VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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VOLUME-IA PART-I CHAPTER-I

PROJECT INFORMATION

A.1.1	Name of the Owner:	:	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD. (TANGEDCO)
A.1.2	Address	:	Kodayar Power House – Stage-1, Tirunelveli Generation circle, District: Kanyakumari (Tamil Nadu)
A.1.3	New Installation	:	1 x 70 MW
A.1.4	Nearest Railway station	:	Kanyakumari railway station is the closest Railway Station (72 KM)
A.1.5	Nearest Road	:	(0 KM)
A.1.6	Nearest City	:	Kanyakumari (75 km)
A.1.7	Nearest Airport	:	Trivandrum Airport is the closest Airport (75 km)
A.1.8	Highest Temperature	:	36 deg C
A.1.9	Lowest Temperature	:	20 deg C
A.1.10	Elevation	:	1158 ft (Turbine Centre line)

Note: - The bidder is advised to visit and examine the site of WORKS and its surroundings and obtain for himself on his own responsibility all information that may be necessary for preparing the bid and entering into the CONTRACT. All costs for and associated with site visits shall be borne by the bidder.

VOLUME-IA PART-I CHAPTER-II

SCOPE OF WORKS

2.1 The scope of works covers mainly Civil, Structural and Architectural works pertaining to Renovation, Modernization and Uprating of existing Kodayar Power House - I (from 1x60 MW to 1x70 MW), Tirunelveli Generation circle, Kanyakumari, Tamil Nadu, as mentioned below, including supply of all materials, labour, tools and plants and hand over the structures to TANGEDCO in all respect as per BOQ, Specifications and drawings.

The scope of work is indicative but not limited to the following:

1. Civil works for discharge chamber - Concrete encasing of discharge chamber to be partly dismantled in line with input drawings and reconstructed in line with civil drawings (dismantling of the RCC in the discharge chamber is included)
2. Civil work for laying new rail-track/modification of existing rail-track of 3 nos. single phase transformer to 1 no. 3-ph transformer
3. Civil works in the Control Room including Vitrified tiles flooring in control room, wall paneling, painting the wall panels, false ceiling, etc.
4. Necessary minor repair and improvement works to the existing Valve House Building
5. Improvement works to the existing Kodayar Power House-I building
6. Testing of existing foundations/structures
7. Construction of foundation & super structure for: -
   a) Deluge valve brick sheds
   b) Hose station
   c) Pump foundation
8. Construction of Misc. Structures & Services: -
   a) RCC fire water trench including buried pipe
   b) Pipe sleepers
   c) Cable gallery drain
9. All civil works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project.

Note:

- The above provided list is indicative only for the bidder's guideline. Any other work not mentioned above, but required for completion of the package in total, deemed to have been included in the bidder's scope under this contract. Such work will be executed under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC.
- **Work shall be executed in such a way that the new constructions/replacement should match with the existing structure. Utmost care shall be taken while carrying out dismantling work so that no damage is done to the existing structures. Also safety of the existing structure shall be looked into while making new construction.**
- **The Contractor shall also coordinate with other Contractors for any interface activity at his battery limits. No remuneration shall be claimed from BHEL for such technical cooperation.**
- **All civil works, like chipping, digging, concreting including filling material etc. associated with erection of instruments and associated equipment to be done in tandem with electro mechanical contractor.**
- All the materials viz. Cement, Sand, Aggregates, Reinforcement steel, Structural steel, Embedments/ inserts etc. required for civil & structural works (as applicable) shall be supplied by the bidder and payment shall be made as per corresponding item in BOQ.
- The preparatory and support works such as transportation and placing of springs and dampers are in contractor scope.
- The excavated earth has to be heaped in the desired location and the same should be utilized for further filling works. No additional lead shall be given.

2.2 The works to be performed under this contract, consist of providing all labour, supervision, material, scaffolding, construction equipment's, tools and plants, temporary works, supplies including POL (Petroleum, oil & lubricants), transportation and all incidental items

not shown or specified but reasonably implied or necessary for the proper completion of work in all respects.

2.3 **Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, preparation of detailed fabrication drawing, preparation of and getting customer/BHEL approval of dismantling scheme & procedure etc. are included in the rates of items of work.**

2.4 Furnishing samples of all materials required by the BHEL Engineers for testing / inspection and approval, for use in the works. The samples may be retained by the BHEL Engineer for final incorporation in the works.

2.5 Furnishing test reports for the products used or intended to be used, if called for the specifications or if so desired by the BHEL Engineer. Contractor shall furnish the manufacturers test certificate for the steel & cement procured by them. Apart from this all the field test shall be arranged by contractor for concrete, bricks, coarse & fine aggregate, Gravels /Boulders etc. either at site or nearby Field Quality Lab. approved by BHEL if so desired by BHEL's Engineer. All the expenses in these regards shall be borne by contractor. Contractor shall procure Reinforcement Steel, Structural Steel & Cement from reputed manufacturer & approval for the same shall be obtained from BHEL/ TANGEDCO well in advance before ordering for the materials.

2.6 The Contractor will carry out all checks and tests as directed by the Purchaser / Consultant and submit the results thereof. Acceptance of works will be subjected to achieving required quality as laid down in code of Bureau of Indian Standards.

2.7 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.

2.8 All the works areas shall be adequately flood lighted to the satisfaction of the Engineer-in-Charge when the work is in progress during the night shifts.

2.9 The unit rates shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.

2.10 The unit rates for various items of B.O.Q shall include all the stipulations mentioned in technical specifications and nothing extra over B.O.Q rates shall be payable.

2.11 In case the description/specifications as per BOQ are found to be incomplete, Indian Standard Codes (IS Codes) specifications shall be followed. Quantities mentioned in the BOQ cum Rate Schedules, are approximate only and liable for variation due to change of scope of work / variation in schedule of quantities, changes in design etc. The tenderers shall undertake to execute actual quantities as per advice of BHEL Engineer and accordingly the final contract price shall be worked out on the basis of quantities actually executed at site and payments will also be regulated for the same.

2.12 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.

2.13 The bidder should fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, local conditions, soil strata and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may have not been specifically brought out in the specifications.

2.14 Special arrangements to be made for tackling pandemic –

2.14.1 Government order (state/ center) being issued time to time for protective measures of COVID-19 pandemic shall be complied with strictly until government (state/ center) declares end of pandemic.

2.14.2 Contractor shall make arrangements for implementation of STANDARD OPERATING PROTOCOL (SOP) as per latest government order. Any person violating the COVID -19 measures published vide government order time to time will be liable to be proceeded for legal action as per the government order.

VOLUME IA PART – I CHAPTER – III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL

(SCOPE MATRIX)

PART I ESTABLISHMENT

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL/ TANGEDCO	Bidder	
3.1	**ESTABLISHMENT**			
3.1.1	**FOR CONSTRUCTION PURPOSE:**			
A	Open space for office	Yes		Free of rental charge
B	Open space for storage	Yes		Free of rental charge
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	
3.1.2	**FOR LIVING PURPOSES OF THE BIDDER**			
A	Open space		Yes	
B	Living accommodation		Yes	
3.2	**ELECTRICITY**			
3.2.1	Electricity for construction purposes		Yes	Chargeable
3.2.1.1	Single point source		Yes	1) Power supply at 400V, 3 Phase, 50HZ at single suitable point shall be arranged By BHEL/customer. However electricity bill raised by power supplier is to be paid by bidder. The bill

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL/ TANGEDCO	Bidder	
				may include fixed charges, minimum consumption charges, taxes, duties etc. 2) Bidder shall also install his 125 KVA (rating is only indicative, however bidder has to examine the capacity as per requirement) silent type DG set for construction power and for backup power as per site requirement.
3.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
3.2.1.3	Running and its maintenance		Yes	
3.2.1.4	Payment of electricity consumption		Yes	As per bill of power supply agency.
3.2.1.5	Maintenance of lighting, distribution boards of power at suitable working areas		Yes	
3.2.1.6	Providing of the consumables such as sockets, switches, MCCB, bulbs etc.		Yes	
3.2.2	Electricity for the office, stores, canteen, labor colony etc of the bidder which include:		Yes	
3.2.2.1	Distribution from single point including supply of materials and service		Yes	
3.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
3.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
3.2.2.4	Living facilities for office use including charges		Yes	
3.2.2.5	Demobilization of the facilities after completion of works		Yes	

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL/ TANGEDCO	Bidder	
3.3	**WATER SUPPLY**			
3.3.1	For construction purposes:			
3.3.1.1	Making the water available at single point		Yes	
3.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
3.3.2	Water supply for bidder's office, stores, canteen etc		Yes	
3.3.2.1	Making the water available at single point		Yes	
3.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
3.4	**LIGHTING/ ILLUMINATION**			
3.4.1	For construction work (supply of all the necessary materials) 1. At office storage area 2. At the preassembly area 3. At the construction site /area		Yes	
3.4.2	For construction work (execution of the lighting work/ arrangements) 1.At office storage area 2. At the preassembly area 3.At the construction site /area		Yes	
3.4.3	Providing the necessary consumables like bulbs, switches, etc. during the course of construction		Yes	
3.4.4	Lighting for the living purposes of the bidder at the colony / quarters		Yes	
3.5	**COMMUNICATION FACILITIES FOR SITE OPERATIONS OF THE BIDDER**			
3.5.1	Telephone, fax, internet, intranet, e-mail etc.		Yes	

PART II ERECTION FACILITIES

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.6	**Engineering works for construction**			
3.6.1	Engineering works for Civil work	Yes	Yes	In consultation with BHEL
3.6.2	Providing the layout drawings for all the areas covered under this scope	Yes		
3.6.3	Drawings for construction methods		Yes	In consultation with BHEL
3.6.4	As-built drawings – where ever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	In consultation with BHEL
3.6.5	Shipping lists etc for reference and planning the activities	Yes	Yes	
3.6.6	Preparation of site construction schedules and other input requirements		Yes	Bidder to prepare in consultation with BHEL
3.6.7	Review of performance and revision of site erection schedules in order to achieve the end dates and other commitments	Yes	Yes	To be jointly done on regular basis
3.6.8	Weekly erection schedules based on Sl No 3.6.6		Yes	
3.6.9	Daily erection / work plan based on Sl No3.6.8		Yes	
3.6.10	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	
3.6.11	Preparation of preassembly bay		Yes	

3.7 **OPEN SPACE:**

3.7.1 To establish a temporary site office and storage area at the job site, minimum open space will be provided free of charges as made available by customer. Location and area requirement for office / storage sheds shall be discussed and mutually agreed to after award of work at site. The contractor will be responsible for handing back all lands, as handed over to him by BHEL/TANGEDCO. Construction of necessary stores and storage of materials shall be in contractor's scope. Security of stores & work place shall be in Contractor's scope.

3.7.2 Contractor has to make his own arrangements for open land required for all other construction activities at their own cost.

3.7.3 Contractor has to make his own arrangements for labour colony at their own cost. The contractor to construct labour colony/ hutment as per his requirements after obtaining approval of formalities from statutory body. The contractor shall provide adequate water arrangement for drinking/washing/bathing with required toilets, drainage system, lighting facilities etc. in labour colony at their own cost. Suitable paved area to be provided in the labour colony at their own cost.

3.8 **WATER**

3.8.1 Contractor has to make his own arrangements for his water requirement for executing the scope of work as well as for his labour colony at his cost.

3.9 **ELECTRICITY:**

3.9.1 The Contractor shall be provided with construction power at 400V, 3-phase for the purpose of the erection/construction under the Contract only at single one point and is chargeable. The contractor to provide necessary energy meter for measuring the power consumption. The Contractor shall make his own arrangements to lay and maintain necessary supply lines for temporary power from a single point. The Contractor shall make his own further distribution arrangement. All temporary wiring must comply with Indian Electricity Rules and Act and will be subject to the customer's inspection and approval before connection to supply and later. Non-availability of power from the customer shall not be an excuse for delay in completion of erection/construction.

Construction power prevailing charges are as below,

The present LT tariff VI rate of TANGEDCO is

a) Consumption charges at Rs.12.25 per unit

b) Maximum demand (MD) charges as applicable per month

c) Low Power Factor (LPF) charges

d) Electricity Tax on total amount

e) Any other miscellaneous charges charged by M/s TANGEDCO pertaining to construction power supply.

Note - The TANGEDCO tariff and tax may vary from time to time and the same is applicable for the bidder.

3.9.2 On the discretion of BHEL site engineer, Construction power to other BHEL contractors/vendors shall be provided by contractor on chargeable basis. The charge towards electricity consumption by other contractors shall be decided by BHEL site in-charge. However, electricity bill raised by power supplier is to be paid by contractor. The bill may include fixed charges, minimum consumption charges, taxes, duties etc.

3.9.3 Display of danger board signs in Hindi, Tamil and English languages near switches is to be ensured by the Contractor. The Contractor will supply and install all distribution cables, wires and switches, etc. of rated capacity for the work starting from the source of power at his own cost. He will employ Electricians having valid Electrical License for carrying out the installations as well as for the maintenance works.

3.9.4 Bidder shall also install DG set of suitable capacity for backup power in case of power failure as per site requirement for construction power.

3.9.5 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.

3.9.6 Contractor has to make their own arrangements for electricity requirement for labour colony at his own cost.

3.10 **MATERIAL SUPPLY:**

Supply/ providing cement (OPC cement,) coarse aggregate, fine aggregate(M-sand) reinforcement steel, structural steel, foundation bolts & inserts/ embedments and all other materials required for the work are in the scope of the contractor

3.11 **CONSUMABLE**

3.11.1 All consumables, like gas, electrodes, chemicals, lubricants etc. required for the scope of work, shall be arranged by the contractor at his cost unless otherwise specifically mentioned in the contract. Prior approval from Engineer In-Charge shall be obtained for all the consumable to be used in permanent work.

3.11.2 In the event of failure of contractor to bring necessary and sufficient consumables, BHEL may arrange for the same at the risk and cost of the contractor. The entire cost towards this along-with overhead shall be paid by the contractor or deducted from the contractor's bills.

3.12 **LIGHTING FACILITY:**

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

3.13 **DEWATERING**

Contractor shall ensure at all times that his work area & approach/ access roads are free from accumulation of water, so that the materials are safe and the erection/ progress schedule are not affected. No separate claim in this regard shall be admitted by BHEL. No separate payments for dewatering of subsoil, surface water or catchments water, if required, at any time during execution of the work including monsoon period (except in case of floods) shall be considered by BHEL.

3.14 **CONTRACTOR'S OBLIGATION ON COMPLETION**:

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

3.15 **BID DRAWINGS**

Bid drawings enclosed for information and this may get revised during execution.

VOLUME-IA PART-I CHAPTER-IV
T&Ps and MMEs TO BE DEPLOYED BY CONTRACTOR

4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.

4.2 The contractor is required to arrange the following indicative T&Ps for the satisfactory completion of the work

Sr No	Tool & Plants (T&Ps)	Quantity	Mobilizing time from the date of commencement of work
A1	40/60 HP Diamond Wire Saw Cutting Machines	As per BHEL requirement.	As per BHEL requirement.
A2	Core Cutting Machines with adequate core bits	As per BHEL requirement.	As per BHEL requirement.
A3	Chipping Machine	As per BHEL requirement.	As per BHEL requirement.
A4	Drilling Machines	As per BHEL requirement.	As per BHEL requirement.
A5	Welding Machines	As per BHEL requirement.	As per BHEL requirement.
A6	Gas cutting set	As per BHEL requirement.	As per BHEL requirement.
A7	Winches	As per BHEL requirement.	As per BHEL requirement.
A8	Hydraulic Trolley 2 T	As per BHEL requirement.	As per BHEL requirement.
A9	Lorries /Trailer of adequate capacity	As per BHEL requirement.	As per BHEL requirement.
A10	Hydra -14T	As per BHEL requirement.	As per BHEL requirement.
A11	Mini batching plant with weigh batcher arrangement	As per BHEL requirement.	As per BHEL requirement.
Note to A11:	Alternately Concrete may be arranged by having tie up with existing batching plants, using Truck mounted concrete mixer cum pump, concrete pump of suitable capacity, transit mixer outside the site premises with the approval of BHEL engineer-in-charge for the day to day requirement of RCC activities or may be directly established by the bidder at site as per above.		
A12	Painting equipment sets complete with compressor, hopper, screen, blasting hose pipe, nozzle airless/conventional spray	As per BHEL requirement.	As per BHEL requirement.

A13	Truck mounted concrete mixer cum pump along with placing boom minimum 36 m high i.e. Concrete boom placer (36m)	As per BHEL requirement.	As per BHEL requirement.
A14	Transit Mixer	As per BHEL requirement.	As per BHEL requirement.
A15	Diesel Mixer machine of 0.5 cum capacity	As per BHEL requirement.	As per BHEL requirement.
A16	Concrete vibrator with adequate needle	As per BHEL requirement.	As per BHEL requirement.
A17	Curing pump – 1.5 /2 HP	As per BHEL requirement.	As per BHEL requirement.
A18	Reinforcement bending machine	As per BHEL requirement.	As per BHEL requirement.
A19	Reinforcement cutting machine	As per BHEL requirement.	As per BHEL requirement.
A20	MS scaffolding pipe / ACROW PIPE	As per BHEL requirement.	As per BHEL requirement.
A21	Civil laboratory equipment's as per list in Sl 4.4 with temporary building	As per BHEL requirement.	As per BHEL requirement.
Note to A21	Alternately concrete testing may be done by having tie up with existing NABL accredited laboratory outside the site premises with the approval of BHEL engineer-in-charge for the day to day requirement of RCC testing activities or may be directly established by the bidder at site as per above.		
A22	Concrete cube moulds	As per BHEL requirement.	As per BHEL requirement.
A23	Compression testing machine (200 T cap)	As per BHEL requirement.	As per BHEL requirement.
A24	Back hoe cum loader like JCB	As per BHEL requirement.	As per BHEL requirement.
A25	Dumper/Tipper/ Truck for shifting dismantled concrete	As per BHEL requirement.	As per BHEL requirement.
A26	Dewatering pump	As per BHEL requirement.	As per BHEL requirement.
A27	Total station	As per BHEL requirement.	As per BHEL requirement.
A28	Auto level & staff	As per BHEL requirement.	As per BHEL requirement.
A29	Drinking water tank	As per BHEL requirement.	As per BHEL requirement.
A30	Mobile toilet for labour use.	As per BHEL requirement.	As per BHEL requirement.

A31	125 KVA DG set (rating is only indicative, however bidder has to examine the capacity as per site requirement)	As per BHEL requirement.	As per BHEL requirement.
A32	Construction power cable	As per BHEL requirement.	As per BHEL requirement.
A33	Construction water Pipeline	As per BHEL requirement.	As per BHEL requirement.
A34	Portable fire extinguishers comprising of: Soda acid sets. Dry chemical powder sets CO2 sets. Water & sand bucket sets. Fire hose with nozzle (50 M length)	As per BHEL requirement.	As per BHEL requirement.
A35	Pick & carry crane (10/ 12 T cap)	As per BHEL requirement.	As per BHEL requirement.

Note:

1. T&P shown in the above mentioned list is tentative requirement considering parallel working in all areas mentioned in scope of work. However, mobilization schedule & quantity/ numbers as mutually agreed at site for major T&Ps, have to be adhered to. Numbers/ time of requirement will be reviewed time to time at site and contractor will provide required T&P/ equipment's to ensure completion of entire work within schedule/target date of completion without any additional financial implication to BHEL. Vendor will give advance intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.
2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.
3. In the event of non-mobilisation of Tools, Plants, Machinery, Equipment, Material or non-availability of the same owing to breakdown and as a result progress of work suffered, BHEL reserves the right to make alternative arrangement (available or higher capacity) in line with SCC clause no. 4.2.1. 7 and hire charges shall be applicable as under:

A: BHEL provides its own Capital T&P: If BHEL provides owned T&P then BHEL, hire charges (as per BHEL norms) will be recovered from the contractor as per the prevailing BHEL Corporate hire charges applicable (as enclosed in Volume I Book I TCC- Volume 1A Part II) as per following cases:

- In case the T&P is specifically listed in "T&Ps to be deployed by Contractor", 'Rates of hire charges applicable to outside agencies other than contractors working for BHEL' will apply.
- In case the T&P is not specifically listed in "T&Ps to be deployed by Contractor", 'Rates of hire charges applicable to contractors working for BHEL' will apply.

The hire charges of Capital Tools & Plants are exclusive of operating expenses e.g., Operator, fuel & Consumables and the same shall be arranged by the contractor at his cost.

B: BHEL provides hired T&P: In all cases other than that specified in "A" above, actual expenses incurred by BHEL along with applicable overheads will be back-charged to the contractor.

4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.

5. Clause no. 6.1 of this specification (i.e. TCC) shall be referred for date of start of work.

6. Mobilization of concrete boom placer in place of concrete pump will be allowed based on site requirement of BHEL.

4.3 In addition to the above, any other tools and plants required for execution of the above work are in contractor's scope.

4.4. The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing. Alternately, bidder can have a tie up for concrete testing with nearby NABL accredited laboratory outside the site premises with the approval of BHEL engineer-in-charge for the day to day requirement of RCC testing activities

4.4.1 The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can carried out in compliance with the standards.

4.4.2 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment's like as given in table below:

	CONCRETE TESTING EQUIPMENT			
SL NO	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**IS REF.**
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513
2	Shrinkage of cement, Auto Clave Test	Le Chatelier's apparatus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value testing machine with blow counter	Standard	IS 9377

5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation gauge	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5,10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorized vibration machine for cement testing	Standard	IS 4031
12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383
13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75 mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	IS 383
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

	Soil Testing Equipment			
SL NO	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**IS REF.**
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

4.5 Contractor shall have at all times experienced operators and technicians for routine and breakdown maintenance of the equipment. Any delay in rectification of defects will warrant BHEL rectifying the defect and charging the cost to the contractor.

4.6 The subcontractor must deploy at least one safety officer at the site for the entire duration of civil contract and in addition one safety supervisor must be deployed for every 100 workers.

4.7 In case the contractor fails to provide any T&P which is in the scope of contractor and if BHEL provides such T&P available with BHEL, hire charges prevailing (as per BHEL norms) as on that day will be recovered from the contractor as per the prevailing BHEL Corporate Crane hire charges (may vary from time to time). Corresponding pages of Corporate Crane hire charges are enclosed in relevant chapter of Part II of Technical Conditions of Contract (Volume-I Book-I). This may get revised further as per the BHEL corporate guidelines. However, prevailing rates as on date of execution may be applicable. Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.

VOLUME-IA PART-I CHAPTER-V

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

LIST OF T&P BEING PROVIDED BY BHEL FOR USE OF CONTRACTOR FREE OF HIRE CHARGES ON SHARING BASIS

S.NO.	EQUIPMENT	CAPACITY	QTY
1.	EOT CRANE (Power House)	135/20 MT	01

NOTE: The above mentioned suitable capacity crane without slings & lifting tackles will be provided by BHEL on sharing basis. The operation and maintenance of cranes shall be the responsibility of contractor. The fuel/power shall be also given by contractor.

1. EOT cranes will be provided by BHEL free of hire charges & on sharing basis for subject work with exclusions as advised. Routine maintenance shall be taken care by the contractor under this scope of work. However, contractor will not be entitled for any compensation due to non-availability of EOT crane.

2. The contractor will have to provide qualified operator adequate in numbers for operating the mobile and EOT cranes round the clock if required or as per requirement.

3. All other terms & conditions shall be as per SCC clause no. 4.2.1 & 4.2.2.

VOLUME-IA PART-I CHAPTER-VI

TIME SCHEDULE

6.1 TIME SCHEDULE

6.1.1 The date of commencement of work at site shall be mutually agreed date between bidder and BHEL.

6.1.2 The entire work as detailed in the Tender Specification shall be completed within **7 (seven) months** from the "date of commencement of work at site."

6.1.3 During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL site.

6.1.4 The date of commencement of contract period shall be the date of commencement of work at site and shall be mutually agreed between bidder and BHEL site in-charge.

6.1.5 The work shall be deemed as completed in all respect only when so certified by the site Engineer. The decision of BHEL in this regard shall be final and binding of the contractor.

6.1.6 The contractor is required to refer Form 15 in Volume 1- BOOK 2 for all the instructions to be taken immediately after receipt of LOI.

6.1.7 Intermediate milestone is not applicable for this work.

6.2 MOBILISATION

6.2.1 The Contractor has to subsequently augment his resources in a prudent manner to achieve the COMPLETION SCHEDULES:

6.2.2 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the successful bidder taking in to consideration of the COMPLETION SCHEDULES /site decision on drawings flow (latest) and submitted for BHEL's approval.

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

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

6.3 SUBMISSION OF L3 SCHEDULE

The contractor shall submit a detailed area/structure wise L3 schedule within 7 days from date of issue of LOI, in consultation with BHEL based on the tentative schedule provided as per the clause 6.10. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects (or any suitable

format as agreed between contractor and BHEL engineer in-charge) to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, fabrication & erection activities, etc. This schedule shall also clearly indicate the interface facilities/inputs to be provided by BHEL/Customer and the dates by which such facilities/inputs are required. The schedule shall be acceptable to BHEL for meeting their mile stone targets/schedule.

6.4 CONSTRUCTION SCHEDULE

6.4.1 Tentative construction schedule for the scope of works is as mentioned below

Sl.No	**Area**	**Completion from Date of commencement of work**
1.	Dismantling of Concrete encasing of discharge chamber	Progressively by 2nd Month
2.	Concreting and strengthening of concrete for discharge chamber	Progressively by 6th Month
3.	All the other repair and modification works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project.	Progressively by 6th Month
4.	Submission of Final bill	By 7th Month

6.5 GUARANTEE PERIOD FOR THE PACKAGE

The guarantee period for the civil works shall be for a period of 12 months from the date of Final Take Over of the Plant & Equipment by the customer/TANGEDCO. Any defect found during this period will be made good by the Contractor at his own cost.

VOLUME-IA PART-I CHAPTER-VII

TERMS OF PAYMENT

7.1 SECURED ADVANCE

Not applicable

7.2 ADVANCE FOR MOBILIZATION

7.2.1 Interest free Secured Mobilization Advance shall be operated as per GCC clause no. 2.13.1 against securities specified therein. If Interest Free Secured Mobilization Advance is approved by Competent authority as specified in GCC clause no. 2.13.1, the stages of major resource mobilization against which the Interest Free Secured Mobilization Advance limited to maximum of 5 % of the contract value will be paid shall be as below

Completion of site Mobilization of Machinery and T&P as given below	% split-up
Establishment of contractor's office	1.00%
On mobilization of concrete dismantling equipments	2.00%
Dumper/Tipper/ Truck for shifting dismantled concrete – 1 No.	0.50%
DG set (of suitable capacity as per site requirement) – 1 No.	0.50%
Concrete pump – 1 No.	0.50%
Reinforcement cutting machine- 2 nos.	0.25%
Reinforcement bending machine - 2 nos.	0.25%
TOTAL	**5.00%**

7.2.2 Payment of the interest free secured mobilization advance as specified herein and recovery of the advance will be as per clause 2.13 of GCC. Option of availing the interest bearing mobilization advance is left with the bidder.

7.3 TERMS OF PAYMENT:

7.3.1 Interim bills in the form of monthly running bills prepared by the contractor in soft as well as Hard copies shall be based on the quantities executed and measured.

7.3.2 95% item rate shall be released after completion of works certification by Engineer in charge.

7.3.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.

7.3.4 Retention amount shall be as per General Conditions of Contract (GCC).

7.3.5 BHEL Site Engineer, at his discretion, may operate the part rate of the items in line with GCC clause no. 2.23.1 (v). Payment for supply portion (subjected to approval of Engineer In-Charge) shall be made only after receipt of material at site.

7.4 **Royalty/seigniorage charges**

7.4.1 Royalty/seigniorage charges for excavation, inside/outside the plant boundary, as applicable as per Govt. of Tamilnadu for earth work shall be payable by the bidder and proof of payment shall be submitted to BHEL.

7.4.2 Royalty for construction materials:

Payment of royalty for construction materials viz. coarse aggregates, fine aggregates, borrowed earth, etc. is to be made by contractor and challan of deposit of royalty/ seigniorage fee shall be submitted to BHEL along with RA bill.

In absence of production of challan following methodology shall be adopted:

Sl. No.	**Construction Material**	**Rate of seigniorage/ royalty per cum (In rupees) to be withheld in RA bill**	**Volume to be considered for calculation**	**Remarks**
1	Coarse aggregate	90.00	A. For RCC: (As per approved design mix proportion + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill) B. For PCC: (As per DSR recommendation + wastage as	Rate mentioned herein is indicative and for information. Actual prevailing rate for seigniorage fee / royalty fee shall be considered for operation in RA bills/ Final bill. The amount so calculated shall be withheld from RA bill and on production of
2	Fine aggregate	90.00		

			specified in IS 383) x (Total volume of concrete claimed in RA bill)	challan, payment of relevant portion will be released.
3	Borrowed earth	56.00	Actual volume of filling shall be considered	
4	Murram	30% (thirty per cent of the local market value of the murram at pit mouth) or as applicable as per latest Tamilnadu govt. order	Actual volume of filling shall be considered	

7.5 **METHOD OF MEASUREMENT**

Mode of measurement shall be as per relevant IS 1200. In case the same is also not available, the standard procedure adopted in CPWD shall be adopted. In case, the same is also not available in CPWD, the measurement of the work done will be based on the mutual agreement between BHEL and contractor. In all the above cases, the interpretation of BHEL will be final and binding to the contractor. Measurement guidelines as a ready reference is also available in the technical specification

7.6 **NO CLAIM WHAT SO EVER MAY BE, WILL BE ENTERTAINED UNDER THIS CONTRACT, AFTER DULY SIGNING THE FINAL BILL ALONG WITH MEASURMENT BOOKS AND ACCEPTED BY BHEL.**

VOLUME-IA PART – I CHAPTER-VIII

TAXES & DUTIES

8.0 TAXES and DUTIES

8.1 All taxes and duty other than GST & Cess and BOCW Cess

The contractor shall pay all (**except the specific exclusion viz GST & Cess and BOCW Cess, both of which are dealt separately**) taxes, fees, license charges, deposits, duties, tools, royalty/ seigniorage, commissions, Stamp Duties, or other charges / levies, which may be levied on the input goods (including construction material viz. sand, coarse aggregates, moorum, borrowed earth, etc.) & services consumed and output goods & services delivered in course of his operations in executing the contract **and the same shall not be reimbursed by BHEL**. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from his bills or otherwise as deemed fit.

8.2 Goods and service Tax (GST) -

For GST Registered bidder:

8.2.1 The successful bidder shall furnish proof of GST registration under GST Law, covering the supply and services under this contract. Registration should also bear endorsement for the premises from where the billing shall be done by the successful bidder on BHEL for this project/ work. The bidder to specify in their offer the category of registration under GST i.e. Regular dealer or composite dealer**.**

8.2.2 Bidder's price/rates shall be exclusive of GST & GST Compensation Cess (herein after termed as GST).

8.2.3 Vendor / Contractor require to ensure that all benefits as per existing laws have been considered.

8.2.4 Price quoted by the composite dealer shall be considered as inclusive of GST. In the event of any change in the status of vendor / Contractor from composite to regular dealer after the submission of the bid but before completion of supply of services or goods, Contract value shall be amended to remove the embedded GST and any ITC benefit arising due to change of status, which shall be passed on to BHEL. GST paid on the amended contract value shall be reimbursed at actuals against the Tax invoice if BHEL is able to take input tax credit. However, no reimbursement of GST shall be made if BHEL is not able to take input tax credit. The decision of BHEL in this regard will be final and binding on the vendor/contractor.

8.2.5 It is the responsibility of the vendor / contractor to adhere to all the provisions of E-Invoicing under GST Act (if applicable). As per the E-Invoicing provisions vendor /

Contractor has to generate IRN and QR Code from the E-Invoicing system and the same need to be printed in the invoice submitted to their customer. Invoices that do not comply to the above requirements, will not be accepted by BHEL. If the successful Bidder is not falling under the preview of E-Invoicing, then he has to submit a declaration in that respect along with relevant financial statements. However, applicability of E-invoicing, shall be verified from the E-Invoicing portal on submission of vendor / Contractor GSTN. BHEL shall reimburse GST only if all the provisions of E-invoicing are complied with.

8.2.6 It is the responsibility of the vendor/ Contractor to issue the Tax Invoice strictly as per the format prescribed under the GST Act within the prescribed time period in order to enable BHEL to avail input tax credit within the due date. Invoices shall be submitted on time to the concerned BHEL Engineer In Charge. Tax invoice should also contain below details

a. Contractor Name and Contact details.
b. GST No of Contractor
c. PAN No of Contractor
d. Document Type: Tax Invoice/ Debit Note/ Credit Note
e. Category: B2B / B2C (B2B is only applicable w.r.t BHEL)
f. Customer Name and Contact details / Bill To Details (as mentioned below)
g. Unique Tax Invoice Number
h. Invoice Date
i. IRN No, QR Code, Acknowledgment No and Acknowledgment Date generated from E-Invoice Portal as per E-invoicing provisions under GST Act (If applicable)
j. Place of Supply (as mentioned below)
k. Description of service provided
l. 8 Digit SAC code
m. GST Rate
n. Gross value of Invoice
o. Taxable Value
p. Tax / GST Amount
q. Total Invoice value including GST.

Above are inclusive and not exhaustive list of requirements.

8.2.7 Bidder should mention the “Bill To “and “Place of supply” as below in the Tax Invoice

Bill To: Location of BHEL Site office

---,

State: ----------
GSTN of BHEL: ----------

Place of Supply: Location of BHEL Site office

---,

State: ----------
GSTN of BHEL: ----------

(Above details will be given later, contractors may contact BHEL, PSSR before billing)

8.2.8 The amount equivalent to the GST amount shall be withheld from the vendor / contractor payments towards non-compliance of GST/ Statutory provisions if below requirements are not satisfied:

a. Vendor / Contractor submitted original copy of Tax invoice /debit note as per the prescribed format under the GST act within the prescribed time period in order to enable BHEL to avail input tax credit within the due date.

b. The details of the invoice or debit note referred to in clause (a) has been furnished/filed by the Vendor/ Contractor in the statement of outward supplies (presently in GSTR1 or IFF) and such details get reflected in the BHEL GST login (Presently in GSTR 2B) in the manner specified under GST Act.

c. Details of vendor/contractor invoice reflected in BHEL GST login should match with the details in the tax invoice submitted by the vendor/contractor (Like Invoice no, Invoice date, GSTN, Place of supply).

d. The tax charged in the invoice /debit note referred to in clause (a) has been has been actually paid to the Government, either in cash or through utilization of input tax credit admissible by the Vendor/ Contractor.

8.2.9 In case, any GST credit is delayed/denied to BHEL or BHEL has to incur any liability (like interest / penalty) due to non/delayed receipt of goods or submission of tax invoice after the expiry of timeline prescribed in the relevant GST Act for availing ITC, or any other reasons not attributable to BHEL, Then the same shall be recovered from the vendor/contractor along with interest levied/ leviable on BHEL.

8.2.10 GST shall be levied on recoveries, wherever applicable and same shall be recovered from payments. BHEL shall issue / raise Tax invoice on contractor/vendors for such recoveries.

8.2.11 E-way bills / Transit passes / Road Permits, if required for materials / T&P etc., bought into the project site is to be arranged by the Vendor / Contractor themselves. BHEL shall not issue or raise any Road Permit/ E- Way Bill for this purpose. Any claim or demand

raised by the GST department for non- generation / non submission of E-way bill shall be to the contractor/ vendor account

8.2.12 BHEL shall not reimburse any expenditure incurred by the contractor towards demand, additional liability or interest / penalty etc., raised by the GST department due to issues such as wrong rates / wrong classification of services or goods.

8.2.13 Where GST is payable by BHEL under reverse charge basis, any demand raised or any interest or penalty levied / leviable by the GST department due to non-submission or delayed submission of invoice by the contractor or for any other reason not attributable to BHEL, the same shall be recovered from the vendor/contractor.

8.2.14 Tax Deduction at Source (TDS) as per Sec 51 of the CGST Act shall be deducted (if applicable). GST TDS certificate in Form GSTR -7A shall be issued to be contractor. However, GST TDS certificate can be generated only if the contractor accepts the TDS details uploaded by BHEL and files his return. If any specific exemption from GST TDS is applicable to any contractor/vendor, then a declaration to that effect along with relevant documents as may be required by BHEL, substantiating such exemption in line with GST law provisions or notification, shall be submitted by the vendor/contractor.

For GST Unregistered bidder:

8.2.15 In case, bidder is not required to register under Goods and service Tax (GST) & Cess, the same is to be specified in the offer.

8.2.16 Successful bidder to furnish a Self-declaration that registration under GST is not required or not applicable as per the provisions of GST Law along with relevant document and provisions in the GST law.

8.2.17 In case BHEL has to incur any liability (like interest / penalty etc.) due to non-compliance of GST law in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.

8.2.18 TDS under GST (as & when applicable) shall be deducted at prevailing rates on gross invoice value.

8.2.19 If RCM is made applicable at a later date, GST will be paid by BHEL to the department at applicable rate treating the quoted the price as inclusive of GST if BHEL is not able to take Input tax credit.

8.2.20 In the event of any change in the status of bidder from unregistered to registered under the GST law after the submission of bid but before the completion of supply of services or goods, the same need to be intimated and all the clauses applicable for Registered

bidder need to be followed. The vendor/ contractor is required to pass on the ITC benefit arising due to change of status, to BHEL. Contract value shall be amended accordingly. GST paid on the amended contract value shall be reimbursed at actuals against the Tax invoice only if BHEL is able to take input tax credit.

8.3 **Statutory Variations**

8.3.1 BHEL shall pay statutory variation only for GST, and no other variations shall be payable

8.3.2 In general, Statutory variation for GST is payable to the Vendor/Contractor during the contract period including extension thereof. Further, for period beyond the contract period, BHEL will reimburse the actual applicable tax even if the same is higher than the amount applicable within the contractual period in case BHEL is able to take the input tax credit. However, the decision of BHEL in this regard will be final and binding on the vendor/contractor otherwise vendor/contractor has to bear the differential upward increase in tax and quoted price is to be adjusted accordingly

8.4 **New Taxes/Levies** –

In case Government imposes any new levy / tax after submission of bid during the tenure of the contract, BHEL shall reimburse the same at actual on submission of documentary proof of payment subject to the satisfaction of BHEL that such new levy / tax is applicable to this contract. However, Contractor/ Vendor shall obtain prior approval from BHEL before depositing new taxes and duties.

Any benefits arise out of new tax levies and/or abolition of existing taxes must be passed on to BHEL.

The decision of BHEL in this regard will be final and binding on the vendor/contractor.

8.5 Direct Tax

8.5.1 Vendor/ Contractor is required to update himself on its own and comply with provisions of Indian Income Tax Act as notified from time to time. Purchaser shall not be liable towards liability of income tax accruing to the vendor/contractor of whatever nature including variations thereof, arising out of this Order/ Contract, as well as tax liability of the vendor/ Contractor and his personnel

8.5.2 Deductions of Tax at source as per Income Tax Act, at the prevailing rates shall be effected by the Purchaser before release of payment, as a statutory obligation, if applicable. TDS certificate will be issued by the Purchaser as per the statutory provisions. The Vendor/Contractor has to mention their Permanent Account Number (PAN) and GSTIN in all invoices.

8.6 BOCW Act & BOCW Welfare Cess Act

8.6.1 Contractor's price/rates shall be exclusive of BOCW Cess .

8.6.2 The Contractor should Register their Establishment under BOCW Act 1996 read with rules 1998 by submitting Form I (Application for Registration of Establishment) and Form IV (Notice Of Commencement / Completion of Building other Construction Work) to the respective Labour Authorities i.e.,

a. Assistant Labour Commissioner (Central) in respect of the project premises which is under the purview of Central Govt.–NTPC, NTPL etc.
b. Appropriate State authorities in respect of the project premises which is under the purview of State Govt.

8.6.3 The Contractor should comply with the provisions of BOCW Welfare Cess Act 1996 in respect of the work awarded to them by BHEL.

8.6.4 The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers, safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.

8.6.5 The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

8.6.6 Contractor shall make remittance of the BOCW Cess as per the Act in consultation with BHEL as per the rates in force (presently 1%). BOCW remittance should be made only after obtaining prior consent from BHEL. BHEL shall reimburse the same upon production of documentary evidence. However, BHEL shall not reimburse the Fee paid towards the registration of establishment, fees paid towards registration of Beneficiaries and Contribution of Beneficiaries remitted.

8.6.7 Non-compliance to Provisions of the BOCW Act & BOCW Welfare Cess Act is not acceptable. In case of any non-compliance, BHEL reserves the right to withhold any sum as it deems fit. Only upon total compliance with the BOCW Act and the discharge of total payment of Cess (in consultation with BHEL) under the BOCW Cess Act by the Contractor, BHEL shall consider refund of the amounts.

VOLUME-IA PART-I CHAPTER-IX

BILL OF QUANTITY

8.7.1 Bill of Quantities

1. As mentioned in the Price Bid.
2. Variation in quantity shall be as per clause 2.14 of GCC.

VOLUME-IA PART – I CHAPTER – X

GENERAL

1.10 The scope of the work will comprise of but not limited to the following:
(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

The scope of the work will comprise of but not limited to the following:
(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.10.1 Successful Bidder is requested to furnish the following at PSSR-HQ Chennai immediately after release of Letter of Intent (LOI)
i)Security Deposit
ii)Unqualified Acceptance for LOI, Detailed LOI / Work Order.
iii)Rs.100/- Stamp Paper for preparation of Contract Agreement.

1.10.2 Successful Bidder is requested to furnish the proof of documents for the following at the respective PSSR- Site
i)PF Regn No.
ii)Labour License No.
iii)Workmen Insurance Policy No.

1.10.3 In addition to the clause 2.8 of General Conditions of Contract (Volume-1C of Book-II) the contractor shall comply with the following.

1.10.4 **PROVIDENT FUND**

1.10.4.1The contractor is required to extend the benefit of Provident Fund to the labour employed by you in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, you are hereby required to get yourself registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to you by the Provident Fund authorities within one month from the date of issue of the letter of intent. In case you are exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of your failure to comply with the provisions of said Act, if recoveries therefore are

enforced from payments due to us by the customer or paid to statutory authorities by us, such amount will be recovered from payments due to you.

1.10.4.2 The final bill amount would be released only on production of clearance certificate from PF / ESI and labour authorities as applicable.

1.10.5 OTHER STATUTORY REQUIREMENTS

1.10.5.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules and Valid WC Insurance copy or ESI Code (if applicable) and PF code no. along with the first running bill.

1.10.5.2 The contactor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r78(1)(a)(1) of Contract Labour Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

1.10.5.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of "Non-compliance of Sec 21 or non-payment of wages" to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.10.5.4 The Contractor shall submit copies of Final Settlement statement of disbursal of retrenchment benefits on retrenchment of each workmen under I D Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act 1948 (if applicable) to BHEL along with the Final Bill.

1.10.5.5 In case of any dispute pending before the appropriate authority under ID Act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserve the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.

1.10.5.6 In case of any dispute prolonged / pending before the authority for the reasons not attributable to the contractor, BHEL reserves the right to release the final bill of the contractor on submission of Indemnity bond by the contractor indemnifying BHEL

against any claims that may arise at a later date without prejudice to the rights of BHEL.

1.10.6 **DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN**

The following clause is applicable in case the contract value / contract price is Rs. Five crores and above.

The contractor shall, at all stages of work deploy skilled / semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute / Industrial Training. Institute / National Institute of Construction Management and Research (NICMAR), National Academy of Construction, CIDC or any similar reputed and recognized Institute managed / certified by State / Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled / semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

1.10.7 OTHER GENERAL REQUIREMENTS

1.10.7.1 The scope of specification covers the installation, testing and commissioning of the erected equipment / instrument along with accessories as detailed in Bill of Quantity.

1.10.7.2 Identification of equipment at storage yard, technical assistance for checking and making the shortage/damage reports, taking delivery at storage yard and pre-assembly of equipment wherever required, erecting the equipment, aligning, fastening, supporting, cleaning, checking and carrying out statutory tests as required, trial operation, pre-commissioning, commissioning and post- commissioning activities up to the time of completion of commissioning activities and commercial operation of the unit and handing over to customer or till completion contract period (including extended period) whichever is earlier, along with the supply of all consumables, tools and tackles and testing instruments.

1.10.7.3 Scope of work covered under this specification requires quality workmanship, engineering and construction management. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments, calibrating equipment etc., in their possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled

personnel. The manpower deployment identified by contractor shall match with above scope of works.

1.10.7.4 It is not the intent to specify herein all details of material. Any item related to this work not covered here but necessary to complete the system will be deemed to have been included in the scope of the work.

1.10.7.5 The contractor shall have valid ELECTRICAL LICENCE as required to carry out the scope of work indicated in the BOQ.

1.10.7.6 All the work shall be carried out as per instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the contractor.

1.10.7.7 Contractor shall erect all items/materials etc. as per sequence prescribed by BHEL at site. BHEL engineer depending upon the availability of materials/work fronts etc. will decide the sequence of erection/commissioning methodology. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of erection/commissioning adopted in erection/commissioning of similar job or for any reasons whatsoever.

1.10.7.8 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations and Field quality plans of BHEL.

1.10.7.9 The contractor shall co-ordinate and provide assistance for satisfactory testing, pre-commissioning, commissioning and trial run of the connected equipment under overall guidance of BHEL and shall locate any cause of malfunction and rectify the same for proper operation. Testing shall also include any additional tests, which the Engineer feels necessary because of site conditions and also to meet system specification.

~~1.10.7.10~~ During the course of erection, testing and commissioning certain rework / modification/ rectification / repairs / fabrication etc. may be necessary on account of feedback from other power stations or units already commissioned and/ or units under erection and commissioning and also on account of design changes and manufacturing incompatibilities and site operation / maintenance requirements. Contractor shall carryout such rework / modification / rectification / fabrication / repairs etc, promptly and expeditiously. Payments for such works shall be governed by Cl. No. 2.15.1 of GCC.

1.10.7.11 The work shall be executed under the usual conditions without affecting power plant construction and in conjunction with other operations and contracting agencies at site. The contractor and their personnel shall co-operate with the personnel of other agencies, co-ordinate their work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.10.7.12 If any item or equipment not covered but requires being erected/commissioned, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be

considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.

1.10.7.13 After completing all the works, contractor shall hand over all remaining extra materials with proper identification tags in a packed condition to BHEL stores. In case of any use over actual design requirements, BHEL reserves the right to recover the cost of material used in excess or misused. Decision of BHEL engineer in this regard will be final and binding on the contractor.

1.10.7.14 Contractor shall, transport all materials to site and unload at site / working area, or pre-assembly yard for inspection and checking. All material handling equipment required shall be arranged by the contractor.

1.10.7.15 Contractor shall retain all T&P / Testing instrument / Material handling equipment etc., at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.

1.10.7.16 Contractor shall remove all scrap materials periodically generated from their working area in and around power station and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect. All the package materials, including special transporting frames, etc., shall be returned to the BHEL stores / customer's stores by the contractor.

1.10.7.17 The scrap generated after executing the work shall be returned to BHEL earmarked area every week and the same shall be vetted by the Engineer-in- charge, to be produced along with the running bill.

1.10.7.18 The contractor at their cost shall arrange necessary security measures for adequate protection of their machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor’s construction equipment and materials. The contractor may consult the Engineer-in-Charge on the arrangements made for general site security for protection of their machinery equipment tools etc.,

1.10.7.19 The contractor shall ensure that their premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor’s site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer- in-Charge.

1.10.7.20 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. However, completion time for erection agreed will be subject to the condition that contractor’s work is not hampered by the agencies.

1.10.7.21 All the surplus, damaged, unused materials, package materials, containers, special transporting frames, gunny bags etc. shall be returned to the BHEL stores / customer's stores by the contractor.

1.10.7.22 If required by BHEL, the contractor shall change the sequence of their operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.

1.10.7.23 Any wrong erection shall be removed and re-erected promptly to comply with the design requirements to the satisfaction of Site Engineer.

1.10.7.24 Contractor has to work in close co-ordination with other erection agencies at site. BHEL engineer will co-ordinate area clearance. In a project of such magnitude, it is possible that the area clearance may be less/more at a particular given time. Activities and erection program have to be planned in such a way that the milestones are achieved as per schedule/ plans. Contractor shall arrange &augment the resources accordingly.

1.10.7.25 The contractor must ensure the necessary formalities like availability of gate pass, etc. for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside.

1.10.7.26 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe/tubes, and handrails etc for any temporary supporting or scaffolding works. Contractor shall arrange themselves all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.

1.10.7.27 The contractor will be responsible for the safe custody and proper accounting of all materials in connection with the work. If the contractor has drawn materials in excess of design requirements, recoveries will be effected for such excess drawals at the rate prescribed by manufacturing units.

1.10.7.28 No member of the already erected structure/ platform, pipes, grills, platform, other component and auxiliaries should be cut without specific approval of BHEL engineer.

1.10.7.29 Contractors shall ensure that all their Staff/Employees are exposed to periodical training program conducted by qualified agencies/ personnel on ISO 9001/2015 Standards.

1.10.7.30 For other agencies, such as piping, Boiler, ESP, TG, insulation etc., to commence their work from/on the equipment's coming under this scope, Contractor has to clear the front, expeditiously and promptly as instructed by BHEL Engineer. Some time it may be required to re-schedule the activities to enable other agencies to commence/continue the work so as to keep the overall project schedule.

1.10.7.31 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.

1.10.7.32 For the purpose of planning, contractor shall furnish to BHEL Site Engineer the estimated requirement of power (month wise) for execution of work in terms of maximum kW demand, before starting the work at site.

1.10.7.33 On Completion of work, all the temporary buildings, structures, pipe lines, cable etc. shall be dismantled and leveled and debris shall be removed as per instruction of BHEL by the contractor at their cost. In the event of their failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.10.7.34 Prior to erection of any components, inspection to be done for any foreign materials and damages and they are to be attended as per directions of BHEL engineer.

1.10.7.35 All the equipment /material to be taken inside the plant building shall be cleaned thoroughly before taking them inside and erect.

1.10.7.36 It is the responsibility of the contractor to do the alignment, checking, etc., if necessary, repeatedly to satisfy BHEL Engineer / Customer Engineers with all the necessary tools and tackles, manpower etc. without any extra cost. The alignment will be completed only when jointly certified so, by the BHEL Engineer & Customer. Also the contractor should ensure that the alignment is not disturbed afterwards.

1.10.7.37 No temporary supports shall be welded on the pressure parts of piping. Welding of temporary supports, cleats, etc. on the boiler columns shall be avoided. In case of absolute necessity contractor shall take prior approval from BHEL Engineer. Further, any cutting or alternation of member of the structure of platform or other equipment shall not be done without specific prior approval of BHEL Engineer.

1.10.7.38 In electrical MCC's the fixed and moving contacts in contactors & Copper strips shall be removed and kept in safe custody. The same shall be re-erected during commissioning of the system.

1.10.7.39 Whenever cable glands are supplied along with MCC'/JB's/ PB's/etc. they shall be removed and kept in safe custody. The same shall be re-erected during cable termination.

1.10.7.40 Permanent nomenclature/identification on LPBS/Junction boxes/Local Motor Starter boxes/AC Fuse DB/DC Fuse DB/Heater JB/Control panel, LT panel & individual feeders, SP Bus duct, heater JB, Transformers are to be done by the contractor as per the requirement decided BHEL Engineer at site.

1.10.7.41 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there (if required) and there is no extra cost in this regard.

1.10.8 Any modification work required by inspector shall be attended by the contractor. Modifications which had raised due to execution deficiencies are at the cost of contractor whereas modifications which are due to design change shall be treated as extra work.

1.10.9 SITE INSPECTION

1.10.9.1 Various Inspection / quality control / quality assurance procedures/methods at various stages of erection and commissioning will be as per BHEL / Customer quality

control procedure / codes and other statutory provisions and as per BHEL Engineer's instructions.

1.10.9.2 The owner / employer or their authorized agents may inspect various stages of work during the currency of the contract awarded to them. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.

1.10.9.3 BHEL / Customer will have full power and authority to inspect the works at any time, either on the site or at the contractor's premises. The contractor shall arrange every facility and assistance to carry out such inspection. On no account will the contractor be allowed to proceed with work of any type unless such work has been inspected and entries are made in the site inspection register by customer / BHEL.

1.10.9.4 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, delay in execution of work or any other matter, BHEL shall have the right to engage labour and get the work executed through other agency and debit the cost including overheads to the contractor and the contractor shall have no right to claim compensation thereof. In such a case, BHEL shall have the right to utilize the materials and tools brought by the contractors for the same work.

1.10.10 MANPOWER REQUIREMENT

1.10.10.1 Manpower requirement for Erection and Commissioning shall be as follows:

a) There shall be a Resident manager as Site In Charge at site, under whom there shall be sufficient area engineers who shall take care of the erection activities.

b) Resident Engineer should have a minimum qualification of Electrical/Electronics/C&I Engineering Degree with minimum 5 years' experience or Diploma in Electrical/Electronics/C&I Engineering with minimum 10 years of experience in Thermal Power Station.

c) Area Engineer should have minimum qualification of Diploma in Engineering or any graduate with minimum 3 years of experience in Thermal Power Station.

d) Supervisor should have a minimum qualification of Diploma in Electrical/Electronics/C&I engineering or any graduate with minimum 3 years of experience in Thermal Power Station.

e) Lab Technicians should have 2 years' experience in Thermal Power Stations.

f) Contractor should have one Store Keeper, one Transport Supervisor for the safe transportation of materials.

g) Planning / safety Engineers should be available and they should have experience in construction field especially in power plant.

h) Dedicatedcommissioningengineershouldbedeployedfor commissioning of the equipment.

i) Licensed supervisor-01 No. with valid HT/LT electrical license

1.10.10.2 There shall be three separate Erection In-charges, each for Boiler, TG, Station C&I. They shall work independently with required manpower, T&P etc., including storage facilities. Each Erection In-charge shall have minimum two erection engineers with adequate Supervisors and Technicians.

1.10.10.3 There shall be separate engineers for Planning, Safety and Quality.

1.10.10.4 Planning/Safety Engineers should have experience in construction field especially in power plant.

1.10.10.5 Each area engineer shall be provided with minimum four (04) supervisors and adequate number of Technicians / electricians and other erection staff and T&P etc. The testing Engineers / supervisors / electricians shall be identified separately for each unit and the minimum requirement shall be as indicated in previous Clause. Besides, there shall be separate engineers for Planning, Safety and Quality.

1.10.10.6 The above manpower is only tentative and for any additional manpower as per site requirement the same shall be arranged by the contractor.

1.10.10.7 The testing Engineers/supervisors/electricians shall be identified separately for each unit as per the site requirement.

1.10.10.8 The Site in charge shall be provided with PCs and good communication facilities like telephone, fax, email etc. at the cost and expense of the contractor. Lack of communication facilities will not be an excuse for extension of completion date.

1.10.10.9 All instructions from BHEL / Customer will be directed to the contractor through the Site in-charge and he shall be responsible for all the contractor's activities at site. The contractor shall name their authorized representative prior to or immediately on commencement of operations at site.

1.10.10.10 The Site In charge shall be present at site during all normal working hours and their contact address after normal working hours shall be made available to BHEL so that if any emergency arises, the presence of the contractor's site Representative at site can be called for.

1.10.10.11 The contractor shall not change the site Representative without the consent of BHEL. Should BHEL require the replacement of the contractor's site Representative for justifiable reasons (including inadequate progress of work) the contractor shall ensure that replacement is made as soon as possible and work is not allowed to suffer delay on this account.

1.10.10.12 The contractor shall provide to the satisfaction of BHEL sufficient and qualified staff for the execution of works. If and whenever any of the contractor's staff is found guilty of any misconduct or be incompetent or insufficiently qualified in the performance of their duties the contractor shall remove them from site as directed by Site Engineer.

1.10.10.13 The contractor shall ensure that all their supervisor's staff and workmen conduct themselves in a proper manner. They shall all be persons who are familiar with and skilled at the jobs allocated to them. Any misconduct / inefficiency noted on the part of the contractor's personnel shall be brought to the attention of the contractor's site representative who shall immediately take such action as necessary including the

removal of such misconducting / inefficient persons, if so required by the Engineer-in-Charge.

1.10.10.14 The contractor shall ensure that replacement for such persons removed from site is provided immediately and the work is not allowed to suffer delay on that account.

1.10.11 DOCUMENTATION

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

a) Bar chart covering planned activities at site

b) Detailed organization chart

c) Details of T&P available with contractors with documents proofs.

1.10.11.2 The following information shall be furnished by the bidder after testing and inspection:

a) Test certificates of various tests conducted at site. All inspection and test certificates shall be signed by customer's representative also, wherever called for as per field quality plan.

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

1.10.12 BOCW Act & BOCW Welfare Cess Act

1.10.12 .1. Contractor's price/rates shall be exclusive of BOCW Cess .

1.10.12.2. The Contractor should Register their Establishment under BOCW Act 1996 read with rules 1998 by submitting Form I (Application for Registration of Establishment) and Form IV (Notice Of Commencement / Completion of Building other Construction Work) to the respective Labour Authorities i.e.,

a. Assistant Labour Commissioner (Central) in respect of the project premises which is under the purview of Central Govt.–NTPC, NTPL etc.

b. Appropriate State authorities in respect of the project premises which is under the purview of State Govt.

1.10.12.3. The Contractor should comply with the provisions of BOCW Welfare Cess Act 1996 in respect of the work awarded to them by BHEL.

1.10.12.4. The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers, safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.

1.10.12.5. The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

1.10.12.6. Contractor shall make remittance of the BOCW Cess as per the Act in consultation with BHEL as per the rates in force (presently 1%). BOCW remittance should be made only after obtaining prior consent from BHEL. BHEL shall reimburse the same upon production of documentary evidence. However, BHEL shall not reimburse the Fee paid towards the registration of establishment, fees paid towards registration of Beneficiaries and Contribution of Beneficiaries remitted.

1.10.12.7. Non-compliance to Provisions of the BOCW Act & BOCW Welfare Cess Act is not acceptable. In case of any non-compliance, BHEL reserves the right to withhold any sum as it deems fit. Only upon total compliance with the BOCW Act and the discharge of total payment of Cess (in consultation with BHEL) under the BOCW Cess Act by the Contractor, BHEL shall consider refund of the amounts.

VOLUME-IA PART – I CHAPTER – XI
PROGRESS OF WORK

The scope of the work will comprise of following but not limited to the following: (All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.11 PROGRESS AND MONITORING OF WORK

1.11.1 Refer forms F -14 to F-15 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

1.11.2 Contractor is required to draw mutually agreed monthly construction programs in consultation with BHEL well in advance monthly as per the Form-14. Contractor shall ensure achievement of agreed program and shall also timely arrange additional resources considered necessary at no extra cost to BHEL. Progress review meetings will be held at site during which actual progress during the week vis-a-vis scheduled program shall be discussed for actions to be taken for achieving targets. Contractor shall also present the program for subsequent week. The contractor shall constantly update / revise his work program to meet the overall requirement. All quality problems shall also be discussed during above review meetings. Necessary preventive and corrective action shall be discussed and decided upon in such review meetings and shall be implemented by the contractor in time bound manner so as to eliminate the cause of nonconformities.

1.11.3 The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials reports, consumables (gases / electrodes / ferules / lugs) report, T&Ps availability report and other reports as per Performa considered necessary by the Site Engineer as per the BHEL formats.

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

1.11.5 The monthly report at the end of every month shall be submitted as a booklet and shall contain the following details:

a) Colour Progress photographs to accompany the report should be submitted.

b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.

c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan

d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.

e) Consumables report giving consumption of all types of gases and electrodes during the previous month (as applicable).

f) Availability report of cranes/T&Ps

g) Safety implementation report in the format

h) Any other inputs required from BHEL for activities planned during the subsequent month.

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

1.11.7 During the course of construction, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians etc employed are not sufficient BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this account including all expenses together with BHEL overheads from contractor's bills.

1.11.8 It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, laborer availability, equipment deployment, testing, etc.

1.11.9 The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.

1.11.10 The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

VOLUME-IA PART-II CHAPTER-1
CORRECTIONS / REVISIONS IN SPECIAL CONDITIONS OF CONTRACT, GENERAL CONDITIONS OF CONTRACT AND FORMS & PROCEDURES

Sl. No.: 01

Following Clauses in General Conditions of Contract (GCC) are modified/ revised/ added:

S. No	**GCC Clause Reference**	**Modification / Revision / Addition in GCC Clause**
1.	GCC Clause 1.9.1, Sl. No (ii)	The following mode of deposit, Sl. No. (e) is added: e) Insurance Surety Bonds
2.	GCC Clause 1.10.3, Sl. No. (vi)	**The following Clause, Sl. No. (vi) is deleted**: Security deposit can also be recovered at the rate of 10% of the gross amount progressively from each of the running bills of the contractor till the total amount of the required security deposit is collected. However, in such cases at least 50% of the required Security Deposit, including the EMD, should be deposited in any form as prescribed before start of the work and the balance 50% may be recovered from the running bills as described above
3.	GCC Clause 1.10.3, Sl. No (vii)	The following mode of deposit, Sl. No. (vii) is **added**: e) Insurance Surety Bonds
4.	Note mentioned under the GCC Clause 1.10.3	Note mentioned under GCC Clause 1.10.3 is revised as below: Note: **(1)** BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith. **(2)** In case of delay in submission of security deposit, enhanced security deposit which would include interest (Repo rate +4%) for the delayed period, shall be submitted by the bidder.
5.	GCC Clause 1.10.8	**GCC Clause 1.10.8 is revised as below:** Bidder agrees to submit security deposit required for execution of the contract within the time period mentioned. In case of delay in submission of security deposit, enhanced security deposit which would include interest (Repo rate+4%) for the delayed period, shall be submitted by the bidder. Further, if security deposit is not submitted till such time the first bill becomes due, the amount of security deposit due shall be recovered as per terms defined in NIT / contract, from the bills along with due interest
6.	GCC Clause 2.22.1	**GCC Clause 2.22.1 is revised as:** Retention Amount shall be 5% of the Contract Value and shall be furnished through BG in line with clause 1.12 of GCC before payment of first RA Bill. The validity of the said BG shall be initially for the contract period & shall be extended, if so required, up to acceptance of final bill. In case of increase in

S. No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		contract value, additional BG for 5% of differential amount shall be submitted by Contractor before payment of next RA Bill due. Retention Amount can also be recovered at the rate of 10% of the gross amount progressively from each of the running bills of the contractor till the total amount of the required retention amount is collected. In case, contractor opts cash deduction from RA bills in the beginning & subsequently offers to submit BG later on, then refund of deducted retention amount may be permitted against submission of BG for 5% of the Contract Value.
7.	New Clause for "Breach of Contract, Remedies and Termination" is added in place of existing clause of Risk & Cost (i.e. 2.7.2.1 to 2.7.3)	**1.Clause 2.7.2 and 2.7.3 are revised as:** **2.7.2 <u>Breach of Contract, Remedies and Termination</u>** **2.7.2.1** BHEL shall terminate the contract after due notice of a period of 14 days in any of the following cases, which if not rectified/ improved within the time period mentioned in the notice, then, 'Breach of Contract' will be considered to have been established: i). Contractor's poor progress of the work vis-à-vis execution timeline as stipulated in the Contract, backlog attributable to contractor including unexecuted portion of work does not appear to be executable within balance available period considering its performance of execution. ii). Withdrawal from or abandonment of the work by contractor before completion of the work as per contract. iii). Non-completion of work by the Contractor within scheduled completion period as per Contract or as extended from time to time, for the reasons attributable to the contractor. iv). Repeated failure of contractor in deploying the required resources, to comply the statutory requirements etc. even after given by BHEL is writing. v). Strike or Lockout declared is not settled within a period of one month. vi). Termination of Contract on account of any other reason (s) attributable to Contractor. vii). Assignment, transfer, subletting of Contract without BHEL's written permission. viii). Non-compliance to any contractual condition or any other default attributable to Contractor.

