grid level.

5.0 LIGHTNING PROTECTION SYSTEM

Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, downcomers, and pipe electrodes.

5.1 Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309 and any building whose risk index is more than 40 shall be provided with lightning protection.

5.2 Lightning Protection System Layout

5.2.1 The lightning systems design and installation shall generally comply with IS:2309 code of practice for the protection of building and allied structure against lightning.

5.2.2 For chimney air termination, rods interconnected by circumferential conductors will be provided at the apex of flue and also upon outer shell of the chimney. The air termination system will be formed by lead coated copper conductors to prevent corrosion of conductors due to flue gas. The down comers shall be of stranded tinned copper conductor.

5.2.3 Lightning protection of the Natural draft cooling tower shall be identical to chimney.

5.2.4 For switchyard down conductors from the shield wires shall be run along the tower connected to rod / electrode.

5.2.5 Each down conductor shall be connected to a rod electrode which in turn shall be connected to the station earthing system through test links.

5.2.6 TG building and limestone milling system building shall be completed for lightning protection.

5.3 Lightning Protection System Installation

5.3.1 Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.

5.3.2 The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Wherever welded, the weld locations shall be treated to provide rust protection.

5.3.3 Each down conductor shall be provided with a test link at a height of about 1000 mm above ground level.

5.3.4 All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors.

5.3.5 All reinforcing bars at the top and bottom shell of chimney shall be connected to the copper downcomers.

5.3.6 Switchyard and transformer yard LA s connection between earthpit and surge counter shall be insulated from LA structure. Similarly earthing conductor of transformer neutral, Generator and DG set neutral shall be insulated from any other conducting part in the vicinity.

5.3.7 For off site building like Lignite and lime stone buildings, Dm plants etc. which do not come under zone of protection from chimney, Lightning protection system, with horizontal/ vertical air termination and adequate nos. of down comers shall be provided as per IS 2309- 1989.

5.3.8 Lightning protection down conductor shall be directly connected to a separate earth electrode.

6.0 **Minimium size and material of main earthing conductors**:-

Systems	**Cross sectional area In Sq. mm**	**RECOMMENDED SIZE**	
		Buried in earth	**Above ground or Embedded in concrete**
MAIN EARTHING CONDUCTOR			
a. 220KV system	500	32mm dia	50x10 mm flat
b. 6.6KV system	500	-Do-	-Do-

c. 415V system	500	-Do-	-Do-
EARTH ELECTRODES			
a.Rod Electrodes	20mm dia , 3000mm long galvanised steel		
b.Pipe Electrode	40mm dia, 3000mm long galvanized steel class C pipe.		
MATERIAL			
a. Above ground	Galvanised Steel- Galvanizing as per IS 2629- 1985		
b. Below ground & Embedded in concrete.	Mild Steel.		

7.0 **Minimum sizes of equipment earthing leads**:-

Sr. No.	Equipment/ Structure	Earth Lead Size
1	Equipment of 220KV/10.5KV/6.6 kV system	50 x 10 mm flat
2	415v switch gears and Motor Control Centers	50 x10 mm flat
3	415 v Motors	
	a. Fractional HP	8 SWG GI wire
	b. Up to 40 KW	25 x 3 mm flat
	c. 41 to 71 KW	25 x 6 mm flat
	d. 71 KW and above	50 x 10mm flat
4	Isolated Phase Bus Duct and accessories	50 x 10mm flat
5	Generator and accessories	50 x 10mm flat
6	Transformer and accessories	50 x 10mm flat
7	Control Desks, Control/ relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles.	25 x 6 mm flat.
8	LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes.	08 SWG GI wires.

9	Columns, Switchyard structures, Fence, Gates, Cable trays etc,,,,	25 x 6mm flat
10	LT bus Ducts	50 x 10 flat
11	Switchyard Structure	50 x 10 mm flat.
MATERIALS		
	a. Above ground	Galvanised Steel- Galvanizing as per IS 2629- 1985.
	b. Below ground & below ground	Mild Steel.