S. No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		2.7.2.2 <u>Remedies in case of Breach of Contract is established</u> In case 'Breach of Contract' is established, Security Deposit and Retention Amount shall be encashed/ forfeited. This is without prejudice to BHEL's right to levy of liquidated damages, debarment etc. which shall be applied as per the provisions of the contract. Sequence of recovery to be made in case of breach of contract is established, is as below: a) In case the value of Security Deposit & Retention Amount, available for the Contract, is less than 10% of the Contract Value, the balance amount shall be recovered from dues available in the form of Bills payable to contractor, BGs against the same contract etc. b) Demand notice for deposit of balance recovery amount shall be sent to contractor, if funds are insufficient to effect complete recovery against dues indicated in (a) above. c) If contractor fails to deposit the balance amount to be recovered within the period as prescribed in demand notice, following action shall be taken for balance recovery: i) Dues payable to contractor against other contracts in the same Region shall be considered for recovery. ii) If recovery cannot be made out of dues payable to the contractor as above, balance amount to be recovered, shall be informed to other Regions/Units for making recovery from the Unpaid Bills/Running Bills/SD/BGs/Final Bills of contractor. iii) In-case recoveries are not possible with any of the above available options, Legal action shall be initiated for recovery against contractor. Note: 1) In addition to above, levy of liquidated damages, debarment, termination, short-closure etc. shall be applied as per provisions of the contract. 2) If tendering is done for the balance work, the defaulted contractor (including all the members/partners in case of JV/ partnership firm) shall not be eligible for either executing the balance work or to participate in the tender(s) for executing the balance work. **2.7.3** In case Contractor fails to deploy the resources as per requirement informed by BHEL in writing to expedite the work, BHEL can deploy own/hired/otherwise arranged resources and

S. No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		recover the expenses incurred from the dues payable to contractor. Recoveries shall be actual expenses incurred plus 5% overheads or as defined in TCC.
8.	GCC Clause 2.7.7	**GCC Clause 2.7.7 is revised as:** 1. BHEL may permit or direct contractor to demobilize and remobilize at a future date as intimated by BHEL in case of following situations for reasons other than Force majeure conditions and not attributable to contractor: i) suspension of work(s) at a Project either by BHEL or Customer, or ii) where work comes to a complete halt or reaches a stage wherein worthwhile works cannot be executed and there is no possibility of commencement of work for a period of not less than three months 2. In such cases, charges towards demobilization and remobilization shall be as decided by BHEL after successful remobilization by contractor at site, and decision of BHEL shall be final and binding on the contractor. After remobilization, all conditions as per contract shall become applicable. In case Contractor does not remobilize with adequate resources or does not start the work within the period as intimated, then BHEL reserves the right to terminate the contract and effect remedies under Clause 2.7.2.2. Duration of the contract/time extension shall be revised suitably. In case of any conflict, BHEL decision in this regard shall be final and binding on the contractor.
9.	GCC Clause 2.11.3	**GCC Clause 2.11.3 is revised as:** However, if any 'Time extension' is granted to the contractor to facilitate continuation of work and completion of contract, due to backlog attributable to the contractor alone, then it shall be without prejudice to the rights of BHEL to impose penalty/LD for the delays attributable to the contractor, in addition to any other actions BHEL may wish to take under clause 2.7.2 of GCC i.e. "Breach of Contract, Remedies and Termination".
10.	GCC Clause 2.19.1	**GCC Clause 2.19.1 is revised as:** The contractor will be fully responsible for all disputes and other issues connected with his labour. In the event of the contractor's labour resorting to strike or the Contractor resorting to lockout and if the strike or lockout declared is not settled within a period of one month, it may be considered as

S. No	GCC Clause Reference	Modification / Revision / Addition in GCC Clause
		'Breach of Contract' under Clause 2.7 and the remedies under Clause 2.7.2.2 may be executed, at the discretion of BHEL.
11.	GCC Clause 2.24.1	**GCC Clause 2.24.1 is revised as:** Even though the work will be carried out under the supervision of BHEL Engineers the Contractor will be responsible for the quality of the workmanship and shall guarantee the work done for a period of Twelve months from the date of commencement of guarantee period as defined in Technical Conditions of Contract, for good workmanship and shall rectify free of cost all defects due to faulty erection detected during the guarantee period. In the event of the Contractor failing to repair the defective works within the time specified by the Engineer, BHEL may proceed to undertake the repairs of such defective works, by itself, without prejudice to any other rights and recover the cost incurred for the same along with 5% overheads from the Security Deposit.

Sl. No.: 02

In addition to The EARNEST MONEY DEPOSIT (EMD) clause 1.9 and The SECURITY DEPOSIT (SD) clause 1.10 published in General Conditions of Contract (Volume I Book II) following is added for FDR

1.FDR should be Lien marked in favour of M/s BHEL.

2.Bank issuing FDR should agree to the following conditions and submit duly signed letter addressed to BHEL, confirming the following points:

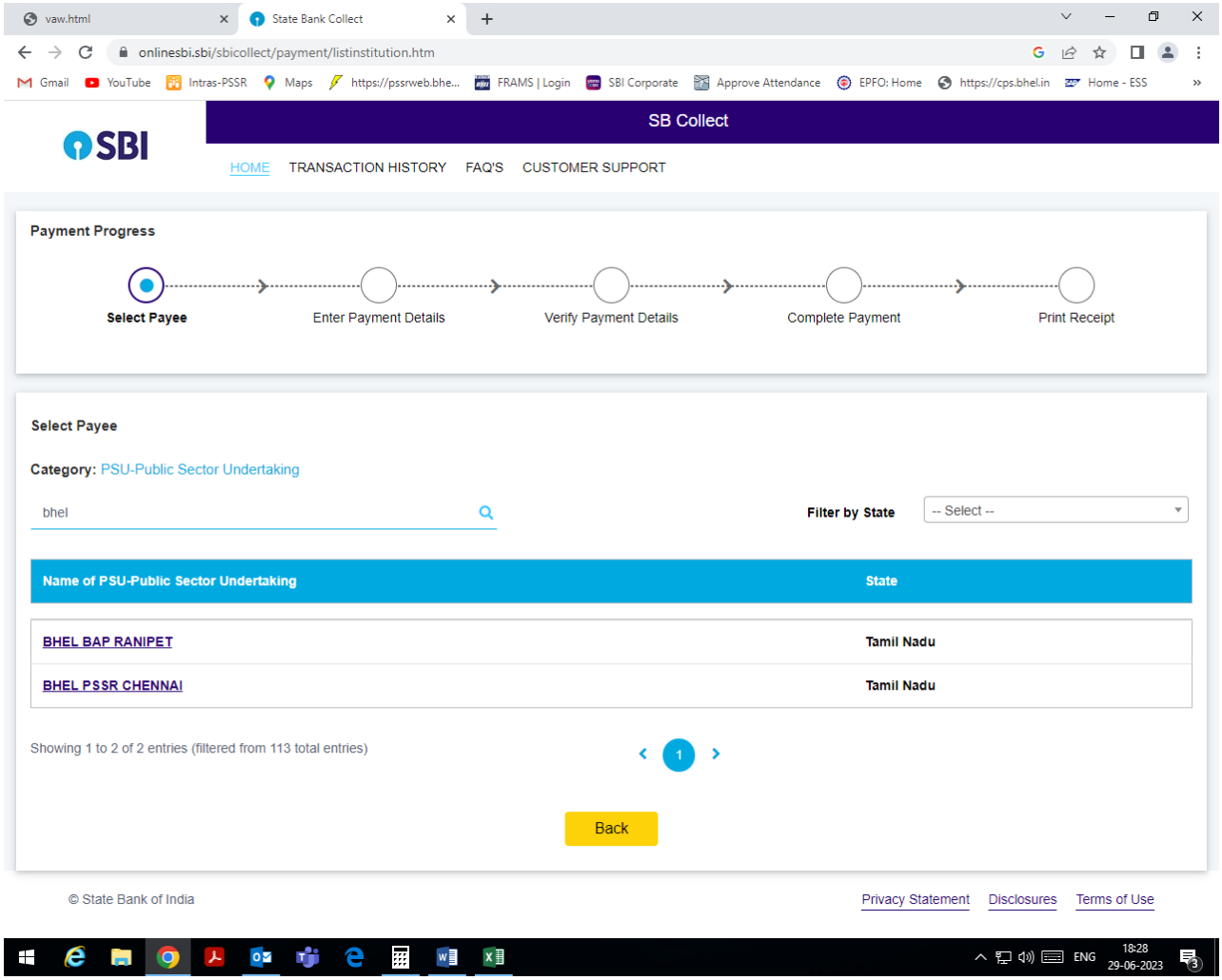
a) There is no Lock in Period for Encashment of the Said FDR
b) The amount under the Said FDR would be paid to BHEL-PSSR on Demand, at any point of Time before, or upon Maturity, without any reference to the …… (Contactor Name).
c) Encashment whether premature or otherwise would not require any clearance from any other authority /Person.
d) FDR will be auto renewed for such period/s initially mentioned in the FDR and the intimation of Such renewal shall be sent to BHEL, PSSR and …… (Contractor), immediately after the renewal.
e) FDR will not be closed, Encashed, Changed or Discharged without the Written permission/Confirmation from M/s BHEL PSSR.
f) Bank to acknowledge and agree that the Lien created on the FDR shall be in Force until M/s BHEL PSSR, gives a Discharge Letter in this regard.

Sl. No.: 03

Detailed Instruction for EMD / Security deposits through SBI e-collect:

Step 1: Vendors may visit SBI collect website, the URL of which is https://www.onlinesbi.sbi/sbicollect where they get the home page with various categories of institutions.

Step 2: Select PSU - Public Sector Undertakings – leading to a page with list of PSUs
Step 3: Type BHEL and search, they get to see all BHEL divisions wherein they shall select BHEL PSSR Chennai. The screen shot of the same is given below.



Step 4: Select EMD receipts. Having selected the Payee in the Payment Progress, it will lead to the payment details – a drop down list of values. From that list, vendors shall select EMD receipts. Upon clicking the entry EMD receipts, a form will open asking for the remitters details and the details of the tender.
Step 5: Confirm details and pay
Fill in all the details correctly, verify the details, and complete the payment as it is leading to the payment gateway.
Step 6: Take a printout on completing the payment and enclose the copy of the same along with the bid submission. Store the copy of receipt for future reference.

Following Clauses are modified in the Special Conditions of Contract (SCC)

Sl. No.: 07

Clause No. 10.5 on RA Bill Payments, in Special Conditions of Contract (SCC), Volume-IB, Book- II, is revised as under:

"The payment for running bills will normally be released within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc., and other dues in the meanwhile."

VOLUME: II B

SECTION – C

SPECIFIC TECHNICAL REQUIREMNTS FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

SPECIFICATION NO: PE-TS-470-600-C001

Bharat Heavy Electricals Limited
Power Sector - Project Engineering Management
PPEI Building, Plot No. 25
Sector – 16A, NOIDA (U.P.) - 201301

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PART-I : GENERAL CIVIL REQUIREMENT

PART-II : SPECIFIC DESIGN REQUIREMENTS - CIVIL

PART-I

GENERAL CIVIL REQUIREMENT

1. GENERAL

Two Volumes-Section C & Section D of this specification cover design and construction of Civil, Structural and Architectural works. The scope of works covers complete Civil ,Structural and Architectural works including supply of all materials, labour, tools and plants as required for successful execution of the packages. This Part-I of Section-C Lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirement and features pertinent to each.

If there is any ambiguity and/or contradiction between Section C and Section D, the provisions / requirements laid in Section C shall prevail. In case of ambiguity between BOQ and Part C former shall prevail.

(Contractor shall read the parts of the specification relevant to the contract and shall ignore the other parts of the specification. Relevant clauses of this section as applicable for respective package to be followed.)

2. CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/ Technical Specifications as appropriate. The latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

2.1. Earthwork

a) IS-1498: Classification and identification of soils for General Engineering purposes.
b) IS-3764: Safety Code for excavation work.
c) IS-7293: Safety Code for working with construction machinery.
d) IS-4701: Code of practice for earth work on canals.
e) IS-9759: Guide lines for dewatering during construction.
f) IS-10379: Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

2.2. Concrete

a) IS-269: Ordinary and low heat Portland cement.
b) IS-383: Coarse and fine aggregate from natural sources for concrete.
c) IS-432: Mild Steel and medium tensile steel bars and hard (Part I & II) drawn steel wire for concrete reinforcement.
d) IS-455: Portland Slag Cement.
e) IS-456: Code of Practice for Plain and reinforced concrete.
f) IS-457: Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
g) IS-460: Test Sieves (all parts).
h) IS-516: Methods of test for strength of concrete.
i) IS-1199: Methods of sampling and analysis of concrete.
j) IS-1566: Hard drawn steel wire fabric for concrete Reinforcement.
k) IS-1786: High strength deformed steel bars and wires for concrete Reinforcement.
l) IS-1791: General requirement for batch type concrete mixers.
m) IS-1834: Hot applied sealing compounds for joints in concrete.
n) IS-1838: Preformed fillers for expansion joints in concrete pavement and structures.

o) IS-2386: Methods of test for aggregates for concrete (all parts).(Part I-VIII)
p) IS-2438: Specification for roller pan mixers.
q) IS-2502: Code of practice for bending and fixing of bars for concrete Reinforcement.
r) IS-2505: Concrete vibrators - immersion type.
s) IS-2506: General requirements for screed board concrete vibrators.
t) IS-2722: Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
u) IS-2750: Steel scaffoldings.
v) IS-2751: Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
w) IS-3150: Hexagonal wire netting for general purposes.
x) IS-3366: Specification for pan vibrators.
y) IS-3370: Code of practice for concrete structures for storage of liquids (all parts).(Part I-IV)
z) IS-3414: Code of practice for design and installation of joints in buildings.
aa) IS-3558: Code of practice for use of immersion vibrators for consolidating concrete.
bb) IS-4014: Code of practice for steel tubular scaffolding.(Part I & II)
cc) IS-4656: Form vibrators for concrete.
dd) IS-4925: Concrete batching and mixing plant.
ee) IS-4948: Welded steel wire fabrics for general use.
ff) IS-4990: Plywood for concrete shuttering work.
gg) IS-5256: Code of practice for sealing expansion joints in concrete lining on canals.
hh) IS-6452: High Alumina Cement for Structural use.
ii) IS-6461: Glossary of terms relating to cement concrete.
jj) IS-6494: Code of practice for water proofing of underground reservoir and swimming pools.
kk) IS-6509: Code of practice for installation of joints in concrete pavements.
ll) IS-7320: Concrete slump test apparatus.
mm) IS-7861: Code of practice for extreme weather concreting.
(Part I & II)
nn) IS-8041: Rapid Hardening Portland Cement.
oo) IS-8112: High strength ordinary Portland Cement.
pp) IS-9012: Recommended practice for shotcreting.
qq) IS-9103: Admixtures for concrete.
rr) IS-9417: Recommendations for welding cold worked bars for reinforced concrete construction.
ss) IS-10262: Recommended guidelines for concrete mix design.
tt) IS-458: Specification for precast concrete pipes.
uu) IS-3935: Code of practice for composite construction.
vv) IS-4995: Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials.
ww) IS-5525: Recommendation for detailing of reinforced concrete works.
xx) IS-11384: Code of practice for composite construction in structural steel and concrete.
yy) IS-11682: Criteria for design of RCC staging for overhead water tanks.
zz) IS:12118: Two parts polysulphide based sealants.
aaa) IS:12200: Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
bbb) IS:13311: Non-destructive testing of concrete - methods of test.
Part I - Ultrasonic pulse velocity.
Part II - Rebound hammer.
ccc) IS-13920: Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
ddd) SP-16: Design codes for reinforced concrete to IS:456-1978.
eee) SP-23: Hand book of concrete mixes.
fff) SP-24: Explanatory handbook on Indian standards code for plain and reinforced concrete.
(IS: 456)
ggg) SP-34: Hand book on concrete reinforcement and detailing.
hhh) ACI-318: American Concrete Institute code for structural concrete.
iii) IS-280: Mild steel wire for general engineering purpose.
jjj) IS-10297: Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
kkk) IS-10505: Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
lll) IS-15658: Pre-cast concrete block for paving.

2.3. Foundations

a) IS-1080: Code of practice for Design and Construction of shallow foundations on soils (other than raft, ring and shell)
b) IS-1904: Code of practice for Design and Construction of foundations in soils: General Requirements
c) IS-2314: Steel sheet piling sections.
d) IS-2911: Code of practice for Design and Construction of Pile foundations (all parts).
e) IS-2950: Code of practice for design and construction of raft foundations.
f) IS-2974: Code of practice for design and construction of machine foundations.
g) IS-4091: Code of practice for Design and Construction of foundations for transmission line towers and poles
h) IS-6403: Code of practice for determination of Bearing capacity of Shallow foundations.
i) IS-8009: Code of practice for calculation of settlement of foundations: (all parts)
j) IS-9556: Code of practice for Design and Construction of diaphragm walls.
k) IS-11089: Code of practice for Design and Construction of ring foundation.
l) IS-12070: Code of practice for design and construction of shallow foundations on rocks.
m) IS-13301: Guidelines for vibration isolation for machine foundation.
n) ISO 10816: Criteria for assessing mechanical vibrations of machines.
o) ISO 1940: Criteria for assessing the st of balance of rotating rigid bodies.
p) DIN: EN13906-1: Helical compression spring made of round wire and rod: calculation and design of compression.
q) DIN: 2096 Helical compression spring out of round wire and rod: Quality requirements for hot formed compression spring.
r) DIN: 4024 Flexible supporting structures for machine with rotating machines.
s) IS: 7207 Criteria for Design of Generator Foundation for Hydel Power Stations.
t) IS: 4247 Part I, Part II & Part III. Code of Practice for Structural Design of Surface Hydel Power Stations.

2.4. Loading

a) IS-875: Code of practice for Structural safety of buildings - loading standards.
b) IS-1911: Schedule of unit weights of building materials.
c) IRC-6: Standard specifications & Code of practice for road bridges.

2.5. Masonry

a) IS-712: Building limes.
b) IS-1077: Common Burnt Clay Building Bricks.
c) IS-1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.
d) IS-1528: Methods of sampling and physical tests for refractory materials.
e) IS-1597: Code of practice for construction of stone masonry (all parts).
f) IS-2212: Code of practice for brickwork.
g) IS-2116: Sand for masonry mortars
h) IS-2185: Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i) IS-2250: Code of practice for preparation and use of masonry mortars.
j) IS-2572: Code of practice for construction of hollow concrete block masonry.
k) IS-2691: Burnt clay facing bricks.
l) IS-3414: Code of practice for design and installation of joints in buildings.
m) IS-3495: Methods of tests of burnt clay building bricks.
n) IS-4441: Code of practice for use of Silicate type chemical resistant mortars.
o) IS-4860: Acid Resistant Bricks.
p) IS-1905: Code of practice for structural use of unreinforced masonry.
q) IS-10440: Code of practice for construction of reinforced brick and reinforced brick concrete floors and roofs.
r) SP-20: Hand book on masonry design and construction.
s) IS-1489: Portland-pozzolana cement.
t) IS-1542: Sand for Plaster.
u) IS-12269: 53 grade ordinary Portland cement.
v) IS-12894: Specification for fly ash lime bricks.
w) IS-13757: Burnt clay fly ash building bricks.

2.7. Roof and Flooring

a) IS-2204: Code of practice for construction of reinforced concrete shell roof.
b) IS-3201: Criteria for the design and construction of precast concrete trusses.
c) IS-2210: Criteria for Design of R.C. shell structures and folded plates.
d) IS-809: Rubber flooring materials for general purposes.
e) IS-1195: Bitumen mastic for flooring.
f) IS-1196: Code of practice for laying bitumen mastic flooring.
g) IS-1198: Code of practice for laying, fixing and maintenance of linoleum floors.
h) IS-1237: Cement concrete flooring tiles.
i) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.
j) IS-2114: Code of practice for laying in situ terrazzo floor finish.
k) IS-2571: Code of practice for laying in situ cement concrete flooring.
l) IS-5491: Code of practice for laying in situ granolithic concrete floor topping.
m) IS-5766: Code of practice for laying burnt clay brick flooring.
n) IS-1197: Code of practice for laying of rubber floors.

o) IS-2441: Code of practice for fixing ceiling coverings.

2.11. Earthquake Resistant Design

a) IS-1893: Criteria for earthquake resistant design of structures.
b) IS-4326: Code of practice for earthquake resistant design and construction of buildings.

2.12. Structural Steelwork

a) IS-800: Code of practice for general construction in steel.
b) IS-802: Code of practice for use of structural steel in Overhead Transmission Line (All Parts).
c) IS-806: Code of practice for use of steel tubes in general building construction.
d) IS-808: Rolled steel beams, channels and angle sections.
e) IS-813: Scheme of symbols for welding.
f) IS-814: Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g) IS-816: Code of practice for use of metal arc welding for general construction in mild steel.
h) IS-817: Code of practice for training and testing of metal arc welders.
i) IS-818: Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j) IS-819: Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k) IS-919: Recommendations for limits and fits for engineering.
l) IS-1024: Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m) IS-1161: Steel tubes for structural purposes.
n) IS-1182: Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o) IS-1200: Method of measurement of steelwork and ironwork.
(Part-VIII)
p) IS-1239: Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q) IS-1363: Black hexagonal bolts, nuts and locknuts (Dia. 6 to 39 mm) and black hexagon screws (Dia.6 to 24 mm). [all parts]
r) IS-1364: Precision and semi-precision hexagon bolts, screws, nuts and locknuts (Dia. range 6 to 39 mm). [all parts]
s) IS-1365: Slotted counter sunk head screws (Dia. range 1.6 to 20 mm).
t) IS-1367: Technical supply conditions for threaded steel fasteners. (Part 1 to 18)
u) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.

v) IS-1608: Method for tensile testing of steel products.
w) IS-1730: Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
x) IS-1731: Dimensions for steel flats for structural and general engineering purposes.
y) IS-1852: Rolling and cutting tolerances for hot rolled steel products.
z) IS-1977: Structural steel (Ordinary quality)
aa) IS-2016: Plain Washers
bb) IS-2062: Steel for General structural purposes.
cc) IS-2074: Ready mixed paint, air drying, red oxide zinc-chrome, priming.
dd) IS-2633: Methods of testing uniformity of coating of zinc coated articles.
ee) IS-3613: Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
ff) IS-3664: Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
gg) IS-3757: High strength structural bolts.
hh) IS-4000: High strength bolts in steel structures.
ii) IS-4759: Hot dip zinc coatings on structural steel and other allied products.
jj) IS-5334: Code of practice for Magnetic Particle Flaw detection of welds.
kk) IS-7215: Tolerances for fabrication of steel structures.
ll) IS-7280: Base-wire electrodes for sub-merged arc welding of structural steels.
mm) IS-7318: Approval test for welders when welding procedure approval is not required. (Part-I)
nn) IS-8500: Structural steel - micro alloyed (medium and high strength qualities).
oo) IS-9595: Recommendation for metal arc welding of carbon and carbon manganese steels.
pp) AWS D.1.1 Structural Welding Code.
qq) IS-8640: Recommendations for dimensional parameters for industrial building.
rr) IS-9178: Criteria for design of steel bins for storage of bulk material (all parts).
ss) IS-12843: Tolerances for erection of steel structures.
tt) IS-1181: Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
uu) IS-2595: Code of practice for Radiographic testing
vv) IS-2629: Hot dip galvanising of iron and steel
ww) IS-3502: Steel chequered plate.
xx) IS-3658: Code of practice for liquid penetrant flaw detection.
yy) IS-4353: Sub merged arc welding of mild steel and low alloy steel Recommendation.
zz) IS-5369: General requirements for plain washers and lock washer.
aaa) IS-6623: High strength structural nuts.
bbb) IS-6649: Hardened and tampered washers for high strength structural bolts & nuts.
ccc) IS-6911: Stainless steel plate, sheet and strip.
ddd) IS-7205: Safety code for erection of structural steel.
eee) IS-7307: Approved test for welding procedures
(Part I) Fusion welding of Steel
fff) IS-7310: Approval test for welders working to approval welding procedure.
(Part I) Fusion welding of Steel
ggg) SP-6: IS Handbook for structural engineers.

2.13. Painting

a) IS-348: Specification for French Polish.
b) IS-427: Specification for Distemper, dry colour as required.
c) IS-428: Specification for Distemper, oil emulsion, colour as required.
d) IS-1477: Code of practice for painting of ferrous metal in buildings.
(Part I & II)
e) IS-2338: Code of practice for finishing of wood and wood based materials.
(Part I & II)
f) IS-2339: Specification for Aluminium Paints for general purposes in dual containers.
g) IS-2395: Code of practice for painting concrete, masonry and plaster surface.
h) IS-2932: Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.
i) IS-2933: Specification for enamel, exterior - a) undercoating, b) finishing.
j) IS-5410: Specification for cement paint.
k) IS-162: Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as

required.
l) IS-1650: Specification for colours for building and decorative materials.
m) IS-2395: Code of practice for painting concrete, masonry and plaster surfaces.
(Part I) Operations and Workmanship.
(Part II) Schedule.
n) IS-2524: Code of practice for painting of nonferrous metals in buildings.
(Part I) Pre-treatment.
(Part II) Painting.
o) IS-15489: Plastic emulsion paint.
p) IS-6278: Code of practice for white washing and Colour washing.
q) IS-10403: Glossary of term related to building finish.
r) IS-12027: Silicone based water repellent.
s) IS-13238: Epoxy based zinc phosphate primer (2 pack).
t) IS-13239: Epoxy surface (2 pack).
u) IS-13467: Chlorinated rubber for paints
v) IS-14209: Epoxy enamel, two component glossy.
w) BS-5493: Code of practice for protective coating of iron and steel structures against corrosion.

2.15. Plastering

a) IS-1661: Code of practice for application of cement and cement lime plaster finishes.
b) IS-2402: Code of practice for external rendered finishes.
c) IS-2547: Gypsum building plaster.

2.17. Safety

a) IS-1641: Code of practice for fire safety of buildings - General principles of fire grading and classification.
b) IS-1642: Code of practice for fire safety of buildings - Details of construction.
c) IS-3696: Safety code for scaffolds and ladders.
(Part I & II)
d) IS-4081: Safety code for blasting and related drilling operations.
e) IS-4130: Demolition of buildings - code of safety.
f) IS-5121: Safety code for piling and other deep foundations.
g) IS-5916: Safety code for construction involving use of hot bituminous materials.
h) IS-7205: Safety code for erection of structural steel work.
i) IS-7969: Safety code for handling and storage of building materials.

2.18. NDT

a) IS : 13311 (Part 2) : Non-destructive Testing of Concrete –Methods of Test, Part 2 Rebound Hammer, BIS, New Delhi.
b) IS: 13311 (Part 1) : Non-destructive Testing of Concrete – Methods of Test , Part 1 Ultrasonic Pulse Velocity, BIS, New Delhi.
c) ASTM C876-91 STM for Half-cell Potentials of Uncoated Reinforcing Steel in Concrete
d) BS EN 14630, Products and systems for the protection and repair of concrete structures. Test methods. Determination of carbonation depth in hardened concrete by the phenolphthalein method.
e) ASTM C900-94 STM for Pullout Strength of Hardened Concrete
f) AS 1012.20- Method of Testing Concrete - Determination of chloride and sulfate in hardened concrete and concrete aggregates
g) BS 4408: pt. 1, “Non-destructive methods of test for concrete-electromagnetic cover measuring devices”, British Standards Institution, London
h) BS 1881: Part 204: Recommendations on the Use of Electromagnetic Covermeters
i) BS 1881: Part 201: Guide to the Use of Non-Destructive Methods of Test for Hardened Concrete

3. GENERAL

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

4. LAYOUT

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. **If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks.** If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.
If required, in the opinion of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderer’s shall take into account the cost of these in quoting their price.

5. WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6. TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.
The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

7. SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.
The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all important items of work.

8. CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, porcelains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done with specific approval of engineer.
Dewatering shall be done using the combination of electrical and standby diesel pumps.
For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.
All handling of materials shall be with cranes.
Heavy trailers shall be used for transportation.
Mechanized modular units of scaffolding and shuttering shall be used.
Grouting shall be carried out using hydraulically controlled grouting equipment.
All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.
Heavy duty hoists for lifting of construction materials shall be deployed.
Compressors for cleaning of foundations and other surfaces shall be used.
Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc.
All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

PART-II

SPECFIC TECHNICAL REQUIREMNT

RENOVATION, MODERNISATION AND UPRATING OF

KODAYAR POWER HOUSE - I

FROM 1 X 60MW TO 1 X 70 MW

IN TIRUNELVELI GENERATION CIRCLE

KANYAKUMARI DISTRICT, TAMILNADU, INDIA

INTERNATIONAL COMPETITIVE BIDDING

TENDER SPECIFICATION NO. HE – 2367

VOLUME II OF IV

TECHNICAL SPECIFICATION-
~~MECHANICAL~~ & CIVIL

OFFICE OF THE
SUPERINTENDING ENGINEER
HYDRO (ELECTRICAL)
5th FLOOR, EASTERN WING
NPKRR MAALIGAI,
144, ANNA SALAI, CHENNAI - 600 002.

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SECTION - A	:	**TURBINE, GENERATOR AND OTHER MECHANICAL EQUIPMENT**
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01. PREAMBLE

i. This specification shall be read in conjunction with the general conditions, other technical details as provided in Vol. I, II, III and the drawings in Vol-IV. This volume deals with the specification for ~~Mechanical &~~ Civil works including Dismantling of TG and all equipment, Renovation of embedded parts, ~~Supply of Turbine, Governing system, Generator, Excitation System, Mechanical Auxiliaries~~ and Civil works on Turnkey Installation for Renovation, Modernisation & Uprating with new Turbine-Generator from 1x60MW to 1x70MW of Kodayar Power House-I, Kodayar in Kanyakumari District of Tamilnadu.

ii. ~~Electrics and Control & Instrumentation (C&I) including Generator CT, PT, LA, NGTR, Generator Transformer, Auxiliary transformers, switchyard equipment and C&I, etc., are covered under Vol. III of the Tender Specification~~.

02. INTENT OF SPECIFICATION

a) This specification is intended to familiarise the tenderer with the scope of work & services and technical requirements of the subject work. The Tenderer shall study the specification and satisfy himself regarding the workability of the proposed system and shall take full responsibility for the design and engineering of the system & equipment, quality of material, workmanship, guaranteed operation and smooth performance of the system & equipment.

b) If the tenderer wishes to deviate from this specification, the same shall be clearly brought out with justification in the format provided. However, reduction / change in scope will not be entertained.

03. SPECIAL INSTRUCTIONS TO TENDERERS

a) This technical specification (TS) is intended to provide general guidance to the tenderer. All such items, even though not specifically mentioned in this TS, but considered necessary for safe & satisfactory operation and guaranteed performance of the offered system & equipment, shall be considered included in the offer.

b) The tenderer shall visit and carefully examine the site and surroundings to satisfy himself about the nature and condition of all existing facilities, general site condition etc. and all other matters affecting the works. Claim and objection due to ignorance of site condition shall not be considered after submission of offer.

c) All equipment, system and works covered under this specification shall comply with all latest statutes, regulations and safety codes as applicable at Kodayar, Kanyakumari District, Tamilnadu, India. All systems and equipment shall comply in all respects with the requirements of the latest editions of the related IS, IEC, IEEE, VDE, DIN, JIS or any other approved international codes and standards. The electrical equipment shall also conform to the latest Indian Electricity rules, Electricity Act as well as Tamilnadu State Government rules.

d) Other standards are acceptable if they are established to be approved equal or superior to the listed standards subject to approval by the TANGEDCO/Purchaser. The tenderers shall provide English version of the codes and standards applicable.

e) Proposals not meeting the above stipulations of the codes and standards may not be acceptable.

f) ~~The successful tenderer shall study the quality of water at site for suitable design of submerged components of the turbine and material shall be so selected that cavitation and corrosion are minimised~~.

g) Special instructions indicated in Vol III are complimentary to the above mentioned instructions and tenderer to consider all instructions as a whole.

04. GENERAL TECHNICAL RULES

04.01 INTRODUCTION

a) This part of the specification describes the general technical rules to be followed while carrying out the work of Renovation, Modernisation & Uprating with new Turbine-Generator from 1x60MW to 1x70 MW of Kodayar Power House-I, Kodayar in Kanyakumari District of Tamilnadu. The technical requirements for electrical and Control & instrumentation work are described in volume III of the Tender Specification.

b) The purpose of this `General Technical Rules' is to provide the Tenderer with certain general information on the location and conditions existing at site and to lay down common guidelines and specifications which the Tenderer shall follow in designing the plant and execution of work. Adherence to the `General Technical Rules' shall, however, not relieve the Tenderer of his responsibility regarding type, quality of materials, workmanship and requirement as specified by the TANGEDCO/Purchaser under `Technical Specifications' `Invitation to Tender' and `Draft Contract'.

c) The Tenderer shall satisfy himself regarding the site conditions and other relevant matters by visiting site. It is desirable, for compelling reasons, to deviate from these instructions; he is required to obtain prior approval from the TANGEDCO/Purchaser.

d) All equipment to be supplied and/or engineering services and technical services to be rendered shall be manufactured/executed in accordance with the best trade/ engineering practices judged by the established standards and as given in the Technical Specification. Wherever the codes are not mentioned the best international standards to be approved by the TANGEDCO/Purchaser shall be followed.

e) Any supplies and services which might have not been specifically mentioned in the Technical Specification, but are necessary for efficient and smooth operation and maintenance of the work under Indian conditions, unless expressly excluded from the scope of supplies and services shall be supplied/ provided by the successful Tenderer without any extra cost to the TANGEDCO/Purchaser.

04.02 PLANT AND EQUIPMENT

04.02.01 GENERAL

a) The selection, design and manufacture/fabrication of plant and equipment shall be suitable for the intended service and duty conditions and ensure maximum interchangeability of components and least maintenance. The unit shall be complete in all respect.

b) All the equipment, technological structures, pipes, valves, fittings, etc shall be subjected to inspection and testing as per accepted national or international standards and practices. All the components shall be subjected to inspection and testing as per standard practices of the manufacturer prior to offering them for inspection by the Purchaser /his authorised representative.

c) All equipment shall be complete with approved safety devices, wherever a potential hazard to personnel and or equipment exists. There shall be adequate provision for safe access of personnel to and around the equipment for operational and maintenance functions.

d) All equipment shall be complete in all respect including all accessories essential for proper installation, operation and maintenance irrespective of whether such items are specifically mentioned in the specifications or not.

e) All working parts shall be arranged for convenience of operation, inspection, lubrication and ease of repair and replacement of parts and sub- assemblies with minimum downtime.

f) Suitable working platforms, walkways, ladders lifting tackles and tools required for the above shall be provided.

g) The fabrication and assembly areas shall be kept clean and free from contamination. During assembly of major components, a polythene covering shall be maintained in position to prevent ingress of dirt, grease, etc from overhead cranes or other equipment.

h) During fabrication, equipment, pipes, etc shall be kept sealed to the extent possible to avoid entry of foreign matter and contamination by dirt.

i) Piping shall be degreased after fabrication and maintained sealed until the end is presented for welding or jointing.

j) All equipment shall be visually inspected in the presence of an inspector immediately before closure. A system of physical identification and accountability shall be used to account for all tools, test equipment, shipping blanks and other items used during assembly to obviate the possibility of their being left inside vessels or equipment.

k) On completion of manufacture, each pressure vessel shall be pressure tested at room

temperature in accordance with the appropriate code. The test fluid used for pneumatic test shall be dry and oil free compressed air. Leaks shall be detected by use of water solution of inhibited detergent.

l) On completion of construction, the entire assembly shall be leak tested as above. The detergent shall be washed off with clean water on completion of test before insulation work.

04.02.02 DESIGN CONSIDERATIONS

a) Life of the Electro-mechanical generating equipment i.e., turbine, generator, transformers, auxiliaries etc. shall not be less than thirty five (35) years.

b) The Unit shall be designed for unconstrained operation over maximum net head and minimum net head and full range of ambient and other environmental conditions. The turbine centre line level shall be as available and indicated in Ch-6. Speed rise, pressure rise, run away speed shall be governed by the limits specified in relevant IS.

c) Chemical analysis of water and data including the petro graphic analysis shall be taken into consideration while designing the turbine and other auxiliary equipment susceptible to abrasive effects of silt. Suitable materials, protective coatings and painting shall be provided to resist silt abrasion as per site conditions.

d) The operation of the each Unit shall be smooth and quiet. The noise level shall not be more than 90 dBA at a distance of 1metre from any equipment.

04.02.03 LAYOUT CONSIDERATIONS

a) Layout of equipment shall be developed considering the proper utilisation of space, functional requirements, and future extensions. The equipment layout shall be compact so as to economise use of materials.

b) Maintenance facilities shall be provided as required for assembly, disassembly and handling during maintenance of all equipment and auxiliaries.

04.02.04 OPERATING CAPABILITY OF THE GENERATING UNIT

a. The Unit shall be capable of giving the rated output continuously as specified by the manufacturer at the rated design head and rated discharge and shall be capable of operating between the minimum and maximum head specified in this specification (Vol-II) and ambient temperature at site specified.

b. The maximum continuous over load capacity of the units at the generator terminals during the high head conditions or high discharge conditions or both as guaranteed by the manufacturer shall be based on the hydraulic parameter of the station.

c. The Units and associated auxiliaries shall be suitable for continuous operation without any restriction within a frequency range of -5% to +3% (47.5Hz to 51.5 Hz). All the equipment driven by the electric motors shall give their rated performance even at a power supply frequency of 47.5 Hz.

d. Provision shall be made for starting the Unit in auto mode up to synchronisation by a single command and loading of the unit to full load quickly. The design of the equipment and control system shall permit participation of the units in auto frequency control mode.

e. The Unit and all its associated auxiliaries shall be designed for trouble free operation up to maximum rating of the units for complete range of operation for active power and reactive power output.

f. The redundancy in the Units auxiliaries and station equipment shall be provided so that the generating unit continues to operate even in the event of outage of a part of the auxiliary system.

04.03 MANUFACTURING AND FABRICATION

04.03.01 GENERAL

a) All forgings, castings and structural materials shall conform to the relevant BIS/ International standards.

b) Special non-ferrous materials required for manufacturing parts subject to heavy pressure, severe working conditions, and/or requiring high tensile strength, toughness and resistance to corrosion shall be used.

c) Bronze used for manufacturing parts such as bearings, shall preferably be forged or centrifugally cast.

04.03.02 WORKING STRESSES

a. For rotating parts the units stresses due to run away speed of turbine shall not exceed two third of the yield strength of the material of construction.

b. For other material used in the manufacture of the generator and exciter, etc, the maximum stresses due to the most severe operating condition shall not exceed one third of the yield point nor one fifth of the ultimate strength of the materials. For temporary over loads, units stress not exceeding one half of the yield point stress will be permitted.

04.03.03 BEARINGS

All parts subject to reciprocal motion and rubbing against other parts, shall be provided with bronze or other suitable liners to minimise wear. The liners shall conform to IS:318 or as detailed against the particular equipment capable of being adjusted to compensate for wear. All rotating parts supported on frames shall have proper bearings depending upon speed, torque, load condition, etc.

04.03.04 MACHINE FRAMES AND BASES

a) All machines bases shall be designed for maximum strength and rigidity consistent with good design.

b) Base plates shall be of welded steel construction. Those shall be designed with sufficient depth and stiffness to ensure rigidity of assembly.

c) If bases are made of two or more parts to make up height, locating pins shall be provided. Machined bolts shall be used in drilled and reamed holes for connecting the parts.

d) The machine frames shall have suitable eye bolts or hooks in requisite numbers for lifting purposes during erection and maintenance.

04.03.05 NUTS, BOLTS, STUDS AND WASHERS

a. Machining and manufacturing of all the nuts, bolts, studs and washers shall conform to International Standards.

b. Nuts and bolts for pressure parts shall be of the best quality steel.

c. Nuts, bolts and studs shall be of materials most suitable for the service operating conditions and designed to ensure the stresses arising in normal operation. For bolts used in critical areas the contractor shall provide the following details :

   i) Allowable elongation
   ii) Recommended torque

d. Fitted bolts shall be a close fit in the reamed holes they occupy, and shall be marked in a conspicuous position to ensure correct assembly.

e. The threaded portion of any bolt or stud shall not project more than 1.5 threads above the surface of its mating nut.

f. Where practicable the use of slotted head screws shall be avoided in machinery component assemblies, hexagon socketed screws being preferred.

04.03.06 STEEL FORGING

a) The successful Tenderer shall supply a list of all important forgings and draw up material specification for each one. Copies of this list and specifications shall be supplied to the Purchaser for his use. In each case the quality and inspection requirements shall be clearly stated.

b) Whenever possible steel forgings shall be in accordance with the requirements of International Standards. Forgings shall be free from cracks externally or internally, extensive non-metallic inclusions and surface defects. The successful Tenderer shall carry out non- destructive testing of forgings during machining to verify that no unacceptable defects are present.

c) Repairs by welding or other means shall not be undertaken on forgings at any stage of the production cycle.

d) Each forging shall be suitably branded with an identification number which shall be transferred throughout all final machining stages. The identification number shall be marked on all documents and test certificates relative to the forging.

04.03.07 CASTINGS

04.03.07.01 GENERAL

All castings shall be homogeneous, free of shrinkage, under sizing, porosity or voids. Welding, filling, interlocking or plugging of defective parts shall be done with the approval of Purchaser in writing. All repairs shall be subjected to non- destructive examination after heat treatment.

04.03.07.02 STEEL CASTINGS

a. The successful Tenderer shall prepare material purchasing specifications for all important castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the Specification shall be issued to Purchaser for his use.

b. Castings may be repaired by welding provided written approval of the Purchaser is obtained in advance. The successful Tenderer shall submit drawings, sketches or photographs showing the location and principal dimensions of the defects together with the proposed weld repair procedure.

c. Only welders who have passed an appropriate qualification test shall be employed on the repair of castings. All repairs shall be carried out by the metal arc process.

d. Ultrasonic inspection shall be applied to all important castings to locate the extent of sub-surface defects and to check the wall thickness.

e. All castings shall be identified by stamped, or cast-on reference marks which shall be entered on all relevant documents and test certificates.

f. The Purchaser may require that certain castings shall be examined using radiographic inspection.

04.03.07.03 CAST IRON CASTINGS

Cast iron shall not be used for any part of equipment which is in tension or which is subjected to impact.

04.03.07.04 ALUMINIUM BRONZE CASTINGS

The successful Tenderer shall prepare material purchasing specifications for all important aluminium bronze castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the Specification shall be issued to the Purchaser for his use. The inspection and quality requirements shall include an analysis of each cast, mechanical testing of test bars from each cast, pressure testing, penetrant flaw detection and radiographic examination of selected critical areas.

04.03.08 HYDRAULIC SYSTEM

a) Hydraulic systems required for various units referred herein generally cover the following:
b) Hydraulic fluid reservoir, pumps of various kinds, valves, accumulators, Hydraulic cylinders, oil coolers, Hydraulic motors, various accessories such as filter, strainers, hydraulic pipe work, fittings, flexible hose supporter for equipment, sealing devices, instruments for indicating, recording and integration of various parameters such as pressure, temperature, velocity etc., control devices for manual and automatic operation of the system, safety devices and alarms for abnormal operating condition, interlocks for sequencing and safe operation.

c) Hydraulic fluids shall be used on the basis of proven performance, operating condition, operating costs and easy availability.

d) The Hydraulic power system shall be suitable in every way for the service intended and shall be oriented forwards maximum interchangeability of component and minimising maintenance.

e) Hydraulic systems shall have filters at various points with adequate capacity and necessary filtration rating so as to keep the hydraulic fluid within permissible limits of contamination to achieve maximum life of the components.

f) Each hydraulic circuit shall be designed to minimise surge pressures, etc.

g) The hydraulic system shall be designed taking into account the maximum pressure encountered. Also one must ensure while designing the system that the components of

hydraulic systems are compatible with the hydraulic fluid selected at operating condition in the plant and under atmospheric conditions prevalent at Kodayar Power House-I. The hydraulic units shall be of standard make.

04.03.09 LUBRICATION

a) The successful Tenderer shall provide for proper lubrication systems for all moving parts of the equipment supplied.

b) All oil lubrication systems shall preferably be of circulating type complete with oil reservoir, pumps with motors, filter pressure vessels, pressure regulators, heat exchangers, oil heater, temperature controllers etc., flow switches, level switches, pressure gauges, pressure switches, temperature gauges, oil flow indicators, etc. The oil tanks shall have adequate capacity so as the return oil de aerates, gives away heat picked up from lubricating points before again being pumped.

c) Wherever there is chance of water ingress into the oil lubrication system, the provision for water detection/removal shall be provided.

d) The selection/design and construction shall be suitable in every way for the service intended and shall be oriented towards maximising interchange- ability of components and minimising maintenance.

04.03.10 OPTIMISATION OF INDIAN SUPPLIES & SERVICES

The successful Tenderer shall make all efforts to optimise the supplies and services from Indian sources and shall, however, ensure that the performance of the plant and equipment are achieved as envisaged in the Technical Specification.

04.03.11 PUMPS

Centrifugal pumps shall be provided unless technical or strong economic reasons dictate that a positive displacement, either rotary or reciprocating is more appropriate.

04.03.12 VALVES

04.03.12.01 GENERAL

a) All valves shall be suitable for the service conditions under which they are required to operate. The design, construction and choice of material shall take into account all operational requirements.

b) A complete valve schedule for each pipe work system shall be provided during the contract engineering, in accordance with the specified format.

c) Parallel slide, butterfly or gate valves may be used for air, water services, and sluice valves for low head applications.

d) Any valve which is designed for uni- directional flow shall have an arrow embossed or cast on the valve body clearly indicating the required flow direction.

e) All valves, unless otherwise approved or specified, shall be of the external rising spindle type. Where desirable to protect the spindle against ingress of dirt, or where the position of the valve may create a hazard to operators when the spindle is extended, suitable spindle covers shall be provided. The spindles and operating gear of all valves for use outdoors shall have weather and dust proof protection.

f) Special attention shall be given to the operating mechanism and correct lubrication of all valves to ensure a minimum of maintenance and ease of operation.

g) All valves shall be positioned so as to be readily accessible for operation and maintenance from permanent floors, galleries or access platforms.

h) Eye bolts or similar facilities shall be provided, where necessary, to facilitate the handling of heavy valves or components.

i) When valves are required to be locked in position for operation they shall be provided with a chain, padlock with three keys or other secure locking device.

j) All valves shall be provided with labels or nameplates.

k) Within 2 months of award of Contract, a valve numbering scheme to cover the complete Contract Works shall be agreed. After approval of the numbering scheme, the successful Tenderer shall draw up a valve schedule to cover the Contract Works. The scheduled details of each valve shall include the valve number, its title as it appears on the valve label, the nominal size of the valve, its design pressure and temperature, the Manufacturer's name and model number and a brief description of the valve material. The valve schedule shall be subject to the Purchaser's approval.

04.03.12.02 BUTTERFLY VALVES FOR AUXILIARIES.

a. The valve must be capable of positive shut-off in both directions against full system pressure. Unless an alternative type is proposed by the successful Tenderer and approved by the Purchaser as being fully suitable for the particular duty, the seating of the disc shall be positive (that is, the disc must not be capable of passing through the shut position); a stop fitted on the actuator/ operating lever is not adequate for this purpose.

b. Internal shaft bearings must be capable of opening dry, that is, not dependent on the presence fluid.

c. Each valves body shall be of best quality cast iron conforming to approved standards with a

closure seating of bronze or stainless steel, or resilient seal material. The valve disc shall be of high quality cast iron with seat facing or bronze or stainless steel which may also include the resilient seal material. Shaft bearings shall preferably be of self-lubricating type, with "O" ring seals.

d. The actual position of the valve disc shall be clearly shown by an external indicator. Beside mechanical operation tests, each valve shall be subjected to a body pressure/leakage test and disc strength test.

04.03.12.03 GLOBE VALVES

a) Globe valves shall generally be used for regulating purposes. An arrow indicating the direction of flow through the valve shall be clearly cast or embossed on the body of each valve.

b) Globe valves shall comply with IS:778-1984, R'90 or IS 2906 or equivalent as might be applicable to the particular installation requirement.

04.03.12.04 GATE AND SLUICE VALVES:

Gate and sluice valve shall conform to IS : 780 - 1984, R'90 or IS: 2906. Gate valves shall be used generally for isolating purposes. The valves shall be of the full way open type unless approved to the contrary and when in the full open position the bore of the valve shall not be obstructed.

04.03.12.05 SAFETY RELIEF VALVES:

Safety relief valves shall be of the spring-loaded type unless otherwise specified, or unless the Purchaser has given written permission for the use of a different type of valve actuation.

04.03.12.06 FLOAT VALVES

a. Float valves should be of the equilibrium ball float type. Floats for cold water duty shall be plastic, of a grade that does not deteriorate in sunlight, and for hot water duty be copper. All operating rods, guides, brackets and covers shall be of non-ferrous material.

b. Float valves operating in liquids other than fresh water shall be of materials to the Purchaser's approval. The float valves shall comply with international standards. Float valves shall be complete with float rods and guides together with covers and brackets where required.

04.03.12.07 NON RETURN VALVES

a) Non-Return Valves shall conform to IS : 5312

b) All non-return valves shall be provided with means of draining the space between the valve and its adjacent isolating valve. The design shall preclude the possibility of the valve jamming in the open position; the effect of solid particles settling- out in dead spaces within the valve should be recognized in this respect. Where screw-down non- return valves are supplied, they shall provide a demonstrable leak-tight joint.

c) Where applicable, check and non-return valves shall have an arrow cast or embossed on the side of the valve body to indicate the direction of flow.

04.02.12.08 MOTORISED VALVES

a. Valves, dampers and similar devices requiring abnormal physical effort to operate or high speed operation, shall be provided with powered actuation. Hand operating equipment shall also be fitted for closing and opening, which is effectively decoupled during power operation.

b. The following criteria are preferred in the selection of the power source for the servo mechanism

- isolation and other duties not subject to operation more than once in 10 minutes - electrical, compressed air.
- continuous or intermittent modulation - compressed air, or hydraulic fluid. Modulating Electrical Actuators shall be to the Purchaser's approval.
- continuous or intermittent modulation involving heavy control forces likely to produce fluttering or hunting-hydraulic fluid, electrical.
- emergency control or isolating duties - compressed air, spring loaded, or hydraulic fluid with sufficient reservoir capacity to complete the operation without an external source.

c. Electric actuators for on/off duties shall be fitted with travel limiting devices capable of accurate and positive adjustment. Torque limiting or other devices shall be provided to prevent damage to the mechanism in the event of jamming of the driven device.

d. All powered valve or damper mechanisms shall be provided with accurate indication of the position of the driven device.

04.03.12.09 HAND OPERATION REQUIREMENTS

a. Where required, valve spindle shall be lengthened so that the hand wheel shall be at a height approximately one meter above the level of the floor or platform from which the valve is to be operated and where necessary they shall be provided with pedestals of rigid construction. All thrusts when opening or closing the valve shall be taken directly on the valve body. Pedestal hand wheels or valve tables shall be provided at a convenient operating floor or intermediate floor level. Such pedestals and valve tables shall be

mounted direct on floors or steel members and not on floor grills or plating.

b. All valve hand operating mechanisms shall be easily operable by one person. Special attention shall be given to the operating mechanism for large size valves with a view to ensuring that a minimum of maintenance is required and to obtaining quick and easy operation.

c. All gate, globe and screw down non-return valves shall be of the non-rising hand wheel pattern unless specifically approved by the Purchaser.

d. All valves shall be closed by rotating the hand wheels in a clockwise direction when looking at the face of the hand wheel. In cases where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced to ensure clockwise closing. The face of each hand wheel shall be clearly marked "open" or "closed" with arrows indicating the direction of rotation to which they refer.

e. Plastic valve hand wheels will not be acceptable, except where such hand wheels are in the Purchaser's best interests. All valve spindles shall be fitted with indicators so that the valve opening can be readily determined. In the case of valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

04.03.13 PIPE WORK

a. Before the award of the contract, the successful Tenderer shall supply to the Purchaser schedules of the pipe work to be provided under this Contract. These schedules shall state, for each pipe work system or parts of a pipe work system, the design and operating pressures and temperatures, the fluid transmitted, the piping and valve materials, the types of valves, any corrosion allowances, the pipe work design code, insulation proposals, pipe supports and any other data relevant to the mechanical design of the pipe work system or part of a pipe work system.

b. All piping shall be routed to provide a neat and economical layout and requiring the minimum number of fittings. Piping shall be arranged so that full access is provided for the operation and maintenance of equipment and that removal or replacement of equipment can be achieved with the minimum dismantling of piping.

c. In specification the term "high pressure" refers to where the design pressure exceeds 20 bar.

d. The tenderer has to follow relevant standard for material of all pipes suitable for working pressure if not specified in the specification. However, approval for the same will be required from Purchaser.

e. The steels shall be suitable to withstand the temperature and pressure conditions involved in the operation of the plant under all circumstances. No piping less than 20 mm nominal bore shall be used except for instrument services or services specifically approved by the

Purchaser.

f. In any one system or pipe service all pipe work and fittings shall be of the same material or similar analysis unless specified or agreed to by the Purchaser.

g. The number of joints shall be kept to a minimum necessary for efficient maintenance of the plant. Tees and bends shall be to standard dimensions. Bends shall be of the pulled type or forged. Hot bending with packing may be used for larger sizes according to facilities available, but hot bends in alloy or stainless steels may only be made after permission has been given by the Purchaser. Where pipelines are to be mechanically cleaned (pigged) the bend radius shall not be less than five pipe diameters unless approved by the Purchaser.

h. Adequate provision for expansion of the pipe work shall be made. Expansion joints or bellows shall be used only where they can be justified technically and economically. All drain and vent valves shall be located in easily accessible positions. All drains and vents shall discharge to safe locations. Drains and vent pipe work shall be neatly run and shall not interfere with maintenance or operating access requirements.

04.03.13.01 PIPE SUPPORTS AND ANCHORS

a) Pipe work shall be supported and anchored in an appropriate manner.
b) The successful Tenderer shall take all necessary precautions to ensure that the piping shall be free from vibration by the installation of vibration dampers or other acceptable means.
c) The successful Tenderer shall prepare and include in the plant operating and maintenance manuals, pipe work layout and other similar drawings marked to show the position of every pipe support.

04.03.13.02 PIPE TERMINATIONS AND CONNECTIONS

a) All pipe connections shall be fusion welded except where flange connections are required or specified to facilitate erection or maintenance or where pipe materials used preclude welding.

b) Screw pipe work will only be permitted for pipes of less than 50 mm bore in non-critical air or water services.

c) Below 25 mm bore connections may be compression type couplings in positions where leakage will not introduce any hazard and the type of coupling and particular application has been approved by the Purchaser.
d) Pipe work flanges shall comply with the requirements of the code to which the pipe work is designed.

e) Jointing material, bolts, nuts and washers shall be provided where necessary for flanged pipes, valves and fittings supplied under this Contract.

04.03.13.03 INTERNAL CLEANING OF PIPES

I. The successful Tenderer is responsible for ensuring that the internal surface of all pipelines is thoroughly clean before the pipelines are placed in commission.

II. The procedure adopted is to include the following:

a) Thorough cleaning of all internal surfaces prior to erection to remove accumulations of dirt, rust, scale, and welding slag due to site welding before erection.

b) Prior to, and during erection, all parts shall be inspected to make sure that they are clean and adequate steps shall be taken to prevent entry of foreign matter both during and after erection. Each section erected shall be cleaned out before being connected into the previous section. All headers shall be cleaned before closing up.

c) Thorough cleaning of all pipe work after erection by flushing with water.

d) Already embedded pipes shall be cleaned with wire brush/ pickling to bring back original / required ID.

III. The successful Tenderer shall provide all necessary facilities in the pipe system for carrying out the requirements of item (b) including and temporary pipe work, valves and supports.

04.03.14 TRAPS, DRAINS AND VENTS

The successful Tenderer shall provide all traps, drains and vents which are called for in this Specification or which are necessary for plant operation, line or plant filling.

Drains and vents from different systems, or parts of systems operating at widely differing pressures, shall not be interconnected. At highest point vent and lowest point drain should be provided to avoid the water hammering.

04.03.15 WELDING GENERAL REQUIREMENTS

04.03.15.01 GENERAL

All welding shall conform to the relevant National or International Standard Specification as agreed by the Purchaser.

04.03.15.02 WELDING EQUIPMENT

Any welding equipment which in the opinion of the Purchaser, unsuitable or unsatisfactory for the service for which it is being used, shall be replaced by the Contractor.

The absence of comment by the Purchaser shall not be taken as approval for any equipment.

04.03.15.03 WELD PROCEDURE DOCUMENTS

Complete and full detailed weld procedure documents shall be kept and these shall be made available to the Purchaser on request.

Prior to the commencement of the welding the Contractor shall submit to the Purchaser for approval the welding procedures to be used in the fabrication of the relevant sections of work.

04.03.15.04 WELDERS QUALIFICATION TESTS

All welders shall be qualified for the work and shall hold current welder's qualification certificates in accordance with National Standards.

Records showing the date and result of the qualification tests performed by each welder and weld operator together with the identification number assigned to him shall at all times be available for scrutiny by the Purchaser.

04.03.16 WELDING INSPECTION

04.03.16.01 QUALITY REQUIREMENTS FOR WELDS

All welds subjected to non-destructive tests shall be entirely free from cracks or crack like defects, lack of root fusion, lack of sidewall fusion, root burn through or tailed pores. The standard for porosity and slag inclusions will be as indicated in the agreed standards for design and welding.

04.03.16.02 VISUAL WELD INSPECTION

Each weld shall be subjected to a stringent visual inspection and shall be free from undercut, cracks, porosity and other surface imperfections.

Fillet welds shall be checked for dimensional tolerance and from using a fillet weld gauge. Fillet welds should be slightly concave in form and each leg of the weld shall have equal length.

04.03.16.03 NON-DESTRUCTIVE EXAMINATION

All non-destructive examinations shall be supervised by a fully qualified and experienced specialist appointed by the successful Tenderer . Individual operators in each of the respective techniques shall be qualified and trained in the respective subject.
Dye Penetrant test, Ultra sonic examination, Radiography, Magnetic crack detection shall be carried out in accordance with National Standards.

04.03.16.04 WELD REPAIRS

The Purchaser's approval shall be obtained prior to commencement of any repair or rectification work.

Weld repairs shall be made to the same procedure as for the original weld. All tests shall be repeated after the repair has been completed.

04.03.16.05 MANDATORY INSPECTIONS

All transmission welds between dissimilar materials, such as high alloy steel to carbon steel, or non-ferrous materials to steels, shall be subjected to 100% ultrasonic examination or crack detection wherever practicable. In addition, all butt welds between dissimilar materials shall be subjected to 100% radiographic examination.

All welds in ferritic alloy steels, e.g., having a carbon equivalent value in excess of 0.40%, and high yield-strength steels, e.g. having yield strength greater than 300 MPa, shall be subjected to 100% ultrasonic examination and crack detection wherever possible. In addition, all butt welds in these materials shall be subjected to 100% radiographic examination.

04.04 NOISE AND VIBRATION

04.04.01 NOISE

Maximum noise level tolerable in work areas shall be within the applicable limit. The equipment and the services shall be designed such that limits are not exceeded. The Tenderer shall indicate the maximum noise level guaranteed for each equipment/system with detailed description of noise control measures adopted, if any.

04.04.02 VIBRATION AND BALANCE

The Plant shall be designed and constructed to operate without vibration in so far as the nature of the works will permit. Where vibration must be expected this shall be reduced to the minimum which can be achieved by good design and careful balancing in the case of rotating plant.

The amplitude of vibration of rotating plant when measured on the bearing housings under steady state conditions at the designed operating speeds shall conform to IEC 34-14(1982) or equivalent International Codes.

04.04.03 SCAFFOLDING, STAIRWAY AND LADDERS

Where safe and easy plant operation and maintenance cannot be arranged from provided floor levels, the Contractor shall supply and erect all platform galleries, stairways, access

ways and ladders necessary for providing the required safe and easy access to the plant items. The Contractor shall ensure that the whole of the access ways are of uniform design and pattern throughout the Works. Where access is required for operation then standard design stairways must be provided, but if infrequent access for maintenance only is required then vertical ladders will be considered.

04.04.04 SAFETY GUARDS

All moving parts, shafts, couplings, flywheels, bare conductors and hot or cold surfaces shall be adequately and securely guarded in accordance with the prescribed legislation and to the Engineer's approval so as to afford complete safety to all personnel.

04.05 SPECIAL TOOLS AND TACKLES

Special tools and tackles shall be supplied under this Contract for use by the Purchaser. List of tools and tackles shall be provided by tenderer.
Each tool or appliance is to be clearly marked with its size and/or purpose.
The tools and appliances supplied shall not be used for erection purposes by the successful Tenderer and shall be handed over in new condition.

04.06 PAINTING

04.06.01 GENERAL

a) The primers & finishing paints will conform to latest Indian Standard or equivalent international standards. There shall be of approved quality and shade.

b) General precautions for painting such as preparation of surfaces, application of paints, inspection and testing etc. will be as per relevant clause of IS:1477 (Part I & II) and shall be followed, wherever possible.

c) General compatibility between primer and finishing paints recommended by the paint manufacturer, supplying these paints shall be followed.

d) General compatibility between successive coats must be ensured.

e) Unless otherwise specified, the general colour scheme for finishing coats for different types of equipment and pipelines as per requirement of the Purchaser are to be followed. The colour schemes, however, may be changed, if necessary, by the Purchaser at any stage before the start of the painting of the equipment.

f) In case of Penstock painting, the painting guide lines given in the chapter “PENSTOCK PAINTING”.

04.06.02 PAINTING INSTRUCTIONS

a) In general, unless otherwise specified, all plant and equipment & pipelines will be given one

coat of antirust primer, lacquers, etc. at the supplier's works after completing surface preparation to remove grease, rust, scales and other foreign materials. The second coat of antirust primer will be applied immediately after erection after completing requisite surface preparation) followed by two coats of finishing paint of approved quality & shade.

b) Technological structures, crane girders & other structures shall be given one coat of primer during manufacturer & one coat of primer after erection followed by two coats of finishing paint.

c) For equipment where original colour as per supplier's practice is desired, both primer & finishing coats will be applied at supplier's works before dispatch of equipment.

d) Structures embedded in concrete shall have no shop painting applied. The portion of the column that is to be embedded in concrete shall be given a coat of portland cement slurry after thoroughly cleaning the surfaces from mill scale, grease & oil immediately after fabrication.

e) The portion of the structures embedded underground shall be given two coats of red lead graphite primer at shop and finished with two coats of bituminous black paint of approved quality.

f) Machined/plained surfaces shall be coated with while lead and tallow before dispatch or before being put into open air & covered with gunny cloth.

g) Surfaces to be site welded shall have no shop paint applied within 100mm of welding zone. After site welding normal painting application will be followed.

h) Areas which become in-accessible after assembly shall be painted before assembly.

i) Cables & other electrical accessories shall have adequate antirust protection.

j) Chequered plates shall be given primer coats only.

k) The phosphate coated surface shall have one coat of baking based and two coats of finished paint of amino alkyd resin stone enamel.

l) External surface of pipe fittings shall be thoroughly cleaned by wire brushing and given two coats of red oxide zinc chromate primer at supplier's works & two coats of final synthetic enamel paint after erection.

m) The equipment which are to be dispatched in knocked down condition and require assembling at site, shall be given two coats of rust and corrosion preventive primer and one coat of synthetic enamel paint of approved quality and shade. After assembly at site, such equipment shall be given one final coat of synthetic enamel paint.

n) The equipment which can be sent as a single block unit duly shop assembled, shall be given full application of paint i.e. two primer coats of rust and corrosion preventive primer and two finish coats of paint of approved quality and shade as per relevant Indian Standards/equivalent international standards.

o) All painting shall be carried out by brushing or roller application with prior permission of the Purchaser.

p) All metal parts not accessible for painting shall be made of rust and corrosion resisting materials. Interiors of equipment will be suitably quoted with anti-rust compounds.

q) The fasteners shall not be painted. These will be dispatched with application of anti-rust compound.

r) Any special painting requirement indicated on the Contractor's drawings by the Purchaser during approval stage shall be binding.

04.06.03 SURFACE PREPARATION AND ENVIRONMENTAL CONDITIONS

a) All surfaces to be painted shall be thoroughly cleaned of dirt, grease, rust & mill scale. Removal of rust & scale shall be by hand brushing, power driven wire brushes or by sand blasting, as the surface condition/service condition warrants.

b) The paint shall be applied on the metallic cleaned surface after it is perfectly dry but not later than 3 hours after cleaning of the surfaces. Reasonable time gap should be allowed between any two consecutive coats of primer or finishing coats.

c) Surfaces coming in contact with acid & acidic fumes alkalis, soda, detergents etc shall be cleaned thoroughly to get complete metallic surface as per IS;1477 Part I & II or BS 4232-1967. After sand blasting the surface shall be cleaned with cotton rags, soaked in benzene, to remove fine rust, grease, etc. No sand blasted surface shall be exposed to weather for more than 3 hours.

d) The choice of primer & finishing paint will depend on the environmental condition to which the plant & equipment & pipelines are exposed to.

e) Paints are to be applied on dry surface only under agreeable weather conditions. Painting in damp & foggy weather conditions will not be permitted.

f) For a selected primer the method of surface treatment best suited for that primer & suggestion of paint manufacturer shall be obtained and followed.

g) Zinc rich primer paints which have been exposed for a long time before the finishing coat is applied shall be washed down thoroughly to remove soluble zinc salt deposit.

h) The recommendation of paint manufacturer shall be forwarded to the Purchaser for

approval.

04.06.04 PRIMER PAINT

a) In general, two coats of primer paints conforming to relevant Indian Standard or equivalent international standards shall be applied on all unmachined surfaces, except noted otherwise.

b) Where equipment is to be finish painted for dispatch, both coats will be applied before finishing coats at supplier's works.

c) Where equipment warrants finishing coat after erection, one coat will be applied just after manufacture at supplier's works and the second coat just after erection at site after surface cleaning.

d) Equipment on which primer coat has been damaged due to prolonged exposition at site, final erection or transport, shall be given two coats of primer at site before applying finishing coats. Before applying paint the surface will be thoroughly cleaned by sand paper.

e) The primer applied should be compatible in quality and colour schemes with the subsequent finishing coats.

f) Unless stated otherwise, the following primer paints shall be used depending upon the exposition and environmental condition to which the plant & equipment, structures & pipelines are exposed to :

- Aluminium zinc oxide - conforming to IS;2931
- Red oxide zinc chromate - conforming to IS;2074
- Heat resistant aluminium primer paint - conforming to IS:161
- Air drying chemical resistant paint
- Epoxy resin paint (cold cured) -
- Poly urethene paint
- Chlorinated rubber based conforming to DEF-1402, Ministry of Defence

04.06.05 FINISHING PAINT

a) Two coats of finishing paint compatible with the primer and conforming to relevant Indian Standard or equivalent international standards shall be applied on all un-machined surfaces unless mentioned otherwise.

b) Unless noted otherwise, the following finishing paints will be applied on plant & equipment, structure & pipelines depending upon the exposition and environmental conditions to which

the plant & equipment, structures & pipelines are on subjected to:

- Synthetic enamel conforming to IS; 2932 exterior type
- Epoxy based finishing paint -
- Heat resistant silicon based Aluminium paint IS:161

c) The finishing paint shall be of approved colour. The undercoat shall have different tinge to distinguish from the finishing paint.

d) The surfaces of the equipment on which finishing coats of paint has been damaged due to prolonged exposition at Contractor's work, erection site, during transport, storage or final erection shall be thoroughly cleaned & touched up with the same paint as applied previously.

04.06.06 THICKNESS OF COAT OF PAINT

a) A single coat of paint when dry should have a thickness of 25 to 30 microns (0.025 to 0.030 mm) or 1 mil to 1.25 mils.

b) Total thickness of 4 coats (2 primer coats + 2 finishing coats) should have thickness of 100 to 125 microns (0.100 to 0.125 mm) or 4 to 5 mils.

c) In case of bituminous aluminum gilsonite based paint 3 coats are to be applied. The total thickness of 3 coats will be not less than 100 microns (0.100 mm) or 4 mils.

d) Immediately following the award of the Contract, the Contractor shall submit the names of the proposed paint supplier and applicator together with a quality assurance program for approval. All paints for one section shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility.

04.07 CODING SCHEME

A coding scheme for identifying the drawings, plant and equipment, structures, spares and shipping documents shall be adopted by the Contractor.

04.07.01 CODING SCHEME FOR DRAWINGS

A 10 digit drawing numbering scheme is proposed for all the plant and equipment/spares to be supplied. The scheme will be cleared by the Purchaser.

04.07.02 CODING SCHEME FOR PLANT AND EQUIPMENT/ SPARES (EQUIPMENT IDENTIFICATION NUMBER)

A 8 digit coding scheme is proposed for all such items of supply. The first 3 digits conform

to the shop complex, next 3 represent the equipment number. Suffixes of 2 digits may be used at the end of six digit, wherever necessary. (Identification number presently used by plant people shall also be given for easy identification number).

04.07.03 SHIPPING CODE FOR PLANT AND EQUIPMENT/SPARES

The various items of plant units which arrive at site in packages have to be stored at proper areas/stores so that they can be retrieved easily and also to ensure the completeness of supply proper storing of the packages have to be done without opening the packages. As such, the boxes/packages have to be marked so that the contents may be easily identified for proper storage and easy retrieval.

Shipping code will comprise :

- Code number assigned to the Contractor
- Code number of equipment
- Package SN/total number of packages

04.07.04 COLOUR SCHEME FOR PLANT & EQUIPMENT

The Purchaser will indicate the colour scheme to be followed during painting of the plant and equipment. This as well as the equipment identification number will be indicated by the Purchaser soon after the Contractor submits the list of plant and equipment along with GA drawings.

04.08 ERECTION, TESTING & COMMISSIONING OF PLANT AND EQUIPMENT AND PIPELINES

04.08.01 GENERAL

a. The successful Tenderer, amongst other things, shall be responsible for renovation of the plant equipment to be reused and erection of plant and equipment, fluid system, electrics, auxiliaries, etc. as per the scope of supply within the design limit as given in the Technical Specification.

b. The successful Tenderer shall take delivery of the equipment and transport the same to his store/erection site, maintain his own stores for the storage of equipment and all related documents and records and finally transport the equipment to site for erection. He will take an erection-cum-storage insurance policy covering all the risks including third party liabilities for equipment as well as human life. All security arrangements also shall be made by the Contractor.

04.08.01

c. The successful Tenderer shall unpack the cases and do visual checking against physical

damages of equipment and do cleaning of the equipment before start of erection.

d. The successful Tenderer shall be responsible for proper and neat storage and also undertake conservation of all consignments including damaged boxes. During storage of equipment, the successful Tenderer shall take into account deterioration and carry out the re-conservation of the complete equipment/parts/supplies as may be necessary as per the Storage Instructions of the Manufacturer of equipment/components. The successful Tenderer shall also supply the consumables required for such re-conservation work and repair/replace parts required thereof for the proper functioning of the equipment after erection and commissioning.

04.08.01

e. Damage/shortage of the equipment/component during transit/transfer/storage, shall be made good by the successful Tenderer without loss of time so as not to upset the agreed erection and commissioning schedule and at no extra cost to the Purchaser. Delay on account of settlement of insurance claims by the Contractor shall not be taken into cognizance by the Purchaser.

f. The successful Tenderer shall be liable to make good any damage to existing equipment and/or facilities caused by the successful Tenderer's personnel. In case any existing equipment or facility is required to be dismantled for erection of the new equipment, the same shall be restored at no extra cost to the Purchaser.

g. The equipment will be installed on the civil foundation provided by the Purchaser/ successful Tenderer r (if specified). However, if any deficiency is noticed in the quality of concreting, dimensions, center-lines, levels, locations, etc of the foundation or anchors bolts or other embedment, the same will be rectified by the successful Tenderer at no extra cost. Minor chipping/minor rectification of the equipment for proper erection, alignment, etc. shall be done by the successful Tenderer. Chipping/dressing of the foundation with air or air and water jet prior to placing the equipment will also be carried out by the successful Tenderer.

04.08.01

h. The successful Tenderer shall lay and maintain properly all the temporary supply lines at the erection site for temporary power, water, air connections required for erection purposes, from the points earmarked by the Purchaser for this purpose.

i. The successful Tenderer shall provide all necessary construction tools, compressors, small hand tools, instruments, all commissioning instruments, welding equipment, service bolts, nuts, jigs and fixtures, winches, alignment tools, precision levels etc. and other equipment which may be required for carrying out the erection work efficiently within the time schedule. Unless otherwise specified, the above construction materials shall be the property of the Contractor after the erection work is over. Special tools & tackles obtained by the Purchaser with the equipment will, however, be the property of the Purchaser.

04.08.01

j. The successful Tenderer shall provide all temporary ladders, scaffolding materials, platforms, supports and other necessary facilities required for handling, erection and visual inspection of supplies at the point of installation and shall also provide necessary packing plates, wedges, shims, leveling screws, etc. required for erection of plant and equipment.

k. The successful Tenderer shall provide erection consumables like oxygen and acetylene gas, welding rods, solder lugs, oil, grease, kerosene, cotton waste, etc. required for erection of plant and equipment.

l. The successful Tenderer shall erect and maintain his own site offices, main stores and site temporary stores as required for the work and arrange for maintaining in neat manner the area placed at his disposal.

m. The successful Tenderer shall provide sufficient fencing, notice boards and lights to protect and warn others as may be considered necessary by the Purchaser.

n. On placement of order, the successful Tenderer shall provide his scheme for mobilisation with bar chart indicating clearly the resources, of erection machinery man-power and machinery proposed to be deployed to ensure timely completion of work and quality of workmanship.

04.08.01

o. The plant and equipment will be erected as per the instructions of the manufacturers/suppliers and under the supervision of the supervisory personnel, to be deputed by the successful Tenderer at site. The successful Tenderer shall also undertake rectification work on account of manufacturing defects, required for proper erection and assembly which can be done at site only according to site condition.

p. The successful Tenderer shall align, level, couple and securely fix all equipment, steel structures, appurtenances and accessories in accordance with drawings and/or instructions.

04.08.01

q. All precision survey instruments including leveling instruments shall be arranged by the successful Tenderer

r. The successful Tenderer shall supply materials and carry out flushing and first filling of oil and lubricants, grease, chemicals and as required till successful commissioning.

s. Laying and termination of cables, bus bars, bus ducts and earthing shall be done by the Contractor.

t. Installation and connection of all piping and fittings from the headers termination points to the equipment and inter-connection of all service lines within the design limit after the main headers/termination points shall be successful Tenderer 's responsibility.

u. The successful Tenderer shall check electrical connections to individual items.

v. The successful Tenderer shall be responsible for calibration of all the instruments at site.

w. The successful Tenderer shall be responsible for checking the correctness of erection of mechanical equipment, auxiliary systems, electrical equipment, other equipment, etc. as per the specification and relevant drawings.

04.08.01

x. The successful Tenderer shall arrange all facilities at site to undertake radiographic testing and stress relieving of butt welded pipe joints, as required.

y. The successful Tenderer shall be responsible for the management of erection work with proper and adequate supervision for ensuring progress of erection work and quality of workmanship.

z. The successful Tenderer shall deploy required number of supervisory, skilled, unskilled and auxiliary labor as required, for the erection work and comply with such reasonable instructions of the Purchaser in the interest of satisfactory progress and completion of the work according to the schedule.

aa. The successful Tenderer shall be responsible for total commissioning of the Plant including mechanical run, commissioning and demonstration of Performance Guarantee Tests.

04.08.01

bb. The successful Tenderer shall organise the work in a manner that other work at site is not impeded and the workmen therein not endangered. He shall arrange temporary access at site, if required, for the erection work.

cc. The successful Tenderer shall intimate the Purchaser/ concerned Plant authorities in writing well in advance about the requirement of shut down of any of the existing units/facilities for inter-connection/ incorporation of additional facilities. The shut down period shall be mutually discussed and finalised. The work to be undertaken during the shut down period shall be planned meticulously by the successful Tenderer to reduce the shut down period to the minimum.

dd. The successful Tenderer shall make temporary arrangement for maintaining the continuity of the services/ facilities before commencement of the diversion of existing service lines wherever shut down is not possible, without any extra cost to the Purchaser.

ee. The successful Tenderer shall return to the Purchaser all crates, packing cases and packing materials and all returnable supplies belonging to the Purchaser at a place designated by the Purchaser at the erection site in the conditions these exist during and after erection work is completed.

04.08.01

ff. The tests/checks to be conducted during erection by the Contractor shall be as per the manufacturer's instructions. The Contractor shall attend to the rectification of erection defects, if any, expeditiously. The Contractor shall arrange all testing instruments for such testing at site.

gg. The successful Tenderer shall carry out final painting including supply of paint of the plant & equipment and pipelines, etc. erected as per the instructions of the Purchaser.

hh. Grouting of the equipment on the foundations with shrinkkomp/ferro grout shall be the responsibility of the Contractor.

ii. The successful Tenderer shall indicate to the Purchaser well in advance the requirement of services such as electric power, water, EOT crane, etc. required during construction/erection period.

jj. The Contractor will arrange for the staying facilities of his working personnel.

04.08.01

kk. All safety, health and pollution control measures, as required to be adopted as per the Statutory Regulations and the Safety Codes for projects issued along with the tender documents otherwise required or implied by statutory regulations or practices, shall be strictly followed by the Contractor during the execution of the Contract. The Contractor shall set up a suitable safety organisation of his own at site in this regard.

ll. The successful Tenderer shall comply with all Statutory Rules & Regulations with respect to the employment of labour at site including payment of minimum wages as per Govt. rules, deduction of employees's contribution to Provident Funds, depositing the same along with Contractor's contribution to the Provident Fund Commissioner, Employees State Insurance and other statutory deductions/obligations.

mm. At the end of the work the Contractor shall remove all such temporary structures put up by him and hand over the site to the Purchaser in neat and tidy manner.

04.08.02 SUPERVISION OF ERECTION, TESTING, COMMISSIONING AND PERFORMANCE GUARANTEE TESTS

a) The successful Tenderer shall depute at site engineer/ specialists from various disciplines for the supervision of renovation erection, testing trial run, commissioning and performance guarantee tests of the plant and equipment under his scope of supply including the foreign

engineers/specialists from various disciplines. The above mentioned Indian and foreign engineers/specialists shall supervise the erection, testing, commissioning and conducting of performance guarantee tests of the plant and equipment with their auxiliaries so as to establish to the Purchaser that the guarantees as stipulated by the Purchaser and agreed by the successful Tenderer are fully met.

b) The Purchaser may place his engineers of respective disciplines to witness successive steps adopted in successful erection, testing, commissioning and performance guarantee tests.

04.08.03 CONTRACT TERMINAL POINTS

(i) The successful Tenderer's responsibility for making connections shall be as follows unless otherwise stated in the Specification:

a) Where pipe work and ducting supplied under this Contract connects the equipment already existing or supplied by the Purchaser, the connection shall be made under this contract.

b) This contract includes the terminating and connecting up all cables, which are supplied under this Contract except where noted.

c) All associated existing cabling not included in the Contract will be checked and tested under the supervision of the Purchaser but it will be the responsibility of the successful Tenderer under this Contract to assist the Purchaser in re-checking all final connections and to ensure the subsequent satisfactory operation of the equipment.

(ii) The successful Tenderer shall be deemed not to have fulfilled his obligation insofar as the commissioning of the plant in concerned until complete end-to-end tests have been carried out to the satisfaction of the Purchaser.

04.08.04 MECHANICAL COMPLETION AND COMMISSIONING

For Mechanical Completion and Commissioning refer Volume -I /tender specification.

05. DESCRIPTION OF THE EXISTING PLANT

05.01 EXISTING FACILITIES OF POWER PLANT TO BE USED FOR RM&U

Following facilities already installed are to be used for RM&U with new TG of 1x60MW Kodayar Power House-I.

05.01.01 RESERVOIR

Name of reservoir	Kodayar Dam – I (Upper)
Reservoir area	3.29sq.mile (8.3sq.km)

Max. water level & FRL	+4350 ft
Min. draw down level	+4250 ft
Maximum storage	2589.8 Mcft
Dead storage	3 Mcft
Effective storage	2586.8 Mcft
Average annual inflow	2211.15 cft

05.01.02 WATER CONDUCTOR SYSTEM

TUNNEL:	
Type	Horse Shoe
Diameter	7 ft
Length	10400ft (RCC 2040ft + PCC lined 8360ft)
SURGE SHAFT:	
Type	Open plain
Surge shaft depth	434 ft
Surge shaft Dia	20 ft
PENSTOCK:	
Length	7000 ft
Diameter	6' ~ 4'6" (1.83 ~ 1.37 m)
Thickness	$^{7}/_{8}$" ~ $1^{1}/_{2}$" (22.225 ~ 38.10 mm)

05.01.03 POWER HOUSE

1.	Length	32.91 m
2.	Width	21.41 m
3.	Height	19.18 m
4.	Machine hall Floor Level	358.750 m (1177ft)
5.	Governor Floor Level	355.40 (1166ft)

05.01.04 STATION CRANE

1.	Capacity	135/20 Ton
2.	Type	E.O.T
3.	Manufacture	M/s. Hindustan Motor Ltd., Calcutta
4.	Commissioned on	1968
5.	Motor Details	
a)	Long travel Motor	
	Make	Associated Ele. Industries

	HP	35
	Rating	½ Hour
	RPM	965
	Voltage	400/440
	Amp	49
b)	Cross Travel Motor	
	Make	AEI
	HP	7
	RPM	910
	Voltage	400/440
	Amp	22
c)	Main Hoist Motor	
	Make	Associated Ele. Industries
	HP	40
	Voltage	400/440
	Amp	56
d)	Auxiliary Hoist Motor	
	Make	Associated Ele. Industries
	Power	24.5 (Hp
	RPM (1/p)	965
	Voltage	400/440
	Amp	35

05.01.05 GANTRY CRANE

1	Make	M/s. Manning Maxwell and Moore Michg
2	RPM	1500
3	HP	20
4	Voltage	400

05.02 EXISTING FACILITIES TO BE DISMANTLED FOR MAKING WAY FOR NEW UNIT

The complete TG set of the unit is to be dismantled. Following are some of the details of major components.

05.02.01 WATER CONDUCTOR SYSTEM

BUTTERFLY VALVE:	
Dia	1700 mm

Max. Working Pressure	224ft of Water Column
MAIN INLET VALVE:	
Dia	1000 mm
Max. Working Pressure	90 kg

05.02.02 TURBINE

Make	Hydro Vevey, Switzerland
Type	Pelton wheel, Vertical shaft
Net head	3109 ft
Discharge	275 cusec
Output of turbine	87130 HP
Rated speed	500 rpm
No of jet	2
Included angle	81^0
Dia of jet	7.6" (193 mm)
Nozzle centre level	+1158 ft
No. of buckets	22
Dia of runner	97" (3100 mm)
Weight of runner	9.6 ton
Material of runner	13:4 (Cromium:Nickle)
Dia of shaft	579.5 mm
Water consumption	16.5 cft / unit energy
Centerline of runner	1158

05.02.03 GOVERNOR

Make	Vevey, Switzerland
Type	Accelero – Tachymetric
Rating	1700 ft Lbs
Oil pressure	415 lbs / sq inch (30 kg/cm^2)

05.02.04 GENERATOR

Type	Synchronous
Make	Alsthom, France
Normal Apparent Rating	66667 KVA
Power factor	0.9

KW	60,000
Volts (Nominal / maximum)	11000/12000 Volts
Nominal Stator current	3500 Amps
No. of Rotor Poles	12
No. of Generator Air Cooler	6
Insulation Class	B
Speed	500 RPM
Minimum. Fly wheel effect of Generator required for regulation	2,50,000Lb ft^2
Zero Sequence reactance	0.06
Direct axis transient open circuit time constant	8.4
Negative sequence reactance X2	0.19
Short circuit ratio	1.2

05.02.05 EXCITATION SYSTEM WITH AVR

Excitation voltage	120V
Excitation current (under nominal load and voltage condition)	1250A

05.02.06 POWER TRANSFORMER

Make	ANSALDO SAN GIORGIO COMPAGNIA GENERALE GENOVA, Italy
Year of Installation	1970
Capacity	3x22500 kVA
DETAILS OF ONE SINGLE PHASE TRANSFORMER OF CAPACITY 22500KVA	
VOLTAGE	
HV	110kV
LV	11kV
CURRENT	
HV	354.5 Amp
LV	3542/√3 Amp
Phase	1
Frequency	50 Hz
Impedance Volts	9.66%
Type of Cooling	OFW
Weight of Core & Winding	16.785Tons

Weight of Oil	6.32 Tons
Total Weight	29.62 Tons
Volume of Oil	1560 gallon
Oil Cooler	
Oil Flow	1560 imp gallons / minute
Water Flow	430tre / minute

05.02.07 UNIT AUXILIARY TRANSFORMER (UAT)

Make	Current Electricals, Madras
Capacity	300 kVA, 3 Phase, 50 Hz
Voltage ratio	11000V / 415V
Vector Group	Dy11
Cooling	ANAN
% impedance	4.8
Current : HV LV	 15.175 A 417.4 A

05.02.08 STATION SERVICE TRANSFORMER

Make	Radio & electricals Limited, Madras
Capacity	250 kVA, 3 Phase, 50 Hz
Voltage ratio	11000V / 416V
Vector Group	Dy11
Cooling	ONAN
% Impedance	4.87
Current HV LV	13.1A 347A

05.02.09 11kV GENERATOR CABLES:

Material / Core	Aluminium / Single Core
Cross Section	625 Sq mm
No. of Cables / phase	10

05.02.10 110kV SWITCHYARD :

POTENTIAL TRANSFORMERS FOR LINE	
Make	BALTEAU, Belgium
Ratio	110kV/√3/110V/√3
VA	250
Phase	1
CURRENT TRANSFORMER	
Make	ASEA
Ratio Available	125/150/250/300/500/600
Ratio Adopted	500/1
Burden /Class	30VA/BM
Burden/Class	60 VA/S

05.02.11. 110kV SWITCHYARD:

	SF_6 Circuit Breaker	
1	Make	AREVA
2	Rated Voltage	145kV
3	Frequency	50 Hz
4	Normal Current	2000 A
5	Lightning Impulse Withstand Voltage	650 kVp
7	Short Circuit Withstand Current	40kA
8	Duration of Short Circuit	3 Sec
9	Total Mass	1534 kg
10	Year of Manufacture	2009

06. SCOPE OF WORK, EXISTING FACILITIES& BATTERY LIMIT

06.01 SCOPE OF WORK

The broad scope of work for the Unit is as follows.

- Dismantling of existing TG Set including associated auxiliaries, like cooling water system, governing system, lube oil system, firefighting system etc. and place these at a suitable storage space / yard nearby.
- Renovate and reuse the Fixed/embedded components: turbine casing, turbine housing/discharge chamber and foundation plates and anchorages.
- Assess the condition of various existing civil foundations, modification of housing to accommodate the new configured manifold, strengthen and reuse the foundations
- Collect all the information/dimension, take all measurement, if any, require carrying out for Computerized Simulation Study.
- ~~Design, Computerized Simulation Study~~, ~~manufacturing, inspection and testing, supply, packing for dispatch/shipment, freight and insurance, port handling including custom clearance, loading, transportation to site, storing at site,~~ complete erection of all the components testing, commissioning, start up and performance testing and handing over of Unit 70 MW Hydro turbine-generator set(TG set). The TG sets includes Pelton turbine, Synchronous Generator along with associated Auxiliaries; Electrics including Step-up transformer, Unit Auxiliary transformer, Station Service Transformer, C□□ □□□□ □□□ □□ □□□□□rd □□□□□ □□□□ □ □□ □□□□□□ □□d 2 □□□ □□□dr □□□ and associated equipment; Control& Instrumentation; associated civil work. Tenderer shall ensure that the TG set shall be completed with all materials and equipment whether specifically mentioned herein or not but required for satisfactory operation of the Unit. The design criteria and detailed scope are given in 06.04.

06.02 EXISTING FACILITIES OF THE UNIT TO BE DISMANTLED

The following existing facilities of the unit shall be dismantled

a) Turbine and associated auxiliaries, Generator set including the associated equipment up to Generator Transformer in the switchyard and station auxiliary transformer in the back side of power house. The broad details of the existing major equipment have been given in **Chapter-5.**

b) All facilities associated with the above including cables, cable structures, maintenance platforms etc.

c) Transport/shift and place all the dismantled equipment (which are to be newly supplied as per detail scope) to the storage space ear marked for the purpose.

d) (Not all tools required for dismantling are available with purchaser, however tools as available can be used by Contractor, but responsibility of assessment of healthiness of tools will lie with the Contractor)

The broad facilities/equipment to be dismantled are given in **Table** below

SL. NO.	NAME OF THE EQUIPMENT / FACILITY TO BE DISMANTLED	REMARKS
1.	Butterfly Valve including complete control system etc.	
2.	Main Inlet Valve including complete control system etc.	
3.	**TURBINE AND ASSOCIATED AUXILIARIES**	
a	Runner with Buckets, nozzles including spears, deflectors and its lever and linkages	
b	Turbine Shaft	
c	Turbine Guide Bearing	
d	Complete governor along with piping	except embedded piping if any
e	Brake system	except embedded piping if any
f	Lube oil System including pipe, valves, pump, motor, strainer, cooler etc.	Except embedded pipe if any
4.	**GENERATOR & ASSOCIATED EQUIPMENT AND ELECTRICS**	
a.	Stator	
b.	Rotor	
c.	Generator shaft	
d.	Thrust Bearing	
e.	Generator guide bearing	
f.	Generator air coolers	
5.	Excitation System including Pilot Exciter, Main Exciter, Slip rings, Excitation panels, Amplidyne etc.	
6.	Generator Transformer and associated facilities	
7.	Station Service transformer and other associated facilities	
8	Unit Auxiliary Transformer	
9	11kV/0.110 kV Potential Transformers, 11kV Current Transformers, Lightning Arrestors and Generator Neutral Grounding Transformer	
10	TG Control Desk and Metering & Protection Panels	
11	ACDB and DCDB	
12	HT Cables, LT Power Cables, Control Cables and Instrumentation cables	
13	Switchyard Equipment	
COMMON FACILITIES		
1.	Cooling water system including pipe lines, filters, valves etc.	Except embedded pipe if any
2.	Fire protection system	Except embedded piping

SL. NO.	NAME OF THE EQUIPMENT / FACILITY TO BE DISMANTLED	REMARKS
		if any
3.	□□□ □ DC □□□□□□ □□□□r□ □□d □□□□r□ □□□r□□r□	

06.03 EXISTING FACILITIES TO BE RENOVATED AND UTILISED:

Fixed/embedded components of Unit e.g.turbine casing, turbine housing/discharge chamber and foundation plates and anchorages, Penstock, Drainage and dewatering system, compressed air system, EOT crane of power house are to be renovated and reused.

The required renovation details are enumerated in table below:

SL.NO.	NAME OF THE EQUIPMENT	DETAILS OF RENOVATION
1	Penstock	As detailed in this chapter
2	Turbine housing/ discharge chamber	As detailed in this chapter & Sec-B of this Volume
3	Foundation plates and anchorages	As detailed in Sec-B of this Volume
4	Drainage and Dewatering System	As detailed in this chapter
5	Compressed air system	As detailed in this chapter
6	EOT crane of power house	As detailed in this chapter
7	Complete Unit area	As detailed in this chapter

06.03.01 PENSTOCK

A. The penstock need to be cleaned and painted with water resistant paint as per the specification detailed below; Anchor blocks are to be repaired; Guide pads are to be refurbished and properly lubricated; All Expansion joints to be replaced with new one. Maintenance platforms are to be painted with weather proof paint if any strengthening is required same shall be carried out by contractor.

□□ Internal surface of the penstock shall be cleaned by using brush, water jet and shot blasting. After cleaning the internal surface shall be painted with water resistant paint. For selection of the paint necessary water analysis shall be carried out by contractor. Contractor shall submit a detailed procedure for cleaning and painting for approval from Purchaser.

□□□ Outer surface of the penstock shall be cleaned by using brush and water jet. After cleaning the outer surface shall be painted with weather proof paint. Contractor shall submit a detailed procedure for cleaning and painting for approval from Purchaser.

□□□□ All Expansion joints shall be designed to take care of the expansions between the two consecutive anchor blocks. The material of the convolute of the expansion joints shall be of stainless steel.

□□□ Guide pads shall be lubricated as per relevant standard.

□□ Radar type - Latest new technology version level transmitter to be provided at Kodayar Dam-I reservoir and Chinna Kuttiyar reservoir as detailed in control and instrumentation specification

□□□ New penstock drain valve with electric motor operation will be provided

vii) Ultrasonic Flow meter with monitoring at control room will be provided as detailed in control and instrumentation specification

06.03.01.01 PENSTROCK PAINTING:

PIPE TUNNEL AND PENSTOCK PAINTING (INNER AND OUTER)

GENERAL

a) The scope shall include cleaning and painting for both outer and inner portion of penstock.

b) The pipe tunnels and penstocks shall be painted after sand blasting and thorough surface preparation.

c) The painting shall be done as per recommendation of CECRI (Central Electro Chemical Research Institute) as follows:

Paint scheme for sand blasted surface condition:	
One coat of zinc ethyl silicate primer to a dry film thickness of	70-75 microns
followed by	
One coat of epoxy– MIO undercoat to a dry film Thickness of	100-110 microns
followed by	
One coat of chlorinated rubber top coat	100-110 microns
Total dry film thickness	270-295 microns

Paint schemes for surface cleaned by wire brush:	
One coat of epoxy polyamide red oxide zinc Phosphate primer to a thickness of	70-75 microns
followed by One coat of chlorinated rubber–MIO undercoat to a thickness of	100-110 microns
followed by	
One coat of chlorinated rubber top coat to a Thickness of	100-110 microns
	----------
Total thickness	270-295 microns

06.03.01.02 SPECIFICATION FOR ZINC ETHYL SILICATE PRIMER

Zinc ethyl silicate primer is of two pack system. One pack contains ethyl silicate binder with suitable solvents. The other pack contains zinc dust with additives. The contents of the two pack are to be mixed in suitable proportions before application over the metallic substrate.

Binder		Ethyl silicate
Figment Zinc content	:	Zinc dust with additives 80-85% by wt.
Dry Film thickness/coat	:	70-75 µm
Application	:	By brush or Spray.
Spreading rate.	:	6-7 sq.m/litre.
Drying time	:	Surface dry in 4 hours.
Over coating.	:	24 Hours.

06.03.01.03 SPECIFICATION FOR TWO PACK EPOXY POLYAMIDE MIO (MICACEOUS IRON OXIDE) UNDER COAT

This under coat is based on two pack iron oxide system. One pack contains epoxy resin pigmented with micaceous iron oxide and other additives.
The other pack contains polyamide resin dissolved in suitable solvent which is the curing agent. The contents of the two pack are to be mixed in suitable proportions before application over the substrate.

Resin	:	Epoxy resin which is the condensation Product of bisphenon-A and Epi-chlorophydrin with terminal epoxide groups.
Epoxide equivalent	:	450-500
Curing agent	:	Polyamide
Pigment	:	The main pigment shall be micaceous iron oxide constituting about 50% by weight of total pigments.
Application	:	By brush or Spray
Dry film thickness /coat	:	100-110 µm
Volume Solids.	:	55-60%
Spreading rate.	:	4-5 sq.m/litre
Drying time	:	Surface dry in 4 hours
Over coating.	:	After 24 Hours
Pigment volume concentration (PVC)	:	40%

Note : Subsequent coatings (Top coat) has to be applied within 20-24hours.

06.03.01.04 SPECIFICATION FOR CHLORINATED RUBBER TOP COAT

This is single pack system. In this system, chlorinated rubber resin containing chlorinated paraffin plasticiser is pigmented with yellow iron oxide and silica extenders.

Resin	:	Chlorinated rubber resin (chlorine content 63% w/m) containing chlorinated paraffin plasticiser.
Pigment	:	The main pigment shall be Yellow iron oxide containing silica as extender material.
Volume Solids	:	50-60%
Dry Film Thickness	:	100-110µm
Application	:	Spray
Spreading rate	:	4-5 sq.m/litre.
Drying time	:	Surface dry in 4 hours
Pigment volume concentration (PVC)	:	20%

06.03.01.05 SPECIFICATION FOR TWO PACK EPOXY-POLYAMIDE ZINC PHOSPHATE PRIMER

This primer is based on two pack system. One pack will contain epoxy resin pigmented with iron oxide, zinc phosphate and other additives.
The other pack will contain polyamide resin dissolved in suitable solvents. The contents of the two pack are to be mixed in suitable proportions before application over the metallic substrate.

Resin	:	Epoxy resin which is the condensation Product of bisphenon A and Epichlorohydrin with terminal epoxide groups.
Epoxide equivalent	:	450-500
Curing agent	:	Polyamide
Pigment	:	The main pigment shall be red iron oxide and zinc phosphate. Zinc phosphate should be 40% by weight of total pigments
Application	:	Spray
Dry film thickness /coat	:	70-75 µm
Volume Solids.	:	55-60%
Spreading rate	:	5-6 sq.m/litre.
Drying time	:	Surface dry in 4 hours
Over coating.	:	24 Hours.
Pigment volume concentration (PVC)	:	30%

Note : Subsequent coatings (Under coat) has to be applied within 20-24 hours.

06.03.01.06 SPECIFICATION FOR CHLORINATED RUBBER MIO UNDERCOAT

A. This is a single pack system. In this system, chlorinated rubber resin containing chlorinated paraffin plasticiser is pigmented with micaceious iron-oxide (MIO) pigments.

Resin	:	Chlorinated rubber resin (Chlorine Content 63% w/w) containing chlorinated paraffin palsticiser).
Pigment	:	The main pigment shall be Micaceous iron oxide (MI0) constituting about 50% by wt of total pigments.
Volume Solids	:	50-60%
Dry film thickness /coat	:	100-110 µm
Application	:	Spray.
Spreading rate	:	4-5q.m.sq. /litre

Drying time.	:	Surface dry in 4 hours
Over coating	:	After 24 Hours.
Pigment volume concentration (PVC)	:	40%

Note : Subsequent coatings (Top coat) has to be applied within 24-36 hours.

B. SPRAY - TABLE

DESCRIPTION	CONVENTIONAL AIR SPRAY	AIRLESS SPRAY
Coverage sq.m/day	400-800	600-1000
Overspray %	20-40	10-15
Portability	Fair	Excellent
Direct Drive units.	No	Yes
Pin holding	possible	Unusual
Hoses	2	Usually one.
Masking	Considerable	Moderate
Penetration of corners &volds	Fair	Good
Thinning before spray	Usual	Sometimes
Film Build/Coat	Lower	Higher
Moisture (Compressor)	Possible	None
Versatility	More	Less
Paint clogging problems	Slight	Possible

06.03.01.07 EXTERNAL PENSTOCK PAINTING :

As done normally. Normal anti-corrosive painting. Cleaning and painting are for both the outer and inner portion of penstock.

PENSTOCK PAINTING (OUTER) - Coal Tar Paint Specification
Product Name: Tarstil Tar Gr.B.
ISI Code: IS: 290/1961 Type B

DESCRIPTION:
TarStil Tar Gr.B is Coal Tar based economical anti-corrosive coating.
TarStil Tar™ Gr. B conforms to IS: 290/1961 Type B.

CHARACTERISTICS

		TarStil Tar Gr.B
Colour	:	Black
Drying Time, hrs.	:	24
Consistency	:	Brushable
Dry film thickness per coat	:	60 Micron
Specific Gravity	:	1.15
Theoretical Coverage, m^2/L • On metal Surface	:	10

• On concrete Surface	:	8
• On wooden surface	:	8
Flash Point, ^{0}C	:	75

06.03.01.08 APPLICATION METHODOLOGY

a The surface to be treated should be thoroughly cleaned and dried. All dirt scales and dust must be removed.
b Apply by brush to form a protective film on evaporation.
c Two coats are normally recommended. The period of protection is, however, considerably increased by the application of a third coat.
d Each subsequent coat should be applied when preceding coat has become dry and hard.
e Three coats of Tarstil Tar Special are generally recommended.

06.03.02 TURBINE HOUSING/DISCHARGE CHAMBER

Housing/Discharge Chamber shall be modified for accommodating the new symmetrical manifold. Internal surfaces of housing shall be weld filled by grinding and providing protection coating. The detail modification work is described under Civil Work.

06.03.03 DRAINAGE AND DEWATERING SYSTEM :

This has been detailed in Cooling Water System

06.03.04 COMPRESSED AIR SYSTEM

a. The existing compressors shall be refurbished with replacement of all pipe, valves, instruments etc. The details of the existing compressors are as detailed below:

Compressor -1:

Make	:	K.G. Khosla and Co.
Type	:	B.D.12
Capacity	:	340 lit/min
Opening Pressure	:	30 Kg/cm2 (to be confirmed)

Compressor -2:

Make	:	K.G. Khosla and Co.
Type	:	B.D.7.2
Capacity	:	505 lpm
Opening Pressure	:	30 Kg/cm2 (to be confirmed)
Air receiver tank:		
Capacity	:	400 liter
Maximum pressure	:	35 Kg/cm2

Working pressure of air brake: 7 Kg/cm2
Working pressure for general purpose: 4 Kg/cm2

b. Two additional compressors (1W+1S) of adequate capacity along with air receiver, pipe, valve,

necessary instruments etc. shall be provided for operation of governor OPU.

c. Each compressor shall comprise of intercoolers, after coolers, intake air filter cum silencer, discharge valve with NRV, relief valve, and all necessary instruments, Air receiver tank etc.

d. There should be interconnection in between the existing and new compressors through pressure reducing valves so that air can be availed for braking purpose in case of failure of both the existing compressors. These compressors shall be installed at coupling chamber floor. A tentative space is proposed in the equipment layout drawing.

06.03.05 EOT CRANE OF POWER HOUSE

The power house consists of an EOT crane with a main hoist of 135 tonnes and auxiliary hoist of 20 tonnes for the erection and maintenance of the unit. For renovation of EOT crane following works to be carried out:

- Replacement of wire ropes and refurbishing of hoist machinery (gears, gear boxes, sheaves, wheels etc.)
- Replacement of power conductors (down shop and/or trolley and bridge)
- Replace/provide power disconnecting devices to meet current standards
- Replacement of mechanical load brakes with electrical load brakes
- Replacement of motors
- Replacement of control systems
- Replacement of control and power wiring or conductor and collector systems.
- Replacement of lighting system
- Refurbishment of lifting beam
- Re-painting
- Load test by certified agency

06.03.06 COMPLETE UNIT AREA INCLUDING GENERATOR TRANSFORMER

Cleaning of the area including minor repairs. All surface drains to be discharged in tail pool/discharge chamber whichever is applicable. All existing pipe valves are to be replaced with new except embedded if any.

06.04 SUPPLY OF PLANT & EQUIPMENT

The broad scope of supply of new equipment/facility is as follows.

SL .NO	NAME OF EQUIPMENT/FACILITY	UNIT	QTY
A	**MECHANICAL EQUIPMENT**		
1	Butterfly Valve including complete control system etc.	Sets	1
2	Main Inlet Valve including complete control system etc.	Sets	1
3	Turbine (suitable for producing 70MW at Generator terminals at rated head and discharge) and accessories	Sets	1
4	Governor and its accessories	Sets	1
5	Generator and its associated equipment	Sets	1

SL .NO	NAME OF EQUIPMENT/FACILITY	UNIT	QTY
6	Excitation system & Voltage regulator	Sets	1
7	Cooling water system	Sets	2
8	Lube oil System	Sets	1
9	Compressed air system	Sets	2
10	Fire protection system	Set	1
11	Air conditioning system	Lot	1
B	**ELECTRICAL EQUIPMENT- REFER VOLUME-III OF T.S.** Complete switchyard equipments for unit bay and 2 nos feeder bay with 110 KV BUS		
C	**CONTROL & INSTRUMENTATION- REFER VOLUME-III OF T.S.**		
D	**CIVIL WORKS**		
	Civil works as per scope	LS	As per Section B of this Volume
E	**SPARES AND TOOLS & TACKLES**		
1	Mandatory spares as per list	Sets.	1
2	Commissioning spares	Sets.	1
3	Recommended spares	Sets.	1
4	Special Tool & tackles	Sets.	1
5	Maintenance tool & tackles	Sets.	1

06.05 BATTERY LIMITS :

The "Battery Limits and Termination Points' shall be as under

(i) shall start from Pipe tunnel (downstream of surge shaft) upto tail race on the water conducting system &

(ii) shall include complete electric and C&I upto the drives and upto switchyard i.e. CTs and feeder breakers, upto the take off towers of Transmission.

06.06 FACILITIES ALREADY INSTALLED FOR THE PROPOSED UNITS

Tunnel, Surge tank, Penstock, Turbine casing, Turbine housing/discharge chamber, Power House, EOT Crane etc. are constructed/installed and to be utilized for the proposed Unit. The details may be seen from the enclosed Drawings. The approximate dimensions and capacities are given in Chapter-05 of this volume.

For Space available inside power house, refer Drgs. enclosed in Vol-IV.

06.07 DESIGN CRITERIA AND DETAILED SCOPE OF WORK

06.07.01 REFERENCE DOCUMENTS

- IEC 60041: latest edition, Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines

- IEC 60193: latest edition, International code for model acceptance tests of hydraulic turbines
- IEC 60308: latest edition, International code for testing of speed governing systems for hydraulic turbines
- IEC 60545: latest edition, Guide for commissioning, operation and maintenance of hydraulic turbines
- IEC 60609: latest edition, Cavitations pitting evaluation in hydraulic turbines, storage pumps and pump turbines
- IEC 60994: latest edition, Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps and pump-turbines)
- ISO 7919 Pt-5: Mechanical vibrations of non-reciprocating machines- measurements on rotating shafts and evaluation criteria of machines set in hydraulic power generating and pumping plants.
- IEC 60995: latest edition, Determination of the prototype performance from model acceptance tests of hydraulic machines with the consideration of scale effects
- IEC 61362, ¾ Guide to specification of hydro-turbine control systems

- ISO 3740: latest edition, Acoustics – Determination of sound power levels of noise sources – Guidelines for the use of basic standards and for the preparation of noise test codes

06.07.02 DESIGN CRITERIA

a) 06.07.02.01 Tenderer shall assess and confirm the possibilities of accommodation of new runner and manifold in the existing turbine pit and fitting with the existing turbine shaft before putting up the bids. Necessary modification if required shall also be included in the scope of tenderer.

b) Tenderer may carry out necessary overall inspection of the unit as may be considered necessary over and above the data/information provided herein, so as to achieve the desired outputs. The data/drawings made available in this tender document are as collected from TANGEDCO and correctness of the data drawings are to be confirmed by tenderers during site visit before pre-bid or later Tenderer shall be solely responsible for arriving at the desired performance and should not make any plea of non-availability/incorrectness of data etc. as the criteria for not achieving the output.

c) Tenderer shall visit the site, study the existing machines in detail satisfy himself with plant details before putting up the offer. The details of existing plant are already described in the **Chapter 05**. The technical requirements for installation of new runner with buckets are given below and to achieve output all suggested and required modification shall be carried out by the Tenderer.

d) The scope of work shall include but not limited to the following:

e) ~~The manufacturers / suppliers shall make in-depth study on various aspects before offering~~

the equipment guaranteeing to meet requirements of cavitations free performance for entire range of head and discharges at the available turbine setting and with the available water.

f) If the Tenderer wishes to deviate from this specification, the same shall be clearly brought out to the Purchaser with justifications in the format provided in Schedule –A of Techno-commercial Schedule.

g) The Tenderer shall specify the minimum head and maximum head at which the unit can be safely operated without any cavitation and vibration.

h) The new turbine shall be designed as per site condition and meet the requirement as specified in the Technical Specification.

i) The weight of the turbine rotating parts and any unbalanced vertical hydraulic thrust shall be supported by the generator thrust bearing.

j) The new turbine shall be manufactured after carrying out computer simulation studies and/ or model test by the successful bidder.

06.07.02.02 COMPUTATIONAL FLUID DYNAMIC STUDIES (CFD MODEL TESTING)

a) To ensure the output and efficiency of the machine, the new turbine shall be designed and manufactured based on computerized simulation studies. Cavitation performance of the turbine shall also be carried out. The successful tenderer shall furnish the results of the study tests to Purchaser for review/approval.

b) In case the successful tenderer proposes model test, then the Tenderer shall furnish details as to where they will carry out the model test. Report of **Model Testing** shall be made available to the purchaser by the successful tenderer before going ahead with the manufacturing of the turbine.

c) In case the contractor has already performed model tests on homologous models, the purchaser, at his discretion, permit the contractor to proceed with the manufacturer after approval by the Purchaser of the model test report.

d) The performance of the model tests either a fresh or that had been done earlier shall be as per IEC 193 and 193A in all respects. Hydraulic performance tests shall be made at various nozzle openings to determine the machine characteristics including regimes of safe operation, zones of vibration etc. These tests shall include determination of capacity, hydraulic thrust, runaway speed, nozzle opening output relationship, etc., and such other details as covered in IEC 193 and 193A. Model tests shall simulate all possible normal operating conditions of the prototype for entire range of the heads and loads.

e) The tenderer shall clearly mention the time within which the model tests including manufacturer of a new model, if required, will be completed. The delivery schedule given by the tenderer shall be recokened from the date of approval of model tests or model test report or from the time of permission to proceed with the prototype manufacturer. If the model test is already available, this shall be submitted within one month after the award of the contract if required by the purchaser.

f) Basic data for **design of turbine** are as follows :

i. The turbine is to be accommodated in the space available in the turbine pit.
ii. The trash rack, intake, penstock, surge tank, turbine casing, turbine pit etc. are already there and the same are to be utilized for the installation of the proposed unit.
iii. The turbine shall be designed for a rated/design head of 940.30m. Necessary modification of the foundation if required shall be done by the Contractor.
iv. The new turbine will be designed based on the following parameters.

Rated /Design Head	:	940.30m
Maximum Head	:	972.92m
Minimum Head	:	914.32m
Elevation of nozzle center line	:	EL506.36m
Temperature of water		
Minimum	:	8 ºC
Maximum	:	31.5 ºC

g) Detail raw water analysis shall be done by the contractor for design of turbine for design of equipment which are directly come in contact of water.

06.08 DETAILED SCOPE OF WORK

06.08.01 BUTTERFLY VALVE

A new butterfly valve of adequate capacity along with the complete control system shall be provided. The size of the valve shall be matching with the existing penstock. The valve and the control system shall be designed in accordance with latest IS 7326 or equivalent standards.

06.08.01.01 DESIGN CRITERIA

MATERIAL: Material shall be as per latest IS 7326. If required necessary water analysis shall be carried out by Contractor.

PERMISSIBLE STRESS LEVELS:
The maximum permissible stress levels at the design head shall be as follows:

For steel:
Tensile strength= 0.25 of ultimate tensile stress or 0.5 of yield strength whichever is less

Shear Stress =0.35 yield point

For Bronze:
Bearing Stress= 0.035 ultimate tensile strength

06.08.01.02 DESIGN OF MECHANICAL PARTS

06.08.01.02.01 VALVE BODY

The valve body should be cast, cast fabricated materials as per latest IS 7326 or equivalent standards. The body should have two hubs for trunnion bearing housings. Flanges for connecting to penstock should be at right angles to the axis of the bore and concentric with the bore and the faces should be parallel. Where design does not permit the use of through bolts, the valve flange may have tapped holes. The body may be made in single piece or in parts for convenience of manufacture and transportation to site. The body should be stress relieved before any machining is done. The shell of the body shall be designed to sustain maximum static head including pressure rise.

06.08.01.02.02 VALVE DISC

Disc shall be designed to offer minimum head loss in open position and to sustain the full differential pressure across the closed valve. The Disc should be cast, cast fabricated materials as per latest IS 7326 or equivalent standards. The Disc should be stress relieved before taking up for machining operation. The angular travel of the Disc shall be nearly 90^0 from open to shut-off position. Thrust collar shall be provided to hold the Disc in the centre of valve body.

06.08.01.02.03 VALVE TRUNIONS

Valve trunnions shall be of either one piece unit extending completely through the disc or of the stub type comprising two separate trunnions in the valve disc hub. The design of trunnions shall be such that it will safely sustain maximum differential pressures across the closed valve. The trunnion and any keys or dowels, etc, used for transmitting the torque between trunnion and disc, should be capable of withstanding the maximum torque required to operate the valve. The trunnion should also be designed for the stress developed during valve closing under emergency condition and over velocity or penstock rupture condition.

06.08.01.02.04 BEARINGS

Bearings shall be self lubricated sleeve type or self centring type. It shall be able to sustain the maximum load imposed by trunion. The materials of the bearings shall be as per latest IS 7326 or equivalent standards.

06.08.01.02.05 SEAL

The seal shall be fibre reinforced solid rubber type. Seal shall be designed to provide tight shut-off. The seal shall be securely attached either to the body or to the disc. The seal material shall be compatible with the temperature and characteristics of the water. Materials of the seal shall be as per latest IS 7326 or equivalent standards.

06.08.01.02.06 SEAL SEAT

Rust resisting seal seat against which sealing ring seats shall be securely attached to either the body or the disc. This can be of bolted or welded construction. Material shall be as per latest IS 7326 or equivalent standards.

06.08.01.02.07 TRUNION SEAL

Trunnion seal shall be provided on both driving and non-driving trunnions. Its design shall be such as to prevent any leakage and to ensure further adjustments and replacement. Material shall be as per latest IS 7326 or equivalent standards.

06.08.01.02.08 FOUNDATION

The existing foundation shall be used. Strengthening of existing foundation shall be checked by Contractor for the proposed butterfly valve and necessary strengthening and any modification if required the same shall be carried out by the Contractor.

06.08.01.02.09 LIFTING DEVICE

There is no EOT provision for handling /dismantling the existing BFV and erection of new BFV. So the tender shall make his own material handling arrangement (mobile crane) to carry out the dismantling / erection of BFV.

06.08.01.02.10 OPERATION AND CONTROL

□□ Operation and control of the valve shall be in accordance with latest IS 7326 or equivalent standards.

b) An oil operated hydraulic servo motor shall be used. One or more servomotors may be used for the operation of the valve. The servomotors shall be fixed type and shall be sized to transmit the required operating torque through levers to the valve trunion & closing shall be achieved with dead weight

□□ For operation of the valve, a separate oil pressure unit including compressed air system shall be installed in the valve house. All the bearings and pivots shall have bushes and of self- lubricated type. The valve seal shall also be operated from the same control unit. All the control equipment such as control panel, indicators, limit switches, alarms, trip switches etc. and necessary valves, pipes shall be provided. Provision of operation from the control room as well as from local shall be provided.

06.08.02 **SPHERICAL VALVE (MAIN INLET VALVE):**

A new spherical valve of adequate capacity along with the complete control system shall be provided. The size of the valve shall be matching with the existing penstock dia. The valve shall have service seal as well as repair seal. The valve and the control system shall be designed in accordance with latest IS 7332 or equivalent standards.

06.08.02.01 DESIGN CRITERIA

MATERIAL: Material shall be as per latest IS 7332. If required necessary water analysis shall be carried out by Contractor.

PERMISSIBLE STRESS LEVELS:

The maximum permissible stress levels at the design head shall be as follows:

For steel:

Tensile strength= 0.25 of ultimate tensile stress or 0.5 of yield strength whichever is less

Shear Stress = 60% of the tensile stress

For Bronze Bushings:

Bearing Stress ≤ 35 N/mm^2

For self lubricated Bushes:

Bearing Stress ≤ 35 N/mm^2

06.08.02.02 DESIGN OF MECHANICAL PARTS

06.08.02.02.01 VALVE BODY

a) The body shall have two holes for trunnion bearing housings and suitable bosses for by-pass connection, drainage, air release and for mechanical locks if necessary. Flanges for connecting to penstock shall be at right angle to the axis of the bore and concentric with the bore and the faces shall be parallel. The flanges shall have tapped or through holes. Repair seal shall have a boss on upstream side for connection of a pipe for equalizing pressure and on inlet side a cylindrical surface lined with stainless steel shall be provided where movable ring of repair seal slides. On the outlet side it shall have a cylindrical surface for fitting the service seal.

b) The body shall be made in two parts from assembly point of view. The joint may be vertical, horizontal or diagonal according to the suitability of assembly and transport.

c) The body shall be designed, such as to sustain maximum pressure including water hammer.

06.08.02.02.02 ROTOR

Rotor and trunnions shall be joined together by means of welding or shall be integrally cast, cast-fabricated or fabricated from materials as per latest IS 7332 or equivalent standards. Rotor shall have necessary provision to accommodate service seal and repair seal. The angular travel of the rotor shall be $90^0$from open to close position. Cylinder of the rotor shall be horizontal when valve is open and vertical when valve is closed. There shall be provision for movement to open and close the service seal.

06.08.02.02.03 VALVE TRUNIONS

Trunnions shall be made of material as per latest IS 7332 or equivalent standards and of forged steel or cast steel when integral with rotor. Levers shall be fixed by means of wedge pins, parallel pins or keys.

The design of rotor and trunnions shall be such that they will safely sustain maximum differential pressure including any surge pressure across the closed valve, and the maximum forces due to the servomotor

06.08.02.02.04 BEARINGS

Bearings shall be self lubricated bush type. It shall be able to sustain the maximum load imposed by trunion. The materials of the bearings shall be as per latest IS 7332 or equivalent standards.

06.08.02.02.05 SEAL AND VALVE

The seal and valve , Operation , lifting device are detailed below:

06.08.02.02.06 SERVICE SEAL

The service seal shall be manufactured using the material as per latest IS 7332 or equivalent standards. The design shall have the provision for movement of the seal. Seal shall be designed to provide tight shut-off.

06.08.02.02.07 REPAIR SEAL

It shall consist of movable and fixed rings and mechanism for movement of movable ring. Fixed ring shall be fixed on the rotor and movable ring shall slide on the valve body. Mechanism for movement of movable ring shall be designed such that ring shall movein axial direction very smoothly and give a good tightness when repair seal is closed. Clearance between movable ring and valve body shall be sealed by suitable design rubber seal or cord. A by-pass connection shall be provided to equalize the pressure to enable smooth opening of the repair seal.

06.08.02.02.08 BYPASS VALVE

A new bypass valve of adequate capacity shall be supplied. The size of the by-pass valve should be sufficient to balance the downstream pressure at least by 60 percent of the upstream pressure, considering the maximum leakages through the guide vanes.

06.08.02.02.09 SEAL VALVE

A new seal valve of adequate capacity to drain pressurised water behind the disc to withdraw the disc instantaneously.

06.08.02.02.10 FOUNDATION

The existing foundation shall be used. Strengthening of existing foundation shall be checked by Contractor for the proposed main inlet valve and necessary strengthening and any modification if required the same shall be carried out by the Contractor.

06.08.02.02.11 LIFTING DEVICE

Existing lifting device shall be used.

06.08.02.02.12 OPERATION AND CONTROL

a. Operation and control of the valve shall be in accordance with latest IS 7332 or equivalent standards.

b. An oil operated hydraulic servo motor shall be used. One or more servomotors may be used for the operation of the valve. The servomotors shall be fixed type and shall be sized to transmit the required operating torque through levers to the valve trunion.
For operation of the valve, a separate oil pressure unit including compressed air system shall be installed. All the bearings and pivots shall have bushes and of self lubricated type. The valve seal shall also be operated from the same control unit. All the control equipment such as control panel, indicators, limit switches, alarms, trip switches etc. and necessary valves, pipes shall be provided. Provision of operation from the control room as well as from local shall be provided.

06.08.03 TURBINE

06.08.03.01 TYPE,RATING AND DESIGN REQUIREMENTS

a. The turbine shall be of the vertical shaft, Pelton type having adequate no. of buckets and suitable for coupling through vertical shaft synchronous generator.
b. The turbine shall be complete and consist of Runner assembly, spear, deflector etc. All other existing equipment shall be renovated and the same shall be utilized for the new turbine set.
c. The turbine shall be designed to give rated output (at generator terminals) at rated head of 940.30m with maximum efficiency of the turbine. The turbine would have output higher (minimum 10%) than the rated output when operating at heads higher than the rated head. The maximum output both at minimum and maximum heads shall also be stated in the offer.
d. The details of the hydraulic system and basic data for design of turbine are given above. There is no transport limitation.
e. The already constructed power house plan and section (enclosed with this specification) shows space availability, turbine setting (Centre line of turbine and Minimum tail water level), penstock details, tentative layout of equipment.
f. The Tenderer shall critically study the silt data and chemical analysis of water and take the same into account in designing the turbine and auxiliary equipment susceptible to abrasive effect of silt, making all such specific provisions and measure including selection of materials, coatings and paintings which will help to resist silt abrasion and enable easy and quick maintenance / replacement of worn out components.
g. The hydraulic turbine shall comply with latest versions of relevant IEC/IS standards.
h. The turbine shall have smooth and quiet operation. The vibrations, pressure pulsations and power fluctuations shall be within the limits specified in relevant standards. The amplitude of vibrations at the shaft shall not exceed the limits specified in relevant ISO standards.

i. The peak efficiency of turbine shall be higher than 91.5% and weighted average efficiency shall not be less than 91%.

06.08.03.02 WEIGHTED AVERAGE EFFICIENCY :

Weighted average efficiency (η_W) will be calculated as follows:
Weighted average efficiency (ηw) = 0.5 x η100 + 0.3x η80 + 0.2x η60
(η100, η80, η60 mean the efficiency of the turbine at rated head and when it delivers 100%, 80% & 60% of rated MW (Electrical) Output respectively).

a) The values of critical sigma as per IEC 193A shall be furnished in form of curves for different nozzle openings and different heads of operation. Plant sigma curves as recommended by the manufacturer shall also be plotted on it clearly to show the safety margin available.
b) The moment of inertia of the unit and normal nozzle and deflector closing shall be so adjusted that maximum momentary speed rise of the unit and the maximum pressure rise in the penstock shall not exceed existing limits. The maximum runaway speed of the unit, under any combination of head and load conditions shall be stated in the tender.
c) Maximum noise level resulting from any of the operating conditions shall not exceed 90 db (A) at any place 1.0 m away from any operating equipment.
d) The turbine shall be capable of running safely at maximum runaway speed without any damage to its parts for a period of not less than 15 minutes for every such occurrence, with cooling water supply on.
e) However critical speed of the machine shall be about 25% higher than maximum runaway speed.
f) The turbine shall be capable of delivering a guaranteed output of not less than 70.96MW at shaft coupling when operated at a rated net head of 940.30 m and at rated speed of 500 rpm. This output shall be generated within 90% nozzle opening and shall be called rated output of the turbine.
g) The capacity curve at net heads of to 914.32 m at different nozzle opening up to full nozzle opening shall be stated.
h) The turbine shall be designed for continuous operation over the range of net heads of 972.92m to 914.32 m.

i) The turbine shall have the required parameters as per standards.

06.08.03.03 COOLING WATER FAILURE DURATION WITHSTAND CAPACITY

The turbine guide bearing shall be designed and guaranteed to withstand operation at maximum continuous rating without any damage or deterioration for a period of at least 15 (Fifteen) minutes without cooling water supply.

06.08.03.04 GENERAL ARRANGEMENT AND CONSTRUCTION

a) The General arrangement shall be same as of existing Unit except the modification of housing to accommodate the new manifold for making the symmetrical nozzle.The turbine

shall be so constructed as to allow all the removable parts to be dismantled conveniently. The design shall also permit vertical movement of runner shaft by an amount sufficient for adjustment of bearings and for clearing the joint at the coupling of the turbine and the generator.

b) All equipment shall be neatly arranged and shall be readily and easily accessible for operation and maintenance. The necessary walkways, handrails, ladders, chequered plates, platforms, etc., required shall be provided by the Tenderer.

06.08.03.05 THE DETAIL PROPOSAL OF TURBINE COMPONENTS

06.08.03.05.01 RUNNER

a) The runner shall be forged fabricated of 13/4 chromium-Nickel stainless steel conforming to relevant standard. The buckets shall be machined and ground smooth. The runner shall be designed to withstand the loads imposed by any combination of fully open nozzles in operation at rated speed including maximum runaway speed and maximum head without exceeding the permissible stress. The forged fabricated construction, runners should be manufactured out of a forged disk on the periphery of which the bucket roots should be milled. The nozzle opening versus output and output versus efficiency curves shall be submitted along with the tender.

b) The machine shall be designed for condenser operation also.

c) The complete runner assembly shall be statically balanced in the shop. During manufacturing of buckets, shape and surface finish shall be maintained to limit the cavitation erosion damages. Proper quality control shall be provided during all phases of fabrication and manufacture to ensure that the final product is a good representation of the model runner or hydraulic design.

06.08.03.05.02 NOZZLE

New set of 02 nos. or 04 nos. symmetrical nozzles shall be provided. The nozzles for supplying the water to turbine runner will be designed for producing a solid uniform jet. The nozzle body should be of welded stress relieved steel tube and the nozzle tip will be provided with a removable stainless steel seat ring at the point of final water discharge. Removal and replacement of the seat ring should be possible without disturbing/dismantling the runner. Adequate distance between the nozzle and runner should be maintained to minimize the jet dispersion.

06.08.03.05.03 SPEAR / NEEDLE

New set of spear shall be provided. The jet will be controlled by spear of 13 Cr 4 Ni Stainless Steel. The needle stem should also be made of Stainless steel. The spears shall be designed in such a way to fit in the proposed nozzle. Spear shall be regulated by spear servomotor through spear rod.

06.08.03.05.04 DEFLECTOR

a) A suitably designed jet deflector, one for each nozzle shall be provided.

b) Deflector should be coordinated to ensure simultaneous action with needle as required by operation. Under normal speed control the needle should do the governing. On larger part load rejections, the deflector should deflect the complete jet until the needle approaches the position required for normal turbine speed. Each deflector shall be actuated by common servomotor through levers & link and will be coordinated with needle so that upon a rise in speed each jet shall be quickly deflected first, followed by slow closure of the needles. The cutting edge deflector will be designed of 13 Cr/4 Ni Stainless Steel. The deflector will be capable of deflecting the jet completely within the time required to keep the speed rise within the specified limits during load rejection.

c) The deflector will be designed to withstand the maximum discharge from the nozzle without damage. A position indicator will be provided to indicate at all times the setting of the deflector cutting edge with respect to the centerline of the nozzle

06.08.03.05.05 TURBINE GUIDE BEARING

a) New turbine guide bearing of self lubricated and segmental type with external lube oil coolers shall be provided. The bearing shall be designed as per latest IS/IEC standard. Guide pads shall be babbit lined with white metal and will be located above the runner and will consist of removable bearing segments. The guide bearing should be designed to support the maximum loading in the horizontal direction imposed by the turbine shaft for any loading of operation.

b) The babbitt lining on the guide bearing segments/pads shall be according to a grade suitable for the bearing and anchored tightly to the shell. The babbitt lining shall be accurately bored and shall be suitable for oil circulation. Suitable lifting eye bolts and backing-out studs shall be provided for use in removing and installing the bearing segments.

c) The bearing should be capable of being operated continuously without failure at normal temperature at rated speed and should be capable of being operated for 15 minutes at maximum runaway speed without failure with cooling water. Also, the bearings should be capable of being safely operated at rated speed without cooling water flow, when starting from normal-level oil temperature, for at least 15 minutes.

d) The lubricating oil system shall be designed so that the temperature of the bearing metal and bearing oil shall not exceed 70^0C and 65^0C respectively under continuous operation in any operating conditions.

e) The bearing housing shall be made of cast steel, or welded plate steel of heavy construction. The bearing shall be rigidly supported on the turbine head cover. Irrespective of the material used, the bearing shall be stress relieved before final machining operation. For ease in maintenance guide bearing housing shall be designed in two halves.

f) The successful Tenderer shall supply and install the following indicating and protection devices for the guide bearing. All electrical contacts shall be wired to terminal blocks in the turbine terminal box. The operating/contact voltage rating of these instruments shall be 220V DC.

i) Adequate numbers of temperature sensing devices, liquid expansion type thermometer, one in each segment/ pad for bearing metal and one in bearing oil for bearing oil

temperature. The devices shall have two sets of separately adjustable contacts suitable for operating alarm and tripping circuits. The device shall have a third contact to indicate loss of thermometer bulb pressure or loss of power supply.

ii) DTT and RTDs in alternate pad shall be provided; however, provision for installation of DTT and RTDs in all pads shall be provided. Two more RTDs shall also be provided for detection of lube oil temperature.

iii) One direct reading flow-meter with electrically separate low-flow alarm contacts for the bearing cooling water supply, if cooling water is required.

iv) One direct visual indicator of the bearing oil level marked in liters and high and low level adjustable alarm contacts.

v) One oil-water contamination detector, if water cooled bearing arrangement is used.

vi) A flow meter with two electrically separated alarm contacts to indicate low water flow to the bearing cooling system. (The piping shall be provided with a sufficient number of unions to permit ease of removal)

06.08.03.05.06 MANIFOLDS

New symmetrical manifolds of adequate size shall be provided. Manifolds shall be designed to fit in the modified existing housing. Material of the manifold shall be high strength structural steel as per the relevant latest IS/IEC standard and shall have suitable sections for ease of shipment and to be within transport limitation. Modification/strengthening of the manifold housing as required to make symmetrical shall be included in the scope of work. It shall be designed to withstand maximum water pressure including water hammer and shall be complete with anchors, supports, turn buckles, hold down rods etc. The manifold shall have suitable flanges for connection to the main inlet valve and openings for provision of nozzle-needle assemblies.