8.0 Minimum size and materials size and materials of lightning system conductors

Sr. No.	Description	Sizes
1	Roof Conductors and down conductors for building and boiler areas	25 x 6 mm GI flats
2	Horizontal Air termination for Chimney	70 mm2 tinned copper conductor coated with Lead
3	Vertical Air termination for chimney	20mm dia copper road coated with lead, approx. 2000mm long.
4	Down Conductor for Chimney / Cooling Towers	25 x 6 mm galvanised steel conductor OR mild steel embedded in concrete.
5	Pipe Electrodes	40mm dia 3000mm long Galvanised steel
6	Rod electrodes	20-mm dia 3000mm long galvanised steel.
Galvanizing shall be as per IS 2629- 1985.		

NOTE	'*' Indicated above shall be filled by CONTRACTOR.
	'**' CONTRACTOR shall furnish the data after placement of order.

FORM NO. PEM-6041-0

	QUALITY PLAN	**CUSTOMER**			**PROJECT TITLE**			**SPECIFICATION NUMBER**					
		BIDDER/ VENDOR			**QUALITY PLAN NUMBER PED-506-00-Q-001/01**			**SPECIFICATION TITLE**					
		SHEET 1 OF 3	**SYSTEM**		**ITEM LT SWGR/CONTROL PNLS/DIST. BD**			**SECTION**			**VOLUME III**		
SL. NO.	**COMPONENT/OPERATION**	**CHARACTERISTIC CHECK**	**CAT.**	**TYPE/ METHOD OF CHECK**	**EXTENT OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORM**	**FORMAT OF RECORD**	**AGENCY**			**REMARKS**	
									P	**W**	**V**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**	
1.0	BOUGHT OUT ITEMS	REF. QUALITY PLAN NO. PED-506-00-Q-002											
2.0	IN-PROCESS	REF. QUALITY PLAN NO. PED-506-00-Q-003											
3.0	FINAL INSPECTION												
		1. PHYSICAL BLEMISHES	MA	VISUAL	100%	BHEL SPEC.	BHEL SPEC.	INSP. REPORT	2	1	-		
		2. ALIGNMENT	MA	VISUAL	100%	IS-8623	IS-8623	-DO-	2	1	-		
		3. DIMENSION	MA	MEASUREMENT	100%	IS-3427	IS-3427	-DO-	2	1	-	1. SHIPPING SECTION JOINTS PLATES TO BE SUPPLIED	
		4. PAINT SHADE	MA	VISUAL	100%	BHEL SPEC.	BHEL SPEC.	-DO-	2	1	-		
		5. PAINT THICKNESS	MA	MEASUREMENT	FEW PLACES	APPD. DRG/ APPD .DATA SHEET.& OTHER RELEVANT IS	APPD. DRG/ APPD .DATA SHEET.& OTHER RELEVANT IS	-DO-	2	1	-	2. GLANDS & LUGS TO BE SUPPLIED ALONG WITH BOARDS	
		6. PAINT ADHESION	MA	MECH. TESTS	-DO-	APPD. DRG.	APPD. DRG.	-DO-	2	1	-		
		7. VERIFICATION OF B.O.M.	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	1	-		
		8. INTER CHANGEABILITY	MA	MECH. TESTS	10%	-DO-	-DO-	-DO-	2	1	-		