06.08.03.05.07 TURBINE SHAFT

a) A new turbine shaft shall be supplied by the contractor to couple the runner with generator shaft. The shaft shall be made of forged/fabricated carbon or alloy steel properly heat treated. It shall be provided with coupling flanges at top and bottom for connecting to the generator shaft and to the runner respectively. The turbine and generator manufacturer shall coordinate for proper design and construction. The shaft typically shall have a bearing journal for oil lubricated hydrodynamic guide bearings on the turbine runner end or wearing sleeve for oil lubricated water cooled.

b) The magnitude of shaft run out shall not exceed the approved tolerances in Indian/international standards. Two bands shall be machined and marked on the shaft for use for verticality and alignment purposes. The length of the shaft and elevation of coupling flange shall be as finalized during detailed engineering, by the contractor after co-ordination with generator manufacturer.

c) Immediately above the turbine guide bearing housing, a circumferential line shall be machined on the shaft and an adjustable pointer shall be mounted on the bearing housing opposite this line to indicate any axial movement of the shaft and to permit realignment after thrust bearing dismantling.

d) The shaft shall be designed for eccentric loading caused by unbalanced operation in addition to torsional loading.

e) The shaft coupling shall be designed as per provision of ANSI/IEEE Std 810 or applicable standard for fabricated shaft. The coupling bolts shall be designed for tightening using hydraulic tensioner/tightening device.

f) The turbine shaft diameter shall be coordinated with the generator shaft diameter. The critical speed of the combined turbine and generator and generator rotating part shall be calculated by the contractor and first critical speed shall be at least 25% above the maximum runaway speed. Calculations satisfying the compliance with these requirements shall be submitted to Purchaser prior to manufacturing.

g) The shaft shall be painted all over except mating surfaces of coupling bearing journal, vibration pickup band and shaft sleeve, which shall be adequately protected during shipment.

06.08.03.05.08 SERVOMOTORS

a) Each nozzle and deflector of the turbine shall be provided with common hydraulic servomotors having sufficient capacity to supply the maximum force necessary to open/close the nozzle/deflector under maximum operating head, at the minimum oil pressure.

b) The servomotor cylinders may be made of cast steel or welded steel plate. The servomotor piston rod shall be of forged steel and provided with bronze bushings. Lubrication shall be arranged to ensure that lubricant is admitted to high pressure areas regardless of nozzle/deflector position. The piston rod shall be arranged for adjustment of stroke. The connecting rod pins shall be hardened and ground.

c) The inner surface of the cylinder shall be bored to uniform diameter, and shall have a surface finish to allow the piston to traverse freely and smoothly with minimum oil leakage past through the piston and seals . Suitable packing shall be used toprevent oil leakage from the cylinder past the piston rod. The piston connecting rod shall be of forged steel of uniform diameter. Each piston shall be fitted with not less than three piston rings, suitably shaped to give close contact and uniform pressure on the cylinder walls.

d) The servomotor cylinders shall be provided with flanges for connecting oil piping. Connections for pressure gauges shall be provided at each end of each cylinder. An air vent and a drain cock shall be provided on each servomotor for bleeding/draining purposes.

e) Provision shall be made for field alignment of the servomotors, using levelling plates supplied by the Contractor. The servomotor flange shall be dowelled in field to its mounting flange.

f) A manual locking device of simple construction shall be provided on the servomotors to permit locking of nozzles in fully open and fully closed positions and capable of withstanding safely the full operating force of the servomotors. The device shall be such that it can be easily engaged and disengaged by one man. Electrical contact switches suitable for indication for 220 V D.C. systems shall be provided to indicate nozzle locked in fully open and fully closed positions. An additional contact for unit start interlock shall be provided. All contacts shall be wired to terminal blocks in the turbine terminal box.

g) Bypass connections equipped with orifices and/or at the adjustable needle valves shall be provided on the servomotors to retard the rate of closure of the nozzles from slightly below speed-no load position to the fully closed position. Bypass connections shall be fitted with check valves to prevent sluggish movement on opening the nozzle from the fully closed position to provide damping effect. A suitable pointer and scale, graduated in tenths with subdivisions, shall be provided to indicate the percent stroke of the servomotor and nozzle opening from the closed position. The scale shall be calibrated in the field and marked “closed” at one end of the scale and “opened” at the other end.

h) The servomotor stroke must be capable of manual adjustment. Means for positively locking the adjustment must be provided. Servomotors shall be shop tested under a hydrostatic pressure equal to 150% of the maximum design pressure of the governor oil system.

06.08.03.05.09 TURBINE GOVERNOR

06.08.03.05.09.01 GENERAL

A. Governor monitors speed deviations in the turbine; converts that speed variation into a change of nozzle and deflector servomotor position which changes the nozzle and deflector opening; to maintain optimal efficiency of the turbine for a given load. It is also used to start the unit, synchronize the unit to the grid, load, and shut down the unit.

B. A new governing system of digital PID type with provision of RGMO. The Digital governor shall be a dedicated redundant microprocessor based PID type. The performance of the governing system shall be governed by relevant IS/IEC standards. The speed sensing system shall have redundancy.

C. Among other things, the restricted governor mode of operation shall essentially have the following features:

a) There should not be any reduction in generation in case of improvement in grid frequency below 50.2Hz. Whereas for any fall in grid frequency, generation from the unit should increase by 5% limited to 105% of the maximum continuous rating of the unit subject to machine capability.

b) Ripple filter of +/- 0.03 Hz. shall be provided so that small changes in frequency are ignored for load correction, in order to prevent governor hunting

06.08.03.05.09.02 OTHER FEATURES OF THE GOVERNOR

The governor offered should have the following salient features.

a) The governor should take into account load fluctuations, speed droop, gate limit control etc. and combine them to achieve the desired operation under various possible modes of operation. The governor should be reliable for safety of turbine and ability to develop power under various head conditions. Easy replacement of components should be possible with modular design, without affecting power generation.

b) The governor shall be capable of operating the following modes – speed control, load control, gate limiter control and water level control.

c) The system program shall be in a language that is easy to understand, learn and implement. The program shall be stored in a non-volatile memory. All programs and listing including changes made during commissioning shall be handed over to Purchaser.

d) The governor shall be independent for each unit. The components of the governor shall be selected on the criteria of high performance, reliability and ease of maintenance. The governor shall be suitable for operation of the unit in complex grid system.

e) Digital governors with either proprietary controllers or controllers based on industrial PLCs shall be supplied. Magneto strictive Linear Displacement Transducer (MLDT) non-contact linear displacement feedback sensor shall be used.

f) Governor pump cycle time shall be monitored during regulating and shutdown to establish a baseline and trend to indicate any increases indicating internal leakage of the valves or problems with the turbine servomotors.

g) Pump noise and vibration shall be monitored for indicating bearing failures, excessive oil foaming, loose pipe connections, and possible blockage of oil flow.

h) Speed Sensor shall be a Speed Signal Generator (SSG) driven directly by the unit. Creep detector shall be part of speed sensor capable of measuring very slow shaft revolutions that might occur from leakage of the nozzles while the unit is shut down. The system shall detect movement and turns on auxiliary equipment to prevent damage.

06.08.03.05.09.02

A. PERMANENT SPEED DROOP CONTROL

There should be a provision for altering frequency vs. gate servomotor relationship by changing the permanent speed droop setting to achieve desired regulation. Speed setting device shall be provided to allow synchronising, manual load control and frequency control.

B. TEMPORARY SPEED DROOP CONTROL

The temporary speed droop control shall be provided for controlling the movement of the servomotor without any hunting. The governing parameters, temporary droop percentage and decay time constant shall be set so as to allow stable operation. This control shall derive its input from the guide vane servomotors.

C. GATE LIMIT CONTROL

A gate control shall be provided to enable the max. Opening of the guide vanes. This shall lock the whole governing system to avoid further opening of the guide vanes irrespective of the load required.

D. PERFORMANCE REQUIREMENTS

The governor shall conform to IEEE / ASME standard no. 125/IEC-308. The governor shall meet the following minimum performance requirements:

06.08.03.05.09.02

E. STABILITY

a. The governor shall be deemed to be stable if the control system (water passages, turbine, generator and voltage regulator) is inherently stable when:

b) Speed oscillations greater than +/-0.15% of rated speed do not occur with the governor controlling the turbine driving a generator at rated speed at no load or with an isolated load.

c) Power oscillations greater than +/-0.15% rated capacity of the turbine do not occur with the governor controlling the turbine driving a generator under sustained load demand in parallel with other generators which are themselves capable of operating in parallel with the governors speed droop not less than 2%

F. DEAD TIME

The elapsed time from the initial speed change of the turbine to the first movement of the nozzle servomotor for a sudden load change of more than 10% of the full load rating of the turbine shall not be more than 0.2 second.

G. DEAD BAND

The total magnitude of the sustained speed change within which there is no resulting measurable change in the position of the nozzle servomotors at rated speed of the turbine shall not exceed 0.02% of the rated speed of the turbine at any opening.

H. ELECTRIC POWER SUPPLY TO THE GOVERNOR

Station Battery 220 V DC Power supply shall be provided for Governor Operations.

I. DIGITAL ELECTRONIC CONTROLLER

Digital electronic controller unit shall consist of

- Digital Processor
- Visual Display Video
- A PLC unit for control, logic and signal I/O.
- Power Supply

- Terminal Cards
- Relays for digital outputs
- Signal Converters
- Humanmachine interface
- Other communication units
- Other Accessories for governor electronics
- All hardware and software required to make program changesincluding a mobile work station.

06.08.03.05.09.02

J. HYDRAULIC ACTUATOR

Hydraulic actuator unit shall consist of following mainomponents:

- Main oil distributing valve
- Proportional (Pilot) Valve
- Restoring (Servo motor Position Feedback) Mechanism/Connections with 100% redundancy
- Control Valves
- Flow Control Valves
- Check Valves
- Pressure Switches
- Manifold blocks associated piping and fittings
- Other required accessories

K. OIL SYSTEM

K-1. OIL PUMPING UNIT: Oil pumping unit comprising of following main components:

- Sump tank
- Motor Driven main and stand by vertical screw oil pumps mounted onthe sump tanks
- Oil pressure tank with associated accessories
- Oil piping and valves
- Instrumentation
- Oil leakage unit.
- Dust preventor.

K-2. HIGH PRESSURE OIL SYSTEM

High pressure oil system shall be provided for operation of nozzle and deflector servomotors through governor. 02 nos. (1W+1S) high pressure compressed air system of adequate capacity as per relevant IS/IEC standard including air receiver/ Accumulator, air dryer, piping, valves instruments etc. shall be considered for operation of oil pressure unit. The sizes of various components of oil sump tank and pressure receiver shall be calculated as per relevant IS/IEEE standards. The oil volume below machine shutdown level shall be sufficient to perform three (3) full operations of servomotor (i.e., close-open-close) with oil pumps being out of operation.

Piston type accumulator with nitrogen bottles shall be used for pressures higher than 60 Kg/cm2

K. INSTRUMENTS

All the instruments of turbine and governing system shall be replaced with new set. The specification for Control and Instrumentation is given in vol. IV Sec.B of Tender document.

06.08.03.05.09.02

L. GOVERNOR OIL

Oil of appropriate quality free from impurities or acidity shall be provided for first filling of the oil sump tank, Pressure receiver, governing circuit and servo motor.

Tenderer shall supply indigenous oil from any reputed oil company of India as approved by the Purchaser.

M. CABLING

All internal and external cabling required for turbine and governor shall be supplied and laid as per the technical specification given in Vol. IV, Sec. A of this document.

06.08.04 GENERATOR AND ASSOCIATED EQUIPMENT

06.08.04.01 GENERAL:

The generator shall comply with the latest versions of IS/IEC standards. The efficiency of generator shall be 98 % or more at rated load.

Insulation shall be thermal class F for the stator and the rotor windings with temperature rise limited to that of thermal class B as per relevant IEC standards.

RTDs or thermocouples shall be provided at suitable locations for monitoring temperature of stator core, stator winding and bearings. The temperature of rotor winding will be displayed in excitation panel by resistance measurement method.

06.08.04.02 GENERAL ARRANGEMENT AND CONSTRUCTION

The General arrangement shall be same as of existing Unit. The Generator shall be so constructed as to allow all the removable parts to be dismantled conveniently.

All equipment shall be neatly arranged and shall be readily and easily accessible for operation and maintenance. The necessary walkways, handrails, ladders, chequered plates, platforms, etc., required shall be provided by the contractor.

06.08.04.03 GENERATOR

The generator shall comprise the following:

One no. synchronous generator, direct driven, vertical shaft with 10% continuous overload each to match the turbines as given in Clause 06.04.03.01 of this Volume, complete with air cooled stator, rotor, shaft, Thrust cum upper Guide Bearing, Lower Guide Bearing (if applicable), safety devices etc., Instruments for measuring flow, vibrations, temperatures, etc with provision of extra contacts / ports for integration with plant SCADA.

One (1) set of fire protection systems for generator complete in all respects.

One (1) set of brake / jack systems complete with high pressure oil jacking pumps, piping, valves etc. for braking, jacking, etc. of the generator rotor.
One (1) set of brake dust collection systems.
One (1) set of carbon dust collection system.
One (1) set of high-pressure, automatic, lubricating systems for lubrication of thrust bearing at the time of starting / stopping of the unit.
One (1) set of anti-condensation heaters.
One (1) set of stator air coolers.
One (1) set of oil coolers for thrust cum upper andlower guide bearings.
One (1) set of all required oil, air and water pipes, fittings, valves, pressure gauges and flow relays.
One (1) set of interconnecting cables, termination, etc. between various parts.
One (1) set of moisture detector system.
One (1) set of sole plates, foundation bolts, sleeves and anchor plates etc. required for proper erection, leveling and alignment of the generators and their components.
One (1) sets of access doors, stairs, railings, and platforms.
All special tools and devices for handling, assembly, installation, erection, dismantling and testing of the generators and auxiliaries.
Oil for the first filling of bearings and jacking system, etc. including 10% extra.
Erection, testing and commissioning of generator.
Field acceptance and performance tests, including submission of report on generator.
Any other item not specified above but necessary to complete the assembly or mentioned hereunder, erection, testing, commissioning including field acceptance testing of generator and associated auxiliaries.

06.08.04.04 SPECIAL DESIGN AND LAYOUT CONDITIONS

The Generator shall be vertical shaft suspension type synchronous Generator with thrust –cum upper guide bearing located above the rotor and lower Guide bearing below the rotor. The design and construction of turbine and generator shafts shall be adequately coordinated between the generator and turbine manufacturers.

06.08.04.05 BASIC DIMENSIONS AND RATING

The dimensions of generator shall be such that ,it is accommodated in the existing slot and generator barrel

A. **RATING**

No. of phases	3
Construction type	Conventional
Rated continuous output, (MVA)	77.78
Continuous overload output (110% of rated output) (MVA)	85.55
Rated generator voltage, (kV)	11 ± 10%
Rated frequency (Hz)	50 +3% -5%
Combined voltage and frequency variation	±10%

Power factor (cos Φ)	0.9 lagging
Rated speed (rpm)	Matching turbine speed
Direction of rotation (when viewed from top)	Matching the direction of rotation of turbine
Insulation class of stator and rotor windings	Epoxy based F
SCR	1.1

Temperature rise of stator and rotor windings shall be limited to that of thermal Class B as per relevant IS/IEC Standards.

06.08.04.06 CAPACITY AND TEMPERATURE RISE

The generator shall be capable of delivering a guaranteed rated continuous output of 77.78MVA and maximum continuous overload output of 85.55 MVA at rated pf., rated voltage and rated frequency at the terminals without exceeding the limit of temperature rise as follows:

FOR RATED CONDITION

- Stator winding :85^0 C(ETD)
- Rotor winding :90^0 C(Resistance)

For overload condition the temperature limits will be 10^0 C more than above temperature rise limits.

SHORT CIRCUIT WITHSTAND CAPABILITY

The generator shall be capable of withstanding a three phase short circuit at the generator terminals when operating at rated continuous power output i.e. 77.78 MVA and at rated power factor for a period not less than 3 sec.

OCCASIONAL EXCESS CURRENT

The generator shall be capable of withstanding occasional excess current equal to 1.5 times the rated current for not less than 30 seconds each time.

06.08.04.07 WAVE FORM AND POLY-PHASE SYMMETRY

The waveform of the e.m.f. between terminals of the generator on open circuit shall be practically sinusoidal. The waveform shall be accepted as practically sinusoidal if none of its instantaneous values varies from instantaneous value of the same phase of the fundamental wave (50Hz) by more than 5 percent of the peak value of the fundamental. The poly-phase voltage system of each generator shall be practically symmetrical. Poly-phase voltage system is considered as practically symmetrical if neither the negative sequence nor the zero sequence components exceeds 5 percent of the positive sequence component. Special steps shall be taken to eliminate harmonic voltage wave, which may cause inductive interference with communication circuits or resonance in the transmission system. Total harmonic distribution factor (THD) shall not exceed 1.5 percent. The calculated no-load harmonics in the voltage waveform shall be furnished.

06.08.04.08 STABILITY AND PERFORMANCE

The generator shall operate satisfactorily in parallel with other machines connected to the grid. The generator shall be able to operate on sudden application / or loss of maximum load and during momentary short circuits and sustained ground faults without causing any abnormal vibration or resonant conditions. The generator shall be capable of operating continuously on an unbalanced system such that with none of the phase currents exceeding the rated current, the ratio of negative sequence component of current (I_2) to the rated current (In) does not exceed 0.08, and under fault conditions shall be capable of operation with the product of $(I_2/ I_n)^2$ and time in seconds (t) not exceeding 20.

06.08.04.09 RUNAWAY SPEED WITHSTAND CAPABILITY

The generator shall be designed and constructed to be capable of safely withstanding maximum runaway speed for a period of 15 minutes (with cooling water flow intact) without incurring damage from stresses under such conditions.

06.08.04.10 SPEED, RUNAWAY SPEED

The unit shall be designed for a nominal speed of 500 rpm. The runaway speed has to be determined by the turbine manufacturer and to be coordinated by the contractor.

06.08.04.11 DIRECTION OF ROTATION

The direction of rotation shall match the direction of rotation of the turbine.

06.08.04.12 EFFICIENCY

T□□ □□□r□□□□□d □□□□□□d □□□□□□□□□□ □□r□□□d □□□□□□□ □□d r□□□□□□□□ □□□□□□□□ □□ □□r□□□□□r □ □r□

- Bearing friction losses (total bearing losses of generator + thrust bearing losses apportioned to generator rotor weight).
- Windage / ventilation losses.
- Iron losses.
- Stator copper losses.
- Stray load losses.
- Field winding copper losses
- Excitation system losses.

06.08.04.13 Performance Criteria & Guarantee

The equipment covered under this contract shall be capable of performing all intended duties and it is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars.

06.08.4.14 DESIGN AND CONSTRUCTION

06.08.04.14.01 GENERAL

a). The generators shall be of suspension type with combined thrust and guide bearing located above the rotor and another guide bearing below the rotor. The generators shall be capable of safely withstanding maximum stresses during normal operation, runaway-speed conditions, two phase and three phase short-circuit conditions or single phase earth fault at the maximum output for which generators are capable of, 180 deg and 120 deg out-of-phase synchronization, magnetic unbalance at runaway speed with 50% of the poles short circuited and brake application etc. Seismic forces shall also be taken into consideration for design of the generators.

b). The construction of the generator shall be such that the rotor poles, stator bar and generator air coolers can be easily maintained/repaired without disturbing the upper bracket.

c). The thrust bearing housing shall be so designed as to provide easy access to the bearing pads. Openings with removable covers shall be provided for this purpose. The thrust bearing pads and the thrust faces shall be capable of being reached and inspected through the oil cooler windows (after emptying the bearing oil, removal of coolers and with rotor jacked up).

d. The guide bearings also shall be of such construction that these can be removed/ dismantled without disturbing the thrust bearings , rotor, stator, etc.

e. The core stacking to the extent shall be carried out at manufacturer's work. In case for sufficient reasons such as transport limits, the work of core stacking for stator shall be carried out at site, it shall be so mentioned by the contractors in their tenders, giving reasons. The stator frame design shall be suitable for lifting the built stator from service bay for installation in pit.

f. Similarly, the rotor construction shall be such that rotor poles are easily removable and replaceable. The poles shall be interchangeable.

g. The rotor shall also be supplied in the maximum possible assembled condition within the transport limits given. If to meet the transport limits rotor rim of lamination sheets is required to be built up at site the rotor construction shall be designed accordingly to suit the assembly at site (stacking, pressing, curing of lamination insulation, installation and mounting of rotor poles).

h. All parts of the generating unit shall be designed mechanically to withstand all electrical, mechanical, and other stresses which may be experienced during the operation of the unit, including short circuit, faulty synchronization, over speed and runaway conditions.

i. All equipment shall be designed and manufactured under due consideration of the prevailing transport limitations.

j. The design of the unit, including the relative locations of the rotor, generator thrust and guide bearings shall be such as to cause no abnormal vibration or resonant conditions. The unit shall be physically stable under worst short circuit conditions.

k. The supporting brackets will be steel fabricated and shall be rigid enough to support and transmit the load to the concrete structure /foundation under worst conditions . The bearing bracket supporting the brake assemblies shall, however, be designed to withstand the braking of the rotor even at 50% speed (though normal braking speed shall be lower).

l. Upper guide bearing bracket shall house the upper guide bearings in their hub.

m. Rotor field poles shall be arranged in a manner to permit easy removal with the unit rotor left in place. Field pole electrical connections shall be located in a position to facilitate ease of inspection, separation and reconnection. The field poles shall be provided with adequate damper windings to reduce voltage distortion etc.

06.08.04.14.02 MAIN SHAFT AND COUPLING

a) The generator shaft shall be made of the best quality forged carbon or alloy steel, properly heat-treated.
b) The design and construction of turbine and generator shafts shall be adequately coordinated by the generator and turbine manufacturers.
c) The critical speed and vibration strength of all rotating parts shall be checked with the turbine manufacturer and shall be verified by calculations.
d) The first critical speed of the combined rotating parts of the turbine and the generator shall be at least 25% above the maximum runaway speed.

e) The main shaft shall have an integrally forged flange for connection to turbine shaft flange. All coupling dimensions shall be agreed upon by the turbine and generator manufacturers and shall essentially conform to IEEE 810 “IEEE standard for hydraulic turbine and generator integrally forged shaft coupling and shaft run out tolerances” or an equivalent approved standard.

f) The generator manufacturer shall be responsible for the alignment and balancing of the rotor with the turbine shaft and runner after installation inaccordance with the stipulations

06.08.04.14.03 BEARINGS

a) The generator shall be provided with thrust cum upper guide bearing arranged in upper bracket. A new set of self-lubricated thrust bearing consisting of thrust pads, thrust collar, oil reservoir with external cooler etc. shall be provided.

b) The thrust bearings shall be with babbit lined pads of ample sized to be capable of safely coping with all operational conditions including runaway speed and start-up/shut-down without lift-pumps, hydrostatic lubrication or applying the brakes. All guide bearing pads shall be white metal lined.

c) The arrangement, design and construction of the bearings shall be duly coordinated with the turbine manufacturer and should take into account weights of the rotating parts of turbine, with unbalanced hydraulic thrust under all conditions of operation. Type and quality of the oil shall be the same for turbine and generator bearings.

d) The bearings shall be capable of operating at the following, guaranteed conditions:

- Continuously at 50 to 110%rated speed.
- 30 minutes at any speed between 110% rated and runaway speed with cooling water supply.
- 15 minutes at rated speed and full load without cooling water supply.
- 2 minutes at runaway speed without cooling water supply.

e) The thrust bearing shall be of the manufacturers standard design, with flexible self-adjusting pad, support (spring mattress type, tilting pad type or of other proven and reliable design), providing sufficient reference for long-term satisfactory operation.

f) Thrust bearing shall □□□□□□□□ so designed so as to remove the T□□r□□□d without dismantling thrust collars.

g) While designing the withstand capacity of the thrust bearing, weight of all rotating parts including shaft and runner, hydraulic tonnage at over load or more for which turbine is capable of under worst hydraulic conditions and severest faults or run away speed shall be taken in to account.

h) The size of the thrust bearing may further be designed by restricting the specific pressure on thrust bearing segments as per IEC.

i) A high pressure lubrication system shall be provided for lubrication of thrust bearing during start-up and shut-down. The system shall operate automatically at set speeds between 0 and 100%. Nevertheless, safe start-up and shut-down shall also be possible in case of failure of this system.

j) New self-lubricated guide bearings with internal/external coolers shall be provided. The guide bearings shall be of the multi-segment type. Guide bearing pads shall be babbit lined.

k) The thrust, lower guide bearing and the upper guide bearing shall be of the self-pumping lubricated type with oil-to-water coolers.

l) Material of coolers shall be as follows :

Tubes	: 90/10 Cu-Ni
Tube plates	: Mild Steel

m) Supply and return line flanges with shut-off valves shall be provided at generator floor level to allow connecting the oil circuits to the oil transfer and treatment system. An overflow with connection to the return line shall be included.

n) Special care shall be taken in the design of the bearing seals. No oil vapour shall enter the generator compartments. The system shall preferably be based on quenching air and vent-

pipes with filters.

o) The bearings shall be adequately insulated to prevent harmful flow of shaft currents induced by the generator field. Test points shall be arranged at an easily accessible location to allow regular checks on the existence of shaft voltage. Above arrangement can be combined with the auxiliary brush-holder provided for the rotor earth fault protection.

p) All provisions shall be included to permit loss measurement using the calorimetric method.

q) The **thrust bearing** shall be equipped with all the necessary indicating and control devices. Some of them are indicated as under:

- One oil level indicator in the bearing oil reservoir with high and low level alarm contacts and tripping contacts for very low oil level.
- Provision for DTTand RTDs shall be kept in all pads
- Resistance temperature detectors located in all the pads.
- Dial type thermometers(DTTs)shall be provided in diametrically opposite pads and one for the oil.
- One direct-reading water flow gauge along with low-flow alarm contacts.
- One oil-water contamination detector.

r) Each guide bearing (upper and lower) shall be equipped with the following:

- One oil level indicator in the bearing reservoir with high and low level alarm contacts and tripping contacts for very low oil level.
- Provision for DTT and RTDs shall be kept in all pads
- Resistance temperature detectors located in all the pads.
- Dial type thermometers (DTTs) shall be provided in diametrically opposite pads and one for the oil.
- One direct-reading water flow gauge, low-flow alarm.
- One oil-water contamination detector.

06.08.04.14.04 BRAKES AND JACKS

06.08.04.14.04.01 BRAKES

a) The generator brakes shall consist of asbestos free brake liners mounted on a vertical piston moving in a cylinder and shall operate against a polished circular steel brake track. The brakes shall be pneumatically operated type; compressed air at suitable pressure shall be supplied from the compressed air system. Existing compressed air system shall be utilized for brake application. Limit switches shall be provided for each brake to prevent the unit from starting if the brake is applied. The brakes shall be mounted on the bottom bracket of the generator.

b) A combined hand – operated and solenoid – operated air valve to control the operation of the generator brakes shall be supplied and mounted in the actuator cabinet – brake control panel. The operation of the solenoid of the air valve shall be selected by means of a control switch with “manual”, “off” and “automatic” positions. The control switch shall be provided with spring return to “off” from the “manual” position and shall maintain the “automatic” position when so placed. A manual locking device shall be provided to permit locking of the brake valve in the “on” position. When in the “on” position, the control switch shall operate

the solenoid of the air brake valve directly. With the switch in "automatic" position, the solenoid of the air brake valve shall be controlled by means of a suitable electric circuit, the requirements of which are given below.

c) Needle Valve position switches and speed switches as specified herein shall prevent the application of the brakes until the Needle valves are fully closed and the unit speed has decreased to the required level. It shall be possible to apply the brakes continuously after an adjustable period of time by means of the automatic control. The brakes shall be automatically released after the adjustable period of time sufficient to ensure that the unit has been brought to a complete stop.

d) When the control switch is in the "automatic" position a separate contact shall be closed for interlock in the auto-start circuit. A pressure switch shall be provided in the air line to the brake cylinders with contacts to open as an, interlock to prevent start – up whenever the brakes are on. A second pressure switch shall be provided in air supply line to brake valve to energize an alarm circuit of low air pressure.

06.08.04.14.04.02 JACKS

The brake cylinders shall also be designed to serve as hydraulic jack to lift the generator rotor to a sufficient height to facilitate removal & adjustment of bearing pads. A limit switch for operation of an indicating lamp shall be provided to indicate when maximum permissible raised position of the rotor is reached.

06.08.04.14.04.03 BRAKES AND JACK CONTROL PANEL

a. Brake and jack control panel shall be supplied. The panel shall house items such as solenoid valves, manual isolation valves, associated piping. The unit shall also house air filters to filter air entering the braking system to prevent rusting etc.

b) Jacking of the generator rotor shall be done when the rotor is standstill. A separate inlet and outlet connections shall be provided in the panel for connecting the pressure and drain line of the pressure oil system. Independent piping of braking and jacking shall be provided which shall become common at the outlet of this panel and shall connect to brake / jack assembly. Necessary provision shall be provided for draining of oil after jacking operation. All required instrumentation and interlocks shall be provided for safe and reliable operation of the system.

06.08.04.14.05 GENERATOR AIR COOLERS

a) The generator shall be provided with a close re-circulating cooling system complete with air ducts, surface air coolers, water header, metal housing, alarm devices, reducing valves and all other accessories.

b) Each air cooler shall be of the straight tube type made of solid drawn cupro nickel alloy, so as to provide adequate thermal conductivity and maintain the efficiency of such conductivity during the life of the surface coolers. The cooler shall have adequate cross section to give sufficient mechanical strength and to reduce vibration. Provision for expansion and contraction over the entire expected range of temperature variation shall be made. Each cooler shall be liberally designed ensuring satisfactory performance of the cooler, even

when 10% of total tubes of all surface air coolers are blocked/chocked.

c) All coolers shall be pressure tested at site before erection.

d) RTDs shall be provided at the inlet and outlet of the air cooler cooling water header. Contractor shall confirm that the opening of the generator barrel is sufficient to draw the quantity of air. Any modification on the barrel required shall be done by the Contractor.

e) Water for cooling will be available at a temperature not exceeding 31.5^0 C. The surface cooler shall have sufficient cooling capacity to limit the temperature cooled air to a maximum of 40^0C, even with one cooler out and balance 20% tubes blocked.

06.08.04.14.06 STATOR AND STATOR WINDING

a) The stator shall consist of a frame, a core and a winding.

b) The stator frame shall be of welded steel of liberal design utilizing only tested quality MS plates and structural only. The stator frame shall be in two or more sections as per transport limits. The stator frame section joining shall be as per manufacturers design practice. The stator frame shall be of robust design to withstand maximum forces acting on it under the worst condition of operation. The stator frame shall be designed for lifting the completely built stator and provided with suitable lifting lugs and devices for handling.

c) The core laminations shall be punched from high grade non-ageing cold rolled silicon steel coated with suitable insulating enamel to minimize eddy current losses and piled on dovetail key ribs which are accurately and securely fastened to the stator frame. The core shall be ventilated by means of radial air ducts throughout the stack length. The ducts, formed by non-magnetic space blocks will direct the air uniformly with minimum obstruction.

d) The stator core shall be clamped by means of flange and finger assemblies at both ends of the core. The assemblies are constructed by welding the non-magnetic fingers to the flanges and together they bridge the core and stator frame. The required pressure is provided and maintained with through studs.

e) All the necessary tests shall be conducted after piling and before winding at manufacturer's work for detection of hot spots. In the event stator winding is carried out at site, all the necessary tests shall be conducted at site by the Contractor and all the required items for test shall be arranged by the Contractor only. The stator winding shall be bar type, Y-connected with line and neutral leads brought out to the stator terminals. Each phase winding shall be distributed around the stator such as to minimize unbalanced magnetic pull. The stator winding and connections as well as connecting leads, main and neutral leads shall be of epoxy cast resin type, corresponding to class 'F' insulation. The maximum accepted temperature rise at maximum output will be limited to the temperature rise corresponding to class 'B' insulation.

f) The insulation shall be made of the best quality material and suitably impregnated insulation method employed shall give a homogeneous insulation without any voids, high thermal stability and insensibility against humidity, oil and other pollutions. All the strands

shall be insulated suitably so that no short circuit between adjacent strands may occur. The stator winding shall be adequately supported and braced to withstand the full stresses due to electrical short-circuiting. End connections of stator bar shall be made at the top of the winding.

g) The winding to the extent possible shall be manufactured and assemled at manufacturer's work before shipping to site. In the event that part of the stator winding is required to be done at site, supply of all insulation materials and other items and performance of all work for completing the winding at site shall be done by the Contractor. Adequate number of temperature detectors per parallel circuit per phase, shall be embedded in various parts of the stator winding. Resistance temperature detectors or thermocouples shall be provided for temperature measurement of the core. All the temperature detectors in and around generator shall be wired by shielded cables.

h) Terminal Arrangement

i) The main end of the windings shall be extended upto the bus bars with suitable insulating enclosure where they pass through the generator housing. Provision shall be made on the main side of terminals for mounting one set of CTs for generator differential protection inside the generator housing itself. The leads on the neutral side shall be so arranged as to permit mounting of all the generator CTs for metering, voltage regulation and protection before the formation of the neutral point. Suitable cable sealing ends shall be provided at the neutral point for facilitating the connection of the cable to be run to the neutral grounding cubicle.

06.08.04.14.07 ROTOR

a) The design and construction of rotor shall be in accordance with most modern practices details of which shall be furnished by the Contractor.

b) The rotor shall be designed for assembly on the rotor assembly bay in the erection area of the powerhouse. The Contractor shall provide all suitable rotor erection pedestals and sole plate adapters for the permanent use by the Purchaser.

c) The rim of the rotor shall be laminated and constructed out of 2mm thick or less steel having radial ventilating ducts located along with lengths and shall be bolted together to make a compact structure. The hub of the rotor shall be securely attached to the main shaft taking care of requirements both at normal operating speed and maximum over speed conditions. The rotor spider shall be of fabricated construction with arm radiating from the central hub. The pole pieces shall be built up of thin laminations secured by bolts passing through supporting end plates.

d) Pole assembly drawings, lifting arrangement drawings shall be furnished. Lugs, handling equipment, special slings etc. shall be supplied. The design should be such that Rotor pole disassembly as when required is easy. The design of the rotor shall be such as to permit the removal and replacement of field poles without the removal of the rotor from the stator. If tapered keys are used to secure the field poles to the rotor rim, the drive key shall project above the rotor rim at a sufficient distance to facilitate removal of this key by

means of a key puller and to permit checking for tightness. Suitable keeper's keys shall also be provided to ensure that the keys do not get loose in service.

06.08.04.14.08 FIELD WINDING

a) The field winding shall be insulated with class "F" insulation and shall consist of copper strips. Temperature rise shall be limited to class B. The field winding shall be adequately braced to withstand the stresses due to worst condition of short circuit and also due to centrifugal forces.

b) The field poles shall be provided with adequate amortisseur winding of the low resistance to improve stability under single phase fault conditions.

c) Equipment to monitor residual voltage of the rotor shall be provided. For each assembly new brush gear and slip ring shall be provided. The connections from the field coils to the collector ring shall be braced against mechanical forces. The brake ring on the rotor shall be supplied in segments, which may readily be replaced. "The brake ring of the rotor shall be designed to withstand all loads/vibrations/ stresses etc. for the braking at 50% of the rated speed".

d) Provisions shall also be made for rotor fans and air baffles at the top and bottom.

06.08.04.14.09 COLLECTOR RINGS

The collector rings shall be in an accessible location above the rotor and provision shall be made for reversing the polarity of the collector rings. The brushes and collector rings shall also be so positioned as to avoid contamination by oil vapours or oil leakage from the bearing.

06.08.04.14.10 ROTOR TEMPERATURE MEASUREMENT

One shunt, to be mounted in the generator field leads, shall be furnished complete with calibrated shunt leads for connection to a field temperature recorder for measurement of rotor temperature.

06.08.04.14.11 ROTOR GROUND FAULT DETECTION

A collector ring and brush assembly shall be mounted on the generator shaft for field winding ground detector relays.

06.08.04.14.12 BRAKE DUST COLLECTOR

Suitable exhausting arrangements for sucking and collection of brake dust, shall be provided during braking operation of the machine, consisting of extraction unit, hoppers

around brake assembly for trapping dust and flexible hoses for connecting hoppers to the extraction unit. The extraction unit shall have a motor driven exhaust fan to be fitted with an easily removable sheet steel bin for collecting heavy dust. The lighter particles of the dust shall be collected by suitable fabric based filter.

06.08.04.14.13 CARBON DUST COLLECTOR

Suitable exhausting arrangement for sucking and collection of carbon produced/emitted by the brushes shall be provided so as to avoid the conduction through carbon deposition resulting in earth faults.

06.08.04.14.14 SPEED MEASUREMENT

For measurement of speed of the unit for governor operation etc. atoothed wheel & necessary probes shall be provided and mounted onthe generator shaft.

06.08.04.14.15 ROTOR LIFTING DEVICE

The contractor shall design the device in an optimum manner and submitthe lifting arrangement drawing.

06.08.04.14.16 COOLING SYSTEM

a) The unit shall be self-ventilating by its own circulation action. The generator shall be totally enclosed. Pit seals shall be provided for separation of the generator air-cooling system from the turbine pit.

b) The air-water heat exchangers (stator air coolers) shall be mounted on the stator frame, each provided with shut -off valves at inlet and outlet. Each cooler shall be readily removable without disturbing the others whenthe machine is not in operation.

c) The surface air coolers shall have sufficient capacity to maintain stator winding temperature rise within class B temperature limit when the unit is operating at overload output, under worst system parameters i.e. at the maximum stator current.

d) The cooling system shall be complete with air coolers, oil coolers, cooling water pipes, fittings, flow indicating devices, flow relays and all other accessories. All internal piping shall be terminated in a flange on the generator barrel for connection with the plant cooling water system as specified in “Cooling Water System”.

e) The number of coolers provided, the normal working pressure and pressure drop through the coolers shall be indicated and supported by calculations. Connections shall be provided at the bottom of the air coolers to facilitate complete drainage. The coolers shall be designed for at least 10-kg/cm2 nominal pressure (Though working pressure shall be 2 to 5 kg/cm2). Automatic air vents with drain pipes shall be provided at the top to prevent air locks in the coolers. Lifting lugs shall be provided to facilitate the removal of any cooler through the top of the generator cover. Each cooler shall be provided with a pocket for

inserting thermometer on discharge end. The cooling water pipes inside the barrel shall be suitably coated with fine quality paint to prevent damage due to condensation on pipes. Various sensors and instrumentation shall be provided.

f) The cooling system of generator shall be provided with the following supervisory equipment:

- RTD's in each water supply line, to measure the temperature of incoming water.
- RTD's to measure the temperature of the outgoing water from each cooler.
- One RTD for each cooler to measure the temperature of the heated air leaving the stator core and entering the air coolers.
- One RTD for each cooler to measure the temperature of the cooled air entering the generator rotor.
- Water flow gauges at inlet and outlet with low-flow alarm contacts and indicating dial mounted on the gauge panel.
- Pressure gauges at inlet and outlet of all the heat exchangers.

06.08.04.14.17 FIRE PROTECTION SYSTEM & FIRE ALARM SYSTEM

a) An automatic carbon dioxide fire protection system complete CO_2 cylinders, ring headers, discharge nozzles, temp. detectors etc., shall be provided for generator. The temperature detectors shall be of the rate the rise of temperature type. Automatic controls shall be arranged to discharge CO_2 into the generator in the event of operation of temperature detector of the differential relay of the generator (if provided). The system shall be complete with manual operation arrangement to release CO_2 and with all necessary pipes, fittings, directional valves, etc.

b). Carbon dioxide based, fire protection system shall be provided for Generators as per Tariff Advisory's latest practice. A common CO2 fire fighting system shall be provided. The system shall contain one set of main cylinder bank for initial and extended discharge and 100% standby cylinder bank. The system shall include fire detection panel, heat detectors, smoke detectors and associated auxiliaries. Two CO2 banks, each consisting of an adequate number of CO2 cylinders will be provided for flooding of unit . One acting as main and the other as standby.

b) Fire Protection system has been detailed in the clause Fire fighting and Fire Protection system in tender specification.

06.08.04.14.18 SAFETY / MONITORING DEVICES

06.08.04.14.18.01 VIBRATION MONITORING SYSTEM:

a) the event of online vibration Monitoring System being offered as part of the package, the same shall be installed and in addition to that a portable vibration meter shall be supplied by the tenderer

b) A continuous vibration monitoring system complete with proximity probes, input/output module, control/processor unit, relays, junction boxes, cabling and associated accessories shall be supplied for on-line monitoring of vibration in the generating unit. It shall comprise:

- 2 nos. non-contact type proximity probes each for all the guide bearings i.e. upper, lower and turbine guide bearing to measure radial vibration in both axes.
- 3 nos. contact type proximity probes at each location at upper bracket, lower bracket and turbine bracket area to measure axial vibrations.
- 1 no. contact type proximity probe at thrust bearing to measure axial vibrations.
- Synchronization probe
- Set of input/output model, control /processing /communication unit, relays, junction boxes, cabling and associated accessories. The monitor with its control accessories shall be located at the unit control panel.

c) The system shall have the provision to monitor, record, analyze, diagnose, indicate and trip etc. as provided in chapter "Control and Instrumentation System" and "Protection System". The system shall be integrated with plant SCADA system.

d) The system shall be of a make of international repute having proven performance and acceptability in the field of Hydropower. The details and scope of the system shall be approved during detailed engineering.

e). IN addition to the above a portable vibration meter of reputed make shall be supplied by the tenderer.

06.08.04.14.18.02 ANTI-CONDENSATION HEATING

In order to avoid water condensation during long non-operative period of the machine, heating elements shall be installed inside the generator barrel. These elements shall be rated for three-phase 415 V A.C., 50 Hz; and their terminals shall be connected to an easily accessible terminal box. The heating shall be controlled automatically by adjustable hygrostat, setting range about 50-100% relative humidity. The anti-condensing heating shall also be provided with manual ON/OFF switch and corresponding indication lamps in the local control panel. Provision shall also be made for adjustable thermostat for automatic control of the heaters.

06.08.04.14.19 MISCELLANEOUS PROVISIONS

INSTRUMENTATION FOR FIELD ASSEMBLY AND TESTS

The Contractor shall make arrangements for bringing all types of electrical and mechanical instruments required for field assembly of the rotor, stator and all testing equipment for testing and commissioning including field acceptance tests. These shall remain the contractor's property after fulfillment of all field tests.

06.08.04.14.20 TERMINAL BOXES

The generator manufacturer shall supply terminal boxes to be located inside the generator pit, for connection of control and secondary leads from the generator equipment and auxiliaries located in the generator enclosure. All leads including control and indications shall be wired to this terminal box.

06.08.04.14.21 CONTROL WIRING AND CONDUITS

All internal wiring and conduits for control, relaying, fire protection, internal illumination and other systems shall be brought out to terminal boxes, and shall be suitably labeled.

06.08.04.14.22 INSTRUMENTATION, CONTROL AND SAFETY DEVICES

Necessary sensors/sensing elements, signal generators for sequential control and interlocks, measurement (indication, recording of quantities), monitoring of abnormal conditions of operation (for safety, alarm annunciation and shutdown) and related instrumentation which are embedded in and/or mounted on the generator or its adjacent (local) gauge panel should be included in the scope of supply of the generator as an integral part.

These items shall generally pertain to the following:

Temperatures	Stator, rotor, bearings.
Liquid Level	Oil in bearing oil baths
Pressure	Brake air, High pressure lubrication oil, cooling water
Flow	Cooling water for generator air coolers, bearing oil coolers
Shaft current/ Over speed/ Creep/ Vibration/Fire	Generator
Thrust bearing oil film monitoring	Thrust bearing

The contractor shall cover these items in the generator supply. They shall also include any additional item not indicated but which are necessary for smooth operation and safety of the equipment. A list of these additional items shall be decided during detailed engineering.

06.08.04.14.23 MISCELLANEOUS PIPING, TUBING, VALVES

All internal piping and valves for the following functions shall be included in the scope of the Tenderer:

- Cooling water inlet, outlet and drain for generator air and oil coolers.
- H.S. Lubrication oil supply to thrust bearing meant for lubrication during start-up and shut down of the unit.
- Oil filling and drain connections at the bearings.
- Piping for brakes and jacks.

- Tubing for connections between temperature sensing elements (vapour bulbs) to dial type thermometers, pressure gauge tubing.
- Any other essential piping, tubing, etc.

06.08.04.14.24 CABLING

The following control and auxiliary power cables and wiring shall form part of the generator supply:

- All wiring within the generator housing for the speed signal generator connections, thermometers, flow meters, RTDs /DTTs, all alarms and control and metering circuits associated with the generator.
- Capillary tubes/Cables between the generator and the gauge board.
- All 240 volts A.C. wiring, lighting fixtures and convenience outlets within the generator housing.
- All conduit and/or cable trays required for conductors and cables within the generator housing.
- A cable-marshalling box with approved disconnecting links to terminate all cables leading to the exterior of the generator.

06.08.05 EXCITATION SYSTEM AND DIGITAL VOLTAGEREGULATOR

06.08.05.01 DETAILED SCOPE OF SUPPLY

The excitation system and DVR shall consist of: -

- One (1) set of dry type excitation Transformer
- One (1) set of full wave fully controlled rectifier system with (n+n) layout thyristor bridge arrangement for 100% redundancy, complete with firing circuit, control system etc.
- One (1) sets of digital voltage regulators with all limiters & power system stabilizer.
- One (1) set of power supply units
- One (1) set of field flashing equipment, including transformers.
- One (1) set of DC field circuit breakers
- One (1) set of discharge resistors
- One (1) set of digital control and metering equipment
- One (1) set of excitation cable connecting the rotor to DC field breaker
- Any other items not specified above but are necessary to complete the system for satisfactory operation.
- Set of Spares

(Note: One set is defined as the total number required for one unit.)

06.08.05.02 SPECIAL DESIGN AND LAYOUT CONDITIONS

The excitation system shall be of the static, digital, constant-voltage type with controlled thyristors. It shall feature a very sensitive, quick acting control of the generator voltage and reactive power respectively. The system shall be of reliable design with an adequate

record of satisfactorily working reference plants.

06.08.05.03 BASIC DIMENSIONS AND RATINGS

Unless otherwise stated, rating, characteristics, test and test procedures, etc. of the equipment of excitation system and DVR shall comply with the provisions and requirements of the latest applicable International / Indian Standards.

06.08.05.04 PERFORMANCE CRITERIA & GUARANTEE

The equipment covered under this contract shall be capable of performing all intended duties and it is the responsibility of contractor to supply the equipment as per guaranteed technical particulars.

06.08.05.05 DESIGN AND CONSTRUCTION

The equipment offered shall be capable of withstanding lightning and switching surges and dynamic over voltages to which they may be subjected to and shall meet all the performance requirements and tests as described in the specification. The equipment shall conform to the latest issue of IEEE 421 or equivalent standard.

06.08.05.06 EXCITATION TRANSFORMER

The excitation transformer shall be of the 3-phase, cast-resin dry type, class H insulated. The winding material of transformer shall be copper .The L.V. and H.V. windings shall be impregnated and vacuum cast into moulds of glass fibre reinforced epoxy resin. The windings shall be provided with temperature sensors (PT 100) and static alarm and tripping device. The transformer shall be naturally air cooled, installed in a cage, designed and constructed to match perfectly with the common switchgear assembly. The L.V. connections to the rectifier cubicle shall be of copper buses and/or cables respectively and shall be in the scope of the contractor.

06.08.05.06.01 CHARACTERISTICS OF EXCITATION TRANSFORMER

Ratings of the excitation transformers shall be sufficient to meet the duties specified herein.

Primary rated voltage	11 kV
Secondary rated voltage	To be decided by generator and Excitation equipment manufacturer
Class of insulation	H
Type of cooling	AN
BIL (High tension)	75 kV
Power frequency withstand voltage	28 kV

The manufacturer shall supply a metal box, which will enclose the transformer high voltage bushings and terminate the isolated phase bus feeding the transformer. The flexible connectors from the isolated phase bus to the transformer bushing shall be arranged by

bus-duct manufacturer. The manufacturer shall provide a flange for bolting the phase bus enclosure to the metal box. To maintain the generator isolated phase bus arrangement, metallic barriers of suitable design to prevent short circuit between phases shall be installed between phases inside the transformer.

06.08.05.07 THYRISTOR EQUIPMENT

a) This equipment shall essentially consist of silicon power thyristor bridges installed in adequate cubicles. Each thyristor with relevant fast acting semi-conducting fuses shall be mounted on draw-out modules facilitating inspection and replacement. The fuses shall be monitored individually or in groups providing alarms and trips as required.

b)The design shall provide 100% redundancy in (n+n) layout arrangement of bridges where n is no. of bridges in one circuit. The rectifier shall be rated for the following duty cycles:

- Continuous operation at its maximum rating.
- Three phase fault adjacent to HV terminals of the generator
- Short circuit on the high voltage side of the transformer with duration of 2 sec.

c) The static excitation equipment shall be of modular design in such a way that it can be readily removed for inspection or replacements of parts.

d) Two independent circuits shall be provided for the manual and automatic control respectively.

e) The following monitoring and protection features shall be included:

- Temperature monitoring of thyristors
- thyristor failure
- D.C. short circuits
- Thyristor and field circuit over voltage protection
- Transient over voltage originating from the A.C. system, lightning or switching surges.
- The system shall operate correctly with supply voltages up to 120% rated voltage or unbalanced supply voltages.

f) Calculation for the capacity of rectifier shall be submitted. While determining the capacity, effect of ageing shall also be considered .The rectifier PIV (Peak Inverse Voltage) rating shall not be less than 4 times the maximum RMS voltage of the inputs.

g) The kVA rating and voltage ratio of the field flashing transformer (forming part of supply) and requirement of DC for field flashing shall be indicated in the tender along with other details.

06.08.05.08 DIGITAL VOLTAGE REGULATOR (DVR)

a. The DVR shall be a digital (numerical) type regulator. The digital voltage regulator shall respond continuously and practically instantaneously to correct any change in generator

voltage. It shall maintain the generator voltage for steady- state load conditions, without hunting, with 0.5% accuracy for any excitation within the operating range of the generator. For steady-state conditions with the generator circuit breaker open, the regulator shall maintain the generator terminal voltage at or below105% of its rated for speeds ranging from rated speed up to an over speed of 120% rated speed. An exciter limiting control shall be provided to limit the generator voltage to max. 125% of rated voltage in the event that the digital voltage regulator is tripped coincidentally with 110%load rejection and the generator speed rising to runaway speed. The voltage regulator shall be provided with over- and under- excitation limiters. The intervention of the limiters shall not cause perceptible

b. deviations or oscillations of the generated active and reactive power. The characteristics of the under-excitation-limiting curve shall match the static and dynamic stability curves of the generator. Such devices shall allow the regulator to reduce the exciter voltage to zero or to negative values in order to prevent over- voltages in case of operation under line reactive load conditions and over speeding of the unit.

c. The following features shall be included:
   i. stator current limiter
   ii. field current limiter
   iii. load angle limiter

d. The field current limiter shall act on DVR with a time delay so as not to disturb transient response of the system during voltage dips/faults. A slip stabilizer unit shall be provided to suppress the low frequency power oscillation during the operative conditions. The voltage regulator shall be equipped with a sensitivity-adjusting device and with an adjustable voltage droop compensation(compounding).

e. After the generator voltage attaining initial maximum value neglecting the instantaneous rises following any load rejection up to 110% of the rated load, DVR shall restore the generator terminal voltage to a value not more than 5% above or below the voltage being held before load rejection and shall maintain the voltage within these limits throughout the period of the generator over speed.

f. The voltage regulating system shall include device for improving the damping of active electromechanical oscillations. These devices shall operate to supplement the voltage regulating action by addition of an additional control signal into the excitation system input. This supplemental input signal shall influence the excitation system as to cause a change in field current of the machine for stabilized operation. As an option, adaptive control function feature to the slip stabilizer shall be offered. The function of the control is to optimize the setting of the slip stabilizer to suit the different configuration system. The setting of device shall be determined by the contractor.

g. The excitation system shall be designed for manual and automatic operation. The change-over from automatic to manual control shall be performed automatically following a failure of the regulator when operating on automatic control. The generator voltage shall be controlled within a range of +10% and –15% of rated voltage. A static follower shall be

provided so that, in the case of change-over from automatic to manual control, it prevents the excitation current from deviating more than 5% of no-load excitation current under steady conditions. An alarm and visual indication shall be provided to indicate change from 'AUTO' to 'MANUAL'. The automatic and manual control circuits shall be fully independent. Local and remote control shall be possible.

h. The voltage setting device shall be of the solid-state digital type providing a range of +10% and –15% for local and remote control and indication. For testing purposes, settings of 0 to 115% shall be adjustable at the DVR cubicle.

Initial Excitation System

i. In order to overcome the deficiency of remnant magnetism when starting the machine, initial excitation shall be applied to the field winding. The respective power shall be derived from the A.C. supply system via transformer and rectifier. All equipment for automatic field flashing, i.e. circuit-breakers, blocking diodes, control devices, protection, etc. shall be included. Provision shall also be made for field flashing through station batteries as stand-by arrangement. The field flashing circuits shall get disconnected when 70 % of the rated voltage is achieved at the generator terminals and normal excitation circuit takes over. This system shall also cope with the requirements of the excitation necessary for test runs.

06.08.05.09 DE-EXCITATION SYSTEM

To achieve a quick suppression of the generator field and thus the voltage, the field winding shall be shunted by a discharge resistor (voltage dependent type). After tripping the generator circuit breaker the DC field breaker shall connect the discharge resistor and simultaneously the polarity of the excitation shall be reversed.

06.08.05.10 CONTROL CUBICLE

The control cubicles shall comprise all control and supervisory devices required for the operation of the entire excitation system and DVR. The minimum requirements for instrumentation are the following:

- A.C. supply voltage
- D.C. supply current
- D.C. field current
- Set-point indicator for DVR control

06.08.05.11 INTERFACE WITH UNIT AND STATION CONTROL EQUIPMENT

A bus oriented control system will be provided. The digital voltage regulating and excitation control equipment shall be capable to communicate via serial interface and the field bus with the unit control boards. All signal interchange shall be realized through the bus.

06.08.05.12 CUBICLES

All the equipment of static excitation and DVR shall be suitably housed in sheet metal, dust proof cubicles. All these cubicles shall be located at one place in a row without any gap in

between. The dimensions of the cubicles shall be identical to present a neat and functional line up.

06.08.05.13 PROTECTION OF STATIC EXCITATION EQUIPMENT

The excitation equipment shall be protected against internal faults, failure of thyristor bridges, cooling fans etc. for which contacts shall be provided for alarm and shut down of the unit .The items of protection covered shall be the following but not limited to:

- Excitation equipment internal faults
- Current asymmetry protection more than two stacks faulty
- Over current protection for overload and short circuit protection of the excitation transformer and rectifiers
- Cooling fan failure (main and reserve)
- Loss of regulator DC power
- Failure of thyristor firing circuit
- Failure of DVRs
- Individual cooling fan failure
- Rectifier cubicle exit air high temperature
- Current asymmetry, one thyristor stack faulty
- Operation at minimum excitation limit
- Operation at maximum excitation limit
- Excitation transformer winding temperature
- Failure of field flashing circuit equipment
- Prevent over fluxing of the transformer

06.08.05.14 EXCITATION CONNECTIONS

Excitation power cable connections between the generator slip rings and the DC field breaker cubicles shall be provided. The power cables shall be of adequate copper cross-section to continuously carry the rated current of the excitation system and the maximum current for 10 seconds. They shall be made of highly flexible conductors and the cable insulation shall be of the heat-resistant type, taking into account the maximum temperature rise of 65°C at 40ºC ambient temperature in the slip-ring compartment. The cables shall be adequately spaced and supported with consideration to the electro-mechanical forces involved and designed to prevent undue heating during continuous operation.

06.08.05.15 OTHER ITEMS

Bus duct - Generator CT, PT, LA & surge panel shall be provided as described in respective chapters (refer vol. IV)

06.08.06 COOLING WATER SYSTEM

06.08.06.01 SCOPE OF WORK

Two numbers (1W+1S) cooling water pump-motor sets of adequate capacity shall be envisaged for meeting the cooling water requirement of bearing oil coolers of generator and turbine, stator air coolers and transformer oil coolers.
All necessary piping, valves, strainer, duplex filters, instruments, flow indicators with contacts are in tenderer's scope. Scope shall also include level monitoring system for emergency overhead tank and cleaning of the overhead tank. Replacement or rerouting of embedded piping shall also be included in the scope.

06.08.06.02 DESIGN CRITERIA

Source of the cooling water pump shall be taken from a sump pit located downstream of the power house situated outside the pump house which is fed by tail race water of running units. Return hot water from each cooler (excluding transformer oil cooler) is discharged in to the turbine pit. Hot water from transformer oil cooler is discharged into tail pool.
In case of failure of cooling water pumps, cooling water can be drawn from an emergency over head tank installed at the top of the power house.
All pipe, valve and fittings shall be designed as per IS 1239 & 3589 of latest edition.

06.08.07 DRAINAGE AND DEWATERING SYSTEM :

Following works to be carried out for drainage and dewatering system

- Exposed pipe is to be replaced by new one. Pipe and fittings shall be designed in accordance with IS 1239 or equivalent standards.
- Replacement or rerouting of embedded piping
- Strengthening of pipe supports if any to be done.

06.08.08 LUBE OIL SYSTEM

A suitable grade of oil (as per IS or IEC standard) for lubrication of bearings of the TG unit shall be considered. All the bearings of the proposed TG unit shall be self-oil lubricating type with internal/external oil coolers as described above in respective clauses. A new portable type oil centrifuge of adequate capacity and of latest design shall be provided. This oil centrifuge shall be used for purification of the lube oil during maintenance of the unit. A suitable mechanism shall be provided for top up the oil to the bearings as required. Standard oil drums shall be supplied for used oil as well as for pure oil. All these arrangements shall be placed on coupling chamber floor.

06.08.09 COMPRESSED AIR SYSTEM

New compressors for governor operation shall be provided. For detail refer Clause 06.01.02 (4) of this volume.

06.08.10 FIRE PROTECTION SYSTEM (FPS)

In addition to details in chapter 06.04.03.04 (p), Technical Specification for complete fire protection system to be provided for the Kodayar Power House-I complex is given below.

06.08.10.01 GENERATOR FIRE FIGHTING SYSTEM (FFS)

Refer the Fire Protection and Fire alarm System clause of tender specification.

06.08.10.02 INTRODUCTION-FIRE PRODUCTION SYSTEM (FPS)

In order to combat any occurrence of fire in various areas/unit of the proposed Kodayar Power house-I complex, an elaborate system of fire protection shall be provided. The system shall be planned in conformity with Tariff Advisory Committee's (TAC) guidelines, BIS and other relevant standard/codes.

Major facilities envisaged are as following:

i. Fire Hydrant System

ii.) Microprocessor based intelligent Fire detection and alarm system

iii). Water spray system comprising of MVWS and HVWS.

iv). Portable fire extinguishers

06.08.10.03 SCOPE OF WORK AND SERVICES IN FIRE PROTECTION SYSTEM

A. The scope of work covers on turnkey basis design & engineering, supply, erection, painting, testing, commissioning and handing over of complete Fire Protection System envisaged for the Kodayar Power house-I complex.

B. The source of water is same that of the CW pump & availed by farming a suction header or using the existing CW suction pipes. The existing CW pump room shall be utilized with necessary modification for installation of fire hydrant pump and associated suction/ delivery piping, valves and fittings

C.Major work comprises of following :-

a. Fire Hydrant system consisting of internal as well as external hydrants for the entire area.

b. High velocity water spray system(HVWS) for transformer and Medium velocity water spray system (MVWS) for cable galleries in power house complex.

c. Provision for Dewatering of water from cable galleries.

d. Portable Extinguishers shall be provided in all control rooms and other services rooms.

e. Microprocessor based intelligent Fire detection and Alarm system for various plant premises.

f. Piping, valves, sluice gates etc.

g. All civil & structural works

h. All electrics.

i. Controls and instrumentation.

j. Shop and site painting for all equipment, pipes etc.

k. Erection, testing, commissioning, PG test and Warranty for the complete fire protection system

l. All the requirements of TAC for complete Fire Protection System shall be incorporated by the tenderer in their scope irrespective of whether the details are described in specification and/or shown in the drawings or not.

06.08.10.03.01 The scope of work and services to be rendered by the tenderer for installation of fire protection systems shall include but shall not be limited to the following activities.

i. Design & engineering, handling at site, preparation of erection drawings, fabrication and erection as per approved drawings, site testing, painting, commissioning and fulfillment of guarantee of all fire protection systems, sub-systems and integrated systems as described above.

ii. Miscellaneous materials and services shall include but not limited to the following

a. All piping integral to and/or between any equipment furnished under this specification, except as otherwise specified.

b. All necessary instruments, power and control wiring integral to any equipment furnished under this specification. This shall include terminal blocks and integral wiring to these terminal blocks for equipment requiring external connection.

c. Earthing strips of all panels, & other firefighting equipment supplied by the

tenderer shall be connected to the nearest earthing ring available at site.

d. Digging of underground trenches, laying of cables, laying of protection slab/bricks over the cable routes, back filling of trench and levelling of earth if required.

e. GI pipes/ conduits and other accessories wherever required for laying of cables.

f. Other erection materials like cable supporting structures, channels, brackets, clamps and other hardware materials, as required, for laying of cables.

g. All erection accessories, consumables and miscellaneous materials, though not specifically indicated in this specification, but actually required for completing the job in all respects.

h. All necessary connections for hook-up with other system, if required and as per instruction of the purchaser.

i. Erection, testing and commissioning materials.

j. Initial fill of gas and other fire extinguishing media (including quantity required for PG test) and demonstration.

k. Valve chambers for all isolation valves.

l. Housing for deluge valves.

06.08.10.03.02 All Civil works as elaborated in Civil specification.

06.08.10.03.03 Civil works pertaining to underground buried pipelines such as excavation, laying, backfilling, compacting, construction of valve chambers, manholes, laying of encasing pipes below roads shall also be in the scope of the tenderer as a part of pipe laying. In case group of pipes are crossing road, RCC culverts to be provided below the roads and the same are included in the scope of the tenderer.

06.08.10.03.04 All civil works for completeness of fire protection systems which may not have been described but required technically.

06.08.10.04 TECHNICAL SPECIFICATION

06.08.10.04.01 FIRE HYDRANT SYSTEM:

06.08.10.04.01.01 GENERAL

Sump pit located downstream of the power house shall be the source of water for the complete fire fighting system. 02 nos. (1W+1S) fire water pump and motor sets including pipe, strainer, valves, instruments etc. shall be supplied. These pumps shall be installed in the existing fire water pump house after modification of the same. The pumps shall supply the water for fire hydrant system, HVWS, MVWS etc.

The scope of the tenderer shall include fire hydrant system, consisting of pipe network, pressure controllers, internal & external hydrants, hoses, valves, hose boxes, nozzles, couplings, related instrumentation, supports for pipes & valves.

Details regarding painting, erection, hydrostatic testing, testing & commissioning, etc. refer chapter- IV of this volume

06.08.10.04.01.02. SCOPE OF WORK OF THE TENDERER ALSO INCLUDES THE FOLLOWING

- Taking taping from firefighting pump discharge header for complete hydrant system.
- Pressure controller- 1 No.
- Piping from tapping point up to each hydrant with necessary pipe supports
- Valves with supports
- Fire hydrant with hoses, nozzles, couplings, etc.
- Taking branch, from the above mentioned tapping, for high velocity water spray (HVWS) system as well as for MVWS system
- Pressure controller on the branch going to HVWS system
- Erection, testing & commissioning of the total system
- Pressure available at the farthest hydrant shall be 3.5 Kg/cm2 minimum.

06.08.10.04.01.03. FIRE HYDRANTS (EXTERNAL & INTERNAL)

i. All fire hydrants shall be designed generally as per IS: 5290 – 1993 Type A, i.e, single outlet type.

ii. Each hydrant shall consist of valve, matching flange, CAF gasket, nuts, bolts and instantaneous spring lock type female outlets with blank cap & chain. \

iii. Each Hydrant shall have a permanent stainless steel name plate and Stainless steel tag fixed on the hydrant indicating the Tag No.

iv. Hydrants shall be designed for 100% tight shut off.

v. Material of construction for the various components shall be as follow:-

Body, Bonnet, stop valve, check nut : SS 04Cr17NiMO2 as per IS:6529-1972.
Female coupling and blank cap : SS 04 Cr 17NiMO2 as per IS:6529-1972.
Hand wheel : CI as per IS:2010 -1978

Other Components : As per IS: 5290-1993.

vi. Companion flanges shall be made of Carbon steel plates conforming to IS:2002 Gr 2A'92 and drilled to IS: 6392-1971 (Reaffirmed 1994) Table 17.

vii. Each internal hydrant shall be complete with two hoses of 15 m for TG area and 7.5 m length for other area and shall include hose couplings, nozzle, spanner & other accessories. The hoses and other accessories shall be kept in a hose box, which shall be installed near each internal hydrant.

viii. Each outdoor hydrant shall be provided with stand pipe with bend, two hoses of 15m length with couplings, spanner, nozzle etc. The hoses & accessories shall be kept at certain hose stations located suitably to facilitate fire fighting.

06.08.10.04.01.04. LOCATIONS OF HYDRANTS

Sl. No.	Unit	Internal Hydrants (single headed) Nos.	External Hydrants (single headed) Nos.
1.	Machine Hall	3	---
2.	Coupling chamber floor	2	---
3.	Cooling water pump house floor	1	
4.	Switch Yard	---	2
5.	Transformer Yard	---	2

06.08.10.04.01.05. HOSE BOX

Each hose box shall be fabricated out of 18 SWG MS sheet. The two sides and back of the hose cabinet shall be made from sheet by pressing. The top shall have pressed edges slightly projecting outside to prevent water (While cleaning etc) from entering the cabinet.

The cabinet shall be fitted with double door having glass panes. The thickness of glass shall not be less than 3.0 mm. The door shall be provided with a lock with duplicated key and knob on the body of door. Suitable hooks etc. shall be provided in the cabinet to hold the hose reel etc. mentioned above. Suitable wall mounting brackets shall be provided with the cabinet.

06.08.10.04.01.06. HOSE STATION

There shall be seven no. of strategically located hose stations for storage of hoses for yard hydrants. The dimension of hose stations will be (2.0x1.5x2.0)m each. These will be constructed of brick masonry and RCC roof and will have glass panelled double doors. Each hose station shall have provision for storing a minimum of 12 houses.

06.08.10.04.01.07. HOSES AND ACCESSORIES

i. Each hose shall be as per IS: 636-1988 Type A& of reinforced, rubber lined flax canvas material and shall be supplied complete with instantaneous spring lock type couplings as per IS:903 – 1993.

ii. Each hose shall have a diameter of 63mm. Each nozzle shall be of 25 mm size.

iii. 2.0 mm GI wire shall be wound around the coupling so as to cover 120 mm length of hose.

iv. Nozzle, Coupler (male/female), lifting key, branch pipe shall be of stainless steel construction. Branch pipe shall include solid stream nozzle.

v. The hoses shall be suitable for a working pressure of 8.5 Kg/cm2 and shall be capable for withstanding water pressure of 32 Kg/cm2 without any leakage, sweating or bursting.

06.08.10.04.01.08. ISI MARKING

All the equipment supplied except (Hose box) shall have ISI stamp/marking on them.

06.08.10.04.02.00 FIRE DETECTION & ALARM SYSTEM: (FDA) (microprocessor based):

a. Fire Detection and Alarm System (FDA) shall be intelligent addressable microprocessor based automatic system. The System shall be designed, manufactured, assembled and tested in accordance with the relevant Standards of National Fire Protection Association (NFPA) latest. All components shall have UL / FM / LPCB / VDS / IS 2189 approval and shall also have approval from Tariff Advisory Committee (TAC). In case of conflict among any Standard / Norm, the stringent one shall govern.

b. All equipment, in general, shall be designed for smooth, efficient and trouble-free operation in tropical humid climate for 45 deg C ambient as 24 hour average with short time maximum of 50 deg C and a humidity of 100%. The derating of equipment shall be done for an ambient temperature of 45 deg C. For specific applications involving arduous conditions, the equipment shall be based on actual ambient temperature of the area of classification.

06.08.10.04.02.01 SCOPE OF WORK

The scope of work includes design, engineering, supply, erection, testing, commissioning, performance tests and handing over of intelligent addressable type Fire Detection and Alarm system for various premises of the project as mentioned in Table-1.
TABLE-1

SL. NO	DESCRIPTION	FALSE CEILING	TYPE OF SYSTEM
1.	Control Room including Battery Charger Room	Yes	FDA system and Fire extinguisher
2.	Battery Bank room	No	FDA system including Fire Extinguisher
3.	office room	No	FDA system with Fire Extinguisher
4.	All other areas including above areas	No	Fire Extinguishers

The system shall mainly consist of the following:

SL.	ITEM DESCRIPTION	TENTATIVE BOQ
A)	Intelligent Addressable-type microprocessor based optical / Photoelectric – cum- Thermal Detectors	LOT
B)	Intelligent Addressable-type microprocessor based fixed cum Rate of Rise Heat Detector	LOT
C)	Intelligent Addressable-type microprocessor based photo-electric Smoke Detector	LOT
D)	Intelligent Addressable-type Manual Pull Station	LOT
E)	Intelligent Addressable-type Control Modules.	LOT
F)	Electronic hooter with Strobe	LOT
G)	Response Indicator	LOT
H)	Intelligent Addressable-type Fire Alarm Panel (Total Loop and one (1) additional spare loop has to be considered)	LOT
I)	Relay/Contactors	LOT
J)	Networking / special Cable	LOT
K)	Control Cable 2X 1.5 / 2.5 Sq. Mm	LOT
L)	Fire Extinguishers	LOT
M)	PC & Printer with Furniture	LOT
N)	Intelligent Addressable Isolator Module	LOT
O)	Intelligent Addressable Monitor Module	LOT
P)	Intelligent Addressable Repeater Panel	LOT
Q)	Auto Dialing Facilities	LOT

a) The Intelligent Addressable Microprocessor based Automatic Fire Detection and Alarm system shall be software controlled automatic system and shall provide necessary programmed activities and various controls. The system shall consist of central processing units, man machine interface, communication system, microprocessor based fire alarm control panels, TFT monitor, printer Addressable Intelligent Automatic sensors and Interface unit as applicable.

b) Fire alarm control panel shall function as communication interface between Central Processing Unit and sensors and controlled devices. Addressable Intelligent type microprocessor based Detectors / Manual Pull Stations and required field devices in the various areas shall be connected to fire alarm control panels by class A wiring to the loop module.

06.08.10.04.02.02 EARTHING:

At least 2 Nos.
One lot of earthing conductors, accessories and electronic earth pit shall be provided, as required, for proper earthing as per statutory norms and to meet the stipulations of IEC. The equipment shall be earthed by connecting it to the nearest earth grid by two separate contractors. Copper strip and wire shall be used for all earth conductors.

06.08.10.04.02.03 ELECTRONIC EARTH PITS

a. At least 2 Nos. Electronic earth pits shall be proved near the control room as per the Indian standard.

b. Test Magnet along with Detector removal telescope handle shall be provided.

c. Automatic Clean Agent such as IG – 55 (Argonite) or IG – 541 (Inergen) based automatic Fire Protection system for control room shall be provided as per NFPA – 2001. While designing of the system 100% stand-by shall be considered.

d. Any of the following system and equipment may be selected for the Fire Protection System:
   i. NOTIFIER SYSTEM
   ii. EDWARDS SYSTEM
   iii. SIEMENS / CERBERUS SYSTEM

e. All items indicated against fire detection cum alarm system shall be supplied by Tenderer as per approved drawings. The system shall be supplied exactly as per specification / as per approved drawing with bill of quantities meeting the NFPA, IS 2189-1988 and TAC norms.

f. Site supervision work shall be carried out by manufacturer's certified persons.

06.08.10.04.02.04 TECHNICAL (FIRE PROTECTION SYSTEM) (FPS)
06.08.10.04.02.05 GENERAL

a) A microprocessor based intelligent addressable type automatic fire detection cum alarm system shall be provided for complete power plant including all electrical and common facility premises mentioned in Table-1.

b) In all the electrical premises multisensor addressable intelligent detectors in double configuration shall be provided except battery room where rate of rise cum fixed temperature type heat detectors shall be provided.

c) The system shall have self-monitored microprocessor panel incorporating the latest technological developments. The automatic fire detection cum alarm system shall operate taking into consideration the air change/air velocity of the ventilation system. Response indicators shall also be provided for all the detectors above false ceiling in control room.

d) Tenderer shall assess the quantity of interconnecting cables and wires, supporting arrangement and include the same on lump sum basis.

a. Following parts of fire detection and alarm system shall be provided:

- Main Fire Alarm Panel
- Personal computer with TFT monitor, key board, mouse and printer
- Manual pull stations (indoor type)
- Manual pull stations (outdoor type) with canopies
- Hooters (indoor type)
- Hooters (outdoor type) with canopies
- Multi sensor detectors (photo electric cum rate of rise and heat detector type)
- Rate of rise cum fixed temp type heat detectors
- Isolators
- Relay modules
- Response indicators
- Area panels
- Photoelectric Detectors
- Maintenance free Ni-Cd battery and battery chargers
- FRLS cables, conduits, junction boxes, earthing materials etc.
- Siren and hooter

06.08.10.04.02.06 SYSTEM DESCRIPTION (Fire protection system) (FPS)

a. Intelligent addressable Microprocessor based control panel shall be provided to detect, differentiate and monitor the following conditions of the detectors.

- Fire
- Fault condition
- Open circuit
- Short circuit
- Low voltage condition of batteries

b. Panels shall have provision to accommodate 20% extra locations or one loop for future use (whichever is more).

c. The system shall have display as well as print options. Fire alarm panel shall have mimic and text display.

d. The system shall also be suitable to work on UPS system. Purchaser will provide one feeder from their board. Requirement of UPS power shall be furnished by the bidder.
e. There will be one number Main Fire Alarm Panel to be installed in Power Plant Control Room.

f. For tripping of A/C, ventilation drives, signals shall be initiated from Main Fire Alarm Panel only if two adjacent detectors give fire signal.
g. Number of loops in fire alarm system shall be finalised based on requirements / future use during detailed engineering stage. The Tenderer to note that all loops shall be closed type. Panel shall have provision to adjust the sensitivity of the detectors from the panel itself. Mimics shall be developed in monitor to know at a glance operation of detectors in a particular area.

06.08.10.04.02.07 MAIN FIRE ALARM PANEL (MFAP)

MFAP shall be located in main control room. Fire signal from all the area panels shall be repeated in MFAP. MFAP shall have text display.

Fire Alarm Panels shall also have the following features:

1. Logging an alarm, time and action text on printers.
2. 'NO & NC' contact for common fire/fault signal of individual loop for sending the information to the 'Power Plant DCS'/ Automation system or other area.
3. Auto dialing facilities with security office, central fire brigade station etc.
4. Networking system with other panels.
5. The possibility of expanding to a bigger system with several control panels and control and information units.
6. Programmable activation of control output relays for tripping Air Conditioning & Ventilation system.
7. System shall be interfaced with existing telecommunication system for alerting central fire brigade station personnel.
8. Main Fire Alarm panel shall have provision of transmitting the signal to the remote station; necessary software for the interfacing with the other panel/DCS system shall have to be included in the scope.
9. Fire alarm panel shall have enclosure protection feature of IP 55 and the sheet steel enclosures shall be minimum 2 mm thick.
10. Ni-Cd batteries shall be provided for the standby back-up of the fire alarm panels.

06.08.10.04.02.08 PERSONAL COMPUTER AND PRINTER:

a. Personal computer with TFT monitor along with key board and printer shall be provided to monitor all the data loggings of events, system diagnostics and to print out the required events / data logged with date, time, etc. Status of all the detectors shall be displayed on demand on TFT monitor. It shall display alarm, pre-warning faults and location of the fire or faults like open circuits and short circuits.

b. TFT screen shall be of minimum 21 inch size. Processor type shall be latest version of Pentium. Printer shall be color Inkjet type. Suitable furniture for PC and printer with revolving and rolling chair shall be included in the scope of the Tenderer. In PC it shall be possible to have geographical mimic and graphic display for the complete area. PC and printer shall be located in main control room and connected to MFAP.

06.08.10.04.02.09 NETWORKING

The MFAP shall have provision for serial interface with Plant DCS. A provision shall be kept to add / remove panels from the network. Necessary cabling, interface cards, hardware and software are included in the scope of the Tenderer. In network connection, Tenderer shall provide two spare cores to be used in case of fault in working cores.

06.08.10.04.02.10 POWER SUPPLY

a. Tenderer shall include all power supply cabling for the fire alarm panel from the existing power supply boards.

b. The fire alarm panel shall be provided with 24 V DC batteries along with battery charger of adequate capacity so that if AC power fails, DC source will be available automatically without interruption. Batteries for above shall be Ni-Cd maintenance free type. Battery shall be capable to withstand the total normal requirement for duration of 48 hours and for duration of 30 minutes to meet alarm load requirement. Alarm load shall consist of normal detection equipment plus all sounders/siren etc. Boost/trickle charging facility shall be provided in the panel. Battery shall be kept separately in the control room at suitable place.

06.08.10.04.02.11 DETECTORS

a) Detectors shall be of latest series intelligent addressable type and microprocessor based. Close loop shall be formed with connections of detectors. Each close area shall have isolator at entry points and exit points which will automatically open the part of loop on short circuit. Alert signal (first) and final fire signal (second) shall have differentiable sound.

b) It shall be possible to adjust sensitivity of detectors through area panel or MFAP. Detectors and Panels shall be from the same make.

c) In Ni-Cd battery rooms rate of rise-cum- fixed type heat detectors shall be provided.

d) Remote response indicators shall be provided for all detectors located above false ceilings in control room. Required work for fixing of the indicator above ceiling shall have to be carried out by the Tenderer. For detectors to be mounted in existing control room over the false ceiling, Tenderer to take necessary precautions so that existing facilities shall not be disturbed.

e) Detectors shall not foul with ventilation duct and shall not be located near diffuser. Detectors and fire panels shall have UL listing FM approval. Fire alarm panel shall be UL/FM/LPC/TAC approved.

f) Multi sensor detectors shall be installed as per latest practices indicated in IS: 2189-1988, TAC and NFPA codes. Minimum two numbers of detectors for the smallest premise shall be provided. Coverage area shall conform to IS 2189-1988.Tenderer shall select the spacing of detectors considering the air change factor of the ventilation/air conditioning system ,height of room ,beam depth etc. as per IS 2189-1988.

g) In cable shafts smoke detectors at top of the shaft shall be provided with required fixing arrangement.

06.08.10.04.02.12 MANUAL PULL STATIONS (MPS)

a) MPS shall be provided at each entry /exit point of electrical room, emergency exit, yard area, transformer bay etc. MPS shall be intelligent addressable, break glass type connected to its location card. Both indoor/outdoor MPS shall have glass cover and removal of glass shall initiate communication to area panel and main fire alarm panel.

b) Total numbers of Manual pull stations and their locations shall be finalized during detailed engineering. Travel distance between two consecutive MPS shall not be more than 50 meters. Signal of the MPS shall appear at the Area Panel and Main Fire Alarm panel. At main entry points of buildings and electrical rooms minimum one number Manual pull stations shall be provided. In outdoor areas, MPS shall be suitable for outdoor location with rain canopy and shall be mounted on structure or wall at prominent places. Whenever existing supports are not available, Tenderer shall consider steel structure support arrangement so that MPS shall be located at 1 meter from ground level.

06.08.10.04.02.13 SIREN / HOOTER

a) Siren shall be mounted on suitable support near chimney (capacity 1 Km range to operate in case of confirmed fire is registered in the main fire alarm panel). Siren shall also be suitable for manual operation. Siren shall have three types of sound; first alarm (or alert), second fire (or emergency) and third clear. Tenderer shall furnish details for above. Siren shall be connected to UPS power supply and all necessary arrangement shall be provided by the Tenderer for this. Purchaser will provide only one UPS feeder from the DB located in main control room.

b) Hooter shall be connected in each zone internally as well as externally. External hooters may be clubbed together i.e. common entry/exit point of view for cable areas.

06.08.10.04.02.14 CABLES & CABLE LAYING

Cables used for interconnecting hooters shall be limited to one premise only. All incoming-outgoing power supply cables & inter connecting cables used for the system shall be fire resistance low smoke (FRLS) type 1100 V grade PVC insulated, PVC inner and outer sheathed having 2.5 mm2 copper conductor, armoured type conforming to IS:1554 (Pt.-1). Three core cables (keeping one core as spare) shall be used for the detector/ device connection.

06.08.10.04.02.15 DETECTOR CIRCUIT CABLES SHALL BE CLASS "A" WIRING.

a) Fire cable routing shall be separated from other cables to the extent possible. All switches, cable ending junction boxes, multi-way junction boxes, FRLS connecting cables, panels etc. shall be included to make the system complete in all respect. This shall include wiring/cabling up to Area Annunciation panels. Cables for detection system shall be laid keeping sufficient space from illumination cables. Cable shall be laid as per approved cable routing and cable layout drawings and as per normal plant practice and manufacturer's guideline. Route markers for fire cables shall be separate and distinct from other markers.

b) Separate cables shall be provided for telephone and public address system. Cables for telephone system shall be twisted pair.

c) All cables for networking, telephone, public address shall be armoured type. The cables shall be laid in pipes while crossing road, drain etc.

06.08.10.04.02.16 QUANTITIES OF ITEMS

No. of detectors, response indicators, manual pull stations, isolators, interconnected cables, incoming cables, conduit for laying of cables shall be provided by the Tenderer as per the requirement to cover all the areas based on approved drawings. Quantities are to be calculated by the Tenderer and shall be provided to meet all requirements. List of electrical premises has been enclosed, however Tenderer to ensure coverage of detection network for all electrical rooms of the plant and cable galleries. Tenderer to cover all electrical rooms by Fire Detection System whether same is indicated specifically or not.

06.08.10.04.02.17 INTERFACE DEVICES

Tenderer shall include all interfaces/ hooking up devices for connecting output of alarm points, interlock points etc.

06.08.10.04.02.18 INTERLOCKING WITH A/C & VENTILATION SYSTEM

a) There will be interlocks to shut off the exhaust fans and simultaneous tripping of A/C and ventilation system. The fire signal from first detector will operate the audio-visual alarm whereas on confirmation of fire signal from the other detector the ventilation/air conditioning system shall be switched off automatically. Appropriate tripping relays and their contacts shall be provided by the Tenderer for this purpose considering zone wise operation, partitions in cable gallery and number of fans/ system operating in the electrical rooms.

b) Potential free contacts shall be made available for each zone for tripping of respective ventilation/air conditioning system. Location of above relay module shall be as finalized during detailed engineering stage. Tenderer to consider all accessories such as cabling/

wiring, contact multiplication etc required to achieve the system requirement.

c) Contact of auxiliary relays shall be made available in relay auxiliary panel of the above mentioned places and shall be suitable to wire directly in MCC control circuit.

06.08.10.04.02.19 ERECTION MATERIALS

a) All fixing accessories for cabling, detectors and panels shall be included by the Tenderer including cable tray.

b) GI conduit shall be provided in outdoor area, wall/floor crossing and inside building, metal or rigid PVC conduit shall be provided.

c) Civil works like chipping of floor, grouting, providing inserts, providing base frame for panels, conduits are included in the scope of the Tenderer.

06.08.10.04.02.20 TESTING, COMMISSIONING & PERFORMANCE GUARANTEE

All tests and inspection of the installation shall be done in conformity with the functional requirement of the system as per IS: 2189, TAC and NFPA norms. The Tenderer shall furnish a detailed testing, commissioning and performance testing procedure for all the systems for approval by the purchaser. Performance testing shall include acceptance criteria for each equipment and complete system. As soon as a given facility or a portion thereof is completed and ready to energize and start-up, the purchaser may test run and operate it without relieving the Tenderer of his responsibility or guarantee.

06.08.10.04.03 WATER SPRAY SYSTEM COMPRISING OF HVWS AND MVWS –

For protection of Cable galleries etc. from fire, Medium Velocity Water Spray (MVWS) system shall be provided. For protection of Generator Transformer (GT) High Velocity Water Spray (HVWS) system shall be provided. The system shall be designed as per TAC, BIS and NFPA guidelines.

06.08.10.04.03.01 DESCRIPTION OF THE SYSTEM

HVWS & MVWS envisaged is a special fixed pipe system connected to a reliable supply of water from existing hydrant main pipe line and equipped with spray nozzles (projectors) for specific water discharge and impingement over the surface or area to be protected. The piping system is to be connected to the water supply through an automatically actuated valve (deluge valve) which can initiate flow of water. Deluge valves for the spray system are to be actuated by an automatic detection system which in the case of transformers consists of quartzoid bulb detectors mounted around the protected area and for cable galleries these are part of fire detection & alarm system.

06.08.10.04.03.02 OPERATION OF THE SYSTEM

a) Initially, delivery line should be pressurized upto deluge valve with the water line pressure upto deluge valve should be maintained at around 7 kg/cm2. The Q.B. detector line should

be pressurized to a pressure of 4 kg/cm2 with the help of water which should be tapped from the header itself. Deluge valve clack is kept in horizontal position in normal condition due to balanced hydraulic pressure on two sides of the clack.

b) In case of transformer fire, temperature will rise all around the transformer. On reaching a predetermined temperature (generally 30°C above ambient temperature) quartzoid bulb detectors, which are installed on pressurised water line (water for which is tapped from the main header itself), will shatter. As the bulb shatters, water in the detector line gets released through the detector openings and water pressure in detection line drops rapidly. This results in creation of pressure differential in the deluge valve and leads to latter's actuation. During this operation pressure in the water delivery line falls rapidly resulting in start up of main electrical driven pump. In case of power failure, pressure in the header shall go on decreasing causing start up of diesel engine driven pump.

c) In case of cable galleries the actuation of deluge valves are effected by signal from fire detection and alarm system provided in the premises. Cable galleries shall be provided with smoke detectors, photoelectric and ionization type alternately. These have been described in detail in FDA specification. In the event of fire in the premises, the detection system shall give signal to Main Fire Alarm Panel (MFAP) which in turn shall actuate the solenoid of the deluge valve concerned. There shall be provision for manual operation of the system also by operating quick opening valves of each deluge valve.

06.08.10.04.03.03 MAIN COMPONENTS OF THE SYSTEM

The HVWS/MVWS System shall be provided with the following major components:

a. Water Supply at high Pressure
b. Arrangement of Spray Nozzles
c. Arrangement of Quartzoid Bulb Detectors (for HVWS)
d. Deluge Valve
e. Y-type Strainers just before deluge valve
f. Pipes, fittings and fixtures
g. Basket strainers in HVWS system header
i. Pressure gauges, pressure switches and solenoid valves
j. Fire detectors

06.08.10.04.03.04 DESIGN CRITERIA

Following salient parameters shall be followed for the design of the system.

i. Water application rate for HVWS - 10.2 lpm/m2 of the surface area of the entire transformer including bottom surface, radiators etc. For MVWS in cable galleries ,6.1lpm/m2 on each tray. The working pump capacity shall be decided based on the water requirement (whichever is higher) and selection of pump shall be from TAC approved pump capacities. The capacity of water reservoir shall be equal to at least one hour pumping.

ii. The system shall be so hydraulically designed that the pressure at the hydraulically

most remote projector in the network shall not be less than 3.5 bars for outdoor transformer and 2.8 bar for indoor installations. For cable galleries also Pressure at remotest sprayer - not less than 2.8 bars.

iii. Velocity in the feed pipe shall not be more than 10 m/s.

iv. The header shall be laid under ground and tappings for the individual deluge valve shall be taken there from.

v. Q.B. detectors shall be installed in two rings one at top and another at bottom around the protected area. Maximum spacing between detectors shall be 2.5 m.

vi. Projectors (for transformers) shall be installed in rings encircling the protected area. One ring shall be provided at the top and subsequently rings for every 3 m from top to bottom shall be provided.

vii. There shall be common header for HVWS and MVWS systems which shall be fed water from the pump dedicated for the spray system. The hydrant header and spray system (HVWS & MVWS) headers shall be inter-connected with a non-return valve in between so that hydrant system can be a back-up for the spray system.

viii. In cable galleries, the protected area shall be divided into several zones, each of which shall be fed by individual deluge valve. In event of fire water shall be sprayed on the zone concerned (i.e. zone under fire) along with preceding and succeeding zones. Zone lengths for cable galleries shall be 30 m .

ix. Distribution of sprayers in cable galleries : The sprayers shall be installed in rows at the central aisle between the cable trays and spaced at not more than 3 m from each other.

06.08.10.04.03.05 EQUIPMENT SPECIFICATION

06.08.10.04.03.05.01 DELUGE VALVE ASSEMBLY

i. Deluge valve assembly functions on differential pressure operation allowing quick opening of the valve and thereby rush of water to the protection system. The valve consists of inlet, outlet and priming chamber. The inlet and outlet chambers are separated from the priming chamber by the valve chamber and a diaphragm. In the `Set' position, pressure is applied to the priming chamber through a restricted prime line. The pressure is trapped in the priming chamber and holds the clapper on the seat due to the differential design. In the `Set' position the clapper separates the inlet from the outlet keeping the system piping dry. When the pressure is released from priming chamber, the clapper moves and allows the inlet water supply to flow through the outlet and to the fire extinguishing system.

ii. The deluge valve assembly will consist mainly of the following :

- Isolation valves on both upstream and downstream sides.
- Inline strainer

- Deluge valve proper
- Actuator/pilot assembly
- Drain valve
- Pressure gauges
- Solenoid valve

iii. The deluge valve shall be of resetting type, taking minimum time for resetting. The deluge valve shall be UL/FM/TAC/IS approved make.

iv The deluge valve shall be installed in the existing DV building. Necessary civil jobs required for the purpose is under the scope of the tenderer.

06.08.10.04.03.05.02 SPRAY NOZZLES (PROJECTORS AND SPRAYERS)

Water spray nozzles for the system shall be of suitable orifice size and varying discharge angles to cover fully all the area supposed to be protected. The nozzles shall be of Gunmetal with Nichrome finish or Stainless steel. The nozzles shall be normally open type, Spray nozzles(projectors) shall bear UL/FM/TAC/IS approvals.

06.08.10.04.03.05.03 STRAINER

Y type strainer shall be provided on the inlet side of each deluge valve assembly. The strainer shall prevent deposition of foreign particles in the valves and thereby malfunctioning of control valves. The material of construction of the strainer shall be gun metal and it will bear TAC/IS approval.

06.08.10.04.03.05.04 QUARTZOID BULB DETECTORS

The Q.B. detectors shall bear TAC/UL/FM approval and shall have a temperature rating of minimum 79 degree centigrade. However the tenderer shall take into account the temperature at which they shall operate.

06.08.10.04.03.05.05 FIRE DETECTORS (PART OF FIRE DETECTION & ALARM SYSTEM)

Detectors have been described in detail elsewhere in the package specification. Following types of detectors shall be used for automatic actuation of MVWS system:- Cable galleries: Analogue addressable type smoke detectors

06.08.10.04.03.05.06 PIPES, VALVES & FITTINGS

i. Pipes and pipe fittings in general shall comply with the requirements of BIS codes. Piping layout must follow good engineering practice. Proper attention shall be given to obtain full functional requirement of piping system with a layout which provides sufficient clearance for other equipment and other personnel and easy access for operation and maintenance.

ii. All piping shall be complete in all respects and shall consist of necessary valves, fittings, supports, air release and drain valves and other accessories. The air release and drain valves shall

be provided at high and low points respectively. Each of the branch connection taken from the network shall be provided with an isolation valve.

iii. Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges to provide the necessary clearance for the traffic movement. A minimum clear height of 6.0 m above road top level shall be maintained.

iv. All pipework shall be designed to provide complete flexibility to prevent development of undesirable forces or moments at points of connection to equipment, at anchorages or at guide points, due to thermal expansion. Flexibility shall be provided by changes of direction or by use of bends, loops, offsets etc.

v. The specification of pipes are as below.

T.S. for Pipes between deluge valve and main header

i) Upto 150 mm nominal size - M.S ERW Black pipes conforming to IS-1239- 1984 Part-I (heavy grade) With Plain ends.

ii) 200 mm to 400 mm size - M.S. ERW Pipes conforming to IS-3589 -1973 but thickness as specified below

Nominal Dia : O.D x Thickness in mm
DN 200 mm : 219.1 x 6.35
DN 250 mm : 273.0 x 7.14
DN 300 mm : 323.9 x 7.14
DN 350 mm : 355.6 x 7.14
DN 400 mm : 406.4 x 7.14

T.S. for Pipes and valves after deluge valve

The material of construction and manufacturing standard of pipes, fittings, valves, fasteners, gaskets, etc. shall be as described in table below:-

Table
Nominal pressure (PN) - 10 Kg/Cm2
Test Pressure (PT) - 15 Kg/Cm2

Sl. No.	Items	Nominal dia.(mm)	Specification
1.	Pipe	65 and below	IS-1239 (Part-1) - '90 heavy, G.I.
		80	IS-1239 (Part-1) - '90 Medium, G.I.
		100 to 150	IS-1239 (Part-1) - '90 Medium, G.I.
		200 to 450	IS-3589 Gr.410 ERW pipe commercial quality or equivalent. Thickness same as in clause 11.02 (ii) above.

Sl. No.	Items	Nominal dia.(mm)	Specification
2.	Pipe fittings		A 234 Gr. IS-1239/3589/2062
2.1	Screwed fittings	65 & below	IS-1239 (Part-1) - 90 Galvanised
2.2	Fabricated fittings		
	Bends	150 and above	Mitred bends with radius 1.5 DN from black pipe.
	Tees/Crosses	150 and above	Fabricated from black pipes by smithing.
	Reducers	150 and above	Fabricated from black pipes by taper cutting and welding.
3.	Bolting	All sizes	IS - 1367
4.	Gaskets	All sizes	Sheets rubber to IS-635-`79 type-A, 3 mm thick compressed Asbestos to IS-2712-`79
5.	Flanges	All sizes	Slip on flanges to IS-6392 - `71 machined from Carbon Steel plates to IS-2002-`92 Gd. 2 with bore to suit pipe O.D.
6.	Valves		
	Isolation	50 & below	CI gate valves, screwed, as per IS-780 - `84 class - PN - 1.6
		65 to 300	CI gate valves, flanged as per IS- 780-84 class - PN - 1.6
		350 and above	CI gate valve, flanged as per IS-2906-`84, Class - PN - 1.6
	Throttling		
		50 and below	Gunmetal globe valve, Screwed, as per IS-778-`84 Class-2.
		65 to 300	CI globe valve with brass/bronze renewable seat rays flanged.

06.08.10.04.03.05.07 VALVES

Valves shall be provided on pipe work for stopping and starting of flow, controlling flow rate, diverting flow, preventing back flow, controlling pressure, relieving pressure and for venting and draining of pipelines etc.

Valve selection shall be made based on the following considerations :

- Suitability of valve materials in regard of properties of fluids, temperature, pressure, erosion and shock.
- Valve size.
- Main function of the valve (viz. throttling, stop, permitting flow in one direction, diverting flow, relieving pressure etc.)
- Friction head losses.
- Ease of operation, i.e. method of actuation-closing time.

- Maintenance considerations.

The valves to be provided shall include but not be limited to the following :

- Isolation valves on the main header at various locations.
- Gate valves in the branch pipes from header to DV and from DV to the served area.
- NRV on all pipe lines requiring unidirection flow only.
- Quick opening safety shut off valves.
- Manual drain valves.

06.08.10.04.03.05.08 PIPE SUPPORTS AND FIXTURES

Necessary pipe supports & fixture, pipe thrust block or pipe bridge to run the pipes overhead/underground or in the pipe trench as the case may be, shall be included in the scope of the tenderer. The tenderer shall study the location of protected premises and their auxiliary equipment and accordingly plan the pipe routing and the location of spray nozzles, deluge valves and manually operated valves. The fire protection equipment and the fixtures located in the vicinity of the transformers should not pose any operational problem. At places, where no supports/trenches are available the tenderer shall consider dedicated supports required for the pipe lines/spray nozzles etc. for the system.

06.08.10.04.03.05.09 CIVIL WORKS

a. The tenderer's scope shall include complete engineering and construction on a turnkey basis inclusive of design, detailed engineering, supply of all construction materials, including cement, reinforcement steel, and structural steel, construction and testing in respect of all facilities required for completion and handing over of the work as per technical specification and tender drawing within the battery limit. Specification for civil works has been given elsewhere in the package specification. All civil works described below shall be under tenderer's scope .

b. Cable and pipe trenches within the battery limit.
c. Earthwork for building and equipments, sumps trenches etc.
d. All masonry in sub structure and superstructure.
e. All finishing work to flooring, walls, ceiling etc. as required.
f. All finishing work and painting works to masonry, concrete structures, steel works as required.
g. All plumbing and water supply fittings, rain water drainage including rain water downcomers and connecting the same to the nearby storm water drain.
h. All necessary civil works required for road lighting.

06.08.10.04.04 PORTABLE FIRE EXTINGUISHERS –

a. Different types of portable fire extinguishers will be deployed in various area of the complex as a measure of first-aid fire fighting.

b. Major units of power house complex where extinguishers are to be deployed are enumerated below:

- Machine hall
- Transformer yard

- Switchyard area
- Main control room
- All other services rooms /units as per site condition if not listed above

c. Portable extinguishers will be conforming to IS 15683-2006 code.

06.08.10.05 ERECTION, TESTING, COMMISSIONING & PERFORMANCE GUARANTEE

a. The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the working drawings, erection specification, instructions etc. duly approved by the Purchaser. The tenderer shall carry out the work in the presence and/or as per the instructions of site engineer/supervisory personnel deputed by the Purchaser. The erection shall be carried out by highly skilled workmen.

b. The tenderer shall be responsible for paying strict attention to statutory regulations for prevention of accidents and to other safety rules. The regulations for prevention of accidents shall be deployed at appropriate places and should be distinctly visible to all personnel working in the area.

c. The tenderer shall supply all required consumables, construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compound, tapes, brazing and soldering materials, welding and brazing gases, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand and emery paper etc. as required for the satisfactory completion of work.

d. The tenderer shall make his own arrangement for handling the equipment and pipelines at the stores and transporting it to the site of installation. In addition to the above, the tenderer shall follow all the relevant erection clauses/conditions stated under various chapters in the tendering specification.

e. The tenderer shall provide all tools, labour including necessary subsistence, erection supervision, equipment, materials, accessories, to erect/install and make ready for operation, functionally complete total fire protection system for as described and specified in this specification.

06.08.10.06 TESTING, COMMISSIONING & PERFORMANCE GUARANTEE OF THE COMPLETE SYSTEM.

TESTING

All tests and inspection of the installation shall be done in conformity with the functional and statutory requirement of the system. The tenderer shall furnish a detailed testing and commissioning procedure for all the systems for approval by the purchaser. As soon as a given facility or a portion thereof is completed and ready to energize and start-up, the purchaser may test run and operate it without relieving the tenderer of his responsibility or guarantee.

06.08.10.07 START-UP AND COMMISSIONING

a. Tenderer shall provide the services of all technicians, erection and start-up engineers necessary to bring the complete installation of fire protection system into operation.

b. The tenderer shall be responsible for the integrated commissioning of the plant & equipment supplied by him including trials, commissioning and demonstration of performance guarantee test.

c. The Tenderer shall render the following services:

a) Prepare equipment for trial runs and start-up
b) Start-up and commissioning of equipment.
c) Preliminary operation, initial operation, trial operation and Final acceptance test.

d) The tenderer shall be required to clean up the equipment and surrounding area and prepare it for trial runs and operation.

e) Priming connections, cooling water supply to bearings, lubrication piping to bearings, stuffing box jackets and sealing glands of all rotating equipment shall be checked by the tenderer.

f) Sequence checking of all control systems, pneumatic and cable connections, checking operation of all interlocks and protective devices shall be done by the tenderer.

g) Blow down of all piping systems, installations and removing strainers in piping and equipment, as required shall be done by the tenderer.

h) Calibration and adjustment of relay settings, instruments etc., disconnecting and reconnecting the driven and driving parts of any equipment and drives, as required, during the trial runs and rectification, if any shall be done by the tenderer.

i) The Tenderer shall provide personnel as required for assisting starting up and commissioning of equipment as well as adjustments, repairs and rectifications of defects in erection of the equipment during commissioning of the equipment and upto final acceptance.

06.08.10.08 COMMISSIONING

On completion of the trial operation, all the systems shall be under observation in operative condition. The Tenderer shall provide skilled personnel including necessary tools and consumables wherever necessary to rectify the deficiencies observed.

06.08.10.09 PERFORMANCE GUARANTEE

a) The performance guarantee tests shall be completed within a time schedule to be mutually agreed upon between the Purchaser and the tenderer. Details of the performance tests, test

procedures and test schedules for the demonstration of the performance guarantee as per IS/TAC regulations, shall be submitted to the Purchaser and shall be mutually agreed upon and approval may be obtained from TANGEDCO.

b) The tenderer shall conduct the operation during the performance tests and shall take full responsibility of the operations.

c) If the tenderer is unable to achieve the performance values as a whole or in part during the performance tests, the tenderer shall repeat the tests for demonstrating the performance values. Before repeating the tests the tenderer shall take any and all measures as may be needed, at his own cost in order that the performance values can be achieved.

d) The observations of each performance test shall be recorded and signed by the Purchaser and the tenderer. If such data conform to the performance test values, the tenderer shall be entitled for the "Final Acceptance Certificate" from the Purchaser.

e) If even with two repetitive tests and if necessary, by using additional operating personnel from the tenderer's crew and at his own expenses, the performance values are not reached the tenderer shall undertake at his own cost such modification or replacement as are considered necessary to obtain the performance guarantee values and the responsibility to demonstrate performance guarantee shall continue to remain with the tenderer till so established.

06.08.11 AIR CONDITIONING SYSTEM

06.08.11.01 SCOPE OF WORK

06.08.11.01.01 Air-conditioning systems shall be of energy efficient and low operating cost.

The scope of work for air-conditioning systems for the control room of Kodayar Power House-I shall include the design, engineering, manufacture / procurement, inspection, shop painting, supply F.O.R. site stores, transportation of materials from above site stores to erection site, storage, erection, painting, testing, commissioning and performance guarantee of air-conditioning systems.

06.08.11.01.02 AIR-CONDITIONING SYSTEM

The air conditioning system to maintain 23±2 …C & RH<70% shall include Split type air conditioners for control room. The control room shall house control and relay panels.

Sl. No.	Area/premises	Type of equipment	Capacity of air conditioning equipment
1.	Control room	Split AC	Adequate capacity.

The details of experience and credentials shall be furnished in their offer. Further, the Tenderer shall take care of the following specific points with respect to air conditioning and ventilation systems.

a) Electrics for Air-conditioning System are included in scope of the Successful Tenderer.

b) Makes: VOLTAS, BLUE STAR, CARRIER AIRCON, LG, SAMSUNG, HITACHI

c) All commissioning spares as required for the air conditioning and ventilation systems shall be supplied by the Successful Tenderer.

06.08.11.02 DESIGN CRITERIA FOR AIR-CONDITIONING SYSTEMS

The outside /inside design conditions for air-conditioning and ventilation systems will be as specified below:

		Summer	Monsoon	Winter
Air-conditioning				
Dry bulb temperature (0C)	:	38.2	30	--
Relative humidity, %	:	70	80	--

Heat load calculations of AC system shall be submitted and get approved by the successful Tenderer for approval of the Purchaser / TANGEDCO before submitting any detail engineering drawing.

06.08.11.03 EQUIPMENT AND SYSTEM DESCRIPTION

06.08.11.03.01 AIR-CONDITIONING FACILITIES

a) Three phase industrial heavy duty type Scroll/rotary compressor shall be used for Split air conditioner and shall be selected with minimum 3 star rating as per BEE (Bureau of Energy Efficiency) standards and labeling programme.

b) Suitable rain protection canopy shall be provided over the condensing unit of split air conditioner. Condensate drain piping shall be made of GI Class B pipe.

c) Power consumption ratings for split air conditioners – Under Test Conditions

Rated Cooling Capacity		**Maximum Power consumption (kW)**
Kcal/h	**kW**	
3000	3.5	1.7
4500	5.2	2.6
6000	7.0	3.4
7500	8.7	4.5
9000	10.5	5.4

Source- Code no. IS1319 (part-2):1992

d). Insulation material for air conditioning application shall be with zero ODP such as HCFC free rigid insulation foam insulation, mineral fibre board, cork wool, expanded (bead) polystyrene, etc. Materials that do not inherently have a zero-ODP shall be avoided and shall not be used.

06.08.11.03.02 SPECIFICATION OF SPLIT AIR CONDITIONERS

The split type air conditioner shall be as per IS 1391 : Part 2 : 1992 (RA 1999) shall essentially be housed in two parts indoor unit& Outdoor Unit. Outdoor unit shall comprise of air-cooled condenser, condenser fan, hermetically sealed compressor and controls housed in a weather proof steel cabinet suitable for outdoor installation. Indoor Unit shall comprise of cooling coil, air circulating low noise fan, supply air grill with motorized flow deflector, evaporator drain connection and controls enclosed in a insulated steel cabinet.

06.08.11.03.02.01 OUTDOOR UNIT

(a) Air-cooled Condenser having condenser coil internally grooved copper tube with split aluminum fins. The condenser shall be fitted with a fan of propeller type. The condenser shall be built on an air-cooled design using outside ambient air to condense the refrigerant. The condenser coils shall be constructed of integrally enhanced Seam less copper tubes arranged in staggered rows. This shall have a minimum of 2 rows to provide proper heat rejection. It should be able to take an additional load of up to 10% more than the required heat surface area for countering high ambient conditions. The copper tubes shall be mechanically expanded into lanced and rippled Aluminum fins of minimum 0.1mm thick with approx. 10 - 13 fins per inch.

b) The refrigerant circuit shall consist of rotary / Scroll type compressor with R-22 refrigerant cooled motor, air-cooled condenser, thermostatic/capillary expansion valve, cooling coil, piping etc. The fan shall circulate ambient air and cool the condenser that in turn will cool & condense the refrigerant vapour flowing through the condenser. The cool refrigerant will reach the cooling coil section via Expansion device as cold liquid vapour mixture at low pressure and will cool the warmer air received in the return air grill from the premises. Then the refrigerant after gaining heat of the circulating air, will return to the compressor via Refrigerant pipe as vapour where it will be compressed and sent to the condenser. Thus the refrigerant will gain heat from the room air in cooling section as well as from compressor drive in the compression process of compressor and will release the total heat to the condenser cooling air at the condenser.

c) Steel structure with heavy gauge G.I. sheet metal casing and duly powder coated in which the above are mounted. The above enclosure shall be mounted on MS Channel frame structure with ribbed rubber pads for isolation of noise & vibration transmission to the building structure.

d) Installation

The wall brackets shall be supplied, grouted in to the walls / laid over chajja of the building and finished. Protective GI sheet (16G) cover shall be supplied along with all outdoor units, exposed to rain/sun/dust.

06.08.11.03.02.02 INDOOR UNIT

a) Cooling coils shall have large diameter copper tubes with aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg / Sq. cm. air pressure while submerged in water. Tubes shall be hydraulically expanded for minimum thermal contact resistance with the fins. Fin spacing shall be approx. 13 /15 fins per inch. The units shall be fitted with minimum 2/3 -row coil for giving the desired cooling effect.

b) The air circulation is achieved by the operation of the blower. The blower shall be low noise, high static – high flow type. This will supply cold air from cooling section of the indoor unit to the premises through the supply air grills provided at the front panel. The cold air supplied will gain the heat of the premises thereby cooling the room and will be sucked into the cooling coil section of the air-conditioner by the same blower through the return air grill provided at the front panel of the unit. Thus the re-circulating room air will remove the excess heat of the premises. There shall be air filter of large area for filtration of the return air into the unit.

c) This LCD remote/panel controller shall be a part of the factory assembled unit which shall be installed in a separate weather proof panel and remotely located. The panel shall have a soft touch keypad which can be used for setting/altering the unit set points/control commands. There shall be alpha numeric display in English with features illustrating the machine operating status.

d) **Installation**

The indoor unit shall be suitable for high ceiling mounting. Necessary refrigerant, condensate drain line and power & control wiring interconnection between outdoor & indoor unit shall be made at site after installation of the indoor unit.

e.) Safety Devices

The units offered shall be provided with all necessary safety devices, which are essential for proper operation of the equipment. These shall not be limited to the scope of this specification and shall have all safety devices required for optimum operation of the unit.

The following minimum safety devices are suggested :

(a) Low voltage cutout
(b) Low evaporating cutout

(c) In-built internal overload
(d) High condensing pressure cutout
(e) Motor overload trip/protection

06.08.11.04 EQUIPMENT SCHEDULE

SL. NO.	System envisaged/ Equipment specification	Description of equipment	Quantity
1	Split Air Conditioners	Split AC Unit of adequate capacity consisting of outdoor unit and connected high ceiling indoor unit along with wall mounted control cubicle, GI sheet canopy on outdoor unit and other standard accessories all assembled in polyester powder coated steel cabinet	----------
		Refrigerant copper piping interconnection between outdoor and indoor units (total Piping length to be included as per site condition)	1 Lot
		MS support bracket (Prefabricated & painted) including operating platform for outdoor unit	1 Lot
		Power & control cabling between outdoor & indoor units	1 Lot
		Condensate drain piping (GI class B) from indoor unit to outside the air-conditioned premises	1 Lot

07. PERFORMANCE REQUIREMENT AND GUARANTEE

07.01 The Tenderer shall study the specification and satisfy himself thoroughly regarding the work ability of the plant, equipment and systems offered and also take full responsibility for the guaranteed operation and performance of the same as well as for their smooth, safe and reliable functioning.

The tenderer shall state and guarantee the following Turbine, Generator and Generator Transformer parameters. The tenderer shall demonstrate the same during P.G. test, failing which L.D. and reduction clause will be applicable as per penalty clause no. 6.34.5 of Vol-I.

Sl. No.	Description	Guaranteed value
1	Turbine output in MW	
a	At rated/ design net head of 940.30 m	
b	At maximum net head of 972.92 m	
c	At minimum net head of 914.32 m	
2	Rated generator output, MW at 0.90 pf	
3	Turbine weighted average efficiency	
4	Generator weighted average efficiency	
5	Transformer weighted average efficiency	

07.02 Values of critical plant sigma as determined as per IEC code 193A should be given in the form of curves of different guide vane positions for different heads. Plant sigma curves as recommended by the manufacturer shall also be plotted on it clearly to show the safety margin available.

07.03 The Tenderer shall study the temperature & quality of water for the components of the turbine in direct contact of water to be designed and material to be selected so that considerable erosion or corrosion due to cavitation will not occur.

07.04 The Tenderer shall incorporate necessary provisions at the time of executing civil work and manufacturing of electro-mechanical equipment, so that the performance testing of the unit can be done.

07.05 The tenderer shall clearly indicate the method he proposes to carry out the Performance guarantee test, with facilities he proposes to provide during construction of civil works, manufacturing and erection of equipment.

07.06 The Tenderer shall carry out the performance test to prove the guaranteed efficiency and performance of turbine in accordance with the IS / IEC publication no.60041 latest edition, (field acceptance tests to determine the hydraulic performance of hydraulic turbines). The total system performance shall also be guaranteed and demonstrated.

07.07 The Tenderer shall state and guarantee the rated output of the unit at generator terminal at rated head and discharge, which will be duly verified and established at site. The tenderer shall also furnish output at max. head & discharge within vibration limits & class B temp limits. Similarly, the max. & min. output at rated head shall be furnished along with corresponding discharges with smooth operation within permissible vibration & class B temp. rise limits.

07.08 The minimum guaranteed weighted average efficiency for turbine cannot be **below 91%** and the peak efficiency shall be **higher than 91.5%.** The Tenderer shall state and guarantee the weighted average efficiency of the unit (combining turbine and generator) at rated head output. The tenderer has to conduct the performance guarantee test immediately after successful commissioning & trial operation. Price for these performance tests shall be quoted separately in the price format.

07.09 The Tenderer shall guarantee the vibration of the machine components in accordance with as per the latest relevant IS/IEC standard.

07.10 The Tenderer shall guarantee the noise limits in accordance with IEC 60034 - 9 (noise limits) and as per the General Technical Rules.

07.11 All equipment shall be guaranteed for workmanship, materials design and satisfactory performance to the parameters in accordance with the tender specification document and relevant clauses of the general conditions of contract. The guarantee for performance shall cover individual items and systems for their ratings/outputs. All machines / equipment shall be guaranteed for 24 (Twenty four) months from the date of initial take over.

07.12 The Tenderer shall also guarantee the integrated operation of all the systems and equipment covered in his scope as a whole including interfaces required to be established with other related systems and equipment. The Tenderer shall study the specification and satisfy himself thoroughly regarding the workability of the plant, equipment and systems offered and also take full responsibility for the guaranteed operation and performance of the same as well as for their smooth, safe and reliable functioning.

07.13 The Tenderer shall conduct performance acceptance tests on each of the major items of equipment supplied to demonstrate that the equipment and system supplied are capable of achieving the performance parameters specified and contracted for, in accordance with the general conditions of contract. The total system performance shall also be guaranteed and demonstrated.

07.14 The tenderer shall guarantee the runner against excessive pitting caused by cavitation for 18 months from the date of commissioning or 8000 hours of operation whichever is earlier.

07.15 Excessive pitting shall be defined as the removal of metal from runner and other hydraulic passages of a weight $W=15\ Dj^2z$ per 1000 hrs of operation, where Dj is the maximum jet diameter in meters, z is the number of jets and W is the weight in kg. If the 18 months of guarantee period expire before completion of 8000 hours of operation, the guarantee shall apply to the actual hours of operation proportionately.

In case of cavitation pitting exceeding the guarantee, the turbine supplier shall at his cost, take corrective measures, such as modification of design, finish, replacement, repair, etc. and the turbine after modification, etc., shall be subject to cavitation guarantee as for the original equipment. In determining whether or not excessive pitting has occurred, metal removal by erosion, corrosion or by the presence of injurious elements in water, etc., shall be exclude. Cavitation and pitting evaluation shall be in accordance with IEC 609 (Cavitation, pitting evaluation in hydraulic turbines, storage pumps and pump turbines).

08. GUARANTEED TECHNICAL PARAMETERS

08.01 GENERAL

Tenderer shall furnish the complete technical guaranteed parameters of all the plant & equipment offered for the project as per the format given in this section.

Tenderer shall provide detailed information of the offered equipment. In case data sheet of any component is not included in this chapter, same shall be furnished by the tenderer.

08.02 TURBINE, GOVERNING SYSTEM AND AUXILIARY

08.02.01 GUARANTEED AND OTHER TECHNICAL PARTICULARS

SL. NO.	ITEM DESCRIPTION	VALUE	REMARKS
A	**TURBINE**		
1.	Name & address of manufacturer		
2.	Type of turbine and shaft orientation		
3.	Critical sigma		
4.	Plant sigma		
5.	Guaranteed rated output at rated head	kW	
6.	Guaranteed max. output max. head	kW	
7.	Guaranteed max. output at minimum head	kW	
8.	Min. output at min. head and min. discharge	kW	
9.	Min. output at max. head	kW	
10.	Guaranteed efficiencies at rated net head and following outputs		
A	100% of full load	%	
B	80% of full load	%	
C	60% of full load	%	
D	Best efficiency at an output	%	
E	Performance curves including model hill curves (Mention No. of drawings enclosed)		
11	**Cavitation guarantee in Kg/1000 hours of operation**		
	Parts subjected to max. erosion	Kg/1000 hours of operation	
	Operational restriction for turbine if any for above guarantee		
12.	Efficiency at max. head and max. discharge	%	
13.	Efficiency at minimum head and minimum discharge	%	
14.	Efficiency at minimum output and max. head	%	
15.	Efficiency at max. output and minimum head	%	
16.	**SPEED**	RPM	
A	Specific speed in M.K. units		
I	per jet		

SL. NO.	ITEM DESCRIPTION	VALUE	REMARKS
Ii	per turbine		
B	Rated speed	RPM	
C	Max. runaway speed	RPM	
D	Direction of rotation when viewed from drive end/top		
17.	Guaranteed minimum factor of safety under worst conditions based on the yield point of the material		
18	Name and location of the part having the factor of safety as above		
19.	**Momentary rise in speed on suddenly reducing load to zero at rated speed from**		
A	100% of full load not exceeding	%	
B	¾ full load not exceeding	%	
C	½ full load not exceeding	%	
20.	**Time of Needle closing for regulation**		
A	Full load rejection	Seconds	
B	¾ full load rejection	Seconds	
C	½ full load rejection	Seconds	
21.	**Momentary drop in speed on increasing load from zero at rated speed to**		
A	Full load	%	
B	¾ full load	%	
C	½ full load	%	
22.	**Time of Needle opening in item (21) above**		
A	Full load	Seconds	
B	¾ full load	Seconds	
C	½ full load	Seconds	
23.	**Fly wheel effect of :**		
A	The generating unit for regulation stated above	Kg/m2	
B	Turbine runner and shaft		
C	Flywheel (if any)		
24.	Max. water hammer pressure % of rated head		
25.	**RUNNER**		
A	Material and composition		
B	No. of runner buckets		
C	PCD of buckets		
D	Weight of runner		
E	Source of runner casting		
26.	**SHAFT**		
A	Material and composition		
B	Diameter	mm	
C	Length	mm	

SL. NO.	ITEM DESCRIPTION	VALUE	REMARKS
D	Weight	Kg	
27.	Elevation of centre line of nozzle(s)		
28	**NOZZLE AND NEEDLES**		
A	No. of nozzles		
B	Material of nozzle mouth		
C	Material of needle tip		
D	Nozzle diameter		
E	Max. jet diameter		
29	**MANIFOLD/DISTRIBUTOR**		
A	Type		
B	Material		
C	Inlet diameter		
D	No. of sections		
E	Maximum design pressure		
F	Weight		
30	**DEFLECTOR**		
A	Material of deflector		
B	Deflector closing time		
31	**HYDRAULIC THRUST**		
A	Maximum thrust	N	
B	Minimum thrust	N	
32	Noise at a distance of 1m from the turbine	db	
33	**VIBRATION (LOCATION ALSO TO BE MENTIONED)**		
A	Horizontal		
B	Vertical		
C	Axial		
33	**TURBINE GUIDE BEARING**		
A	Location		
B	Type of bearing		
C	Diameter and length	mm	
D	Working temperature of bearing surface	^{0}C	
E	Medium of lubrication		
F	Recommended grade and make of lube oil/water		
G	Quantity of lube oil/water		
H	Material of bearing		
I	Weight		
J	Max. runaway speed the bearing can withstand		
K	Max. duration of above runaway speed		
L	Whether the bearing can withstand the runaway speed with or without cooling water		

SL. NO.	ITEM DESCRIPTION	VALUE	REMARKS
B.	**GOVERNING SYSTEM**		
1	Make		
2	Type of governor		
3	Rating		
4	Guaranteed sensitivity of governor (Minimum speed change to which governor will respond)	RPM	
5	Range of adjustment of permanent speed droop		
6	Range of adjustment in speed setting		
7	Governing opening and closing times		
8	Description and method of operation		
9	Adjustment range in governor opening and closing time		
10	**HYDRAULIC ACTUATOR**		
A	Range of adjustment of guide vane /needle opening time	s	
B	Range of adjustment of guide vane /needle closing time	s	
C	Range of pressure for satisfactory operation	Kg/cm2	
11	**OIL PRESSURE VESSELS**		
A	No. of vessels per unit		
B	Dimensions of pressure vessels		
C	Normal volume of oil in each		
D	Normal working pressure		
E	Grade of oil recommended		
12	**OIL PUMP AND SUMP TANK**		
A	No. of oil pumps per unit		
B	Type of pump		
C	Capacity of each pump		
D	Total volume of sump tank		
E	Effective volume of sump tank		
F	Total volume of oil in the governing system		
13	**COMPRESSED AIR EQUIPMENT**		
A	type		
B	make		
C	details		
C	**COOLING WATER SYSTEM**		
1	Source		
2	No. of pumps		
3	Rating of each pump		
4	Capacity of duplex strainer		
5	Material and size of strainer element		
D	**COMPRESSED AIR SYSTEM**		
1	No. and capacity of compressors		

SL. NO.	ITEM DESCRIPTION	VALUE	REMARKS
2	Make		
3	Type		
4	Working pressure		
5	Design Pressure		
6	Test Pressure		
7	Capacity of air receiver		
E	**BUTTERFLY VALVE**		
1	Make		
2	Diameter		
3	Working pressure		
4	Design Pressure		
5	Test Pressure		
F	**SPHERICAL VALVE**		
1	Make		
2	Diameter		
3	Working pressure		
4	Design Pressure		
5	Test Pressure		
G	**GENERAL**		
1	**HEAVIEST PACKAGE FOR SHIPMENT**		
A	Name		
B	Weight		
C	Dimension (LxWxH)		
2	**LARGEST PACKAGE FOR SHIPMENT**		
A	Name		
B	Weight		
C	Dimension (LxWxH)		
3	**HEAVIEST ASSEMBLY TO BE LIFTED BY POWER HOUSE CRANE**		
A	Name		
B	Weight		
C	Dimension (LxWxH)		

08.03 GENERATOR, EXCITATION SYSTEM AND AVR

08.03.01 GENERATOR

Sl. NO.	DESIGNATION	VALUE	REMARKS
1.	Make of generator		
2.	Type and reference		
3.	Rated synchronous speed for synchronous frequency of 50 Hz		
4.	Direction of rotation		
5.	Name and location of part of party stressed to maximum under runaway condition		
6.	Maximum permissible continuous negative phase sequence current.		
7	Normal voltage and voltage range.		
8	Power factor		
9	Frequency and frequency range		
10	**Guaranteed rated output for temperature rise mentioned in specifications under conditions of**		
a	0.90 power factor at any voltage in the operating range.		
b	Rated voltage, zero leading power factor during line charging with 5% full load positive excitation margin.		
c	0.90 power factor lagging continuous overload capacity at any voltage		
d	95% rated kV, zero leading power factor during line charging with 5% full load excitation margin.		
11	Flywheel effect of the rotating parts of the generator, GD^2		
12	Inertia constant of the generator based on the generator rated KVA.		
13	Short circuit ratio.		
14	Runaway speed at which all parts are guaranteed to withstand safety.		
15	Minimum factor of safety based on yield point of materials		
16	Maximum temperature rise for the output guaranteed under item 10 (a)		
17	**At any voltage and frequency in the operating range**		
a	Stator winding by embedded temperature detector.		
b	Rotor winding by resistance measurement.		
c	Bearing by embedded temperature detector		
d	Other parts by thermometer.		
18	**Guaranteed under item 4 (iii) at any voltage and frequency in the operating range**		
a	Stator winding by embedded temperature detector.		

Sl. NO.	DESIGNATION	VALUE	REMARKS
b	Rotor winding by resistance measurement		
c	Bearing by embedded temperature detector		
d	Other parts by thermometer		
19	**Overall efficiency of generator while operating at rated voltage, 0.90 power factor lagging and 75^{0}C winding temperature at**		
a	110% full load		
b	100% full load		
c	90% full load		
d	80% full load		
e	60% full load		
f	40% fullload		
g	**Weighted average efficiency.**		
20	**Inherent regulation i.e. increase in voltage at constant speed and excitation on taking off.**		
a	110% full load		
b	100% full load		
c	60% full load		
21	**Reactance (referred to rated generator KVA base)**		
a	**Synchronous reactance**		
	i) Direct axis (X_d) sat/unsat.		
	ii) Quadrature axis (X_q)		
b	**Sub transient reactance**		
	i) Direct axis (X'd) sat/unsat.		
	ii) Quadrature axis (X'_q)		
c	**Sub transient reactance**		
	i) Direct axis ($X"_d$) sat/unsat.		
	ii) Quadrature ($X"_q$) sat/unsat.		
22	**Negative phase sequence reactance**		
a	(X_2) sat/unsat.		
b	Zero phase sequence reactance (X_6)		
c	Armature leakage reactance		
d	Ratio of quadrature axis sub-transient reactance to direct axis sub-transient reactance ($X"_q/X"_d$)		
23	**Thrust bearing.**		
a	Temperature rise by RTD's while delivering rated output with cooling water supply at 30^{0}C.		
i	Pads		
ii	Oils		
b	Temperature rise by RTD's while delivering the maximum output with cooling water supply at 30^{0}C.		

Sl. NO.	DESIGNATION	VALUE	REMARKS
i	Pads		
ii	Oils		
24	**Guide Bearing.**		
a	Temperature rise by RTD's rated output with cooling water supply at 30^0C.		
i	Pads		
ii	Oils		
c	Temperature rise by RTD's of the bearing while delivering the maximum output with cooling water supply at 30^0C.		
i	Pads		
ii	Oils		
25	**Operating capability of thrust bearing (in minutes) for the following conditions of operation.**		
a	At rated speed without cooling water supply.		
b	At runaway speed with cooling water supply		
c	At runaway speed without cooling water supply		
d	At low speed of 4% of rated speed with lubrication system 'ON'		
26	**Operating capability of guide bearing (in minutes) for the following conditions of operation.**		
a	At rated speed without cooling water supply.		
b	At runaway speed with cooling water supply		
c	At runaway speed without cooling water supply		
d	At low speed of 4% of rated speed with lubrication system 'ON'		
27.	**Generator resistance at 75^0C.**		
i)	Armature winding per phase.		
ii)	Field winding		
iii)	Damper winding		
28.	**Generator time constants**		
i)	Direct axis transient open circuit time constant		
ii)	Direct axis transient short circuit time constant		
iii)	Quadrature axis transient short-circuit time constant		
iv)	Direct axis sub-transient time constant		
v)	Short-circuit time constant of armature winding.		
vi)	Short-circuit time constant of damper winding with excitation winding shorted.		
29.	Maximum $(I_2/I_n)^2$ t value.		
30.	Synchronizing power at rated voltage 50Hz, 0.90 power factor lagging.		