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN	**CUSTOMER**			**PROJECT TITLE**			**SPECIFICATION NUMBER**			
		BIDDER/ VENDOR			**QUALITY PLAN NUMBER PED-506-00-Q-001/01**			**SPECIFICATION TITLE**			
	SHEET 2 OF 3	**SYSTEM**			**ITEM LT SWGR/CONTROL PNLS/DIST. BD**			**SECTION**			**VOLUME III**
SL. NO.	**COMPONENT/OPERATION**	**CHARACTERISTIC CHECK**	**CAT.**	**TYPE/ METHOD OF CHECK**	**EXTENT OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORM**	**FORMAT OF RECORD**	**AGENCY**			**REMARKS**
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		9. ROUTINE TESTS	CR	ELECT . TESTS	100%	APPD. DRG.	APPD. DRG.	-DO-	2	1	-	
		10. FUNCTION PERFORMANCE	CR	ELECT. & MECH. TESTS	100%	-DO-	-DO-	-DO-	2	1	-	SHALL INCLUDE REMOTE SIMULATION
		11. TYPE TESTS	CR	ELECT. TESTS	1/ITEM	-DO-	-DO-	-DO-	2	-	1	SEE NOTE 'C'
		12. INTERLOCKS, PROTECTION & METERING	CR	SECONDARY INJECTION	100%	-DO-	-DO-	-DO-	2	1	-	PHYSICAL VERIFICATION DURING INSPECTION
		13. EASE OF WITHDRAWAL & INSERTION	MA	MECH. TESTS	100%	-DO-	-DO-	-DO-	2	1	-	
		14. ACCESSIBILITY OF COMPONENT & SAFETY (SHROUDING)	MA	VISUAL	100%	BHEL SPEC./ APPD. DRG.	BHEL SPEC./ APPD.DRG.	-DO-	2	1	-	
		15. WIRING NEAT-NESS & FIRMNESS	CR	PULLING	SAMPLE	-DO-	-DO-	-DO-	2	1	-	
		16. BUS BAR TIGHTNESS	MA	MECH. TESTS	SAMPLE	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	-DO-	2	1	-	

	PARTICULARS	**BIDDER/VENDOR**	
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FORM NO. PEM-6041-0

	QUALITY PLAN		**CUSTOMER**			**PROJECT TITLE**			**SPECIFICATION NUMBER**			
			BIDDER/ VENDOR			**QUALITY PLAN NUMBER PED-506-00-Q-001/01**			**SPECIFICATION TITLE**			
		SHEET 3 OF 3	**SYSTEM CABLE**			**ITEM LT SWGR/CONTROL PNLS/DIST. BD**			**SECTION**			**VOLUME III**
SL. NO.	**COMPONENT/OPERATION**	**CHARACTERISTIC CHECK**	**CAT.**	**TYPE/ METHOD OF CHECK**	**EXTENT OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORM**	**FORMAT OF RECORD**	**AGENCY P**	**W**	**V**	**REMARKS**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
	NOTE :											
	A. ONLY APPROVED MAKE OF COMPONENTS ARE TO BE USED.											
	B. TYPE TESTS WILL INCLUDE (BESIDES OTHERS)											
	1. TEMPERATURE RISE TEST											
	2. DEGREE OF PROTECTION TEST AND EXPLOSION PROOF TEST, IF ANY											
	3. SHORT TIME CURRENT TEST											
	4. P & Q TEST											
	C. REGARDING ACCEPTANCE OF AVAILABLE TYPE TCS, REFER CL.NO. 9.4 OF SPECIFICATION NO. PES-506-01.											
	D. INDIVIDUAL BREAKER SHALL BE TESTED AT VARIOUS POSITIONS AND AT NORMAL +10% AND -10% OF CONTROL SUPPLY.											
	E. FUNCTIONAL/PERFORMANCE CHECKS TO BE CONDUCTED ON ENTIRE BOARD AND ALL POWER SUPPLIES SWITCHED ON.											