Sl. NO.	DESIGNATION		VALUE	REMARKS
31.	Allowable continuous single phase loading at rated voltage and power factor			
32.	Calculated generator capacitance per phase to ground of stator winding.			
33.	**Voltage waveform**			
i)	Waveform deviation factor			
ii)	No load harmonies in the voltage wave			
34.	**Telephonic harmonic factor**			
i)	Balance			
ii)	Residual			
35.	**Schedule of losses (At Rated voltage, power factor and frequency)**			
	Losses	**110 % F.L**	**100% F.L**	**60% F.L**
i	Friction windings losses			
ii	Core losses			
iii	Armature I^2 R losses at 75^0C			
iv	Stray load losses			
v	Field I^2 R losses at 75^0C			
vi	Static Excitation system losses			
Total losses.				
36.	**Generator stator**			
a	Material of stator core			
b	Number of sections in which stator is divided for transportation.			
c	Grade thickness and insulation of stator Laminations.			
d	Insulation thickness of winding.			
	i) Slot portion			
	ii) Over-bang portion			
e	Stator core dimensions			
i	Inside diameter.			
ii	Outside diameter.			
iii	Length without/with air ducts.			
iv	Ratio of stator core diameter and length			
v	Total number of slots			
vi	Finished slot size.			
vii	Net weight of active iron			
f	Outside diameter of stator frame.			
g	Diameter of stator foundation			
h	Width of air gap at centre of pole top			

Sl. NO.	DESIGNATION	VALUE	REMARKS
i	Flux density at rated voltage on no load in		
	a) Air gap.		
	b) Stator core.		
	c) Teeth		
	d) Pole body.		
j	Current density in stator winding		
k	Cross sectional area of copper winding stator, cach bar.		
l	Weight of copper in stator winding.		
m	Resistance of stator winding per phase at I^2 R losses at 25^0C		
n	Calculated capacitance of stator winding per phase.		
o	Detail of transposition of stator		
p	Total weight of stator		
37.	GENERATOR ROTOR		
a	Materials		
i	Pole Punching.		
ii	Rim punching.		
iii	Spider arms		
iv	Spider hub.		
v	Pole and plates.		
b	Type of rotor rim construction		
c	Construction of field poles		
d	Method of attaching field poles to the rotor rim		
e	Class of insulation o field winding		
f	Material and thickness of insulation.		
g	Width and height of pole body		
h	Weight of active iron in each field pole		
i	Maximum current density in rotor winding.		
j	Cross-sectional area of copper in field winding.		
k	Weight of copper in filed winding per pole		
l	Damper winding.		
i	Number and diameter of damper bars per pole		
ii	Whether connected between poles.		
m	Resistance of filed winding at 25^0C		
n	Factor of safety at maximum speed based on yield strength of material.		
o	Type of collector rings.		
p	Number of brushes/collector rings		
q	Diameter of assembled rotor		
r	Total weight of rotor		
38.	**SHAFT**		

Sl. NO.	DESIGNATION	VALUE	REMARKS
a	Material and construction		
b	Diameter (nominal)		
c	Length		
d	Diameter of axial bore		
e	Diameter of coupling flanges.		
f	Weight of assembled shaft.		
g	Computed critical speed of		
i	Without considering unbalanced magnetic force (pull)		
ii	Considering unbalanced magnetic force (pull)		
h	Tolerance for shaft alignment		
i	Factor of safety (based on the yield strength of the material)		
39.	**THRUST BEARING.**		
a	Type.		
b	Location.		
c	Diameter of bearing		
i	Inside		
ii	Outside		
d	No. of pads and size		
e	Effective bearing area.		
f	Composition of pad material		
g	Thickness of material		
h	Type, number and location of		
i	Temperature detectors		
ii	Dial type thermometers		
iii	Cooling water requirement		
iv	Quantity		
v	Pressure range		
i	Normal working temperature of bearing (pad)		
j	Maximum permissible temperature of bearing for		
i	Alarm		
ii	Trip		
k	Total load on thrust bearing including hydraulic thrust		
i	Design load.		
ii	Actual during working conditions.		
l	Distance through which rotor is to be raised for removal of thrust bearing pads		
m	Pump motor rating for lubrication system		
40.	**GUIDE BEARINGS**		
a	Type		
b	Location and number		

Sl. NO.	DESIGNATION	VALUE	REMARKS
c	Number pads and size		
d	Effective bearing area		
e	Material of bearing pads		
f	Normal working temperature of bearing		
g	Maximum permissible temperature of bearing for		
i	Alarm		
ii	Trip		
41.	OIL		
a	Type and grade of specification		
b	Standard to which it shall conform		
c	Quantity of oil for first filling of thrust and guide bearing oil.		
42.	**BEARING BRACKETS**		
a	Material and composition		
b	Type and construction		
c	No. of arms		
d	Weight		
43.	**GENERATOR BRAKES**		
a	No. of brake units		
b	Size of brake shoe		
c	Size of piston		
d	Material of brake ring.		
e	Material of brake liner.		
f	Air pressure required for operation.		
g	Speed at which the air brakes are applied.		
h	Time required for bringing the machine to rest by applying mechanical brakes.		
i	In normal shut down.		
ii	In emergency shut down.		
44	**GENERATOR COOLING**		
a	Type and method of cooling		
b	Number and location of fans.		
c	Number of surface air coolers.		
d	Temperature of air entering generator from coolers.		
e	Maximum number of surface air cooler required for maximum output of generator.		
f	Details of other method cooling (if required)		
45	Weight of generator rotating parts		
46	Weight of complete generator		
47	**Heaviest package for transportation**		
a	Name		

Sl. NO.	DESIGNATION	VALUE	REMARKS
b	Weight		
c	Dimensions (L x B x H)		
48	**Largest package for transportation.**		
a	Name		
b	Weight		
c	Dimensions (L x B x H)		
49	**Heaviest assembly to be lifted by power house crane.**		
a	Name		
b	Weight		
c	Dimensions (L x B x H)		
50	**Largest assembly to be filled by power house crane.**		
a	Name		
b	Weight		
c	Dimensions (L x B x H)		
51.a	Maximum clearance required for the EOT crane hook above service bay for lifting of assembled generator.		
51.b	Whether the available EOT crane clearance is good enough for the assembled generator		
52	**Largest assembly to be taken out through the stator bore**		
a	Name		
b	Weight		
c	Dimensions (L x B x H)		

08.03.02 EXCITATION AND AVR SYSTEM

ITEM	DESIGNATION	VALUE	REMARKS
	EXCITATION SYSTEM AND AVR		
1.	Manufacture		
2.	Place of manufacture		
3.	Type designation		
4.	Applicable standards		
5.	**Rating of excitation system at rated generator output and rated power factor (hot rotor winding)**		
i)	Field voltage		

ITEM	DESIGNATION	VALUE	REMARKS
ii)	Field current		
iii)	Field power		
iv)	No load excitation voltage		
v)	No load field current		
vi)	Field flashing current and duration		
6.	**Ceiling voltage in per units of rated field voltage**		
i)	Ceiling voltage at no load		
ii)	Ceiling voltage at rated load.		
7.	Field current at rated ceiling voltage.		
8.	Excitation system voltage response ratio		
9.	Response time to reach 95% of the difference between rated ceiling voltage and full load field voltage.		
10.	Time to rach+0.5% of ceiling voltage from rated voltage.		
11.	Maximum time period for operation at ceiling voltage power factor 0.9 and maximum generator power.		
12.	Data of excitation system at 110% rated generator terminal voltage, power factor 0.9 and maximum generator power.		
i)	Field voltage		
ii)	Field current		
13	Maximum continuous output capability of excitation system.		
i)	Maximum field current		
ii)	Maximum field voltage		
14	Maximum duration of over excitation		
15	Time to reach 5% limit of generator terminal voltage in case of load rejection		
16	Maximum overshoot of generator terminal voltage in case of load rejection.		
17	Setting time to reach 0.5% limit of generator terminal voltage after over speed conditions.		
18	Range of voltage level setting		
19	i) Range for manual control of excitation.		
	ii) Frequency range of operation		
	iii) % transformer drop compensation		
20	Excitation transformer		
i)	Type		
ii)	Transformer continuous three Phase power rating.		

ITEM	DESIGNATION	VALUE	REMARKS
iii)	Transformer voltage ratio		
iv)	Transformer no-load losses (three-phase) at rated voltage, and rated frequency.		
v)	Vector group / connection.		
vi)	Transformer total losses (75^0C three-phase) at full load at rated voltage and rated frequency.		
vii)	No-load current at rated voltage frequency.		
viii)	Impedance voltage (75^0C) at rated frequency on 100% rated kVA.		
ix)	Transformer temperature rise after continuous operation with rated kVA, under rated conditions. - Winding (by resistance) - core		
x)	Transformer rated voltage at rated frequency and no-load.		
a)	High-voltage		
b)	Low voltage		
xi)	Standard applicable		
xii)	Material		
a)	Core		
b)	Conductor		
xiii)	Class of insulation		
xiv)	BIL		
xv)	Temperature rise		
21	Voltage Regulation system.		
i)	Make		
ii)	Type		
iii)	Accuracy of voltage regulation		
iv)	Range of voltage setting.		
a)	Auto mode		
b)	Manual mode		
v)	Voltage regulation from no load to full load.		
22	Rectifiers		
	Type of rectifiers		
	Type of thyristors		
	Number of thyristor per Interchangeable module.		
	Number of modules per bridges or stacks		
	Number of bridges or stacks		
	Number of parallel paths.		
	Number of thyristors		
	a) In series		

ITEM	DESIGNATION	VALUE	REMARKS
	b) In parallel per path		
	Rated current of rectifiers		
	Rated voltage of rectifier		
	Average forward current rating per thyristor.		
	Forward voltage drop per thyristor		
	Maximum safe operating temperature.		
	Maximum surge current rating.		
	Max. permissible duration of surge current.		
	Cooling fans for rectifiers (if necessary) number of fans.		
	Fan ratings		
	Electrical fan motor ratings		
a)	Rated voltage		
b)	Rated power consumption		
	Auxiliary transformer(s) for cooling fans and other		
a)	Ratings		
b)	Rated primary voltage		
c)	Rated secondary voltage		
23	Field circuit breaker		
i)	Rated current		
ii)	Rated voltage		
iii)	Rated breaking current		
iv)	Total opening current		
v)	Total opening time		
vi)	Total closing time		
vii)	Operating sequence		
24	AC-field flashing equipment		
i)	Duration of flashing		
ii)	Power rating of field flashing transformer.		
iii)	Rated voltages of transformer		
a)	Primary		
b)	Secondary side		
25	DC-field flashing equipment		
i)	Power requirements		
ii)	Supply voltage		

09. QUALITY CONTROL, INSPECTION & TESTING

09.01 QUALITY CONTROL AND INSPECTION

09.01.01 GENERAL

a) Inspection & testing of plant & equipment shall be carried out by TANGEDCO/Purchaser at the works of successful tenderer (Contractor/Sub-contractor(s)) during manufacturing and on final product to ensure conformity of the same with the acceptable criteria of technical specifications, approved drawings, authenticated manufacturing drawings and reference national/international standards.

b) This specification is in addition to provisions laid-down in TANGEDCO/Purchaser's General Condition of Contract (GCC) and special instructions to tenderers, if any.

09.01.02 QUALITY ASSURANCE PLAN (QAP)

a) Contractor shall furnish Quality Assurance Plan (QAP) for respective equipment after completion of detailed engineering and finalisation of billing schedule / equipment identification number for TANGEDCO/Purchaser's approval prior to start of manufacturing.

b) QAP shall be prepared and furnished by the successful tenderer in FORM No. 11.20(DQM)F-09 and 10 Rev 0 (enclosed) for structural & mechanical and electrical items respectively in four sets.

09.01.03 INDICATIVE SURVEILLANCE BY TANGEDCO

Surveillance level by TANGEDCO shall vary from equipment to equipment as per product below for guidance of contractors in developing QAP.

SN	Categories of Equipment	Extent of Inspection (as applicable from equipment to equipment)
i.	Forged, cast, lined products and piping	Material test certificates to be submitted by the contractor at the time of giving inspection call for the main equipment in the final stage. Following checks/tests will be carried out in final stage. Visual inspection Alignment and fitment checking Dimensional checking Witnessing of NDT as per design requirement.
ii.	Manufactured items (Mechanical, fabricated and welded)	Material and manufacturer's test certificates to be submitted by the contractor at the time of giving inspection call for the main equipment in the final stage. Visual inspection Alignment and fitment checking

SN	Categories of Equipment	Extent of Inspection (as applicable from equipment to equipment)
		Dimensional checking Weld inspection – visual and NDT as per design requirement. Radiographs are to be shown and reports to be submitted to TANGEDCO for review during inspection, if applicable. Witnessing of other tests like pneumatic, hydraulic no-load running, functional, balancing, performance etc. depending upon criticality of the part item / equipment.
iii.	Bought-out items	Following standard bought-out items shall be accepted on the basis of manufacturer's test certificates. ERW Pipes, if supplied by approved manufacturer's Flowmeters Pneumatic & hydraulic cylinders Insulation materials Bolts, nuts & washers (Grade 4.6).
iv.	Electrical equipment	Final inspection & Testing Verification of test certificates Visual & workmanship Dimensional Witnessing of routine tests as per relevant standards. Manufacturer's to be submitted for verification. Witnessing of type/acceptance tests, as applicable
v.	Instrumentation	Final inspection & testing. Verification of test certificates Workmanship and visual Dimensional checking Calibration of the instrument for specified parameters shall be checked.

09.01.04 CALIBRATION OF MEASURING EQUIPMENT

All the measuring equipment used for inspection & testing shall be calibrated and appropriate accuracy class of measuring equipment shall be used. Calibration standards used for calibration of measuring equipment shall be traceable to national standards of National Physical Laboratory (NPL), New Delhi with unbroken chains of comparison.

09.01.05 CALIBRATION CERTIFICATE OF ALL MEASURING EQUIPMENT

a) Valid calibration certificate for all measuring equipment used during inspection and testing with traceability to national standards of NPL/NPL-accredited laboratories shall be furnished along with inspection call prior to undertaking inspection by TANGEDCO/Purchaser.

b) Calibration certificate shall also indicate reference no. of calibration standards calibrated by NPL/NPL- accredited laboratories and copies of such calibration certificates of calibration standards shall also be furnished when asked for.

09.01.06 TEST CERTIFICATES AND DOCUMENTS

a) For each of the items being manufactured, following test certificates and documents, as applicable for each of the equipment, in requisite copies including original shall be submitted to Inspection Agency. All test certificates must be endorsed by the manufacturer and Contractor with linkage to project, purchase order and acceptance criteria.

b) Raw materials identification & physical and chemical test certificates for all materials used in manufacture of the equipment (except IS 2062-1992 Gr. A & IS 210-1993, FG-150).

c) WPS, PQR & WPQ Documents as per applicable code.

d) Details of stage wise inspection & rectification records for fabricated items, castings, forgings and machined articles.

e) Control dimension chart with records of alignment, squareness etc.

f) Manufacturer's material and performance/relevant test certificates for all bought-out items.

- Details of heat treatment and stress relieving charts as per specification.
- Non-destructive Test report as per respective code.
- Static /dynamic balancing certificate for rotating components / machines.
- Hardness test certificate
- Pressure Test Certificates
- Performance Test Certificates for all characteristics.
- Geometric accuracy and repeatability test reports of machine tools
- Routine / type / calibration / acceptance /special test certificates for electrical items.
- Surface preparation and painting certificates.
- Certificates from components authority for the item coming under statutory regulations.

g) Where physical and chemical test certificates of material are not available, the contractor/Sub-contractor shall arrange to have specimens and test samples of the materials. Tested in his own laboratory at his cost and submit the copies of test results in requisite numbers to Inspection Agency for scrutiny and approval. Number of test samples against each heat / cast / lot or batch of materials shall be as per relevant Indian or

International Standards.

h) Where facilities for testing do not exist in the contractor/Sub-contractor's laboratories or in case of any dispute, samples and test pieces shall be drawn by the Contractor/Sub-contractor in presence of Inspection Agency and sealed sample shall be sent to any approved laboratory for necessary tests at Contractor/Sub-contractor's cost.

i) The Inspection Agency shall have the right to be present and witness all tests being carried out by the Contractor-Sub-contractors at their own laboratory or approved laboratories. Also the Inspection Agency shall reserve the right to call for confirmatory test on samples, at his discretion.

09.01.07 MANUFACTURING AND INSPECTION SCHEDULE

a) The Contractor shall submit to the TANGEDCO/Purchaser quarterly programme of inspection and tests one month in advance of the commencement of the quarter. The Contractor shall give the TANGEDCO/Purchaser a minimum of 30 days clear notice of any work being ready for inspection and tests specifying the period likely to be required for such inspection and tests.

b) Thereafter, the TANGEDCO/Purchaser or his inspector shall, unless inspection or test is voluntarily waived, attend at the Contractor's or his Sub-Contractor(s)'s premises, such inspection and tests within 7 days of the date on which the equipment is notified as being ready for inspection and test.

c) Should the TANGEDCO/Purchaser fail to attend such inspection and test, the Contractor may proceed with the inspection and test at his option which shall be deemed to have been made in the TANGEDCO/Purchaser's presence and shall forthwith forward to the TANGEDCO/Purchaser copies of inspection/test certificates for acceptance by the TANGEDCO/Purchaser. The proforma and number of copies for inspection/test certificates shall be mutually agreed. However, if the TANGEDCO/Purchaser request the Contractor for a revised date of inspection but within 15 days of the date of inspection as communicated by the Contractor, the Contractor shall arrange the inspection on the revised date as requested by the TANGEDCO/Purchaser.

d) Contractor/manufacturer shall not dispatch any equipment till receipt of MDCC from TANGEDCO/Purchaser.

09.01.08 INTERNAL INSPECTION BY CONTRACTOR / MANUFACTURER

a) Inspection and tests shall be carried out by Contractor / Manufacturer in accordance with approved drawings, TS P. O., and approved QAP. Contractor / Manufacturer shall maintain record of each inspection and test carried out and signed documents shall be submitted to TANGEDCO for verification.

b) Contractor shall carry out their internal inspection & obtain clearance from statutory bodies e.g. IBR, CCE, TAC, Weights & measures, safety. IE rules etc. prior to offering any

equipment for TANGEDCO inspection in accordance with approved QAP.

c) Contractor / manufacturer shall ensure use of appropriate calibrated measuring equipment during their internal inspection, as well as make available the same during TANGEDCO inspection and tests. Also they shall make necessary arrangement for access and use of TANGEDCO owned measuring equipment during inspection.

d) Contractor / Manufacturers shall identify all the inspected equipment/component/raw materials & shall maintain the record of status of inspection viz. Inspected & found acceptable, require rectification/rework, rejected etc.

e) The contractor shall establish and maintain procedures to ensure that product that does not conform to specified requirements, is prevented from inadvertent use or installation. The description of non-conformity that has been accepted subsequently by TANGEDCO/Purchaser by concession and/or or repairs, shall be recorded.

f) Repaired and reworked product shall be offered for re-inspection to TANGEDCO along with records of corrective action taken.

g) Contractor / Manufacturer shall not dispatch any equipment till receipt of dispatch clearance from TANGEDCO.

09.01.09 METHOD OF ISSUING INSPECTION CALL TO TANGEDCO/PURCHASER

Inspection call shall be floated to respective offices in the enclosed Form No. 11.20 (DQM)F-05/2, REV-0 duly filled in, with ten days clear margin, enclosing all documents like test Certificates, Internal Inspection Reports, P.O., Sub-P.O., T.S., Approved QAP, approved GA drawings/data sheets and manufacturing drawings with a copy of call letter to Inspection Co-ordinating Office, Inspection calls without above documents shall be ignored.

09.01.10 OBLIGATIONS OF CONTRACTOR

a) The Contractor shall provide all facilities and ensure full and free access of the Inspection Engineer of TANGEDCO/Purchaser to the Contractor's or their Sub-contractor's premises at any time during contract period, to facilitate him to carry out inspection & testing of the product during or after manufacture of the same.

b) The Contractor shall delegate a Representative/Co-ordinator to deal with TANGEDCO/Purchaser on all inspection matters. Also, Contractor's Representative shall be present during all inspection at Sub-Contractor's works.

c) The Contractor / Sub-Contractor shall provide all instruments, tools, necessary testing & other inspection facilities to Inspection Engineer free of cost for carrying out inspection.

d) The cost of testing welds by ultrasonic, radiographic and dye penetration tests etc. in the

fabrication workshop shall be borne by the Contractor.

e) The Contractor shall ensure that the equipment/assembly/component of the plant and equipment required to be inspected, are not dismantled or dispatched before inspection.

09.01.11 INSPECTION CERTIFICATE

a) On satisfactory completion of final inspection & testing, all accepted plant & equipment shall be stamped suitably and Inspection Certificate in standard form shall be issued by the Inspection Engineer for the accepted items. If a final certificate can not be issued, a provisional certificate shall be issued.

b) If the tests were not witnessed by the TANGEDCO/Purchaser or his representative the certificate shall be issued on receipt of the inspection and tests report from the Contractor but not later than 30 days after the receipt of the said report by the TANGEDCO/Purchaser.

c) In the event a certificate is not issued by the TANGEDCO/Purchaser during 30 days, the Contractor, if considered necessary, can arrange dispatch along with the certificate with the clear understanding that if the TANGEDCO/Purchaser reject such equipment at a later date, the Contractor shall rectify the same at his own cost to the TANGEDCO/Purchaser's satisfaction. No Plant shall be shipped or left or otherwise dispatched before such certificate has been issued.

d) The satisfactory completion of these inspection and tests or the issue of the certificate shall not bind the TANGEDCO/Purchaser to accept the work, should it on further tests during or after erection be found not to comply with the Contract.

09.01.12 INSPECTION WAIVER CERTIFICATE

For the waiver category of items indentified in the approved QAP, TANGEDCO/Purchaser shall issue Inspection Waiver Certificate after scrutiny of Contractor's internal Inspection Report, Test Certificates and other Documents as identified in QAP.

09.01.13 GENERAL CLAUSES

a) The Contractor shall bear all costs of any and all inspections and tests. Where special tests in addition to agreed tests are required by the TANGEDCO/Purchaser, the Contractor shall bear the cost of the testing provided the Contractor is convinced that within this/these special test(s) the quality of the equipment in accordance with the specification can not be proved. If such special tests are necessary based on the results of the agreed test, then cost of all such special tests shall be to the account of the Contractor in all cases.

b. The TANGEDCO/Purchaser upon giving 7 days notice in writing and stating any grounds of objection, shall have the right to reject any or all equipment or demand rectification or replacement thereof.

b) In the case of commissioning spares, operating & maintenance spares and mandatory spares, the same shall be offered for inspection along with the main equipment or after the main equipment has been satisfactorily inspected and tested.

c) TANGEDCO/Purchaser reserve the right to inspect any product at any stage of manufacturing without prior notice to Contractor/Manufacturer beyond pre-identified stages & hold points of approved QAP.

d) Inspection / tests including mechanical running test, material test, performance test shall be carried out and relevant test certificates shall be furnished.

e) All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining. The pressure parts shall be kept pressurised for at least 15-20 minutes at this pressure.

f) All other parts including interconnecting piping shall be hydraulically tested wherever possible as per relevant standards.

09.02 TESTING

09.02.01 SHOP ASSEMBLY AND TESTS

a) The equipment / components of turbine and generator such as runner, turbine shaft, needle, servomotor, turbine guide bearing, generator shaft etc. shall be shop tested as per relevant National/ International Standards/approved shop assembly drawing .

b) Shop tests of turbine and associated equipment shall be carried out by the manufacturer at their works not limited to the following:

1. Once turbine manufactured first shall be assembled in the shop to the extent possible
2. Static balancing of runners
3. Hydrostatic testing at 1.5 times the maximum working pressure for not less than 15 minutes for manifold, servomotors etc.
4. Non-destructive testing of welds
5. Performance tests for individual auxiliary equipment
6. Complete assembly and simulation of governors
7. Assembly of distribution
8. All motors/pumps/compressors, etc shall be tested as per relevant IS/IEC standards

09.02.02 FIELD ACCEPTANCE TESTS

a) The turbine shall be tested at site for establishing fulfillment of guarantees in respect of turbine output & efficiencies including weighted average efficiency. The test shall be carried out as per **IEC – 60041** for field acceptance tests of hydraulic turbine. The arrangement for this test including the testing devices shall be supplied and erected by the successful tenderer.

b) The TANGEDCO/Purchaser at his discretion may call third party for witnessing the tests before acceptance.

c) The field acceptance test shall include testing during erection, certification of the completion of erection of the equipment by the TANGEDCO/Purchaser and tenderer. Equipment wise field quality plan shall be submitted by the tenderer. After completion of erection pre-commissioning checklist points shall be attended by the tenderer. Equipment wise pre-commissioning checklist schedule shall be submitted by the tenderer.

d) After attending the pre-commissioning checklist points the tenderer shall go for commissioning of the equipment as per commissioning procedure and the same shall be submitted by the tenderer before commissioning. After successful commissioning of the complete system the tenderer shall go for PG test as per the TGP approved by TANGEDCO/Purchaser.

e) The successful tenderer shall submit formats of protocol for each of erection, testing and commissioning for approval by TANGEDCO/Purchaser.
If the performance at field is found not to meet the requirement, then the equipment shall be rectified by the Tenderer without any extra cost within the overall time schedule.

09.02.03 PERFORMANCE GUARANTEE TEST

- The PG tests for the turbine and generator shall be done for satisfactory performance in accordance with the following standard and TGP approved by TANGEDCO/Purchaser:

- IEC 60545 - Guide for commissioning, operation and maintenance of hydraulic turbines
- IEC 60034 - Rotating electrical machinery and
- IEEE Guide Std 115 - Test procedure for synchronous machine.

- Report & Test certificates shall be submitted to TANGEDCO/Purchaser.
- The PG test shall be conducted by the prospective bidder by arranging Accredited / Reputed third party agencies like IIT, Roorkee, STEAG, etc.

- TANGEDCO/Purchaser or his authorised representative shall be given full access to witness all tests. Prior to performance tests, the contractor shall intimate TANGEDCO/Purchaser allowing adequate time so that if TANGEDCO/Purchaser so desires his representative can witness the test.
- All equipment, measuring instruments including tools and tackles necessary for conducting the performance test to be brought by the contractor / third party agency.
- The contractor shall get approval from TANGEDCO before nominating the third party agency for PG test.
- Necessary additional control/instrumentation points to facilitate third party PG Test shall also be provided as per standards.

09.02.04 TESTS ON GENERATOR & ELECTRICS

The tests listed below are to be carried on each set

09.02.04.01 Test Prior to initial run

1. Insulation resistance of bearings
2. Insulation resistance of the slot winding thermometer
3. HV testing of RTD
4. Measurement of the insulation resistance and polarization index of the stator winding
5. Measurement of the insulation resistance of the field winding including slip rings
6. High potential DC test on stator winding
7. High potential DC test on field winding
8. Evaluation of the stator winding capacitance & tan delta measurements
9. Measurement of rotor impedance / interturn test
10. DC resistance measurement of the stator winding
11. DC resistance measurement of the field winding
12. Preliminary test of all systems

09.02.04.02 TESTS AFTER INITIAL RUN, MACHINE NON-EXCITED

1. Bearing temperature test up to rated speed
2. Measurement of air pressure in winding overhang space and specified measuring points in the unit
3. Measurement of the air flow rate and determination of the cooling effect
4. Measurement of air pressure in the bearing housing / vapor exhaust
5. Determination of the braking time
6. Balancing of the rotor
7. Over speed test
8. Measurement of shaft / bearing vibration
9. Check for mechanical vibration on parts of the system

09.02.04.03 ELECTRICAL TEST AFTER INITIAL RUN AND PRIOR TO SYNCHRONIZATION

1. Primary tests of generator protection
2. Short – circuit saturation curve, checking of voltage in all relays & meters
3. Open-circuit saturation curve, checking of voltage in all relays & meters.
4. Determination of the synchronous reactance & short circuit ratio.
5. Phase sequence test

6. Measurement of the voltage balance
7. Wave from analysis
8. Optimization of excitation system
9. Measurement of the shaft voltage
10. Shaft / bearing vibration measurement; generator excited
11. Synchronization tests

09.02.04.04 CHECK OF THE EXCITATION SYSTEM

1. AVR-operation including automatic follow up of manual regulator and auto change over
2. Response tests of excitation system
3. De excitation circuit
4. Insulation test
5. High voltage test
6. Performance test at reduced voltage (to extent possible)

09.02.04.05 AVR-

- Accuracy test
- Sensitivity test
- High voltage test
- Performance test at reduced voltage
- Manual channel followed by auto channel
- Range of voltage adjustment test for both auto & manual channel
- Performance test of all limiters
- IR test

All the tests listed above shall also be repeated at site.

- Check OPN of all devices & function of all units / sub units.
- IR Test

09.02.04.06 SYNCHRONIZATION TEST

To be indicated by the tenderer.

09.02.04.07 OTHER TESTS :

- pressure tests on all water pipe lines of cooling water (For generator circuit)
- operation check of cooling water circuit with measurement of inlet / outlet
- Measurement of water quantity in air cooling ckt during rated operation
- Braking time from half speed to zero speed with torque reduced to 10% of rated and with excitation removed.
- Bearing temperatures (all bearings) during rated operation.
- Functional tests of fire fighting equipment.
- Start / Stop sequence test; integrated operation of the plant
- Checking of each equipment, relay, meter, LT motor etc shall be carried out as per the details given in the respective chapters.

Inspection & Testing

For excitation transformer, field control equipment & items not mentioned in the writer up, routine test as per relevant codes shall be conducted at works and at site tests shall be

conducted as per the manufacturer's erection / commissioning manuals.

09.02.05 COOLING WATER SYSTEM (CWS)

a) The contractor shall conduct hydrostatic test on the complete system. For hydrostatic test, the contractor shall furnish the pumps, barrels, tanks, blanks, connections, calibrated test gauges along with and all other necessary apparatus for the test. The contractor shall furnish, install and dismantle all temporary lines from the TANGEDCO/Purchaser's water supply to the system under test, after obtaining due permission from the TANGEDCO/Purchaser regarding finalization of the tapping point.

b) All testing and commissioning shall conform to IS: 5822-1970 for activities, which have not been specified in this specification but found necessary for proper execution of the work.

c) Before commissioning, all the pipelines shall be blown with compressed air to remove any dirt from inside. The portion of pipe to be blown at a time shall be selected in consultation with the TANGEDCO/Purchaser, for maximum effectiveness of the operation. The contractor shall arrange, all the temporary connection, blanking, compressors, etc. required for the job.

d) After air blowing, the pipelines shall be furnished with clear water until the discharge from the pipe is found clean. Flushing velocity shall not be less than the working velocity. contractor shall provide all the temporary connections required for inlet and outlet of flushing water as well as the facilities for drainage of the flushed out water.

09.02.06 OTHER AUXILIARIES

Testing & commissioning of the other auxiliary systems such as Butterfly valve, Spherical valve, Compressed Air system, Dewatering system etc shall be carried out as per relevant standard.

09.02.07 FIRE PROTECTION AND HVWS & MVWS SYSTEM

Testing & commissioning of Fire Protection System shall be carried out as per TAC, NFPA & BIS norms.

10. DATA, DRAWINGS AND INFORMATION TO BE SUBMITTED

10.01 ALONG WITH OFFER

10.01.01 Scope of work with general description of the system and equipment offered specifying the important features. Tenderer shall indicate clearly the work to be carried out in turbine, generator and all other auxiliaries with regard to modifications, additional accessories if required for completion of the job shall be supplied by the contractor without any extra charge, etc. to achieve the rated design capacity.
The description to be accompanied by single line diagrams, and equipment layout to enable the TANGEDCO/Purchaser to have a proper appreciation of the equipment offered and its operation.

10.01.02 Filled in Technical Particulars as given in Ch. 08

10.01.03 Specific Exclusion, if any

10.01.04 Work schedule with bar chart indicating all activities

10.01.05 Main cross section drawing of proposed turbine and generator showing the various components/ parts/ assemblies of the turbine to the extent possible.

10.01.06 Layout drawings of the power house showing the overall dimensions and layout of turbines, clearly indicating unit spacing, dimensions of turbine distributor, etc., and all important elevations

10.01.07 Description of lubrication system along with drawings

10.01.08 Physical and schematic drawings of excitation system and AVR along with descriptive literature.

10.01.09 The general arrangement and overall dimensions of the generators, exciters and bearings, ducts, cable and piping etc.

10.01.10 Charts, Curves and Hill Curves showing performance and cavitation characteristics of the turbine.

10.01.11 Generator Characteristic Curve showing performance of generator

10.01.12 Schematic Diagram and Block Diagram of bearing oil lubrication system, Cooling water System, Drainage /Dewatering system, Compressed Air System, Brake Air System, Fire Protection System

10.01.13 Detailed write up of Microprocessor based digital governor

10.01.14 Physical & Schematic drawings and descriptive literature on the governor and governing mechanism.

10.01.15 Block diagram of excitation and governor control system with start/stop sequence of the plant with control levels.

10.01.16 Phase-wise requirements of power for construction, erection/testing and commissioning activities.

10.01.17 List of performance tests proposed by the tenderer to demonstrate the guaranteed parameters for turbine, generator, electrical equipment and other auxiliaries in addition to tests/checks given in the specifications.

10.01.18 Technical catalogues of equipment offered.

10.01.19 List of annunciation considered in turbine panel, generator desk and in common aux. panels.

10.02 AFTER PLACEMENT OF ORDER

The list of Data/Drawing/Documents to be submitted by Successful tenderer for approval, information will be intimated to the successful tenderer.

11. LIST OF PREFERED MAKES

The Tenderer shall have to select any of the sub-vendors from the list of preferred makes only and no deviation to this effect will be entertained during the execution of the contract unless a specific approval has been obtained for by the Tenderer from the TANGEDCO/Purchaser.

Sl. No.	EQUIPMENT	Preferred Makes
1.	PUMPS	KI RLOSKAR/KSB/MATHER & PLATT/WPIL
2.	MOTORS	NGEF/BBUGEC/BHEUKEC/ JOYTI/ABB
3.	SOLENOID VALVE	ASCO(INDIA), SEITZ-ROTEX, SCADER DUNCAN
4.	INSTRUMENT CABLES	CABLE CORP., FINLOEX CABLES, TOSHNIWAL CABLES
5.	GATE, GLOBE, BALL VALVE	AUDCO, DEZURIC, TIFLIN, SAKHI INTERNATIONAL, BDK
6.	DUPLEX FILTER	OTOKLIN, SUPERFLO, FILTERATION ENGINEERS
7.	PRESSURE CONTROLLERS	SAIL, TISCO, AJANTA TUBE, MAN INDUSTRIES, MUKAND
8.	PLUG VALVES	AUDCO, DEZURIC, TUFLIN
10.	COMPRESSOR	ATLAS COPCO/ IR/ ELGI/ KPC

12. SALIENT FEATURES

Sl.No.	SALIENT FEATURES		
1.	Name of the Dam/Weir	**Kodayar Dam - I**	**Kodayar Dam - II**
2.	Location	K.K.District	K.K.District
3.	River	Kodayar	Kodayar
4.	Purpose	Fore Bay Dam	Fore Bay Dam
5.	Catchement Area	29.12 Sq.km	29.01 Sq.km
6.	Type of Dam/Weir	Masonry Gravity	Masonry Gravity
7.	Height	87.78 m	61.00 m
8.	Length	166.0 m	152.40 m
9.	Length of Earthern Dam Left Flank		
10.	Right Flank		
11.	Reservoir F.R.L.	1325.90 m	350.52 m
12.	Reservoir M.W.L	1325.90 m	350.52 m
13.	Reservoir M.D.D.L.	1295.40 m	318.82 m
14.	Reservoir Capacity at	3.0 Mcft.	3.23 Mcft.

	MDDL		
15.	Reservoir Capacity at FRL	98.69 x 10^6 m^3	0.883 x 10^6 m^3
16.	Reservoir Capacity at MWL	98.69 x 10^6 m^3	0.888 x 10^6 m^3
17.	**SpillWay**		
	Discharge Capacity	257 Cumec.	787 Cumec.
	Crest Length	9.14 m	12.19. m
	Crest Level	1319.80 m.Msl.	341.13 m.Msl.
18	**Gates**		
	Type of Gates	Lift Type	Lift Type
	No. of Gates	One	One
	Size of Gates	9.14 x 6.10 m	12.19 x 9.14 m
19	**Scourvent**		
	Size	1.52 x 2.13 m	1.52 x 2.13 m
	Gate size	2.40 x 2.31 (R) & 2.40 x 2.99 (E)	3.17 x 2.36 (R) & 2.57 x 2.97 (E)
	Still Level	1274.06 m MSL	300.23 m MSL
20	**Intake**		
	Size	2.135 m Dia.	2.74 m Dia.
	Discharge Capacity	8.21 Cumec.	19.40 Cumec.
	Still Level	1290.56m	313.94m Msl
21	**Tunnel** Shape & Size of Tunnel Lined/Unlined Length of Tunnel	Horse Shoe 1555.80 m 3571	- 2.13 m dia. 2015.20 m
22	Flume/Channel		
	Size		
	Lined/Unlined Length		
23	Surge Shaft		
	Size	20 Ft. Dia.	20 Ft.
	Height	434 Ft.	394 Ft.
	No. of Gates		
	Size of Gates		
24	**Valve House**		
	Type of Valve	Butterfly	Butterfly
	Type of operating		
	Mechanism	Open-Water Servo Motor	Open-Water Servo Motor
		Close-Counter Weight	Close-Counter Weight
	Make	Litostraj	Litostraj
	Operating Pressure (Servo)	14 Kg	14 Kg
25	**Penstock**		
	No. of Penstock	One	One
	Length	7000 Ft. (2150.67m)	259 m

	Dia. of Penstock	1.68/1.52/1.37 m	2.13/1.65 m
	Discharge capacity	275 Cusec.	698 Cusec.
	Under Ground		
	No. of Penstock		
	Dia of Pressure Shaft		
	Discharge capacity		
26	**Main Inlet Valve (MIV)**	Spherical	
	Nos.	One	One
	Dia.	1000 mm	1500 mm
	Make	Hydovevey. Switzerland	Litostraj
	Operating Pressure	96 kg/cm^2	26.5 Kg/Sq.C.m.
27	**Tail Race**		
	Size of Tail Race		
	Length of Tail Race		
	No. of Gates		
	Discharge Capacity		

SECTION –B

CIVIL WORKS

SECTION –B

CIVIL WORKS:

1.0 GENERAL:

1.1 The project comprises of renovation, modernisation and uprating with new Turbine set of Hydro-Electric Power Generating Unit of 1x60MW Kodayar Power House – I at Kodayar, Kanyakumari Distt., Tamilnadu. Work shall be executed in such a way that the new constructions/replacement should match with the existing structure. Utmost care shall be taken while carrying out dismantling work so that no damage is done to the existing structures. Also safety of the existing structure shall be looked into while making new construction.

1.2 The tenderer shall visit and carefully examine the site and surroundings to satisfy himself about the nature of all existing structure, existing underground services, general site condition, extent of dismantling work, the site for disposal of surplus materials, debris etc., and all other matter affecting the works. Claim and objection due to ignorance of site condition shall not be considered after submission of tender.

2.0 SCOPE OF WORK:

The civil engineering work consists of the following works including providing foundations and repair/renovation works in the following areas.

(i) Civil works in discharge chamber and replacement of new manifolds and nozzles with new design.

(ii) Civil work for laying new rail-track/modification of existing rail-track of 3 nos. single phase transformer to 1 no. 3-ph transformer.

(iii) Civil works in the Control Room including Vitrified tiles flooring in control room, wall paneling, painting the wall panels, lighting arrangements, false ceiling, Furniture, Glass partitions for control room, storage units and providing air conditioning system.

(iv) Necessary Repair and Improvement works to the existing Valve House Building.

(v) Improvement works to the existing Kodayar Power House-I building.

(vi) All civil works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project.

(vii) Construction/ modification of foundation for the structures of switchyard equipment

2.01 IN DISCHARGE CHAMBER AND PLACEMENT OF NEW MANIFOLDS & NOZZLES WITH NEW DESIGN:

(a) Analysis of structural stability of modified discharge chamber to accommodate symmetrical nozzles.

(b) Cutting concrete in the housing to remove existing nozzles and to make the surface smooth matching with adjacent surface.

(c) Cutting concrete as per changed layout and placement of new manifolds & nozzle

(d) Concreting and strengthening of concrete to fix manifolds and nozzle
(e) Steel lining of discharge chamber

2.02 CIVIL WORK FOR LAYING NEW RAIL-TRACK/MODIFICATION OF EXISTING RAIL-TRACK OF 3 NOS. SINGLE PHASE TRANSFORMER

All the civil works required for laying new Rail-Tract /Modification of the existing rail Tract is the scope of the contractor.

2.03 CIVIL WORK FOR MODIFICATION IN CONTROL ROOM:

2.03.01 FLOORING & LIGHTING

Vitrified tiles flooring in control room and necessary lighting to be provided by the contractor.

2.03.02 WALL PANELING

59.5mm Thick Dry Wall Partitions with 9.5mm USG Fiberock boards fixing one side with 50mm floor Channel & 48mm Stud, joint finishing with USG All Purpose jointing Compound & laminate (1.8mm minimum) finish upto 2.1 mtr from floor.

2.03.03 PAINTING ON WALL PANEL

All interior wall panels shall be coated with approved shade of water based low VOC led free Acrylic emulsion paint over plaster of paris / wall putty of 1st quality. A minimum of two finishing coats of paint over a primer will be provided.

02.03.04 FALSE CEILING AND AIR-CONDITIONING

Air conditioning and false ceiling of the control room covering Control and Relay Panels should be provided.

Providing and fixing in position false ceiling with LUXALON 84 R/C ceiling system comprising of 84 mm wide x 16mm deep perforated panels roll of approved colour formed of 0.5mm thick Aluminum alloy stove enameled on both sides fixed on panel carriers 62 mm wide x 29mm deep out of 0.95mm thick enameled Aluminum satin black with cutouts to hold panels in a module of 100mm (16 mm gap between panels) at maximum 1.3 M c/c carriers to be suspended from roof by 4mm dia galvanised steel wire hangers with special height adjustment clips made of spring steel at maximum 1.3 M c/c hangers fixed to roof by "J" hook and Nylon inserts with provision of openings for fixing light fittings, air conditioning grills etc. complete with all bye works as per drawing and manufacturer's specification.

2.03.05 FURNITURE IN CONTROL ROOM INCLUDING TECHNICAL SPECIFICATIONS:

2.03.05.01 WORKSTATION:

L-Shaped workstation 1500x1500 overall worktop size. (Four person module with 1200 high cross partition in between).

2.03.05.02 PARTITIONS (TILE BASED) ATTACHED WITH WORK STATION:

a) Construction of Glass Partition wall with door in control room to separate LT Switchgear, Battery Bank etc from area covering control & Relay Panels.

b) The double skin partition system shall consist of powder coated metallic frames, interchangeable panels of marker/writing white panels/powder coated metallic tiles, plain /frosted glass minimum 5mm thick, powder coated aluminum capping and curvilinear trimmings, heavy duty connectors etc. complete. The entire system shall be modular based, free standing but rigid, without any toxic material, and flexible to accommodate changes. Partition system shall be hollow type with concealed wire way ducts for cable management of power, communication and LAN. Metal Tile Sheets shall be of minimum 0.8mm thickness with stiffener as per IS: 513-1994 or other approved IS.

c) Main frame work of partitions shall be double walled, **1200**, unless otherwise specified, with facility to extend in all direction. These should be firmly secured to work station/ground, with no crippling or chasing of Floors.

d) The frame work and partition system including tiles shall be of sound structural design to support mounted storages, work surfaces and supplementary components. Such hanging slots shall be concealed and provided with safety catches to prevent unintended pull fall out. The partitions shall be designed to support work surfaces on either or both faces of the modules. Partition shall be assembled with proper fittings to form basic skeleton structure on to which panels are slide in /snap tiles finished in 50 micron (minimum) powder coating. Overall thickness of partition system shall be minimum 50 mm.

02.03.05.03 ALL PARTITION MAIN FRAMEWORKS SHALL HAVE FOLLOWING MINIMUM COMPONENTS & DIMENSION:

a) VERTICAL MEMBERS/MAINFRAME:
CRCA mild steel sections with 50 micron powder coated / Extruded anodized / powder coated aluminum sections & thickness varying from 1.2mm to 2.1mm.

b) BOTTOM HORIZONTAL MEMBERS:
CRCA mild steel (Graded) 'C' channel

c) TOP HORIZONTAL MEMBERS:
1.2mm thick M.S. tube / composite section made out of 0.8mm thick CRCA in parts welded together having enough stability.

d) INTERMEDIATE MEMBERS:
Minimum two numbers horizontal members shall be provided at intermediate excepting top and bottom with additional member above/below worktop shall be provided for raceways. All partition shall have continuous raceway at the bottom of all partition.

e) LEVELER BRACKET AND LEVELLER:
Leveler bracket shall be 2mm thick CRCA with M4 nut to be weld for connecting vertical channel with M8 nut to be weld for better stability along with M8 leveler and shall have minimum 20mm adjustment.

f) COVER SECTION ASSEMBLY:

Cover sections (0.8mm thick CRCA) should be fixed with 2mm bracket / sliding arrangement for the panels.

g) END POST:

End post shall be of minimum 1.5mm thick CRCA of minimum 50 micron powder coated with cap provided at the end or in between to provide strength to the free standing partition of height 1200/1500 mm.

g) VERTICAL & HORIZONTAL TRIM WITH CAP:

Vertical & Horizontal Trim shall be of 1.2mm thick (minimum) aluminium curvilinear sections. Staggered height junction shall be of same profile of vertical & horizontal trim and the profile at junction shall match with the top profile of the trim. Universal cap / end cap and junctions shall be of die cast .

h) RACEWAY:

There shall be raceway (and not mounting plates) at 2 different levels (one continuous raceway at skirting level & 2nd part raceway of 750 mm long below worktop), for each modular workstation. Each raceway shall be 750mm long and 100 to 150mm high. Total length of raceway per workstation shall be minimum 4500 mm.(for L- shaped).

J) TILE SIZE:

100mm to 150mm high skirting & There will be 2 module tiles above skirting (externally). No. of internal tiles to match with the technical requirements.

2.03.05.04 STORAGE UNITS:

A. LATERAL FILING CABINET:

(i) Lateral filing cabinet, two drawer unit of approx size { (750 (W) x 450(D)x750(H)} with ball bearing slides full extensions of capacities 40 Kg per pair with recess handle / flush type handle / built in pulling system with central locking system (made out of zinc die-cast/alu. Bar, nickel plated).
It shall be made of CRCA sheet (minimum 0.8mm thick) with powder coating (minimum 40-50 micron) with top covered with approved board matching with worktop with edges sealed with PVC lipping. Shutters made of CRCA (minimum 0.8mm thick)/ both side pre-laminated particle board 25mm thick.

(ii) Lateral filing cabinet three drawer unit approx size 750(W) x 450(D)x1050(H) with ball bearing slides full extension of capacities 40 kg/pair with handle/pull out arrangement with central locking systems (Made out of zinc die – cast / Alu. bar, nickel plated).
It shall be made of CRCA sheet (minimum 0.8mm thick) with powder coating (minimum 40-50 micron) with top covered with approved board matching with worktop with edges sealed with PVC lipping. Shutters made out of CRCA (minimum 0.8mm thick)/both side pre-laminated particle board 25mm thick.

2.03.05.04-B- HINGE DOOR UNIT:

(i) Hinge door unit (Full height) approx size 900(W) x450(D)x1980(H)}with two leaves shutters & 5 (five), shelves inside. Shutters, made of CRCA/ both sides 25mm thick pre-laminated particle board with espagnolette lock (Finish- zinc alloy, nickel plated).

It shall be made of CRCA sheet (minimum 0.8mm thickness) with powder coating (minimum 40-50 micron) with all front facia covered with CRCA (0.8mm minimum thick)/ Pre-Lam particle board matching with worktop and top covered with approved board matching with worktop with edges sealed with PVC lipping it shall have minimum 60 Kg per shelf load bearing capacity.

a) All locks shall be of Hafele/hettich make.
b) Leveling bolt & matching nut shall be welded with the bottom horizontal members for proper gripping (dia of bolt shall be minimum 8mm).

2.04 IMPROVEMENT WORKS TO THE VALVE HOUSE & POWER HOUSE BUILDING:

2.04.01 VALVE HOUSE

Necessary Minor repair works shall be carried out in the existing **Valve House building** by erection of new steel door and ventilators and painting with 2 coats of acrylic emulsion paint over wall surface and enamel painting for steel works is the scope of the contractor.

2.04.02 POWER HOUSE

Minor repairs, Power House painting and improvement works to the **Power House building** such as Replacing the damaged steel door and windows including replacing the glass panes, Repairing and servicing the rolling shutter gates and painting with enamel paint, Damaged downfall pipes shall be replaced, Necessary treatment shall be done in water leaking/damp wall areas, Providing 2 coats of acrylic emulsion over a primary coat inside and outside of power House building after scrapping out the existing surface completely in all floors and providing enamel painting for steel door & windows and Providing floor finishing with industrial type flooring for the area excluding Control room Building and finished with power trovel after dismantling/chipping the existing flooring is sthe scope of the contractor.

2.5 ALL CIVIL WORKS FOR THE BUILDINGS, EQUIPMENT FOUNDATIONS, FACILITIES AND MISCELLANEOUS CIVIL WORKS TO BE PROVIDED FOR THE PROJECT SHALL INCLUDE BUT NOT BE LIMITED TO THE FOLLOWING:

a) Civil foundations for equipment - The repair, refurbishment and modification / strengthening of existing TG & Auxiliary equipment foundations should be done as per the requirement of the equipment base profile and static/dynamic loading. Strengthening should be done by injecting cement slurry with admixture. The existing concrete surface should be given treatment to develop adequate bond between old and new concrete. Anchor bolts should be provided by drilling holes in the existing concrete and fixing it by epoxy based mortar. The grouting under the base plate should be done with non-shrink free flow grout.

b) Refilling redundant recesses in floor

c) Drilling panel cable access holes through floors/RCC wall

d) Modification of turbine foundation and the pit to accommodate new runner.

e) Strengthening of existing concrete structure

f) Rehabilitation of distressed concrete structure and inserted parts/steel linings

g) Stoppage of leakage of water from surface of concrete

h) Cleaning of dewatering pit

i) Removal of debris after completion of construction.

2.6 CONSTRUCTION/ MODIFICATION OF FOUNDATION FOR THE STRUCTURES OF SWITCHYARD EQUIPMENT .

3.0 TECHNICAL SPECIFICATION:

3.1 TURBINE & GENERATOR, AUXILIARY EQUIPMENT FOUNDATIONS AND DISCHARGE CHAMBER:

Modification of existing foundations of turbine & generator and other equipment is to be done as per the base profile of the equipment. The structural stability of modified discharge chamber is to be analysed to accommodate symmetrical nozzles. The successful tenderer shall check the adequacy of the strength/serviceability of the existing foundation/structure considering the static and dynamic loads of the equipment. The preparation of strengthening scheme/plan, if required and implementation of the same shall be under the scope of successful tenderer. The successful tenderer has to furnish the calculations justifying adequacy of the proposed scheme strengthening.

3.2 STRENGTHENING OF EXISTING CONCRETE STRUCTURE

Strengthening of existing concrete structure shall be carried out where it is expected to carry more superimposed loads than the original design due to new/ upgraded technological requirement. All necessary modification in the existing structure shall be simultaneously considered to accommodate the new set up.

The Successful Tenderer shall submit the following with regard to strengthening work.

a) As built drawing of the existing portion.

b) Load data of the new structure.

c) Scheme and design calculation for all new structures. The design calculation shall include static design calculation for all structures and dynamic analysis for all important structures subjected to impact, vibrations etc. induced by equipment.

d) After getting approval of the TANGEDCO/Purchaser for the scheme and design calculations, the Successful Tenderer shall prepare construction drgs. for the same and submit for TANGEDCO/Purchaser's approval.

The successful Tenderer shall stand fully responsible for design/safety of all structures irrespective of approval of the same by the TANGEDCO/Purchaser.

3.3 CONCRETE AND REINFORCED CONCRETE STRUCTURE:

a) All concrete and reinforced concrete structures shall be constructed.

b) The mix design adopted shall be suitable for proper strength, workability and service condition of the structure. Minimum cement content and maximum water cement ratio shall be normally

as per stipulations of BIS codes. However, in case of exposure to aggressive environments, the mix design adopted shall be suitable to ensure durability of the concrete under the condition.

c) Unless specifically approved by the Engineer the maximum nominal size of coarse aggregates for concrete shall be 20mm and down.

d) Steel reinforcement to be used shall be Fe415 grade or equivalent shall be used unless otherwise specified.

e) Wherever there is a joint of old and new concrete, suitable chemical treatment shall be given to the surface of old concrete to develop adequate bond between them.

3.4 DESIGN LOADS:

Loads due to normal operating condition as well as due to extra ordinary conditions shall be taken into account. For normal operating condition, following loads shall be considered.

- Dead loads
- Live loads (not less than $2T/m^2$)
- Load throw loads
- Piping loads
- Thermal loads
- Unbalanced dynamic loads from turbine and generator
- Torque load
- Temperature load (as specified by manufacturer) for extra ordinary conditions, following loads shall be considered.
- Seismic load (as per IS: 1893)
- Wind load (as per IS: 875)
- Short Circuit load
- Any other abnormal load due to machine breakdown, as specified by manufacturer.
- The load combinations shall be as per IS: 2974(part-3).

3.5 MATERIAL OF CONSTRUCTION:

All reinforced concrete work will be of grade M30. Corrosion inhibitors of approved make will be used in Concrete for all RCC work excepting for storm water drains as per manufacturer's specification and details.

The following standards shall be taken as guidelines unless otherwise specified above:

(i) IS: 2974(Part-3)
(ii) IS: 1893-2002
(iii) IS: 456-2000
(iv) IS: 4247-1993

3.6 QUALITY OF CONCRETE:

(i) The quality of concrete of the existing foundations of various equipment in the Power House is not showing any visible damage. The surface does not show any sign of distress excepting spalling at a few places. Repair of damage of any concrete structure, if found during removing of equipment, shall be done with epoxy based concrete/mortar/grout.

(ii) The modification/strengthening of existing foundation should be done as per the requirement in case any defect/crack is found.

1) Strengthening should be done by injecting cement slurry with admixture.
2) The existing concrete surface should be given treatment to develop adequate bond between old and new concrete.
3) Anchor bolts should be provided by drilling holes in the existing concrete and fixing it by epoxy based mortar.
4) The grouting under the base plate should be done with non-shrink free flow grout.
5) Concrete work shall secure a dense, homogeneous, smooth mass including required finishes, possessing required strength and resistance to weathering and abrasion for the structures and foundations.
6) Design of all reinforced concrete structures shall be as per the IS:456 and of pre-stressed concrete structures as per IS:1343. The structural safety of all foundations on soil shall, in general, be based on IS:1904. The design of water retaining structures shall be according to IS:3370.
7) For calculation purpose "Working Stress Design" or "Limit State Design" methods may be adopted, but design shall be consistent throughout.

(h) Unless otherwise specified, minimum grades of concrete to be used shall be as follows:

Blinding concrete	M 7.5
Plain cement concrete	M10 & M15
All reinforced concrete	M30

(i) Grouting below machine/equipment bases and pockets shall be of non-shrinking grout of adequate thickness and strength. Grouting below bases of building structural members shall be with concrete of minimum grade M35.

4.0 STRUCTURE AND FOUNDATION DESIGN:

4.1 STRUCTURE DESIGN :

a) The design calculations for all the structures and foundations shall be furnished. The design calculations shall include static design calculations for all structures and foundations, dynamic analysis for all important structures and foundation subjected to impact, vibrations etc. induced by equipment and other external forces.

b) The data sheet showing specifications of materials, design standards followed, load data assumed including the seismic loading, vibration considerations, deflection, etc. shall be furnished. The loading combinations and other design assumptions made in design are to be furnished.

c) Measures required for the safety of the buildings and foundations.

d) Design and construction/reconditioning of structures, facilities etc. shall take into account requirement for operation and maintenance of all equipment and its users.

e) This being a RM&U project, while designing and preparing new facilities the successful tenderer shall take into account the structures, foundations, drains, sewers etc of the existing units and modify them, if found necessary, to match the new ones.

4.2 FOUNDATION DESIGN

f) Foundations for structures and equipment shall be proportioned to resist the worst condition of loadings and shall be generally designed as per the provisions of IS:1904.

g) Generally foundation for buildings & equipments shall not be structurally connected to ground floor slab. The top level of the stem for building column foundations shall be so provided that no part of the steel column base assembly protrudes over finished floor level. The column base assemblies shall be encased with concrete up to floor level.

h) Foundation of equipment subjected to dynamic loading shall be isolated from adjoining floors/foundations to prevent propagation of vibration to adjoining structures.

i) Supporting structures and foundation for equipment which may cause vibration shall be designed for the dynamic effect of equipment together with the direct loads. The dynamic loads and other relevant data required for analysing the dynamic effect shall be taken as per manufacturers' data and recommendations.

j) Structures and foundations supporting vibrating equipment shall be proportioned to avoid resonant frequencies. The dynamic analysis shall be done as per the stipulations as recommended by respective IS codes as well as the stipulations recommended by equipment manufacturer.

5.0 DESIGN CALCULATIONS, DRAWINGS AND DOCUMENTS:

5.1 The design calculations/scheme drawing shall be submitted by the successful tenderer for approval of the TANGEDCO/Purchaser prior to submission of construction drawings. The following aspects shall be considered with regard to design calculations.

a) The successful Tenderer shall undertake investigation of field problems by critical visual examination and additional field test non-destructive as required to be ascertained:

Defects associated with concrete like erosion, cracks, cavities, pitting, corrosion, spelling and peeling of and deterioration of reinforcement etc.

- Leakage of water through the structures
- Condition of components
- Condition of external surfaces
- Condition of internal surfaces

b) The successful Tenderer shall prepare detailed working drawings considering overall foundation layout for the equipment, buildings services etc., space requirement and clearances as necessary. The successful Tenderer shall submit a comprehensive and complete list of drawings.

c) The successful Tenderer shall submit for approval/information, general arrangement and detailed working drawings for all concrete, reinforced concrete and other civil works.

d) The successful Tenderer shall submit As-built drawings incorporating all site modifications after completion of construction work.

e) If the successful Tenderer intends to carry out any part of the work through subcontractor then prior approval of the subcontracting agencies shall be taken from the TANGEDCO/Purchaser.

f) The successful Tenderer shall submit photographic records of observation of field problems. Along with this the successful Tenderer shall submit report/drawing showing scheme for rehabilitation/reconstruction of distressed concrete structure/inserted parts.

6.0 QUALITY CONTROL:

The successful Tenderer shall carryout all checks and tests as directed by the Purchaser / TANGEDCO and submit the results thereof. Acceptance of works shall be subjected to achieving required quality as laid down in code of Bureau of Indian Standards.

7. TECHNICAL RULE:

a. This Technical Rule is meant for civil engineering works included in the scope of work in the package. It includes loading standards, permissible stresses, functional requirement, quality standard, architectural guidelines, norms etc to be adopted as a basis for preparation of design and drawings by the successful Tenderer.

b. The design prepared by the successful Tenderer shall not only provide for the requirement indicated in this technical rule but also consider the overall process requirement, service conditions and provisions to be made for future expansion. The design shall be compatible with the operating conditions in the plant and the atmospheric conditions prevalent at location of project site.

c. Standardisation and unification shall be carried out to the maximum extent possible.

d. TANGEDCO/Purchaser reserves the right of selecting a particular make of materials and components. The successful Tenderer shall supply materials / components of the particular make, if so required.

8. DESIGN PARAMETER:

8.01 GENERAL

a) In addition to the minimum requirements outlined herein, the successful Tenderer shall design and construct the buildings, structure, foundations and other civil items as required for all equipment and systems considering all aspects of operational requirements and maintenance of these equipment and facilities.

b) General provision, materials, workmanship, dimensional tolerances, safety requirements for construction works etc. shall be in accordance

8.02 LOAD CONDITION

a. All foundations and concrete structures shall be designed to resist full operating dead and live loads, with appropriate combination of wind and seismic forces and with due allowance for impact, vibration etc. as secondary effects of live loads, temperature variation etc. While designing structures and foundations either the effect of seismic forces or wind loads, whichever produces the worst effect, shall be considered along with usual load conditions**.**

b. Apart from the operating loads indicated by the equipment manufacturers, the design of buildings and structures shall be based on dead and imposed loads calculated according to IS: 875, subject to minimum imposed loads indicated below.

c. The live loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary. Additional loading due to electrical cables, ventilation and air conditioning, piping etc. shall be considered as per technological requirements.

d. All buildings (except as noted separately):

i.	Roofs	150 kg/m^2
ii.	Platform and stair	500 kg/m^2
iii.	On ladders	120 kg at centre of rung
iv.	Removable covers	1500 kg/m^2
v.	Generator lay down area	2000 kg/m^2
vi.	Control Room	1000 kg/m^2

e) Design wind pressure and forces shall be as per the provisions of IS:875. Stresses induced due to dynamic effect of wind shall be considered in design as per relevant IS codes.

f) Seismic forces shall be considered according to the provisions of IS:1893.

g) Members subjected to temperature variations shall be designed to withstand the stresses arising out of such temperature variations.

h) Design of structures shall provide for temporary loads, which may be lifted during erection and maintenance of plant and equipment. Consideration shall be given in the design of structures to the contributing loads from piping and cabling including provisions for piping anchors and dead endings of electrical conductors.

i) In case of moving loads, full load under worst operating condition together with minimum 25% vertical impact factor shall be considered for vehicles and machinery travelling on tracks (rails). Horizontal forces along and transverse to the rails as per equipment manufacturers data and recommendations shall be considered in design of the track supporting structures and foundations.

j) The design of buildings and structures shall take into account the loadings due to future extension of units as well as due to and installation of additional equipment, in future in the units.

8.03 PERMISSIBLE STRESSES :

Allowable stresses for all reinforced concrete structures shall be as per IS: 456 and for prestressed concrete structure as per IS:1343

9.0 <u>STANDARDS:</u>

a) The design criteria for civil engineering work shall be in accordance with this Technical Rule. Detailed instructions on such aspects as are not indicated herein shall be as per the latest standards, codes and recommendations of the Bureau of Indian Standards (BIS) specifications/Indian road Congress and specifications published by Ministry of Surface and Transport (MOST). In the absence of suitable BIS specification and codes of practices, other recognised international standards and codes such as of International Standards Organisation (ISO), British Standards and codes, Deutsche Industries Norm (DIN), American concrete Institute (ACI) may be used, with prior approval of the TANGEDCO/Purchaser.

b) In case of anything mentioned in this Technical Rule is at variance with BIS or other standards mentioned herein, the provisions of this Technical Rule will prevail.

10. SUBMISSION OF DESIGN CALCULATIONS, DRAWINGS AND DOCUMENTS BY SUCCESSFUL TENDERER:

a. The successful Tenderer's scope shall include complete engineering and construction on a turnkey basis inclusive of detail design, basic engineering, detailed engineering, supply of all materials, construction and testing in respect of all facilities required for completion and handing over of the work as per technical specification.

b. The successful tenderer shall undertake within the battery limits any change in the location of unit/item and/or structures/parameters, sizes etc. of civil structures which may be necessary during engineering/execution from those indicated by the successful tenderer in their contract drawings at no additional cost to the TANGEDCO/Purchaser.

c. The checking and correctness of all main centerlines is the responsibility of the successful tenderer irrespective of any checking by TANGEDCO/Purchaser.

d. All other civil works that will be necessary to complete the work in all respects.

e. The design calculations shall be submitted prior to submission of construction drawings.

f. Necessary approval for civil drawings and other documents may be obtained from TANGEDCO.

11. GENERAL:

a) Renovation of the Inspection Bungalow and the approach roads to the Power House and Camp area will be taken up by TANGEDCO prior to taking up the RMU works by the contractor.

b) The available quarters at Kodayar Lower camp will be provided to the contractor as is where is condition with market rent and electricity consumption charges will be levied based on the conditions stipulated by TANGEDCO then and there.

c) All the materials which can obviously be quantumized should be furnished individually in price break up schedule, unless specified by the Purchaser. Materials not specified, but felt necessary by contractor shall also be furnished in the breakup schedule.

d) All the materials/work/modification necessary for satisfactory completion of the scope of work, whether specified in pricing, specification, commercial and technical terms of this order including annexure, etc., or not, shall be supplied/work done by the contractor without any extra cost and shall not cite the details furnished in the price breakup schedule as a base for any extra claim thereof.

e) Split up of quantity and working sheet for data including lead particulars (Rate/per) has to be furnished.

f) Applicable GST in % may be indicated.

12. LIST OF RELEVANT I.S. CODES:

IS: 269-1989: Specification for 33 grade ordinary Portland cement.
IS: 383-1970: Specification for coarse and fine aggregates from natural sources for concrete.
IS: 432 (PART-1)-1982: Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement-hard drawn steel wire.
IS: 432 (PART-2)-1982: Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement-hard drawn steel wire.
IS: 455-1989: Specification for Portland slag cement.
IS: 456-2000: Code of practice for plain and reinforced concrete.
IS: 458-1988: Specification for precast concrete pipes (with or without reinforcement).
IS: 651-1992: Specification for salt glazed stone ware pipes and fittings.
IS: 771-1963: Specification for glazed earth ware sanitary appliance (line water closets, urinals wash basins, sink etc.)
IS: 782-1978: Specification for caulking lead.
IS: 783-1985: Code of practice for laying of concrete pipes.
IS: 814-1991: Covered electrodes for manual metal are welding of carbon and carbon manganese steel.
IS: 816-1969: Code of practice for use of metal arc welding for general construction in mild steel.
IS: 875(PART-1)-1987: Code of practice for design loads (other than earthquake) for buildings and structures - dead loads.
IS: 875(PART-2)-1987: Code of practice for design loads (other than earthquake) for buildings and structures - imposed loads.
IS: 875(PART-3) –1987: Code of practice for design loads (other than earthquake) for buildings and structures - wind loads.
IS: 875(PART-5)-1987 Code of practice for design loads (other than earthquake) for buildings and structures - special loads & load combinations
IS: 1038 -1983: Specification for steel doors, windows and ventilators.
IS: 1080 -1986: Code of practice for design and construction of shallow foundations on soil (other than raft, ring and shell).
IS: 1609 -1991: Code of practice for laying damp proofing treatment using bitumen felts
IS: 1742 -1983: Code of practice for building drainage
IS: 1786 -1985: Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1893 -2002: Criteria for earthquake resistant design of structures.
IS: 1904 -1986: Code of practice for design and construction of foundations in soil: General requirement
IS: 1905 -1987: Code of practice for structural use of unreinforced masonry
IS: 2062 -1992: Structural steel (fusion welding quality)
IS: 2751-1979: Welding of mild steel plain and deformed bars for reinforced concrete construction
IS: 2950(PART-1)1981: Code of practice for design and construction of raft foundations – design
IS: 2974(PART-1) 1982: Code of practice for design and construction of machine foundation - foundation for reciprocating type machines.
IS: 2974(PART-2) 1980: Code of practice for design and construction of machine foundations - foundations for impact type machine (Hammer foundations).
IS: 2974(PART-3) 1982: Code of practice for design and construction of machine foundations - foundations for rotary type machines (medium and high frequency).

IS: 2974(PART-4) 1979: Code of practice for design and construction of machine foundations - foundations for rotary type machine of low frequency.
IS: 2974(PART-5) 1987: Code of practice for design and construction of machine foundations - foundations for impact type machines other than hammers (forging and stamping press, pig breakers, drop crusher and jolter).
IS: 3006-1979: Specification for chemically resistant glazed stone ware pipes and fittings.
IS: 3067-1988: Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS: 3114-1985: Code of practice for laying of cast iron pipes.
IS: 33'70(PART-1) 1965: Code of practice for concrete structures for the storage of liquids - general requirements.
IS: 3370(PART-2) 1965: Code of practice for concrete structures for the storage of liquids - reinforced concrete structures.
IS: 3370(PART-4) 1967: Code of practice for concrete structures for the storage of liquids - design tables.
IS: 3614(PART-1) 1966: Specification for fire check doors - plate, metal covered and rolling type.
IS: 3764-1992: Excavation work - code of safety.
IS: 3414-1968: Code of practice for design and installation of joints in buildings.
IS: 4127-1983: Code of practice for laying of glazed stone ware pipes
IS: 4326-1976: Code of practice for earthquake resistant design and construction of buildings.
IS: 6494-1988: Code of practice for water proofing of underground water reservoirs & swimming pools.
IS: 7452-1990: Hot rolled steel sections for doors, window sand ventilators
IS: 1239-1968: Specification for mild steel tubes, tubular and other wrought steel fitting (Part -I Mild Steel Tubes).
IS: 1580-1991: Bituminous compounds for water proofing and caulking purposes.
IS: 13311(Part-I)-1992: Non-destructive testing of concrete

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RENOVATION, MODERNISATION & UPRATING OF
KODAYAR POWER HOUSE-I FROM 1x60MW TO 1x70MW

TECHNICAL SPECIFICATION - VOL-IV - DRAWINGS

RENOVATION, MODERNISATION AND UPRATING OF KODAYAR POWER HOUSE - I

FROM 1 X 60MW TO 1 X 70 MW
IN TIRUNELVELI GENERATION CIRCLE
KANYAKUMARI DISTRICT, TAMILNADU, INDIA

INTERNATIONAL COMPETITIVE BIDDING
TENDER SPECIFICATION NO. HE. **2367**

VOLUME IV OF IV

DRAWINGS

OFFICE OF THE
SUPERINTENDING ENGINEER
HYDRO (ELECTRICAL)
5th FLOOR, EASTERN WING
NPKRR MAALIGAI,
144, ANNA SALAI, CHENNAI - 600 002.

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RENOVATION, MODERNISATION & UPRATING OF

KODAYAR POWER HOUSE-I FROM 1x60MW TO 1x70MW

TECHNICAL SPECIFICATION - VOL-IV - DRAWINGS

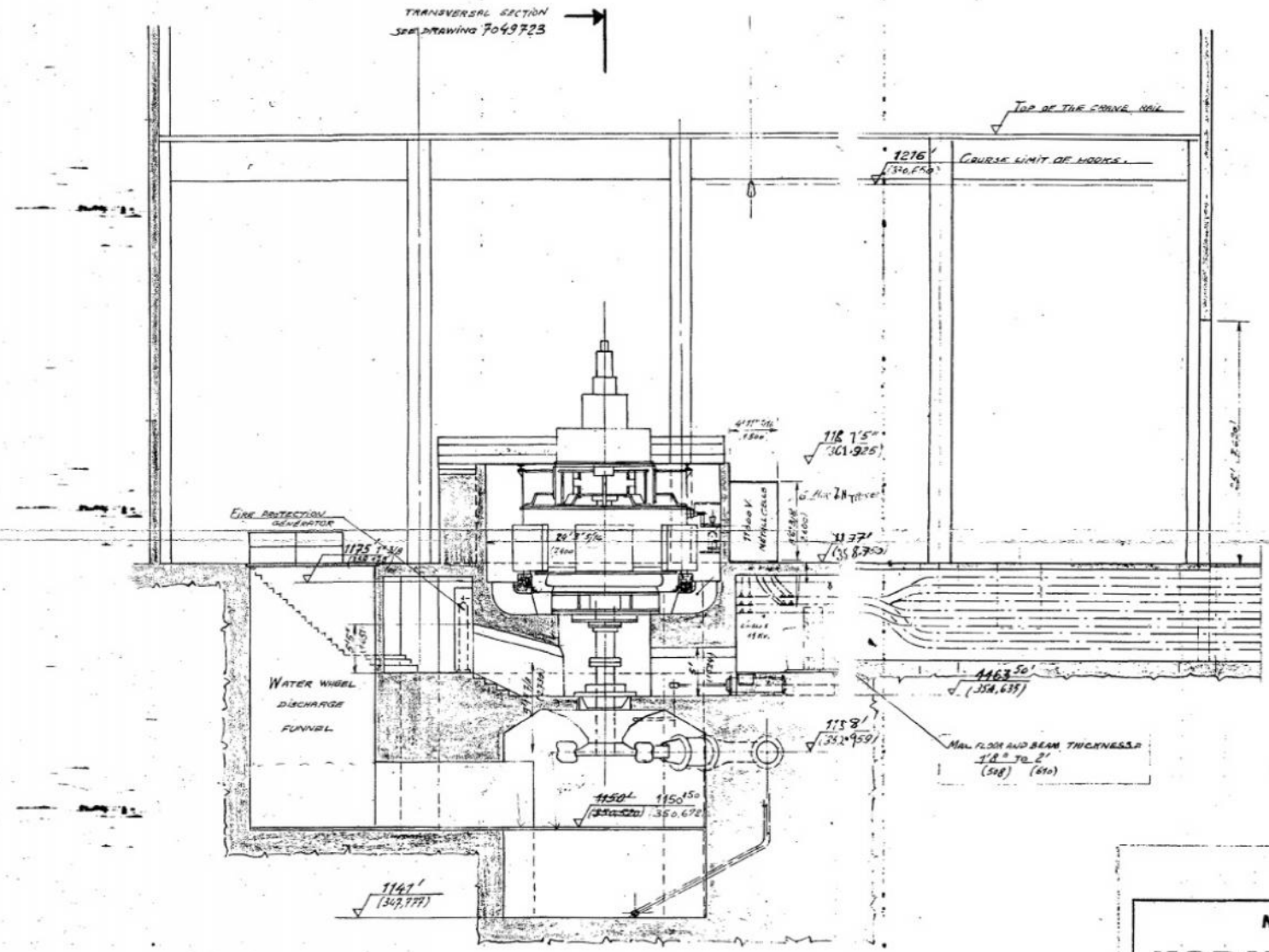
INDEX TO VOLUMES

VOLUME I	:	NOTICE INVITING TENDER (NIT) COMMERICAL SPECIFICATION INCLUDING INVITATION TO TENDER, INSTRUCTIONS TO TENDERER AND GENERAL TERMS AND CONDITIONS OF CONTRACT
VOLUME II		TECHNICAL SPECIFICATION FOR
SECTION - A	:	TURBINE, GENERATOR AND OTHER MECHANICAL EQUIPMENT
SECTION - B	:	CIVIL WORKS
VOLUME III		
	:	ELECTRICS
	:	CONTROL AND INSTRUMENTATION
VOLUME IV	:	DRAWINGS

LIST OF DRAWINGS

Sl. No.	Title	Drawing No.
1	Power house - Cross-section (Existing)	MEC/S/10H0/11/S3/TS/M/01
2	Equipment Layout (Existing)	MEC/S/10H0/11/S3/TS/M/02
3	Equipment Layout (Proposed)	MEC/S/10H0/11/S3/TS/M/03
4	Cooling Water Scheme (Proposed)	MEC/S/10H0/11/S3/TS/M/04
5	Compressed Air System Scheme	MEC/S/10H0/11/S3/TS/M/05
6	Proposed Arrangement of Nozzles (Indicative Drawing)	MEC/S/10H0/11/S3/TS/M/06
7	Water Conductor System (Existing)	MEC/S/10H0/11/S3/TS/M/07
8	Control Room Layout (Proposed)	MEC/S/10H0/11/S3/TS/E/01
9	Proposed Generator Electrical Single Line Diagram	MEC/S/10H0/11/S3/TS/E/02
10	SLD of LTAC Distribution board	MEC/S/10H0/11/S3/TS/E/03
11	System Configuration of PLC System for Kodayar 1x70MW Power House	MEC/S/10H0/11/S3/TS/I&PC /01
12	Layout of 110 kV Switchyard at Kodayar PH-1	
13	Proposed Layout of Switchyard	
14	Existing Layout of Switchyard	
15	Kodayar Hydro Electric Power House-I (1 X 60 MW)-Scheme	
16	Single Line Diagram of Battery Limit of Proposed RMU on Kodayar PH-1 (1 x 60 MW to 1x70 MW)	

N° 7049924 Fo



N° 7049724 Fo

DWG. MEC/S/10H0/11/S3/TS/M/01

TITLE: POWER HOUSE CROSS SECTION (EXISTING)

E1 1 5

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME
LONGITUDINAL SECTION VIEW OF POWER STATION

PLANS GÉNÉRAUX DE PRINCIPE
COUPE LONGITUDINALE DE LA CENTRALE

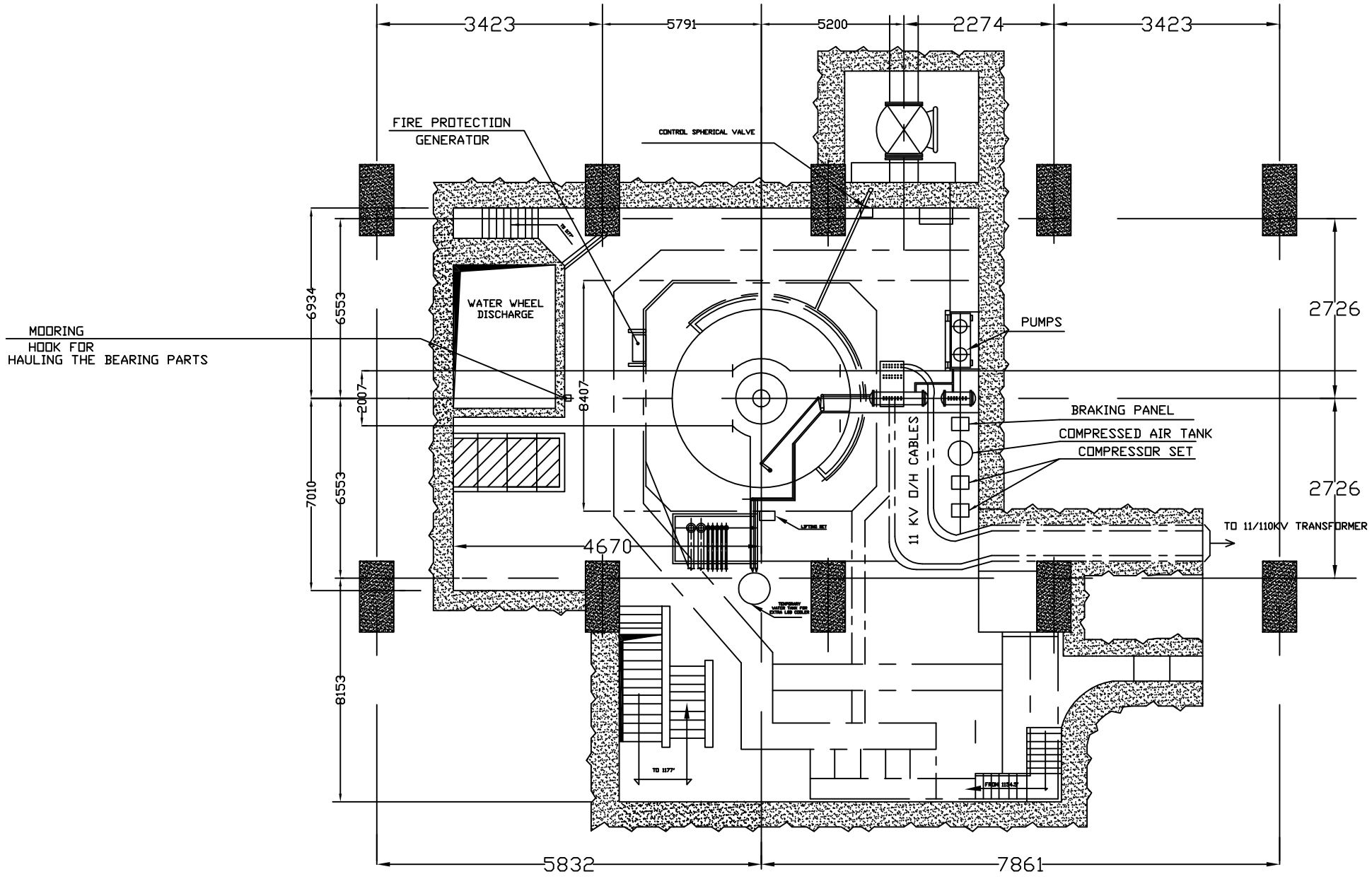
Dessiné : JOUAN
Vérifié :
Enregistré 5-12-65
Echelle 1/100
Service EREAL
Cde N° 45/66a2
N° de Class'

Rectifications following MS.E.B.S letter dt 21/9/66 (EN/62/KDR. I/8) Drawing No D 450-A/362 and ALSTHOM note dt 17-10-66 — 17-10-66 B
G.G.66 A

ALSTHOM 38, AVENUE KLÉBER PARIS

N° 7049724 F°

Nbre F°
Voir F°



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DRAWN	SATISH
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APPROVED	
SIG.	
DATE	

RM&U OF KODAYAR HYDRO ELECTRIC POWER HOUSE-I

EQUIPMENT LAYOUT AT 1166' (EXISTING)

SCALE –

SHEET 1 of 1

REV 0

DRG.NO.MEC/S/10HO/11/83/TS/M/02

NOTES:

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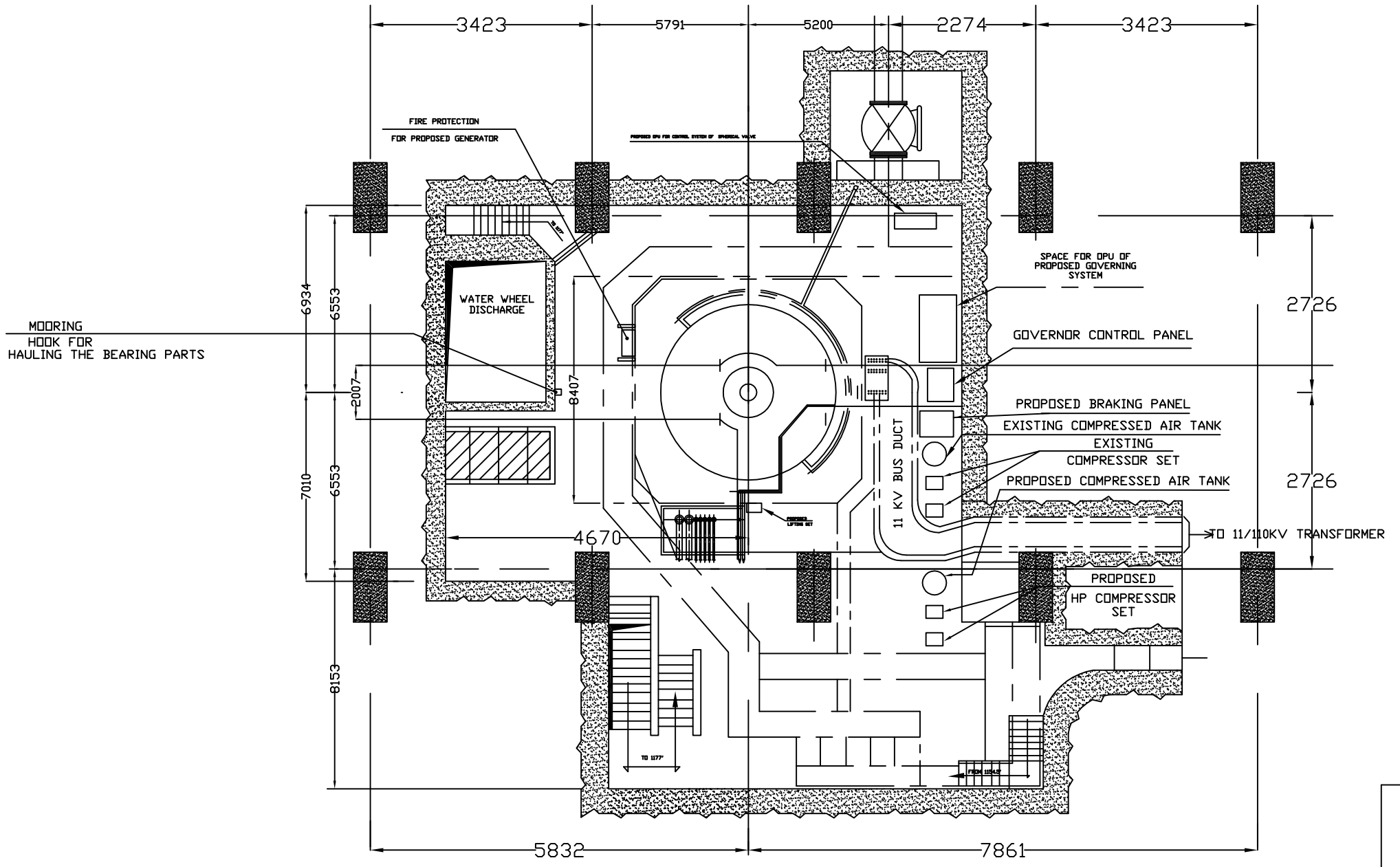
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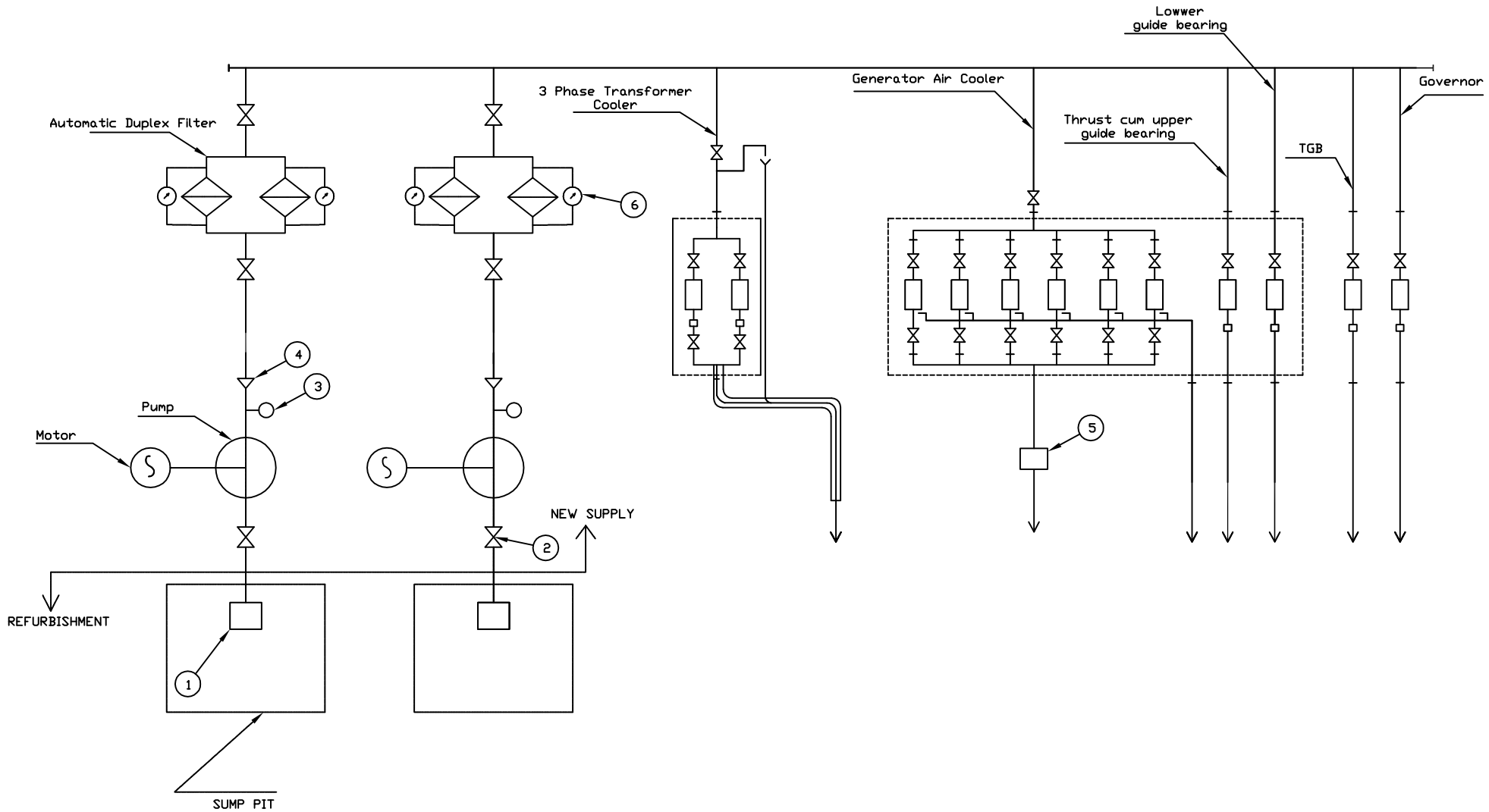
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RM&U OF KODAYAR HYDRO ELECTRIC POWER HOUSE-I

EQUIPMENT LAYOUT
AT 1166'(PROPOSED)

SCALE –	SHEET	REV
DRG.NO.MEC/S/10HO/11/S3/TS/M/03	1-OF-1	1



LEGEND

1. STRAINER
2. VALVE
3. MANOMETER
4. NON RETURN VALVE
5. WATER FLOW INDICATOR
6. DIFFERENTIAL PRESSURE GAUGE

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	DATE

RM&U OF KODAYAR HYDRO ELECTRIC POWER HOUSE-I

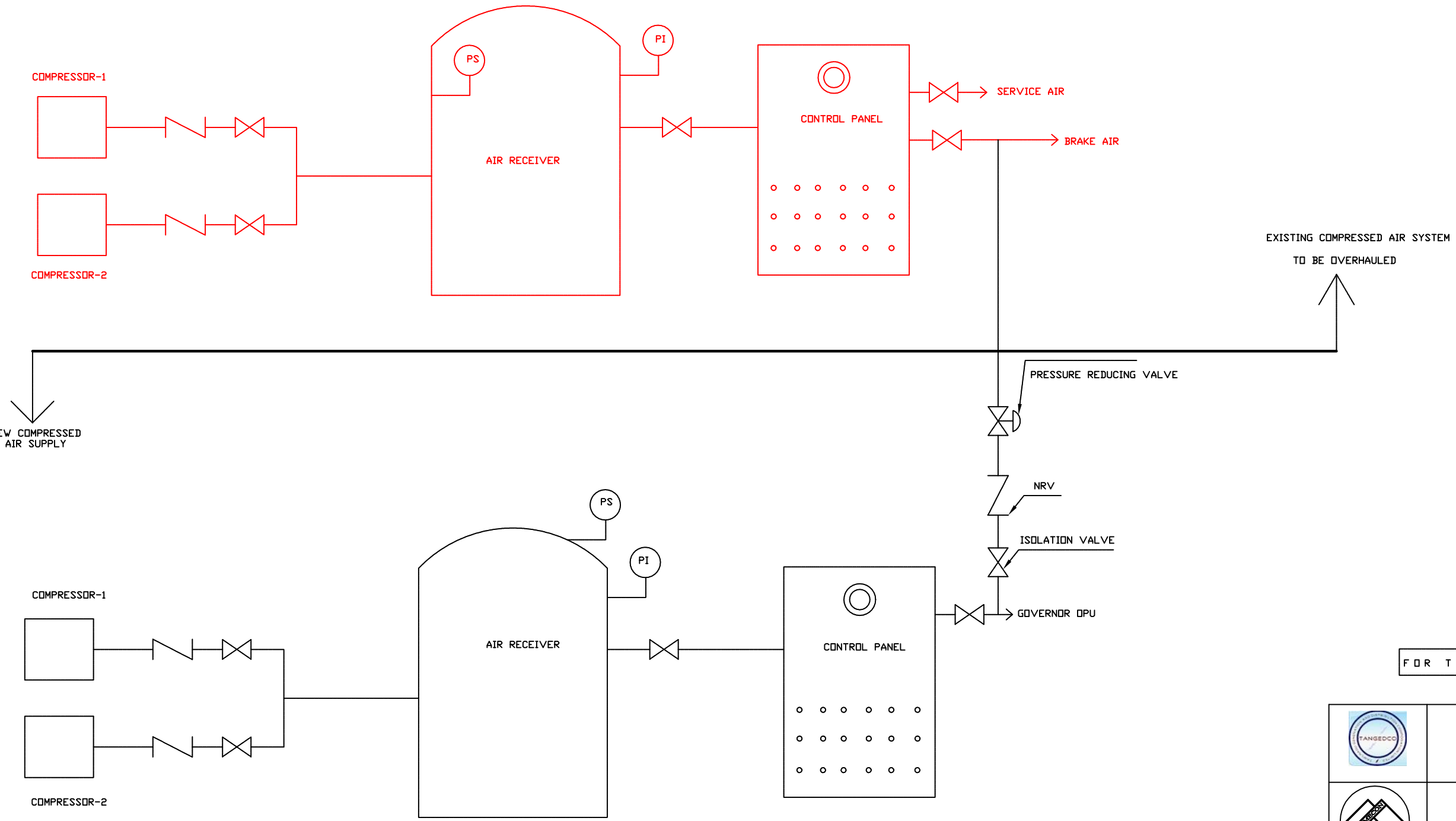
COOLING WATER SCHEME

SCALE -

DRG.NO.MEC/B/10HO/11/B3/TB/M/04

SHEET 1-OF-1

REV 1



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CHECKED AND VERIFIED	RKP
APPROVED	
SIG.	
DATE	

RM&U OF KODAYAR HYDRO ELECTRIC POWER HOUSE-I

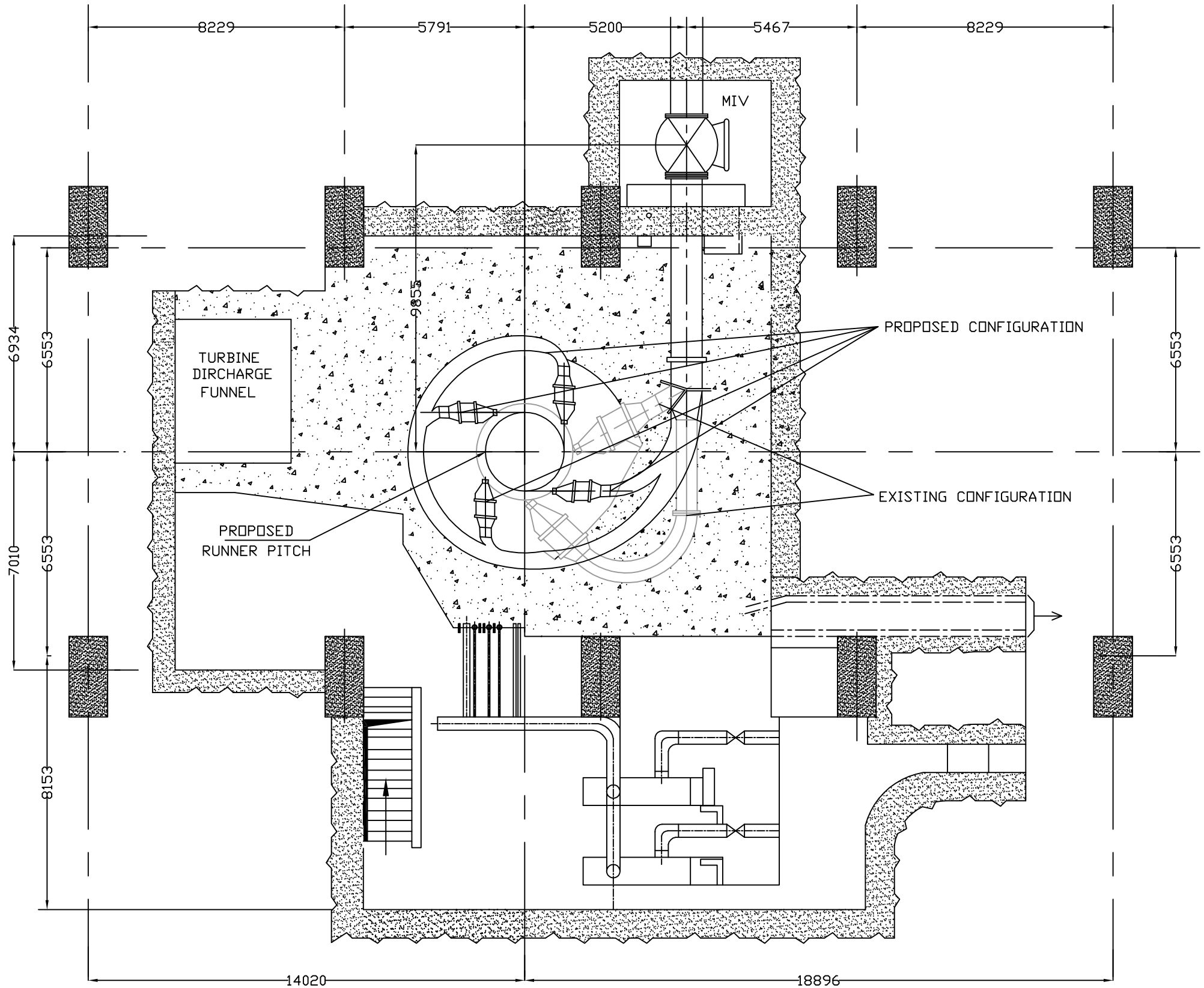
COMPRESSED AIR SYSTEM SCHEME

SCALE -

SHEET 1-OF-1

REV 1

DRG.NO.MEC/S/1CHQ/11/83/TS/M/08



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LOCATION	RANCHI
DESIGNED	K.Kumar
DRAWN	SATISH
CHECKED AND VERIFIED	Dr. P.K.Maji
APPROVED	

RM/RM&U OF KODAYAR POWER HOUSE – I

PROPOSED ARRANGEMENT OF NOZZLES (INDICATIVE DRAWING)

SIG. | SCALE – NTS | SHEET 1 OF 1 | REV.

DRG.NO.MEC/S/10H0/11/S3/TS/M/06

DRG.No. MEC/10HO/11/S3/DPR/M/06

KODAYAR DAM 1
FRL 4350 FT
MDDL 4250 FT
EFF. STORAGE 2586.8 MCFT
INTAKE SILL LVL 4235 FT

TUNNEL: HORSE SHOE, DIAMETER: 7 FT, LENGTH: 10400 FT (RCC 2040FT + PCC LINED 8360 FT)

SURGE SHAFT
TYPE: OPEN PLAIN
DEPTH: 434 FT
DIAMETER: 20 FT

VALVE HOUSE A17 EL3786FT
BFV Dia 1700mm
32°30'30"
A16 EL3564FT
DIA 5'6"
34°01'39"
A15 EL3300FT
25°39'29"
A14 EL3139FT
DIA 5'6"
14°29'44"
A13 EL3056FT
17°27'51"
A12 EL2920FT
25°48'10"
A11 EL2720FT
DIA 5'6"
29°01'51"
DIA 5'0"
A10 EL2493FT
13°45'45"
A9 EL2380FT
03°11'12"
A8 EL2355FT
DIA 5'0"
18°18'03"
A7 EL2202FT
20°02'43"
A6 EL2094FT
DIA 5'0"
20°37'45"
A5 EL1985FT
DIA 4'6"
12°28'29"
A4 EL1894FT
32°32'30"
A3 EL1760FT
DIA 4'6"
19°58'59"
A2 EL1640FT
16°10'20"
A1A EL1524FT
DIA 4'6"
34°26'20"
A1 EL1380FT
54°04'17"
AT MIV
Dia 1000mm
EL1158FT
PH
KODAYAR DAM 2

ELEVATION

KODAYAR DAM-I

SURGE SHAFT

11°50'39" A17
04°53'24" A16
02°36'36" A15
A14
02°35'44" A13
A12
A11
A10
07°22'00" A9
A8
A7
A6
A5
12°45'00" A4
A3
A2
23°46'20" A1A
A1
AT MIV
PH
KODAYAR DAM 2

PLAN

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SECTION	PP & EE
LOCATION	RANCHI
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RM&U OF KODAYAR HYDRO ELECTRIC POWER HOUSE-1

WATER CONDUCTOR SYSTEM

SIG.
DATE :-
SCALE -
DRG.No. MEC/S/10HO/11/S3/TS/M/07
SHEET 1 OF 1
REV. 0

NOTE :-

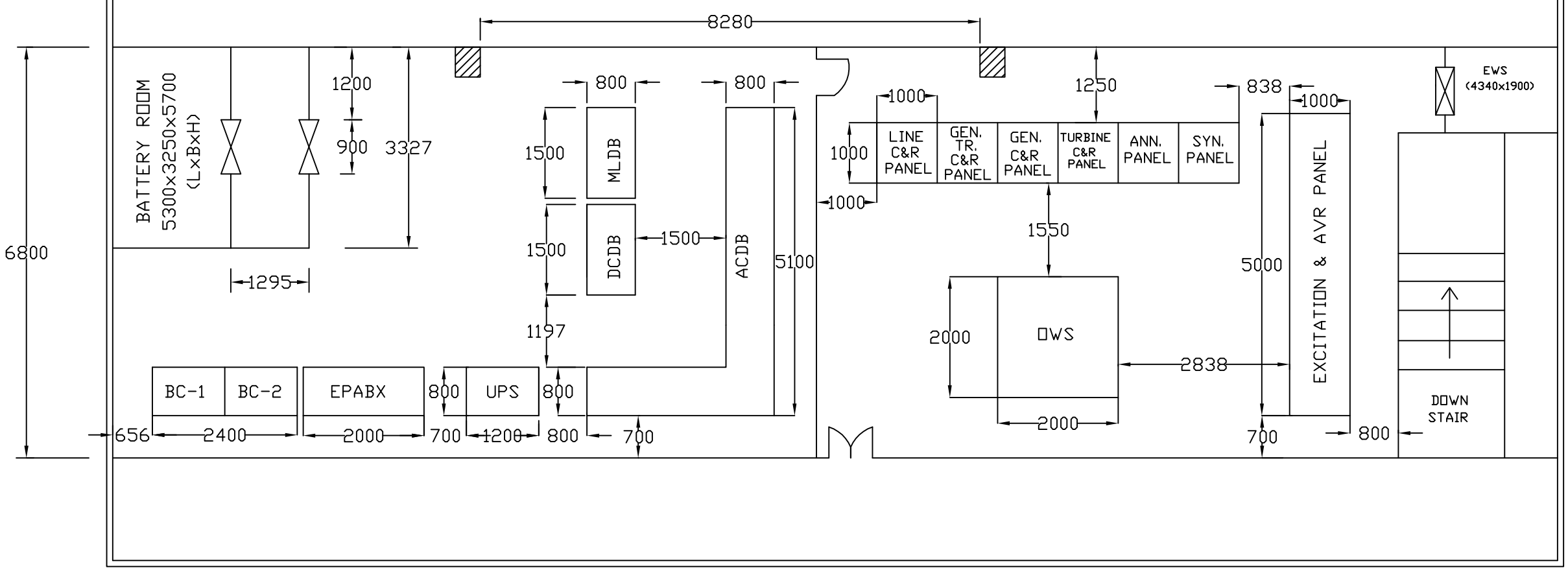
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2. DRAWING IS INDICATIVE

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2					
3					
4					

SEC	ELECT	GL&T	MH
REV			

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DESIGNED	SKS
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CHECKED AND VERIFIED	RKP
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	DATE:

RM&U OF 1 x 60 MW UNIT OF KODAYAR HYDRO ELECTRIC PH-I

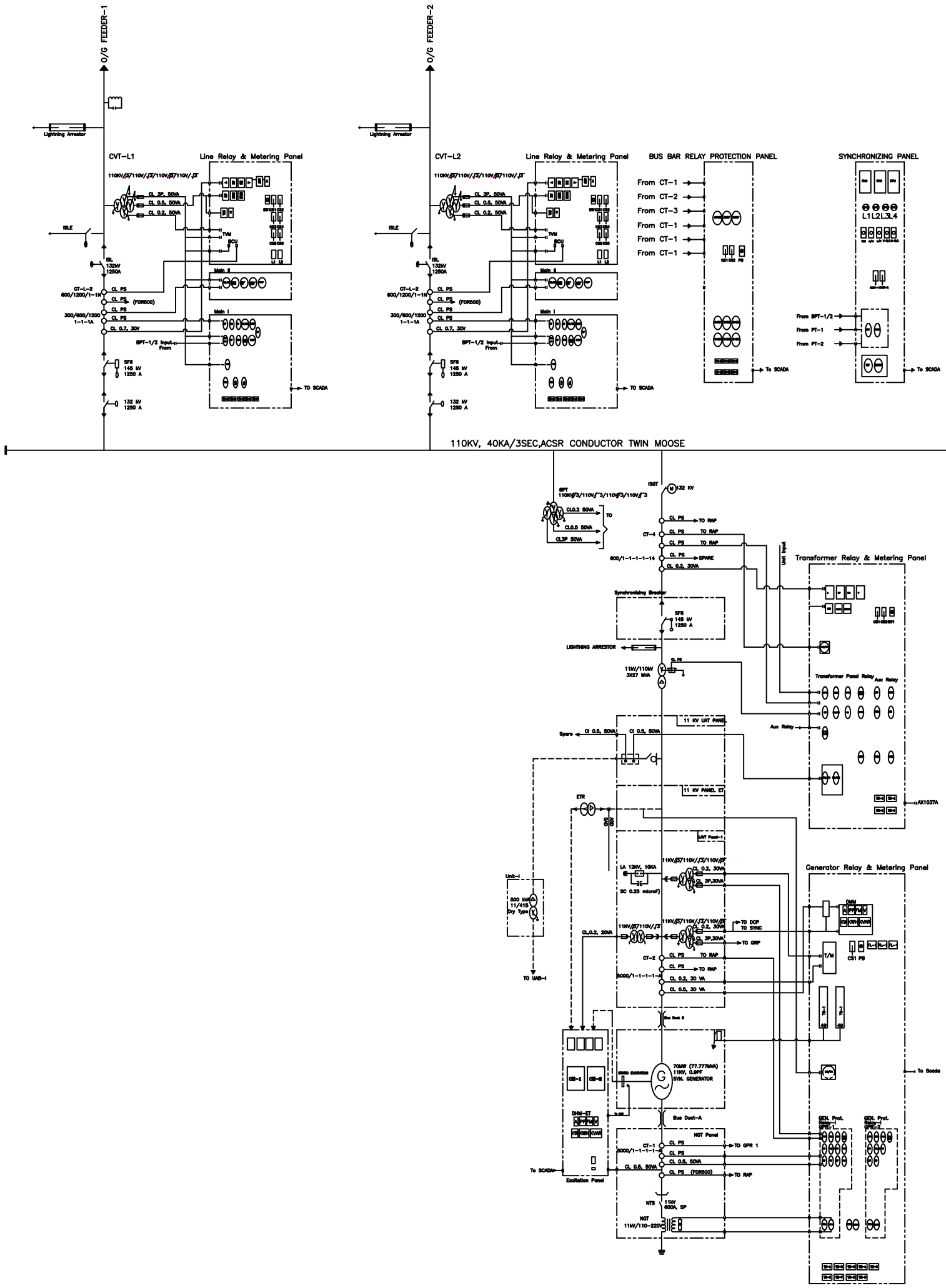
CONTROL ROOM LAYOUT (PROPOSED)

SCALE -

SHEET 1-OF-1

REV 0

DRG.NO.MEC/S/10HG/11/S3/TS/E/01



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R M & U OF KODYAR HYDROELECTRIC POWER HOUSE

PROPOSED GENERATOR ELECTRICAL SINGLE LINE DIAGRAM

SCALE - NTS | SHEET 1 of 1

DG SET FEEDER (FUTURE)

SPARE PANEL

11KV INCOMER FROM KODAYAR PH-2

415V,800A,50KA

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SECTION	PP&EE
LOCATION	RANCHI
DESIGNED	SKS
DRAWN	SATISH
CHECKED AND VERIFIED	RKP
APPROVED	SIG.
	DATE:-11-09-2015

RM&U OF 1 x 60 MW UNIT OF KODAYAR HYDROELECTRIC PH-I

LTAC DISTRIBUTION BOARD ELECTRICAL SINGLE LINE DIAGRAM

SCALE -

SHEET 1-OF-1

REV 1

DRG.NO.MEC/E/1OHO/11/23/TS/E/03

MEC/11/10H0/I & PC/01

MAIN CONTROL ROOM

LVS LED
65"

ENGINEERING ROOM

OPERATOR
STATION
(OS)24" TFT

PRINTER
Colour Laser(A4)

PRINTER
(DMP)

ENGG CUM OP.
STATION

A3 Colour laser

Future facility
COMMUNICATION VIA–VSAT

BUS

TCP/IP

BUS

BUS

ROUTER

TCP/IP OPC

LEVEL–2

SYSTEM CABINET

C
P
U

C
P
U

BUS

BUS

I/O

I/O

I/O

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C:\ACAD\P637\P637–03

NOTES :

Note : OS, ES & LVS qty shall be as per configuration

REV/SEC	CONCURRED BY

REV.NO.	DATE	ZONE	DESCRIPTION	BY	VERIFIED
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REFERENCES	DRG. NO.

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SECTION	I & PC
LOCATION	RANCHI
DESIGNED	D.K.MISHRA
DRAWN	P.K.DEY
CHECKED AND VERIFIED	D.K.Mishra
APPROVED	
SIG.	
DATE	

RM&U OF KODAYAR HYDRO
ELECTRIC POWER HOUSE–I

SYSTEM CONFIGURATION
OF PLC SYSTEM FOR
KODAYAR 1x70MW POWER HOUSE

SCALE –

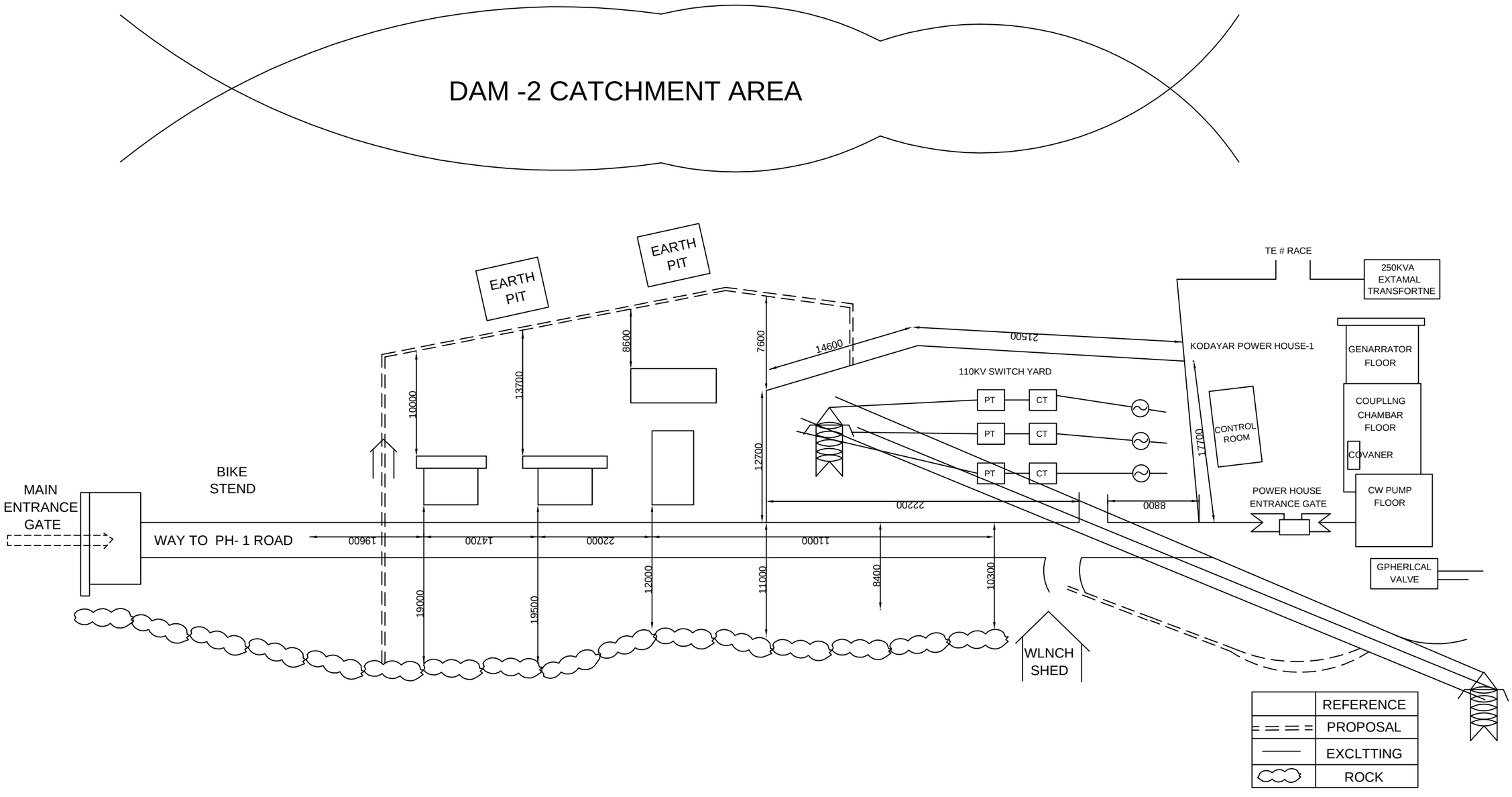
SHEET 1 OF 1

REV. 0

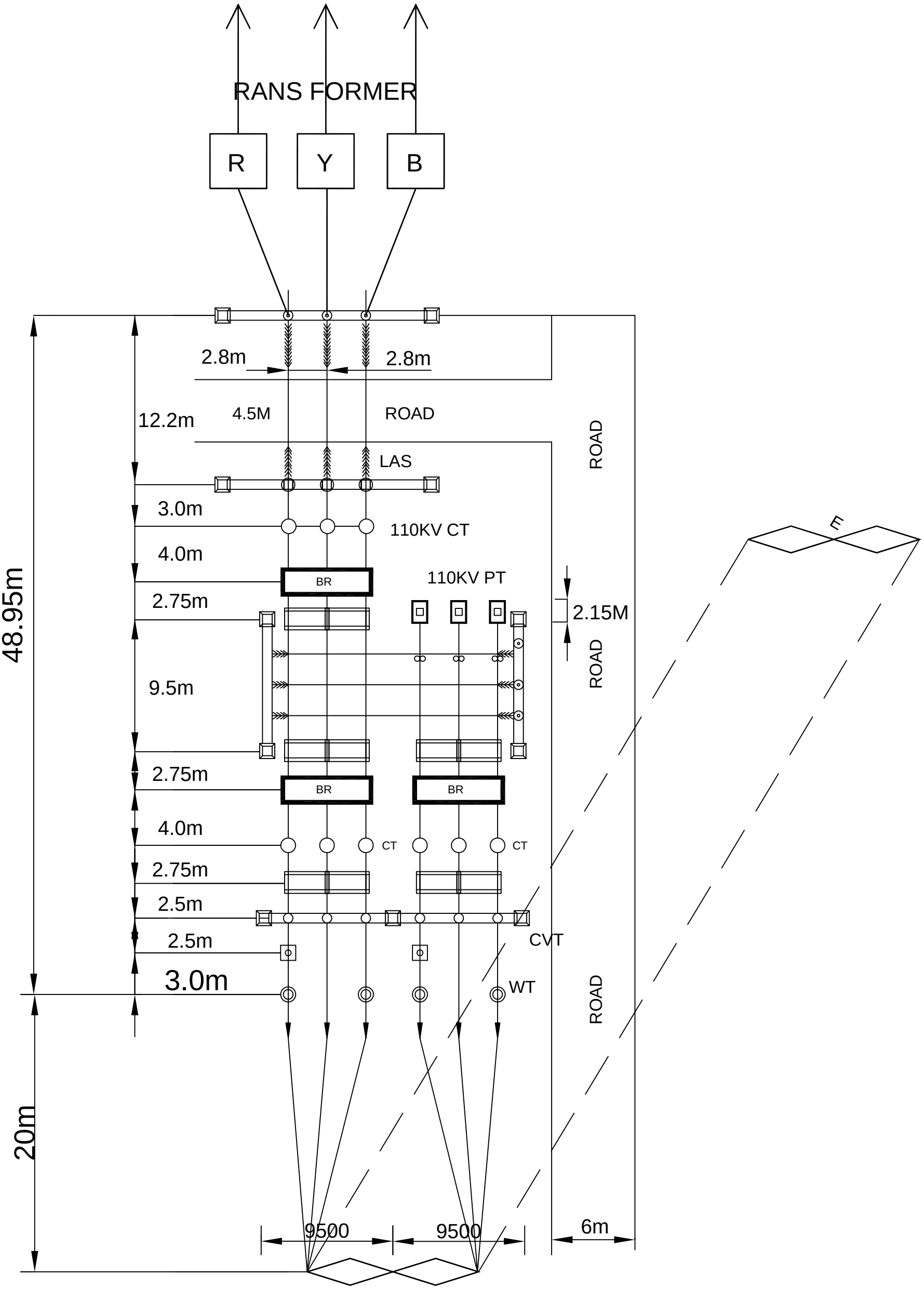
MEC/S/10H0/11/S3/TS/I&PC/01

LAYOUT OF 110KV SWITCH YARD AT KODAYAR POWER HOUSE - 1 (AVAILABLE SPACE)

SPECIFICATION NO. HE2367

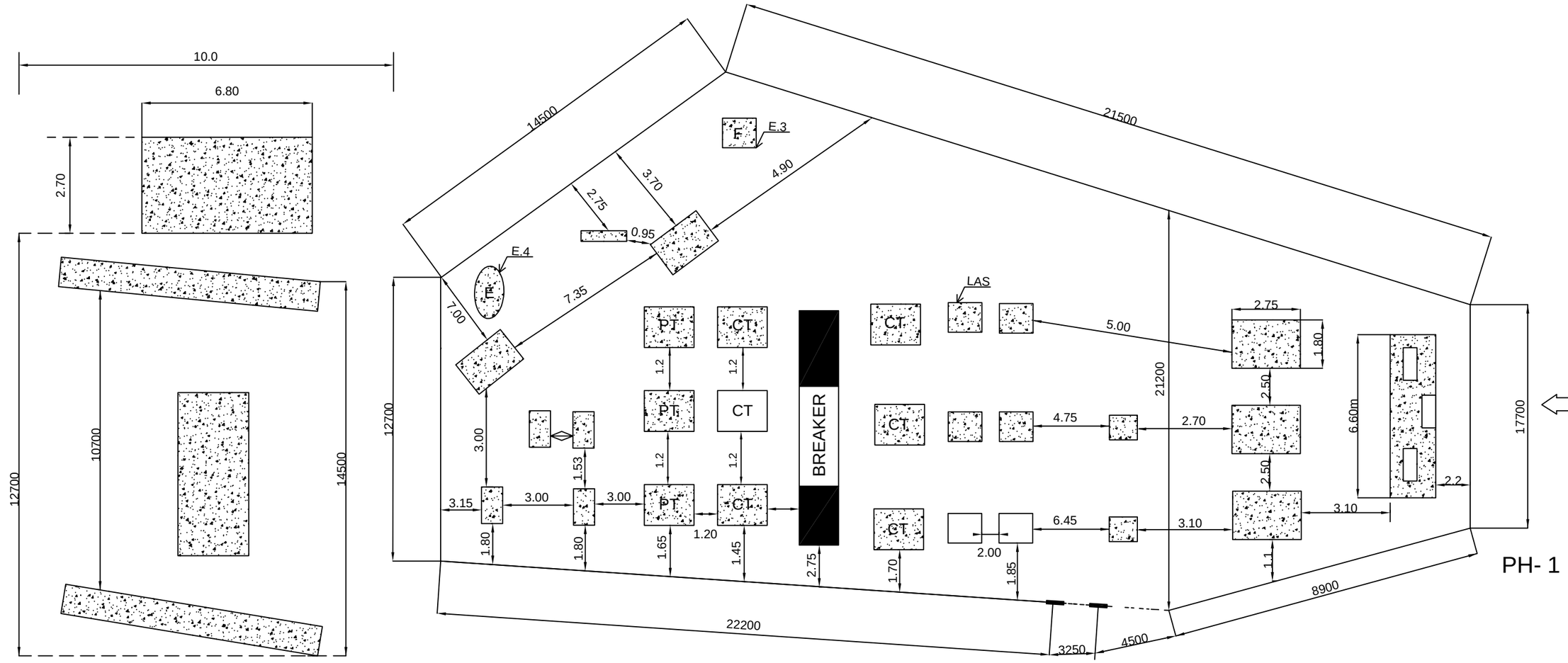


KODAYAR PH.1



PRO. TOWER

SPECIFICATION NO. HE2367



SCALE ALL IN METERS

0.3 x 0.3 - SUPPORTING PILLAR PLLNTH

LAS 0.75 x 0.75 - SUPPORTING PILLAR PLLNTH

0.75 x 0.75 - SUPPORTING PILLAR PLLNTH

CT 1.10 x 1.10 - SUPPORTING PILLAR PLLNTH

PT 1.10 x 1.10 - SUPPORTING PILLAR PLLNTH

SF6 BKR 1.50 x 1.50 - SUPPORTING PILLAR PLLNTH

2.50 x 2.50 - 110KV AB SWITCH SUPPORTING PILLAR PLLNTH

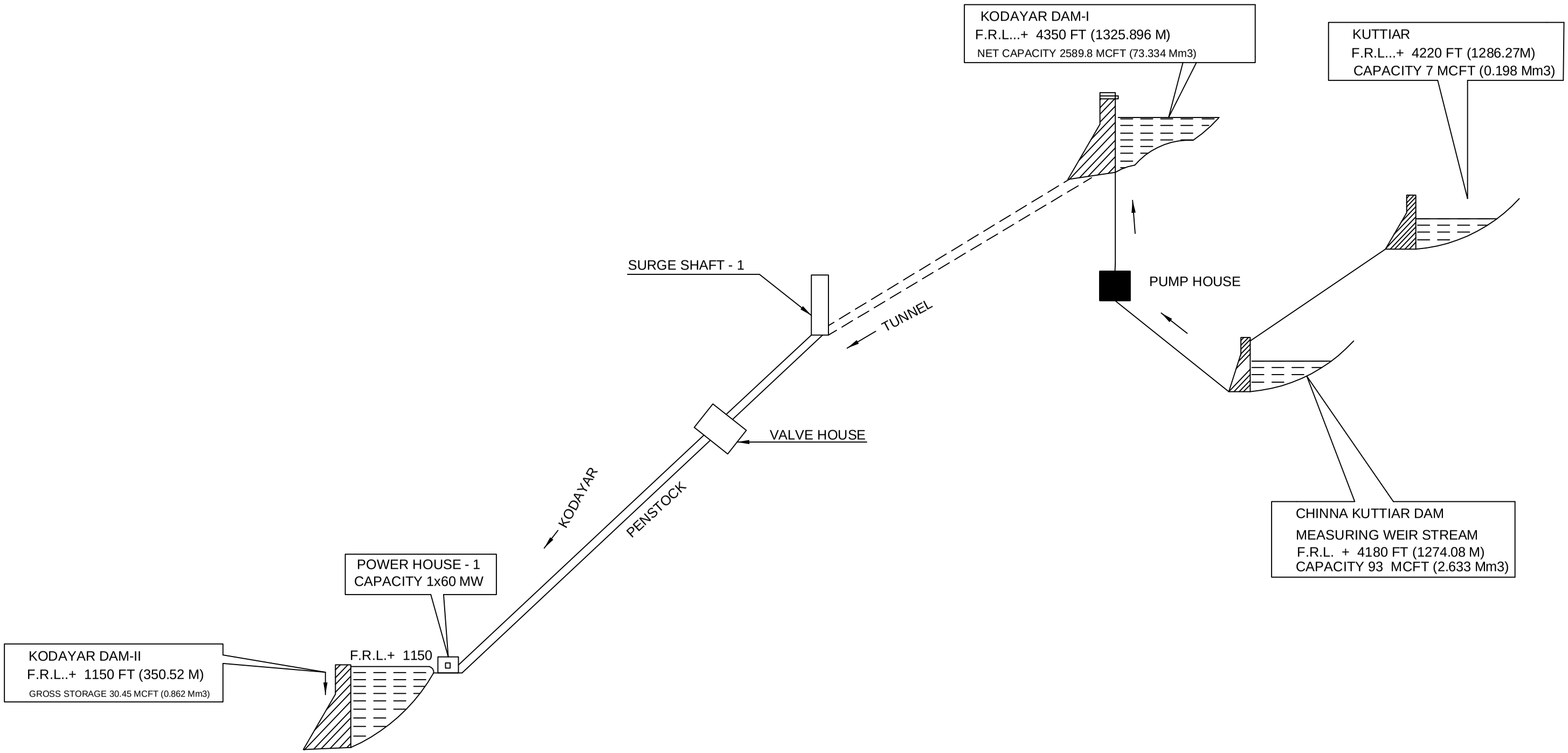
1.50 x 1.50 - CC SET SUPPORTING PILLAR PLLNTH

0.35 - WIDTH PARAPET WALL

SPECIFICATION NO. HE2367

KODAYAR HYDRO - ELECTRIC POWER HOUSE-1 (1 X 60 MW)

IN KANYAKUMARI DISTRICT



DETAILS OF EXISTING FACILITIES

1. TUNNEL

LENGTH - 10400 FT (3169.96 M)
SHAPE - HORSE SHOE
DIAMETER- 7 FT (2.133 M)

2. PENSTOCK

LENGTH - 7000 FT (2133.63 M)
DIAMETER - 6 FT TO 4.5 FT (VARIES FROM)
THICKNESS- 22.28 MM TO 38.10 MM (VARIES FROM)

3. SURGE SHAFT

TYPE - OPEN PLANE
DEPTH - 434 FT (132.28M)
DIAMETER- 20 FT (6.096 M)

4. POWER HOUSE

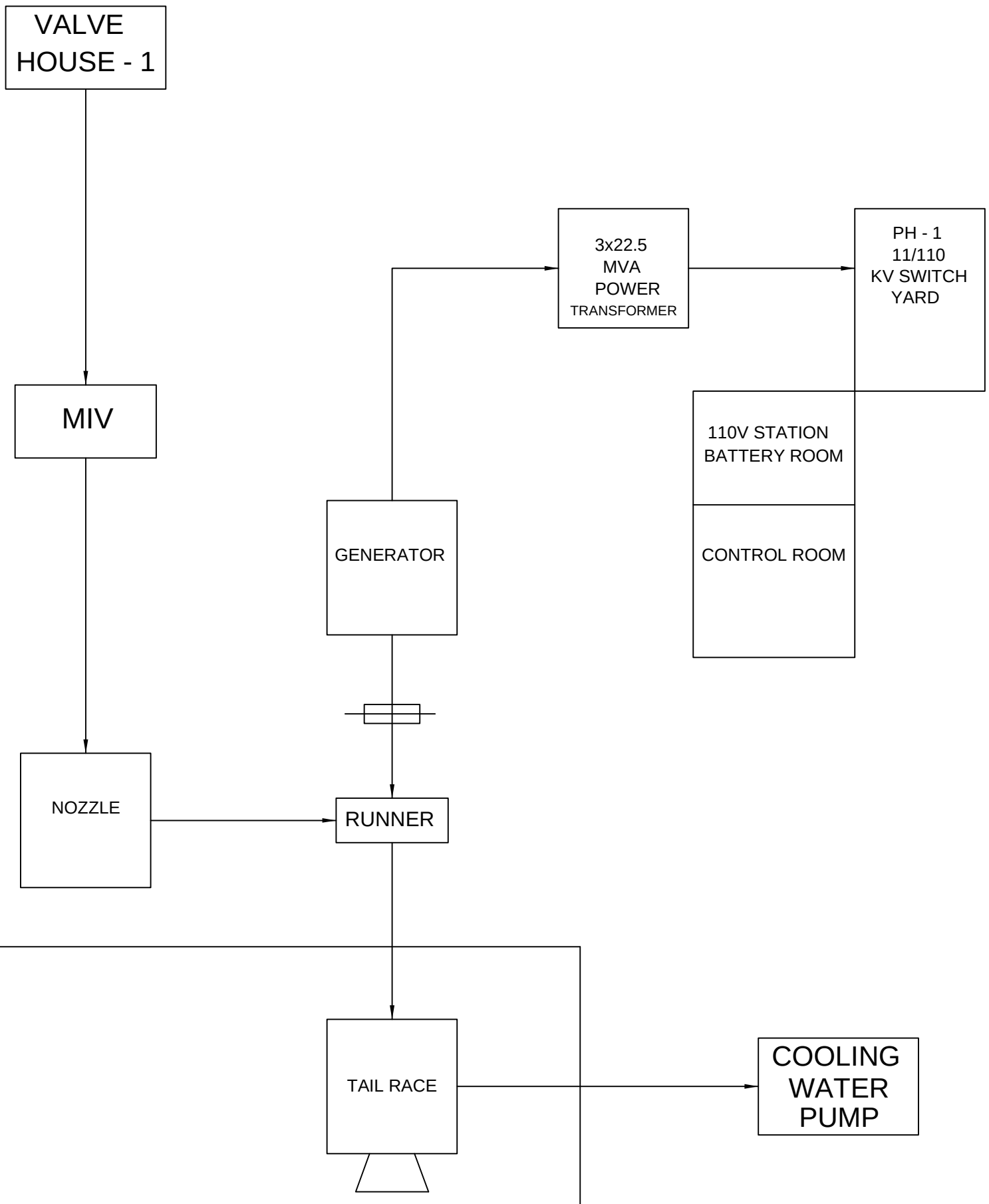
LENGTH - 32.91 M)
WIDTH - 21.41 M
HEIGHT - 19.18 M)

SPECIFICATION NO. HE 2367

VOLUME - IV OF SPECIFICATION HE-2367

SINGLE LINE DIAGRAM OF

BATTERY LIMIT OF PROPOSED RMU ON KODAYAR PH - 1 (1 x60 MW TO 1x70 MW)



RENOVATION, MODERNISATION AND UPRATING OF KODAYAR POWER HOUSE-I

(1x60MW TO 1x70MW)

IN TIRUNELVELI GENERATION CIRCLE

TENDER SPECIFICATION NO.HE 2367

PRE-BID MEETING HELD ON 29.11.2018

REPLY TO THE PRE-BID QUERIES (VOLUME -2)

OFFICE OF THE
CHIEF ENGINEER / HYDRO
5th FLOOR, EASTERN WING
NPKRR MAALIGAI,
144, ANNA SALAI, CHENNAI - 600 002.

TANGEDCO LIMITED

Er.R.Kamaraj,M.E.,
Chief Engineer/Hydro,
Fifth Floor, Eastern Wing,
144, Anna Salai,
Chennai-600 002.

Phone : 044 28520409
Fax No: 044 28553356
e-mail:cehe@tnebnet.org

Lr.No.CE/H/SE/H(E)/EE HRM/A4/F. Kodayar.RMU.HE 2367.Vol-II/D. 318 /18,dt. 27.12.2018.

Sir,

Sub: TANGEDCO – Hydro – Tirunelveli Generation Circle – Renovation, Modernization & Up rating (RMU) of **Kodayar** Power House-I from 1x60MW to 1x70MW – Specification (HE-2367) – Pre-bid Queries **VOLUME-II** (**TURBINE, GENERATOR AND OTHER MECHANICAL EQUIPMENT & CIVIL)** – Clarification on certain TECHNICAL terms – Communicated - Regarding.

Ref: 1. Specification No. HE 2367
2. Pre-bid meeting held on 29.11.2018

*****

The reply of TANGEDCO to the pre-bid queries relating to **Volume –II** (**TURBINE, GENERATOR AND OTHER MECHANICAL EQUIPMENT & CIVIL)** of Tender Specification HE.2367 raised by various firms and during the pre-bid meeting held on 29.11.2018 are furnished and uploaded as a separate PDF file alongwith the following.

1. Reply for Volume-2
2. Drawings
3. Water Analysis Report
4. QAP
5. Inspection call

All the other terms and conditions of the specification HE.2367 remain unaltered.

Yours faithfully,

Sd/xx
Chief Engineer/Hydro

Encl. : As above.

KODAYAR PHI RMU WORKS - SPEC.HE.2367

PRE BID QUERIES & TANGEDCO's REPLY

Sl. No.	PAGE. NO: .... of 161 of Vol-II	Clause No. .in VOLUME-II of HE.2367	AS PER SPECIFICATION VOLUME-II-HE.2367	QUERY	TANGEDCO's REPLY
1	4	Volume-II Cl. No. 04.02.02.(a)	Design Consideration / Life of equipment	Please provide the no. of start up and stop for the machine in a day.	The no. of start-up and stop for the machine in a day can not be specified
2	4 & 54	Volume-II Cl. No. 04.02.02.(b), 06.08.03.02.(b)	Speed rise, pressure rise, runaway speed	We understand that the existing penstock is to be retained hence the design pressure should be kept same.	The existing penstock is to be retained.
3	4 & 54	Volume-II Cl. No. 04.02.02.(b), 06.08.03.02.(b)	Speed rise, pressure rise, runaway speed	Kindly provide the limit of pressure rise, speed rise and runaway speed for existing unit.	Run away Speed of the existing unit is 915 rpm, for the new machine Speed rise is to be less than 30 % and the pressure rise is to be less than 15% and Runaway speed as per standard.
4	4	Volume-II Cl. No. 04.02.02.(c)	Chemical analysis of water and data including the petro graphic analysis	Kindly provide the water analyses report of the river water as it should be carried out by the purchaser and should be made available to the tenderer for tendering work.	Furnished.
5	4	Volume-II / Cl. No. 04.02.02.(c)	Chemical analysis of water and data including the petro graphic analysis	Also kindly provide the petrographic analysis and silt load analysis of the river water.	No need as the water is silt and abrasive particle - free.
6	4 & 54	Volume-II clause 04.02.02.(d), 06.08.03.02.(c)	Noise level	Normally the noise level in the turbine pit should be in the level of 95 dBA to 100 dBA as the noise level depends on other influencing factors like acoustic in Power House design, concreting of distributor and other auxiliary equipment inside the Power House. Please confirm.	As per specification/ as per OSHA standard.