	PARTICULARS	**BIDDER/VENDOR**	
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-509-00-Q-001/01			SPECIFICATION : TITLE			
	SHEET 1 OF 3		SYSTEM			ITEM : EARTHING COND. & ELECTRODES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	RAW MATERIAL											
1.1	MILD STEEL & COPPER (AS SPECIFIED)	1.CHEMICAL & PHYSICAL PROPERTIES	MA	CHEM & PHYS TESTS	1/ LOT/SIZE	APPD. DRGS/ DATA SHEETS/ TECH. SPEC.	APPD. DRGS/ DATA SHEETS/ TECH. SPEC.	MILL TEST CERTIFICATE	2	-	-	
		2.SURFACE FINISH	MA	VISUAL	100%	-DO-	-DO-	IR	3/2	-	2	
		3.DIMENSIONS	MA	MEASUREMENT	1/ LOT/SIZE	-DO-	-DO-	-DO-	2	-	-	
1.2	HARDWARES	1.DIMENSIONS	MA	MEASUREMENT	100%	TECH. SPEC. APPD. DRGS/ DATA SHEETS	TECH. SPEC. APPD. DRGS/ DATA SHEETS	-DO-	3/2	-	2	
		2.COATING	MA	VISUAL	SAMPLE	-DO-	-DO-	-DO-	3/2	-	2	
1.3	ZINC FOR GALVANISATION	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	RELEVANT IS.	RELEVANT IS.	TC	3/2	-	2	
2.0	IN-PROCESS											
2.1	CUTTING, DRILLING	1.WORKMANSHIP DIMENSIONS & DISTORTION	MA	VISUAL & MEASUREMENT	100%	APPD. DRGS/ TECH. SPEC.	APPD. DRGS/ TECH. SPEC.	IR	2	-	-	
2.2	WELDING	1.WELDING QUALITY	MA	VISUAL & MALLET TEST	SAMPLE	MFR'S. STD	MFR'S.STD.	IR	2	-	-	
2.3	SURFACE PREPARATION FOR GALVANISING	1.CLEANING PICKLING & RINSING, BATH STRENGTH/ PURITY & TEMPERATURE	MA	CHEM. & MEASUREMENT	PERIODIC IN EACH SHIFT	IS:2629/ RELEVENT:IS	IS:2629/ RELEVENT:IS	IR	3/2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-509-00-Q-001/01			SPECIFICATION : TITLE			
	SHEET 2 OF 3		SYSTEM			ITEM : EARTHING COND. & ELECTRODES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629/ RELEVENT:IS	IS:2629/ RELEVENT:IS	IR	3/2	-	-	
2.4	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	-DO-	-DO-	-DO-	3/2	-	-	
		2.DURATION OF DIP	MA	VISUAL	PERIODIC	-DO-	-DO-	-DO-	3/2	-	-	
		3.ROSS QUANTITY AGITATION	MA	TEST	PERIODIC	RELEVENT:IS	RELEVENT:IS	-DO-	2	-	-	
		4.BATH AGITATION	MA	VISUAL	PERIODIC	MFR'S STD	MFR'S STD	-DO-	2	-	-	
		5.SURFACE QUALITY	MA	VISUAL	100%	-DO-	-DO-	IR	3/2	-	2	
2.5	PAINTING	1.SURFACE PREPN. DEGREASING & DERUSTING	MA	CHEM. TEST	100%	TECH.SPEC.	TECH.SPEC.	LOG BOOK	2	-	-	
		2.THICKNESS & ADHESION	MA	MEASUREMENT	SAMPLES	-DO-	-DO-	-DO-	2	-	-	
3.0	FINAL TESTS	1.APPEARANCE	MA	VISUAL	SAMPLE	IS:2629	IS:2629 FREE FROM ROUGHNESS LUMPS ETC	IR	2	1	-	
		2.DIMENSION	MA	MEASUREMENT	-DO-	TECH.SPEC./ APPD.DRG.	TECH.SPEC./ APPD.DRG.	IR	2	1	-	
		3.UNIFORMITY OF COATING	MA	DIP TEST	SAMPLE AS PER IS-2633	IS:4759	IS-2633	IR	2	1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :					
		BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-509-00-Q-001/01			SPECIFICATION : TITLE					
	SHEET 3 OF 3	SYSTEM		ITEM : EARTHING COND. & ELECTRODES			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4. WEIGHT OF COATING	MA	PREECE TEST	IS-4739	IS-6745	TECH. SPEC.	IR	2	1	-	
		5.ADHESION	MA	HAMMER/ KNIFE	-DO-	IS-2629	IS-2629	IR	2	1	-	
		6.THICKNESS	MA	ELKOMETER	SAMPLES	TECH. SPEC.	TECH. SPEC. AND IS-2629	IR	2	1	-	

BHEL	PARTICULAR	BIDDER / VENDOR	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-507-00-Q-005/02			SPECIFICATION : TITLE			
	SHEET 1 OF 2		SYSTEM			ITEM : CABLE TRAYS & ACCESSORIES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	RAW MATERIAL											
1.1	ROLLED SHEET	1.SURFACE FINISH	MA	VISUAL	100%	IS-1057/ TECH. SPEC.	IS-1057/ TECH. SPEC.	QC RECORD	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-DO-/IS-1730	-DO-/IS-1730	-DO-	2	-	-	
		3.CHEM.& PHY. PROPERTY	MA	VERIFICATION OF TC	100%	IS1079/TECH SPEC	IS1079/TECH SPEC	MILL TC	3/2	-	-	
1.2	ZINC	CHEM.COMP.		CHEM TEST	EACH HEAT	IS-209	IS-209	TC	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	FABRICATION	1.DIMENSIONS & DISTORTION	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	-	
		2.SURFACE FINISH	MA	VISUAL	100%		FREE FROM BURRS	-DO-	2	-	-	
		3.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	-DO-	2	-	-	
		4.RIGIDITY (CABLE TRAYs)	MA	DEFLECTION TEST	2 OF EACH SIZE	BHEL SPEC.	BHEL SPEC	-DO-	2	-	-	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING, BATH STRENGTH/ PURITY & TEMPERATURE	MA	CHEM. & MEASUREMENT	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-005/02			SPECIFICATION : TITLE			
		SHEET 2 OF 2	SYSTEM			ITEM : CABLE TRAYS & ACCESSORIES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	-DO-	2	-	-	
		2.DURATION OF DIP	MA	VISUAL	-DO-	MANUFS.PRACT	MANUFS.PRACT		2	-	-	
		3.SURFACE QUALITY	MA	VISUAL	100%	-DO-	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	-DO-	2	-	-	
		4.GROSS QUANTITY & AGITATION	MA	TEST	PERIODIC	RELEVENT:IS	RELEVENT:IS	-DO-	2	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSO-RIES & HARDWARES)	1.DIMENSIONS DISTORTION	MA	MEASUREMENT	IS-2500 (1) LEVEL IV	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	BOLT AND NUTS SHALL BE OF REPUTED & APPROVED MAKE
		2,SURFACE FINISH	MA	VISUAL	-DO-		FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	-DO-	2	1	-	
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	1 OF EACH SIZE	BHEL SPEC.	BHEL SPEC.	-DO-	2	1	-	
		4.WEIGHT OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745	BHEL SPEC.	-DO-	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	-DO-	-DO-	IS-2633	IS-2633	-DO-	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	-DO-	BHEL SPEC.	BHEL SPEC.	-DO-	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	-DO-	2	1	-	

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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :				
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-006/01			SPECIFICATION TITLE				
	SHEET 1 OF 1		SYSTEM			ITEM RIGID STEEL CONDUITS & PIPES			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	**W**	**V**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**	
	FINISHED PRODUCT												
		1. DIMENSIONAL CONFORMITY	MA	MEASUREMENT	5 SAMPLES PER SIZE PER LOT	AS PER IS-9537 PT I & II AND OTHER IS	AS PER IS-9537 PT I & II AND OTHER IS	IR	2	1	-		
		2.FINISH	MI	VISUAL	-DO-	-DO-	-DO-	-DO-	2	1	-		
		3. SCREW THREAD	MI	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	1	-		
		4. BEND TEST	MA	MECH.	1 SAMPLE OF EACH SIZE	-DO-	-DO-	-DO-	2	1	-		
		5. COMPRESSION TEST	MA	MECH. TEST	-DO-	-DO-	-DO-	-DO-	2	1	-		
		6. WT. OF ZINC COATING	MA	MEASUREMENT	ONE SAMPLE	IS-6745	IS-4736	-DO-	3	2,1	-		
		7.UNIFORMITY OF ZINC	MA	CHEMICAL	-DO-	IS-2633	IS-2633	-DO-	3	2,1	-		
		8. ADHESION TEST	MA	PIVOT/HAMMER TEST	-DO-	IS2629	IS-2629	-DO-	3	2,1	-		

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