7	5	Volume-II Clause 04.03.01	MANUFACTURING AND FABRICATION-GENERAL: All forgings, castings and structural materials shall conform to the relevant BIS/ International standards. Special nonferrous materials required for manufacturing parts subject to heavy pressure, severe working conditions, and/or requiring high tensile strength, toughness and resistance to corrosion shall be used. Bronze used for manufacturing parts such as bearings, shall preferably be forged or centrifugally cast.	We will supply the equivalent to the International standard material. We request you to kindly accept the sameGenerator CT, PT, LA & surge panel	Irrelevant querry.
8	17	Volume-II Clause 04.03.16.05	MANDATORY INSPECTIONS: All welds in ferritic alloy steels, e.g., having a carbon equivalent value in excess of 0.40%, and high yield-strength steels, e.g. having yield strength greater than 300 MPa, shall be subjected to 100% ultrasonic examination and crack detection wherever possible. In addition, all butt welds in these materials shall be subjected to **100% radiographic examination**.	It is proposed to carry out 100% Ultrasonic Testing (UT) in place of Radiographic Testing (RT) since UT is equally efficient to detect volumetric flaws. In addition, now-a-days UT is being done with special probes and equipment which gives better results in terms of size and location of defects compared to RT in detecting volumetric defects. Moreover, the radiographic examinations are hazardous and not recommended from health and environment hazards point of view. Therefore it is proposed to carry out 100% ultrasonic test in stead of radigraphic test at work shop and site to ensure more reliability. Please review & confirm.	As per specifications.
9	18	Cl. No. 04.06	Painting	Painting specification shall be done according to manufacturer's standard which can be further discussed during contract negotiation.Please confirm.	As per specification.
10	18	Vol-2 / C no. 04.05	**Special tools and tackles:** The tools and appliances supplied shall not be used for erection purposes by the successful Tenderer and shall be handed over in new condition.	Same tools shall be used during erection and AHPL will ensure the tools shall be handed over in good condition.Please review and confirm	The tools and appliances supplied can be used for erection purposes by the successful Tender and shall be handed over in good working condition.

11	29	Volume-II Clause 05.01.04 /	STATION CRANE : Make	Make of various items such as motors , cables, DSL, control system , brakes etc shall be as per bidder's standard sub-vendor list.	For bought-out items, Contractors are requested to adhere to the list in the spec. In case of vendors not listed in the preferred makes, the main contractor has to get prior approval from TANGEDCO by furnishing the credentials of the vendor before proceeding
12	30	Volume-II Clause 5.02.01 12. SALIENT FEATURES	05.02.01 WATER CONDUCTOR SYSTEM BUTTERFLY VALVE: Dia 1700 mm 224ft of Water Column	Name of Package: Penstock butterfly Valve: Please confirm design pressure (with pressure rise due to water hammer effect) to be considered for the valve parts.	Design pressure as per IS 7332
13	35	Volume-II Clause No.06.01.(b)	SCOPE OF WORK	Sub Clause (b) -re-use of the fixed /embedded components etc.	Clause 06.01.(b) (ii) may be inclused as " In case the new turbine requires replacement of any of these parts, the same shall be considered in the scope of tenderer"
14	35 & 43	Volume-II Clause No. 06.01.(b), 06.03.02	Turbine Housing	(i) . As per tender specification, the turbine housing shall not be replaced. If the distributor is replaced with a new configuration with 4 nozzles, it makes no sense to keep the existing housing. (ii) Furthermore, it is questionable if it would be feasible to maintain the housing. (iii) Kindly check & clarify.	The Turbine housing shall be refurbished/replaced as per bidder's design requirements and site conditions.
15	35, 43, 46, 55	Volume-II Clause 06. SCOPE OF WORK, EXISTING FACILITIES& BATTERY LIMIT 06.01 SCOPE OF WORK	**06.01 SCOPE OF WORK** c) Assess the condition of various existing civil foundations, modification of housing to accommodate the new configured manifold, strengthen and reuse the foundations **06.03.02 TURBINE HOUSING/DISCHARGE CHAMBER** Housing/Discharge Chamber shall be modified for accommodating the new symmetrical manifold. Internal surfaces of housing shall be weld filled by grinding and providing protection coating. The detail modification work is described under Civil Work. 0**6.07.02 DESIGN CRITERIA** a) 06.07.02.01 Tenderer shall assess and confirm the possibilities of accommodation of new runner and manifold in the existing turbine pit and fitting with the existing turbine shaft before putting up the 06.08.03.05.02 NOZZLE New set of 02 nos. or 04 nos. symmetrical nozzles shall be provided. The nozzles for supplying the water to turbine runner will be designed for producing a solid uniform jet. The nozzle body should be of welded stress relieved steel tube and the nozzle tip will be provided with a removable stainless steel seat ring at the point of final water discharge. Removal and replacement of the seat ri.....minimize the jet dispersion	We understand that either 2 nos. or 4 nos. of symmetrical nozzles/jets to be provided in new manifold. Please confirm. It is to be noted that replacing existing manifold with new one involves major civil works. Please provide analysis/study report if any done for the feasibility of the same.	"The synchronous speed proposed is 500 rpm . However the synchronous speed & number of jets is left to the bidders to decide as per their hydraulic design. However, the basis for selection of the speed & number of jets will be the overall economy to the Purchaser considering Power House civil works modifications required, Turbine and Generator efficiencies, price of matching Generators, existing EOT crane capacity, etc. Any modifications - civil or mechanical whatsoever, is under the scope of the contractor."

16	36	Volume-II Clause No.- 06.02/ point 1 of the table Page No.-36 of 161	1. Butterfly Valve including complete control system etc.	Kindly provide the distance between Butterfly Valve house and Power House Control Room	Approximately 2.6 KMs. Also Site visit recommended
17	37 & 45	Volume-II Clause. No. 06.03, 06.06	Fixed/embedded components of Unit e.g. turbine casing	New turbine casing / turbine distributor shall be supplied. Kindly clarify	As per bidder's requirement and site conditions.
18	37 & 48	Volume-II Clause 6.03.01, 6.07.02.02	WATER ANALYSIS REPORT	6.08.06. COOLING WATER SYSTEM: 6.08.08 LUBE OIL SYSTEM: Please furnish water analysis report for design of air and oil coolers	Furnished.
19	37	Volume-II Clause 6.03.01 (Penstock) / Page 37 of 161	"Anchor blocks are to be repaired; All Expansion joints to be replaced with new one.All Expansion joints shall be designed to take care of the expansions between the two consecutive anchor blocks"	Please provide us existing civil drawings,details of anchor blocks and related design documents.	Drawings already furnished in Volume IV. For Anchor Blocks detail visit site
20	37	Volume-II Clause 06.03.01 A (i)	**PENSTOCK :** Internal surface shall be cleaned by using brush, water jet and shot blasting. Outer surface shall be cleaned by using brush and water jet	Internal & outer surface will be cleaned by using any one of following method brush or water jet or shot blasting - Please confirm	Accepted. Atleast commercial Blast condition is to be achieved before the commencement of painting.
21	37	Volume-II Clause No. 06.03.01 A (i)	**PENSTOCK :** The internal surface shall be painted with water resistant paint. The outer surface shall be painted with weather proof paint	Please provide paint specifications	As per specifications in Clause 06.03.01.01 and 06.03.01.07.
22	38	Volume-II Clause No. 06.03.01 PENSTOCK	vi) New penstock drain valve with **electric motor** □□□r□□□□ □ □□□□ □r□□□d□d.	As per normal practice penstock drain valve is operated manually with an additional guard valve in series. Please review and confirm.	Accepted.
23	44	Volume-II Clause No. /06.03.05/ Page 44 of 161	**EOT CRANE OF POWER HOUSE:** The power house consists of an EOT crane with a main hoist of 135 tonnes and auxiliary hoist of 20 tonnes for the erection and maintenance of the unit.	Kindly provide details (span, lift, approaches etc) and GA drawing along with structural drawings of existing one no. 135/20T Power House EOT Crane for assessment.	Drawings furnished.

24	44	Volume-II Clause No. 06.03.05(iv)/	Replacement of mechanical load brakes with electrical load brakes	We understand brakes to be provided are Thruster/electromagnetic type and 2nos Brakes shall be provided for each motor.	Yes
25	44	Volume-II Clause No. 06.03.05/	**EOT CRANE OF POWER HOUSE:** For renovation of EOT crane following works to be carried out: i) Replacement of wire ropes and refurbishing of hoist machinery (gears, gear boxes, sheaves, wheels etc.) ii) Replacement of power conductors (down shop and/or trolley and bridge) iii) Replace/provide power disconnecting devices to meet current standards iv) Replacement of mechanical load brakes with electrical load brakes v) Replacement of motors vi) Replacement of control systems vii) Replacement of control and power wiring or conductor and collector systems. viii) Replacement of lighting system ix) Refurbishment of lifting beam x) Re-painting xi) Load test by certified agency	Sizing /selection of of crane parts requiring renovation/replacement shall be as per IS 3177. We understand that refurbishment of existing crane structure (bridge girder, operator's cabin & end carriage) is not required. Also we understand refurbishment/ replacement of rail & end stopper are not in scope of tender.	Refurbishment of existing crane structure (bridge girder, operator's cabin & end carriage) is not required. Refurbishment/ replacement of railrs are not in scope of tender. However refurbishment/ replacement of end stopper is under the scope of tender.
26	44	Volume-II Clause No. /06.03.05(vi)/	Replacement of control systems	Customer may clarify the type of control system in existing crane and type of control system required. We propose that motor shall be controlled through VVVF drives as per prevalent practice of industry. Further the operation shall be done either from operator's cabin situated on bridge girder or pendent push button operation from operating floor of power house.	For the existing crane, operation is being done from operator's cabin. For refurbishment radio control shall also be provided.
27	44	Volume-II Clause No. 06.03.06 Generator transformer	COMPLETE UNIT AREA INCLUDING GENERATOR TRANSFORMER	There are no transformer pits below the transformers and the existing pipes can be used for drainage of oil and water. Please confirm	As per site condiitions.
28	44	Volume-II Clause No. . 06.03.06 Generator transformer	COMPLETE UNIT AREA INCLUDING GENERATOR TRANSFORMER: After site visit it observed that Transformer rails are in good condition and hence the existing rails can be used for transformer movement. Please confirm	After site visit it observed that Transformer rails are in good condition and hence the existing rails can be used for transformer movement. Please confirm	Accepted

29	44 & 45	Volume-II Clause No. 06.04 SUPPLY OF PLANT & EQUIPMENT	7) Cooling water system - Sets - 2 9) Compressed air system - Sets - 2	Kindly confirm that the quantity of supply shall be 1 set instead of 2 sets for the specified systems.	Cooling water system 2 sets. Compressed Air system refers to 2 Nos., of Compressors (1 W +1 S). refers 1 working and + 1 standy motor pump sets
30	44	Volume-II Clause No. 06.03.05 (xi)	**EOT CRANE OF POWER HOUSE:** Load test by certified agency	Load test for the Max weight to be handled by EOT Crane will only be conducted (Since, crane Structural parts are old) in presence of TANGEDCO Engineers and there is no need for certification from Certified agency. For Conducting load test, required load to be issued by TANGEDCO at site free of Cost. - - Please Confirm	For load test the heaviest assembly during assembling of TG components/ equipments shall be used for load testing and the deflection of the bridge shall be as follows. The maximum vertical deflection of the girder produced by the dead load, The weight of the trolley and the rated load shall not exceed 1/600 of the span (EOT span 10.50 m). In case of non availability of rated load, the maximum permissible deflection shall be within limits in proportion to the actual load used. (should be less than or equal to max permissible deflection = span/600 x actual load/ rated load). Existing crane structure shall be cleaned and painted Drawings uploaded. For other details visit site.
31	45	Volume-II Clause No. 06.04 (E) Supply of Plant & equipment/ Page 45 of 161	1. Mandatory Spares as per list -1 Sets 2. Commissioning spares- 1 Sets 3. Recommended Spares- 1 sets 4. Special Tools & tackles - 1 sets 5. Maintenance Tool & tackles - 1 sets	We understand that mandatory spares, as mentioned in Annexure-II (Page 204 of volume-I) & in line with clause no. 06.04(E) of Vol-II only are in the scope of bidder. Further, we understand that O&M spares for a period of one year from commissioning as well as mandatory spares for operation & maintenance for 5 years thereafter (as mentioned in cl. no. 6.07.04, vol-I) are already covered in Annexure-II(7.03.02) and shall not be quoted separately. Please Confirm	Yes. However , spares which are mandatory and not listed in the annexure shalll also be supplied.
32	45 &46	Volume-II Clause No. 6.07	DESIGN CRITERIA AND DETAILED SCOPE OF WORK: Reference document indicated are only IEC standards	Equivalent National/International standards shall also be accepted	Equivalent Indian/International standards are accepted (such as IEC , IEEE, ANSI ,ASME, ASTM)

33	47	Volume-II Clause No. . 06.07.02.02	CFD / Model test	(i) If a model test shall be performed, CFD analysis is not performed. (ii)If an existing model is used, CFD comparison of distributor, nozzle, casing flow can be done. Then cavitation performance tests will not be done. Kindly confirm.	Cavitation performance test not required. CFD simulations / model test have to be carried out in the presence of TANGEDCO Engineers.
34	47	Volume-II Clause No. 06.07.02.02 (a)	COMPUTATIONAL FLUID DYNAMIC STUDIES (CFD MODEL TESTING): To ensure the output and efficiency of the machine, the new turbine shall be designed andmanufactured based on computerized simulation studies	If Model test report of Homologous Model is submitted, computational Fluid Dynamics studies will not be carried out - - Please Confirm	CFD simulations or model test have to be carried out in the presence of TANGEDCO Engineers for acceptance
35	47	Volume-II Clause No. 06.07.02.02	**Computational Fluid Dynamic Studies / Model Testing** To ensure the output and efficiency of the machine, the new turbine shall be designed and manufactured based on computerized simulation studies. Cavitation performance of the turbine shall also be carried out.	Due to two phase flow and the transient process involved, a reliable and accurate prediction of pelton turbine performance through CFD analysis is not possible till now. Hence model test report shall be submitted for approval and performance guarantee shall be evaluated based on model test report only. Kindly confirm.	As per Specification
36	Page 47 of 161 Page 113 of 161 Page 115 of 161	**Volume-II** **Clause No.** **06.07.02.02** **Clause 07.02** **Clause 08.02.01**	Cavitation performance of the turbine shall also be carried out. **PERFORMANCE REQUIREMENT AND GUARANTEE** Values of critical plant sigma as determined as per IEC code 193A should be given in the form of curves of different guide vane positions for different heads. Plant sigma curves as recommended by the manufacturer shall also be plotted on it clearly to show the safety margin available. **Guaranteed and other technical particulars** 3. Critical sigma 4. Plant sigma	Kindly note that cavitation occurs in Reaction turbine, where there is a chance of bubble formation due to vaporization at low pressure. As pelton machine runs at atmospheric pressure, hence cavitation phenomenon is rare in such turbines and hence these clauses are not relevant. Kindly review and confirm.	Cavitation clause with respect to plant sigma not applicable and, GTP Cl. No 08.02.01 Sl.No.3&4 shall be furnished as “not applicable"

37	48	Volume-II Clause No. . 06.07.02.02.(f).(iv) AND Volume-IV / Drawings / dwg.no. 7049724	Nozzle centerline	As per Cl. No. 06.07.02.02.(f).(iv), Nozzle centerline is EL. 506.36 m , while as per Volume-IV / Drawings / dwg.no. 7049724 / sectional view of power house, Nozzle centerline is EL. 352.959 m. Kindly clarify.	**Nozzle center line is EL 352.959 m**.
38	48	Volume-II Clause No. No. 06.07.02.02.(f).(iii), (iv)	Net Head	We understand the provided head in clause No. 06.07.02.02.(f).(iii), (iv) are the net head. (i) Rated /Design Net Head - 940.30m (ii). Maximum net Head - 914.32m (iii) Minimum Net Head - 914.32m Kindly confirm	**(i) Rated /Design Net Head - 940.30m (ii). Maximum net Head - 944.80 m** **(iii) Minimum Net Head - 914.32 m**
39	48	Volume-II Clause No. . 06.08.01	By-pass line & air valve	We propose to provide the suitable size of the bypass line and air release valve. Kindly confirm.	Suitable bypass system in place of existing bypass valve with hydraulically operated needle valve / barrel type valve and isolation gate valve shall be provided. Air valve as per AWWA standards shall be provided.
40	48	Data collected from site, Document - Turbine\EQUIPMENT REGISTER KODAYAR PH 1\TURBINE Volume-II Clause No. : 6.07.02.02 Computational fluid dynamics studies (CFD Model Testing)	3. Head : Gross – 3192 “ Nett – 3109 “ iv. The new turbine will be designed based on the following parameters. Rated /Design Head : 940.30m Maximum Head : 972.92m Minimum Head : 914.32m Elevation of nozzle center line : EL506.36m	According to tender specifications, calculated maximum gross head equals to 4350 ft - 1158 ft = 3192 ft ~ 972.92 m and maximum net head is indicated as 972.92m which means zero head loss is considered. Please furnish maximum net head value when unit is operating at full load with maximum head water level.	Max. head : 972.92 m. Max Net Head= 944.80 m based on consultant simulation stubies.. However the same shall be evaluated by the bidder as per standard IS 7326 . Elevation of nozzle center line : EL. 352.959 m
41	48	Volume-II Clause No. 06.08.01 BUTTERFLY VALVE	Scope of supply	We understand that upstream and downstream pipes (with expansion joint) of valve is not in the supply scope. Please confirm.	All the necessary fittings and Pipes including expansion joints to install the new Valve with the existing Penstock are under Contractor's scope.
42	48	Volume-II Clause No. 06.08.01 BUTTERFLY VALVE	Scope of supply	Please confirm scope of supply for below items: By pass system, drain valve including drain line Air valve, Movable platform	YES. By pass system, drain valve including drain line, Air valve, Movable platform

43	49	Volume-II Clause No. 06.08.01.02.01 VALVE BODY 06.08.01.02.02 VALVE DISC	The valve body should be cast, cast fabricated materials as per latest IS 7326 or equivalent standards. The Disc should be cast, cast fabricated materials as per latest IS 7326 or equivalent standards.	We understand that valve body and disc shall be of cast or fabricated material. Kindly confirm.	As per specification.
44	49	Volume-II Clause No. 06.08.01.02.03 VALVE TRUNIONS	The trunnion should also be designed for the stress developed during valve closing under emergency condition and over velocity or penstock rupture condition.	Kindly provide the free discharge value to be considered for the valve design.	As per specification.
45	50	Volume-II Clause No. 06.08.01.02.10.(c)	Operation and control	We propose the high pressure oil system with 120 bar nominal pressure, Piston type accumulator with nitrogen bottles system and hence no high pressure compressed air system is required. Kindly confirm the same.	Accepted.
46	50	Volume-II Clause No. 06.08.01.02.01 VALVE BODY- 06.08.01.02.08 FOUNDATION / Page 50 of 161	"The existing foundation shall be used. Strengthening of existing foundation shall be checked by Contractor for the proposed butterfly valve and necessary strengthening and any modification if required the same shall be carried out by the Contractor"	Please furnish existing civil drawings, details and design documents.	Site visit recommended.
47	50	Volume-II Clause No. 06.08.02 SPHERICAL VALVE (MAIN INLET VALVE)	Scope of supply	Name of Package: Main inlet Valve: We understand that upstream and downstream pipes (with expansion joint) of valve is not in the supply scope. Please confirm.	All the necessary fittings and Pipes including expansion to install the new Spherical Valve with the existing Penstock are under Contractor's scope.
48	50	Volume-II Clause No. 06.08.02 SPHERICAL VALVE (MAIN INLET VALVE)	Scope of supply	Please confirm scope of supply for below items: Air valve, Movable platform	Suitable bypass system in place of existing system hydraulically operated needle valve/barrel type valve and isolation gate valve shall also be provided.

49	50 & 53	Volume-II Clause No. , 06.08.02 SPHERICAL VALVE (MAIN INLET VALVE),06.08.02.02.12 OPERATION AND CONTROL	c) For operation of the valve, a separate oil pressure unit including compressed air system shall be installed in the valve house. b. For operation of the valve, a separate oil pressure unit including compressed air system shall be installed.	We propose high oil pressure (>=120 bar) system with nitrogen-based pressure accumulator as It has advantages of easy handling & maintenance. The proposed system occupies less space, which has advantageous from layout point of view. We have many reference projects where we have provided high pressure OPU system & running successfully. Please review and confirm.	Accepted. However the complete system, remote monitoring has to be made at Control room.
50	53	Volume-II Clause No. . 06.08.02.02.12.(b)	Common OPU	As per the latest design and practice, we propose common oil pressure system for turbine and MIV with 120 bar operating pressure. Kindly confirm.	Accepted.
51	53	Volume-II Clause No. 06.08.02.02.11 LIFTING DEVICE	Existing lifting device shall be used.	Kindly provide the list for the available lifting device with capacity.	Adequate capacity (26 T) Gantry Crane available.
52	Page 53 of 161	Volume-II Clause No. 06.08.03.01	**TURBINE:** c. The turbine shall be designed to give rated output (at generator terminals) at rated head of 940.30m with maximum efficiency of the turbine. The turbine would have output higher (minimum 10%) than the rated output when operating at heads higher than the rated head. The maximum output both at minimum and maximum heads shall also be stated in the offer.	**TURBINE:** Kindly confirm maximum discharge available for Kodayar HEP. Since turbine output is a function of net head, discharge & efficiency and for a particular discharge, it will be proportional to net head. Therefore, turbine would have higher output than the rated output proportionately for the heads lying between rated net head and max net head. Kindly confirm.	As per specification the Machine shall also be designed for 10% continuous overload and the head, and / or flow requirement shall be indicated in the GTP
53	53	Volume-II Clause No. 06.08.03.01 (c)	**TURBINE:** The turbine would have output higher(minimum 10%) than the rated output when operating at heads higher than the rated head. Max head as per specification is 972.92m	Discharge at Rated head also not indicated, please specifiy the same. Discharge at max head is not indicated and as per preliminary calculations 9 Cumecs is required to Generate 77MW. - Please Confirm	(i) Rated /Design Net Head - 940.30m (ii). Maximum net Head - 944.80 m (iii) Minimum Net Head - 914.32 m

54	53, 63, 64	Volume-II Clause No. 06.08.03-TURBINE & 06.08.04-GENERATOR AND ASSOCIATED EQUIPMENT	10% above rated capacity	1. Present capacity is 1x60 MW so uprating by 10 MW is too much on higher side it should 10% above rated capacity i.e. 66 MW. As the unit pit dia. and levels will remain same.	As per spec, Machine shall also be designed for 10% continuous overload and the head and/or flow requirement shall be indicated in the GTP
55	53	Volume-II Clause No. 06.08.03.01	f. The Tenderer shall critically study the silt data and chemical analysis of water and take the same into account in designing the turbine and auxiliary equipment susceptible to abrasive effect of silt, making all such specific provisions and measure including selection of materials, coatings and paintings which will help to resist silt abrasion and enable easy and quick maintenance / replacement of worn out components.	We understand that requirement of coating is optional. Hence we understood that guaranteed Weighted Average Efficiency of turbine is to be given without considering effect of coating on the same. Please confirm.	As the water is silt and abrasive particle - free, coating not required.
56	54	Volume-II Clause No. 06.08.03.02	**GOVERNING:** **b) Weight average efficiency** The moment of inertia of the unit and normal nozzle and deflector closing shall be so adjusted that maximum momentary speed rise of the unit and the maximum pressure rise in the penstock shall not exceed existing limits.	Please furnish the limits of speed rise and pressure rise.	Speed rise is to be less than 30 % and the pressure rise is to be lless than 15% and Runaway speed as per standard.
57	54	Volume-II Clause No. 6.08.03.02	Evaluation Criteria	Evaluation Criteria w.r.t. difference in weighted average efficiency among different bidders may be furnished.	As per specification
58	54	Volume-II Clause No. 6.08.03.02	Penalty	The amount of penalty on short fall of weighted average efficiency with respect to guaranteed value is not specified. Please review & inform the same.	As per specification

59	54& 115	Volume-II Clause No. 06.08.03.02 WEIGHTED AVERAGE EFFICIENCY Volume-II Clause No. 08.02.01 Guaranteed and other technical particulars	WEIGHTED AVERAGE EFFICIENCY (ηw) will be calculated as follows: Weighted average efficiency (ηw) = 0.5 x η100 + 0.3x η80 + 0.2x η60 (η100, η80, η60 mean the efficiency of the turbine at rated head and when it delivers 100%, 80% & 60% of rated MW (Electrical) Output respectively). Guaranteed efficiencies at rated net head and following outputs A. 100% of full load. B. 80% of full load. B. 60% of full load	Weighted average efficiency will be guaranteed while part load efficiency will be provided as an informative value. Please confirm	The bidders should Guarantee flow, turbine efficiency, turbine output, generator efficiency and generator output at rated net head of 940.30 m and power factor of 0.9 for 100%, 80%, 60% of load and for full nozzle opening. The machine shall develop 70MW at rated net head of 940.30 m for a discharge of 8.6 cumecs
60	54	Volume-II Clause No. SECTION A MECHANICAL 12. SALIENT FEATURES	06.08.03.02 b) The moment of inertia of the unit and normal nozzle and deflector closing shall be so adjusted that maximum momentary speed rise of the unit and the maximum pressure rise in the penstock shall not exceed existing limits. 26 Main Inlet Valve (MIV) Spherical Nos. One Dia. 1000 mm Make Hydovevey. Switzerland Operating Pressure 96 kg/cm2	Kindly confirm maximum speed rise and pressure rise limits allowed for new machine. Accordingly design pressure (including pressure rise due to water hammer effect) shall be considered for manifold, nozzle and MIV.	Speed rise is to be less than 30 % and the pressure rise is to be less than 15% .
61	55	Volume-II Clause No. 06.08.03.05.01.(b)	**RUNNER:** Condenser mode operation	**RUNNER:** Tender calls that the machine should be designed for condenser mode operation. For this requirement, the cooling water shall be required for sprinkling on the runner.Kindly confirm.	Yes . Suitable cooling arrangement for Runner shall be provided.
62	55 & 56	Volume-II Clause No. 06.08.03.05.04.(b)	Deflector - open / closed position	We understand that one common deflector servomotor shall be used for actuating the deflectors. In addition, the deflectors shall be either in full open or full closed position. Kindly confirm.	Each nozzle with own internal servomotor is acceptable and each deflector with its own servomotor is also acceptable. However it should suit the site conditions. The deflectors shall be either in full open or full closed position.

63	55	Volume-II Clause No. 06.08.03.05.02 NOZZLE	NOZZLE	2. As per our understanding either existing RPM .i.e 500 rpm is considered or higher, change from 2 jet to 4 jet nozzle will required the removal of complete distributer assembly housing, And in order to remove this housing , Bidder need to remove the complete generator foundation also. Means in any case Bidder would not be able to use existing set up.	"The synchronous speed proposed is 500 rpm . However the synchronous speed & number of jets is left to the bidders to decide as per their hydraulic design. However, the basis for selection of the speed & number of jets will be the overall economy to the Purchaser considering Power House civil works modifications required, Turbine and Generator efficiencies, price of matching Generators, existing EOT crane capacity, etc. Any modifications - civil or mechanical whatsoever, is under the scope of the contractor."
64	55, 115	Volume-II Clause No. : 06.08.03.05.01 RUNNER 08.02.01 GUARANTEED AND OTHER TECHNICAL PARTICULARS	a) The runner shall be **forged fabricated** of 13/4 chromium-Nickel stainless steel conforming to relevant standard. E. Source of runner **casting**	Please confirm that single piece forged runner (i.e. machining to be done from single piece disc) shall be supplied.	Yes, accepted.
65	55	Volume-II Clause No. 06.08.03.05.01 RUNNER	b) The machine shall be designed for **condenser operation** □□□.	Please confirm that synchonous condenser operation is required in new turbine.	Yes. Necessary cooling for the Runner shall be provided for Condenser mode operation.
66	58	Volume-II Clause No. 06.08.03.05.07.(f)	Critical speed	(i) As per the tender lause, first critical speed shall be at least 25% above the maximum runaway speed which is on higher side. (ii) We would like to recommend that first critical speed should be 15% above the calculated maximum runaway speed. Kindly review and confirm.	The first critical speed should not be 20 % above the calculated maximum runaway speed.
67	58	Volume-II Clause No. 06.08.03.05.08.(b)	Servomotors / Adjustment of stroke	As per the tender clause, The piston rod shall be arranged for adjustment of stroke. The requirement “adjustment of stroke” seems not possible. Kindly review and confirm.	As per specification.

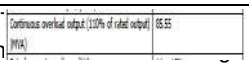
68	58	Volume-II Clause No. 06.08.03.05.08.(b)	Pointer and scale at servomotor	As per the tender clause, pointer and scale for servomotors is asked, this requirement will only be possible for the deflector servomotor. In our design, the nozzle servomotor is integrated in the nozzle itself. So we will provide the electronic feedback system to know the percentage stroke of the servomotor and nozzle opening from the closed position. Kindly confirm the same.	Accepted.
69	58	Volume-II Clause No. 06.08.03.05.07	**Turbine shaft:** The first critical speed shall be at least 25% above the maximum runaway speed.	For such a high speed generating unit recommend that the first critical speed shall be 15% above the maximum runaway speed. It is generally considered safe & sufficient.	The first critical speed should not be 20 % above the calculated maximum runaway speed.
70	58	Volume-II Clause No. 06.08.03.05.08 SERVOMOTORS	a) Each nozzle and deflector of the turbine shall be provided with common hydraulic servomotors having sufficient capacity to supply the maximum force necessary to open/close the nozzle/deflector under maximum operating head, at the minimum oil pressure.	We understand that a common deflector servomotor shall be supplied and nozzle servomotors shall be within each individual nozzles. Please confirm.	Each nozzle with own internal servomotor is acceptable and each deflector with its own servomotor is also acceptable.However it should suit the site conditions.
71	59	Volume-II Clause No. 06.08.03.05.08.(f)	Manual locking device	As per the tender clause, manual locking device for servomotors is asked, this requirement will only be possible for the deflector servomotor. In our design, the nozzle servomotor is integrated in the nozzle itself. Kindly review and confirm.	As per bidder's design.
72	60	Volume-II Clause No. 06.08.03.05.09.02 (e)	OTHER FEATURES OF THE GOVERNOR: Digital governors with either proprietary controllers or controllers based on industrial PLCsshall be supplied	The controllers shall be Non-Redundant - Please Confirm	Redundancy required

73	62	Volume-II Clause No. 06.08.03.05.09 Turbine Governor,K. OIL SYSTEM (K.1). OIL PUMPING UNIT: Oil pumping unit comprising of following main components:	Motor Driven main and stand by vertical screw oil pumps mounted on the sump tanks	Name of Package : Governor: In addition of screw type, the vane and gear type pump also acceptable for oil pressure system. Kindly review and confirm.	Gear pumps/Axial Piston pumps is acceptable.
74	62	Volume-II Clause No. 06.08.03.05.09 Turbine Governor, K-2. HIGH PRESSURE OIL SYSTEM VOLUME IV,DRAWINGS, compressed air scheme	High pressure oil system shall be provided for operation of nozzle and deflector servomotors through governor. 02 nos. (1W+1S) high pressure compressed air system of adequate capacity as per relevant IS/IEC standard including air receiver/ Accumulator, air dryer, piping, valves instruments etc. shall be considered for operation of oil pressure unit. Piston type accumulator with nitrogen bottles shall be used for pressures higher than 60 Kg/cm2 Compressor I and II indicate in drawing for governor ORU	We understand that high pressure system (>=120 bar) with nitrogen bottles pressure accumulator system also acceptable instead of compresses air system. Please review and confirm.	Yes, As per specification.
75	64 & 65	Volume-II Clause No. 06.08.04.05 Rating Page No: 64 & 65 of 161	BASIC DIMENSION AND RATING **SCR**	SCR is specified as 1.1 . For modern excitation & digital voltage control system, higher SCR is not required. In our opinion, SCR value of not less than 1 is suitable. Please confirm the acceptance.	Short circuit ratio shall be maintained at 1.20 as per specification. (Existing machine SCR = 1.2). As per specification.
76	64 in vol-2 & page.24 in Vol-3	Volume-II Clause No. 06.08.04.05, page 64 of 161- BASIC DIMENSION Volume-3- Clause 04.01.02, page 24 of 225	Continuous rating : 81 MVA (3x27)	Kindly correct the rating of GT in the specifaction in line with Generator's Continous overload output of 85.55 MVA.	The Generator's rating is 77.77 MVA , however for GT , higher rating i.e., 81.0 MVA is envisaged. Max continuous rating for GT is 89.1 MVA (110 %) GT may be corrected as 90 MVA (3 x 30 MVA)

77	64	Volume-II Clause No. 06.08.04.05 BASIC DIMENSIONS AND RATING	A. RATING Continuous overload output (110% of rated output) (MVA) : 85.55	Name of Package: GENERATOR : As per tender specifications, uprating of unit is asked from existing 60 MW to 70 MW and further 10% continuous overload (which is over and above 70 MW) is asked to consider. Please review and confirm overload.	As per spec Machine shall also be designed for 10% continuous overload
78	64	Volume-II Clause No. 06.08.04.05 BASIC DIMENSIONS AND RATING	A. RATING	Kindly inform the min. inertia constant requirement at Generator rated MVA.	These values are based on the Bidder's design and for the existing 60 MW Generator, GD^2 = 2,50,000 $lbft^2$ please refer Clause: 05.02 .04 : Vol-II of TS.
79	65	Volume-II Clause No. 06.08.04.06	**Capacity and temperature rise :** The generator shall be capable of delivering a guaranteed rated continuous output of 77.78MVA and maximum continuous overload output of 85.55 MVA at rated pf., rated voltage and rated frequency at the terminals without exceeding the limit of temperature rise as follows:.....**.For rated condition** : (i) Stator winding :85°C (ETD) & (ii) Rotor winding :90°C (Resistance) . .. For overload condition the temperature limits will be 10°C more than above temperature rise limits.	Tender specification ask for temperature rise guarantee at rated voltage / frequency condition however Sr. No. 16, 17 & 18 of Generator GTP clause is asking for guarantee in complete range of voltage / frequency. Please review tender specification / generator GTP.	Vol-2 / C no 06.08.06 - Capacity and Temperature rise is applicable. However,Vol. II Cl: 08.03.01 Generator GTP Sl.No: 17 & 18 shall be deleted . Instead, Temperature rise for Stator winding and Field winding for maximum continuous output (85.55 MVA) shall be indicated in GTP .
80	65	Volume-II Clause No. 06.08.04.07 Generator	Total harmonic distribution factor (THD) shall not exceed 1.5 percent. The calculated no-load harmonics in the voltage waveform shall be furnished.	THD and THF shall be as per IEC 60034-1. Please confirm	Accepted

81	65	Volume-II Clause No. 06.08.04.06 CAPACITY AND TEMPERATURE RISE Volume-II Clause No. 06.08.04.14.16-c Generator	FOR RATED CONDITION • Stator winding :85 deg C(ETD) • Rotor winding :90 deg C(Resistance) For overload condition the temperature limits will be 10 deg C more than above temperature rise limits. The surface air coolers shall have sufficient capacity to maintain stator winding temperature rise within class B temperature limit when the unit is operating at overload output, under worst system parameters i.e. at the maximum stator current.	There is a discrepancy in both clauses. We understood that temperature rise of stator and rotor winding shall be as per clause no. 06.08.04.06. Kindly review and confirm.	Clause No. 06.08.04.06 is applicable.
82	66	Volume-II Clause No. 6.08.04.10 SPEED, RUNAWAY SPEED	RPM of Machine	Bidder requested to allow higher RPM Machine below is the explanation as desired (i) For the existing machine b/D1 is 0.19 seems quite low in performance terms especially in terms of efficiency, simply we can say efficiency in range of 89-90% or may be less, and there is some deign constrain with this b/D1.	The synchronous speed proposed is 500 rpm . However the synchronous speed & number of jets is left to the bidders to decide as per their hydraulic design. However, the basis for selection of the speed & number of jets will be the overall economy to the Purchaser considering Power House civil works modifications required, Turbine and Generator efficiencies, price of matching Generators, existing EOT crane capacity, etc. Any modifications - civil or mechanical whatsoever, is under the scope of the contractor.
83	66	Volume-II Clause No. 06.08.04.12 EFFICIENCY	OPTIMUM POINT EFFICIENCY	Whereas, if b/D1 is 0.23 then comes the best performance zone, where optimum point efficiency will be higher.This is not only with the single bidder that taht bidder have best performance in range of 0.22-0.24 b/D1 ratio and low in range of 0.18-20 b/D1. All other bidder shall also have the same feedback, because this is a part of Pelton selection and sizing.	The synchronous speed proposed is 500 rpm . However the synchronous speed & number of jets is left to the bidders to decide as per their hydraulic design. However, the basis for selection of the speed & number of jets will be the overall economy to the Purchaser considering Power House civil works modifications required, Turbine and Generator efficiencies, price of matching Generators, existing EOT crane capacity, etc. Any modifications - civil or mechanical whatsoever, is under the scope of the contractor.

84	67	Volume-II Clause No. 06.08.04.14.01-(b)	**GENERAL:** The construction of the generator shall be such that the rotor poles, stator bar can be easily maintained /repaired without disturbing the upper bracket.	For such a high speed machine, the size of the machine is less, so it is seems to be a very critical to handle the stator bar and rotor poles without lifting the upper bracket. Please review and confirm	As per bidder's design.
85	67	Volume-II Clause No. 06.08.04.14.01 General, Page No: 67 of 161	f. The rotor construction shall be such that rotor poles are easily removable and Replaceable. The poles shall be interchangeable.	As per this clause, rotor poles shall be interchangeable. Please note that there are four types of rotor pole i.e. north, south, first pole & the last pole and rotor poles will be interchangeable only with the same type of poles. Please review and confirm the acceptance.	As per specification
86	67 & 69	Volume-II Clause No. 06.08.04.14.01 GENERAL 06.08.04.14.03 BEARINGS	c). The thrust bearing housing shall be so designed as to provide easy access to the bearing pads. Openings with removable covers shall be provided for this purpose. The thrust bearing pads and the thrust faces shall be capable of being reached and inspected through the oil cooler windows (after emptying the bearing oil, removal of coolers and with rotor jacked up). j) New self-lubricated guide bearings with internal/external coolers shall be provided. The guide bearings shall be of the multi-segment type. Guide bearing pads shall be babbit lined. k) The thrust, lower guide bearing and the upper guide bearing shall be of the self-pumping lubricated type with oil-to-water coolers.	We understood that for upper combined bearing & lower guide bearing, bidders are free to propose their standard proven design for bearing oil coolers.Kinldy review and confirm.	Bidder's Standard proven design for Bearing Oil coolers accepted.
87	69	Volume-II Clause No. 06.08.04.14.03 BEARINGS	f) Thrust bearing shall possibly so designed so as to remove the Thurst pad without dismantling thrust collars.	Removal of thrust pad assembly without removal of thrust collar is only feasible by side openings provided in bracket for oil water coolers. This also results in leackage in oil from these openings which may contaminate active generator components. Hence we request to allow removal of thrust pad assembly by removal of thrust collar. Kindly review and confirm.	Removal of thrust pad assembly by removal of thrust collar- Accepted.

88	72	Volume-II Clause No. 06.08.04.14.05-e Generator	 h capacity to limit the temperature cooled air to a maximum of 40 deg C, even with one cooler out and balance 20% tubes blocked.	As per given clause 20% tube blocked while in 06.08.04.14.05-b it is 10%. Please confirm tube blocked need to consider is 10%	Each cooler shall be liberally designed ensuring satisfactory performance of the cooler, even when 10% of total tubes of all surface air coolers are blocked / chocked. In addition to that Generator can be loaded to rated MW for (N-1) coolers are in service
89	73	Volume-II Clause No. 06.08.04.14.07	**ROTOR:** The rim of the rotor shall be laminated and constructed out of 2mm thick or less steel having radial ventilating ducts located along with lengths and shall be bolted together to make a compact structure.	Air circulation can also be achieved using shaft mounted fans, which is a better solution for given rating of generator. Hence, choice of air circulation (shaft mounted fan OR Rim duct cooling) shall be left to bidder's choice. .. Choice of rim sheet thickness should also left to bidder based on actual strength requirement. Please review & confirm.	As per bidder's design
90	73	Volume-II Clause No. 06.08.04.14.07-c Generator	The rim of the rotor shall be laminated and constructed out of 2mm thick or less steel having radial ventilating ducts located along with lengths and shall be bolted together to make a compact structure.	The thickness of rim lamination and provision of ventilatiing duct inside the rim stacking i.e. ventilation system shall be left to the bidder choice based on their design/technology. Please confirm	Thickness of the rim laminations of the rotor shall as per bidder's design.
91	75 & 76	Volume-II Clause No. 06.08.04.14.16 Cooling System.	f) Pressure gauges at inlet and outlet of all the heat exchangers.	In our opinion following number of pressure gauge is sufficient for smooth running of machine: 1. Pressure gauge at inlet of common air coolers. 2.Pressure gauge at inlet of common upper guide bearing coolers. 3. Pressure gauge at inlet of common lower guide bearing coolers.4.Pressure gauge at outlet of common air coolers.5. Pressure gauge at outlet of common upper guide bearing coolers.6. Pressure gauge at outlet of common lower guide bearing coolers.. Please confirm acceptability. However, it is proposed to use pressure transmitters in place of pressure gauge at above specified location	As per specification

92	76	Volume-II Clause No. 06.08.04.14.16	f) Water flow gauges at inlet and outlet with low-flow alarm contacts and Indicating dial mounted on the gauge panel.	Please note that flow meters will be provided with integral dial & display with 4 to 20 mA output and the flow meters and indicators will be directly mounted on cooling water piping	accepted.
93	77	Volume-II Clause No. 06.08.04.14.18.01 (a)	VIBRATION MONITORING SYSTEM: The event of online vibration Monitoring System being offered as part of the package	Only monitoring of Vibrations and shutting down of the Generating unit in case of excessive Vibrations will be provided - Please Confirm	as per specification
94	78	Volume-II Clause No. 06.08.04.14.22	Instrumentation, Control and Safety Devices...Thrust bearing oil film monitoring	Designed value of oil film thickness shall be provided hence “Oil Film Monitoring” system is not required. Please review and confirm	As per specification.
95	79	Volume-II Clause No. 06.08.05 EXCITATION SYSTEM AND DIGITAL VOLTAGEREGULATOR	06.08.05.01 DETAILED SCOPE OF SUPPLY The excitation system and DVR shall consist of: - ・One (1) set of dry type excitation Transformer	Kindly inform proposed location of excitation Transformer for cable calculation.	Power House layout drawing enclosed. Also Visit site recommended.
96	79	Volume-II Clause No. 06.08.05	EXCITATION SYSTEM AND DIGITAL VOLTAGE REGULATOR: Digital voltage regulators	Will be non-redundant with one Auto and one Manual channel with redundant Bridges - Please Confirm	The design shall provide 100% redundancy in (n+n) layout arrangement of bridges with independent manual and Auto Channel automatic control (DVR) with PSS
97	82	Volume-II Clause No. 06.08.05.08 DVR (d)	DIGITAL VOLTAGE REGULATOR (DVR): A slip stabilizer unit shall be provided to suppress the low frequency power oscillation during the operative conditions	Not required for this capacity as per CEA regulations - Please Confirm	As per specification.
98	84	Volume-II Clause No. 06.08.05.14 Page No.-84 of 161	EXCITATION CONNECTIONS	Power Cables between Generator bus duct to Excitation transformer HV Side and Transform LV side to Thyristor panels are not specified in the tender specification. Please confirm whether the same need to be included in bidder's scope.	All power, control and instrumention cables/wirings are under contractor's scope

99	84 & 85	Volume-II Clause No. 06.08.06 COOLING WATER SYSTEM	06.08.06.01 SCOPE OF WORK Scope shall also include level monitoring system for emergency overhead tank and cleaning of the overhead tank.	Kindly confirm the location of emergency overhead tank, its elevation & route distance from power house.	Rear side of the Power House, adjacent to Tail Race - Also Visit site recommended.
100	84	Volume-II Clause No. 06.08.05.15	**OTHER ITEMS:** Bus duct - Generator CT, PT, LA & surge panel shall be provided as described in respective chapters (refer vol. IV)	Volume-IV pertains to drawings and detailed specification for Bus duct is not available	Drawings furnished for the existing setup. The same shall be used for designing the new Generator CT, PT, LA & surge panel
101	85 & 86	Volume-II Clause No. 06.08.10	**FIRE PROTECTION SYSTEM (FPS)**	Please confirm that " Bidder " can participate as a Fire Fighting Vendor (as system integrator) for TSGENCO RMU of Kodayar Power Houre-I 1x70MW HEP. Secondly all items will be supplied as per BHEL vendor list.	Fire fighting is part of the RMU package None can participate as fire fighting vendor.
102	85 & 86	Volume-II Clause No. 06.08.10	FIRE PROTECTION SYSTEM (FPS)	Please furnish the following details :- 1. Area Layout and Power House Layout in legible form. 2. Details and drawings of existing Fire Fighting System for Water Based Fire Fighting system. Please furnish the details of Fire Detection and Alarm system, Fire Panel, Fire Water Pumps, Pipes etc. 3. The location of Fire Water storage tank and associated Pump House.	Drawings furnished. The source of water is same that of the CW pump & availed by forming a suction header or using the existing CW suction pipes. The existing CW pump room shall be utilized with necessary modification for installation of fire hydrant pump and associated suction/ delivery piping, valves and fittings
103	85 & 86	Volume-II Clause No. 06.08.10	FIRE PROTECTION SYSTEM (FPS)	Please furnish the details of Fire Fighting System in the Power Plant. 1. Process Flow Diagram for Fire Fighting System. 2. Hook up if any with existing Fire Fighting System with new Fire Fighting System.	The existing diesel fire pump discharge shall be connected to the newly envisaged fire hydrant ring main

104	85	Volume-II Clause No. 06.08.06 COOLING WATER SYSTEM	06.08.06.02 DESIGN CRITERIA In case of failure of cooling water pumps, cooling water can be drawn from an emergency over head tank installed at the top of the power house.	We understand that filling of emergency over head tank shall be in the scope of employers. Please confirm.	Piping, Valves and pipe fittings filling of emergency over head tank is in the scope of Bidder.
105	85	Volume-II Clause No. 06.08.07 DRAINAGE AND DEWATERING SYSTEM :	Following works to be carried out for drainage and dewatering system a) Exposed pipe is to be replaced by new one. Pipe and fittings shall be designed in accordance with IS 1239 or equivalent standards. b) Replacement or rerouting of embedded piping c) Strengthening of pipe supports if any to be done.	Please provide Schematic diagram & technical specification of existing drainage & dewatering system.	There is no dewatering and drainage system with pumps etc., . All drains (such as cooling water return) are let into the Runner chamber / Tailrace. Visit site.
106	89	Volume-II Clause No. 06.08.10.04.01 FIRE HYDRANT SYSTEM:	06.08.10.04.01.01 GENERAL Sump pit located downstream of the power house shall be the source of water for the complete fire fighting system. 02 nos. (1W+1S) fire water pump and motor sets including pipe, strainer, valves, instruments etc. shall be supplied. These pumps shall be installed in the existing fire water pump house after modification of the same. The pumps shall supply the water for fire hydrant system, HVWS, MVWS etc.	As per TAC, In case of electrically driven pumps it is recommended that diesel engine driven stationary pump of similar capacity and one Jockey pump shall be installed in addition to the main pump set. Kindly review the requirement.	The existing diesel fire pump discharge shall be connected to the newly envisaged fire hydrant ring main. In lieu of 1 standby pump, 1 No., of Jockey pump shall be provided.
107	89 & 99	Volume-II Clause No. .06.08.10.04.01-FIRE HYDRANT SYSTEM:	FIRE HYDRANT SYSTEM: High velocity water spray system(HVWS) for transformer and Medium velocity water spray system (MVWS) for cable galleries in power house complex.	Please provide Layout drawing of cable galleries in Power house.	Drawings furnished. Also Visit site recommended.

108	93	Volume-II Clause No. 06.08.10.04.02.03 (c)	Automatic Clean Agent such as IG – 55 (Argonite) or IG – 541 (Inergen) based automatic Fire Protection system for control room shall be provided as per NFPA – 2001.	In addition to IG – 55 (Argonite) or IG – 541 (Inergen), IG-01 or IG-100 based automatic Fire Protection system for control room shall also be considered. Please confirm	accepted provided if they suit to the site conditions
109	93 of 161	Volume-II Clause No. 06.08.10.04.02.03 (d)	Any of the following system and equipment may be selected for the Fire Protection System: i. NOTIFIER SYSTEM ii. EDWARDS SYSTEM iii. SIEMENS / CERBERUS SYSTEM	In addition, Fire alarm system approved by UL/FM/VDS shall also be considered. Please confirm.	As per specification
110	93	Volume-II Clause No. 06.08.10.04.02.03 (e)	The system shall be supplied exactly as per specification / as per approved drawing with bill of quantities meeting the NFPA, IS 2189-1988 and TAC norms.	FDA system shall be designed as per IS 2189 only. Please confirm.	As per specification
111	95	Volume-II Clause No. 06.08.10.04.02.07 (10)	**MAIN FIRE ALARM PANEL (MFAP):** Ni-Cd batteries shall be provided for the standby back-up of the fire alarm panels.	SMF batteries shall be provided instead of Ni-Cd batteries. Please confirm.	Accepted
112	95	Volume-II Clause No. 6.08.10.04.02.07 (6) / Page 95 of 161	**MAIN FIRE ALARM PANEL (MFAP):** Programmable activation of control output relays for tripping Air Conditioning & Ventilation system.	As per the specification Split AC are required for control room, interlock of split ACs with Main fire alarm panel is not feasible. Further any requirement of ventilation system is not mentioned in the specification , hence interlock of the same with Main fire alarm panel is not applicable. Please confirm.	Interlocking of fire alarm detection system with Split AC operation/Control not applicale
113	95	Volume-II Requirement of UPS power shall be furnished by the bidder.	UPS of adequate capacity shall be provided for Control and instrumentation system	We propose to use Invertor connected Station DC 220V system instead of UPS	Inverter in place of UPS is acceptable and Inverter shall be connected to Plant 220V DC system. But two nos inverters from two Plant 220V DC source with static switch shall be provided with adequate capacity.

114	96	Volume-II Clause No. 06.08.10.04.02.10 (b)	**POWER SUPPLY:** Battery shall be capable to withstand the total normal requirement for duration of **48 hours** and for duration of 30 minutes to meet alarm load requirement.	Battery shall be capable to withstand the toral normal requirement for duration of **24 hour** and for duration of 30 minutes to meet alarm load requirement. Please confirm.	As per specification
115	97	Volume-II Clause No. 06.08.10.04.02.12 (a)	**MANUAL PULL STATIONS (MPS) :** MPS shall be intelligent addressable, break glass type connected to its location card.	MPS shall be pull type or break glass type depending on the make of FDA system.	As per specification
116	97	Volume-II Clause No. 06.08.10.04.02.14	**CABLES & CABLE LAYING:** Three core cables (keeping one core as spare) shall be used for the detector/ device connection.	Following cable shall be considered. Loop cable : 2C x 1.5 sq.mm Power cable : 2C x 2.5 sq.mm. Plese confirm.	As per specification
117	98	Volume-II Clause No. 6.08.10.04.02.18 (a)/ Page 98 of 161	**INTERLOCKING WITH A/C & VENTILATION SYSTEM:** The fire signal from first detector will operate the audio-visual alarm whereas on confirmation of fire signal from the other detector the ventilation/air conditioning system shall be switched off automatically		Not Applicable
118	98	Volume-II Clause No. 6.08.10.04.02.18 (b)/ Page 98 of 161	INTERLOCKING WITH A/C & VENTILATION SYSTEM: Potential free contacts shall be made available for each zone for tripping of respective ventilation/air conditioning system		Not Applicable
119	108	Volume-II Clause No. 6.08.11.01.02/ Page 108 of 161	AIR-CONDITIONING SYSTEM: The air conditioning system to maintain 23±2 deg. C & RH<70% shall include Split type air conditioners for control room	Please note that humidity control option is not available in split AC hence inside condition for Air conditioned area with RH<70% shall not be applicable. Please confirm.	Humidity control model split A/c s are available like DAIKIN

120	108	Volume-II Clause No. 6.08.11.01.02/ Page 108 of 161	AIR-CONDITIONING SYSTEM: Configuration of split AC	Since configuration of split AC has not been mentioned, we are considering (N+1) configuration for split ACs, where N is number of working split Acs. Please confirm.	(N-working + 3 - standby)
121	108	Volume-II Clause No. 6.08.11.01.02/ Page 108 of 161	AIR-CONDITIONING SYSTEM: The details of experience and credentials shall be furnished in their offer	Since Air conditioning with Split AC is applicable, split AC shall be supplied from make list mentioned in specification. Details of experience and credentials is not required to be furnished. Please confirm.	Acceptable, but reputed makes mentioned in the TS have to be considered.
122	109	Volume-II Clause No. 6.08.11.02/ Page 109 of 161	DESIGN CRITERIA FOR AIR-CONDITIONING SYSTEMS	Only outside ambient temperature condition has been furnished for heat load calculation. Other design parameters shall be considered based on ISHRAE. Further, please note that since there is no addition of fresh air and same Air conditioned air is circulated in AC area for split AC, fresh air and bypass shall not be applicabe for heat load calculation for Split AC. Please confirm.	As per ISHRAE
123	109	Volume-II Clause No. 6.08.11.03.01 c) / Page 109 of 161	AIR-CONDITIONING FACILITIES: Power consumption ratings for split air conditioners Source- Code no. IS1319 (part-2):1992	IS 1319 is applicable for Edible Tapioca Starch. Power consumption rating shall be based on latest BEE rating based on ISEER.	IS 1391 is applicable. Power consumption rating shall be based on latest BEE rating based on ISEER.
124	110	Volume-II Clause No. /6.08.11.03.02 / Page 110 of 161	SPECIFICATION OF SPLIT AIR CONDITIONERS: Regarding split AC specification	Split ACs are the mass production item of OEMs, modification in standard specification of equipment supplied by OEM may not be feasible. It is requested to accept split AC as per OEM standard practice. However refrigerant shall be R-22 or equivalent (Environment friendly) and Makes of split ACs shall be per the specification requirement.	Split AC as per OEM standard practice acceptable.

125	112 & 53	Volume-II Clause No. 07. Performance requirement and guarantee Volume-II Clause No. 06.08.03.01 - TURBINE: Type, Rating and Design Requirement	**WATER ANALYSIS REPORT:** The Tenderer shall study the temperature & quality of water for the components of the turbine in direct contact of water to be designed and material to be selected so that considerable erosion or corrosion due to cavitation will not occur. f. The Tenderer shall critically study the silt data and chemical analysis of water and take the same into account in designing the turbine and auxiliary equipment susceptible to abrasive effect of silt, making all such specific provisions and measure including selection of materials, coatings and paintings which will help to resist silt abrasion and enable easy and quick maintenance / replacement of worn out components.	**Please provide below information :** • River Water Chemical analysis report. • 10 daily or monthly average silt concentration data (mg/litre) & petrographic analysis including monsoon and non-monsoon season of last three years • Size of sediment particles	Petrographic analysis recommended shall be dispensed with as the water is silt and abrasive particle - free, however latest water analysis is furnished.
126	Page.81 of 230 in Vol-1 & Page.113 of 161 in Vol-II	Kodayar RMU-Specn HE-2367 –Volume-1 5.01 SECTION– V 5.01.01 BID EVALUATION PROCEDURE Volume-II Clause No. 07. PERFORMANCE REQUIREMENT AND GUARANTEE, Clause 07.08 Clause 07.01	5. Weighted average efficiency (ηw) will be calculated as follows: 6. Weighted average efficiency (ηw) = 0.5 x η100 + 0.3x η80 + 0.2x η60 7. (η100, η80, η60 mean the efficiency of the turbine at rated head and when it delivers 100%, 80% & 60% of rated MW (Electrical) Output respectively). 07.08 The minimum guaranteed weighted average efficiency for turbine cannot be below 91% and the peak efficiency shall be higher than 91.5%. The Tenderer sha**ll state and guarantee the weighted average efficiency of the unit (combining turbine and generator) at** r□□d □□□d □□□□□□ T□□ □□□d□r□r □□□ □□ □□□d□□□□□□ □□r□□r□ □□□□ □□□r□□□□□ □□□□ □□ □ □d□□□□□□ □□□□r □□□□□□□□□□□ □□□ □ □□□□□□□□□ □ □r□□□□□r□□□□. Pr□□□ □□r □□□□□ □□r□□r□ □□□□ □□□□□ □□□□□□□ □□□□□d □□□□r□□□□□ □□ □□□ □r□□□ □□r□ □□.	In tender specifications, - Formula to calculate Turbine WAE is available but in GTP of turbine, WAE is not mentioned. - Formula to calculate Generator WAE is not available but in GTP of generator, WAE is mentioned. - In turbine tender specifications clause 07.08, weighted average efficiency of the unit combining turbine and generator is asked. Please clarify whether bidder is required to guarantee seaprate turbine and genetrator WAE or combined T-G WAE and furnish formula which is not available in tender. Also furnish updated GTP.	For weighted average efficiency, the values indicated in the Volume I clause 5.01.01 (0.5 x η100 + 0.3x η80 + 0.2x η60) shall be used for turbine, generator for WAE assessment. Bidder is required to guarantee seaprate turbine and genetrator WAE bases on which, combined T-G WAE can be calculated .
127	115	Volume-II Clause No. 08.02.01.(pt.10)	Efficiency at partial load	Only turbine weighted average efficiency and power shall be guaranteed. Other parameters like flow, single efficiencies shall be provided for information only. Kindly confirm.	The bidders should Guarantee flow, turbine efficiency, turbine output, generator efficiency and generator output at rated net head of 940.30 m and power factor of 0.9 for 100%, 80%, 60% of load and for full nozzle opening. The machine shall develop 70MW at rated net head of 940.30 m for a discharge of 8.6 cumecs

128	120	Volume-II Clause No. 08.03.01 s.No. 16. & Volume -3	**GENERATOR:** Maximum Temperature rise for the output guaranteed under item (10)	Tender specification ask for temperature rise guarantee at rated voltage / frequency condition however Sr. No. 16, 17 & 18 of Generator GTP clause is asking for guarantee in complete range of voltage / frequency. Please review tender specification / generator GTP.	Vol-2 / C no 06.08.06 - Capacity and Temperature rise is applicable. However,Vol. II Cl: 08.03.01 Generator GTP Sl.No: 17 & 18 shall be deleted . Instead, Temperature rise for Stator winding and Field winding for maximum continuous output (85.55 MVA) shall be indicated in GTP .
129	120	Volume-II Clause No. – 08.03.01 Guaranteed Technical Parameters	Generator technical particulars (GTP)	Generator technical particulars should be into two parts, first part will be guaranteed parameters in which all guaranteed data like efficiency, temperature rise, output should be included and other part will be informative data which will have other detail data of generator. Please confirm the acceptance.	In GTP, wherever non-guaranteed technical parameters are furnished, the same shall be indicated as " Non - Guaranteed" by the side of the value.
130	131	Volume-II Clause No. 09.01.02	**QUALITY ASSURANCE PLAN (QAP)** b) QAP shall be prepared and furnished by the successful tenderer in FORM No. 11.20(DQM)F-09 and 10 Rev 0 (enclosed) for structural & mechanical and electrical items respectively in four sets.	No form is Enclosed. Please Provide all forms whatever specified in the tender.	Furnished.
131	137	Volume-II Clause No. 09.02.02	Field acceptance test	Tender does not call for the efficiency measurement method. So we propose to carry out the field acceptance test as per IEC-60041 by thermodynamic method only.. Kindly confirm the same which will be followed by every bidder.	Kindly refer Cl: No: 07.06 of Vol. II . IEC - 60041 specifies many methods. Thermodynamic method is not acceptable.

132	138	Volume-II Clause No. 09.02.03 Performance Guarantee Test Page No: 138 of 161	The PG test shall be conducted by the prospective bidder by arranging Accredited / Reputed third party agencies like IIT, Roorkee, STEAG, etc.	Bidder will conduct PG test as per IEC 60034/IEEE115 in presence of customer with prior approval of testing procedure. BHEL is fully capable to conduct PG test themselves, and so far conducted at various hydro sites. Hence third party agency as mentioned is not required. However, if still TANGEDCO envisaged the requirement of third party agency, then the customer will arrange and BHEL will conduct test in presence of that third party.	As per specification
133	139	Volume-II Clause No. –09.02.04.01 Tests Prior to initial run Page No: 139 of 161	Field tests – During installation and pre commissioning 6. High potential DC test on stator winding 7. High potential DC test on field winding	In this clause, High Potential DC Test on stator winding & field winding is specified. As per prevailing practice HV AC test is used and recommended. Please confirm acceptance of HV AC test.	HV AC test accepted.
134	144	Volume-II Clause No. 11 List of Preferred Make Page No: 144 of 161	List of preferred make.	The preferred make list given in the bid document for procurement /outsourcing is not sufficient as most of the vendors are not known to BHEL. Hence, It is requested to allow BHEL approved vendors for the same. Also, we request you to provide complete address and contact details of the vendors mentioned in your list.	For bought-out items, Contractors are requested to adhere to the list in the spec. In case of vendors not listed in the preferred makes, the main contractor has to get prior approval from TANGEDCO by furnishing the credentials of the vendor before proceeding

135	144	Volume-II Clause No. 11.0 Page 144 of 161	LIST OF PREFERED MAKES	Kindly note that bidder being a public sector undertaking has to follow the company's purchase policy and CVC guidelines. We are having a dynamic vendor list which keeps on updating based on requirement in which new vendors are registered after rigorous process of evaluation and non performing vendors are deleted. In view of the above the vendor list furnished in the specification shall not be binding. ADDITION/DELETION of vendors shall be mutually discussed and finalized during contract stage. Bidder's proposed vendor list shall be submitted along with the bid.	For bought-out items, Contractors are requested to adhere to the list in the spec. In case of vendors not listed in the preferred makes, the main contractor has to get prior approval from TANGEDCO by furnishing the credentials of the vendor before proceeding.
136	144	Volume-II Clause No. 11. LIST OF PREFERED MAKES LIST OF PREFERRED MAKES (INDIGENOUS)	SOLENOID VALVE :- ASCO(INDIA), SEITZ-ROTEX, SCADER DUNCAN 34 Solenoid Valve :- Herion, Burkert, Scharader-Schovill, Jucomatic, Rotex, Asco	We request you to also accept the Hydac, Rexroth and other reputed make solenoid valve.	Rexroth make Solenoid valves accepted.
137	144	Volume-II Clause No. Clause 11	**LIST OF PREFERED MAKES** The Tenderer shall have to select any of the sub-vendors from the list of preferred makes only and no deviation to this effect will be entertained during the execution of the contract, unless a specific approval has been obtained by the Tenderer from the TANGEDCO/ Purchaser.	In accordance with provisions of Clause 11, we propose to finalize the list of subcontractor/ vendors for bought-out items mutually agreed during detail design. Please accept.	For bought-out items, Contractors are requested to adhere to the list in the spec. In case of vendors not listed in the preferred makes, the main contractor has to get prior approval from TANGEDCO by furnishing the credentials of the vendor before proceeding.
138	144	Volume-II Clause No. 11	LIST OF PREFERRED MAKES	Bidders may propose alternative suppliers other than the listed with credentials for approvals - Please confirm	For bought-out items, Contractors are requested to adhere to the list in the spec. In case of vendors not listed in the preferred makes, the main contractor has to get prior approval from TANGEDCO by furnishing the credentials of the vendor before proceeding.

139	146	Volume-II Clause No. 12.00 Salient features	Main Inlet Valve (MIV)-Dia =1000mm	As per preliminary studies the MIV diameter of 1000mm is inadequate to meet the Discharge to achieve the max output of 10% i.e 77MW (70+10%). The Penstock Dia near to Power house is 1370 mm hence, we propose to supply 1300mm MIV request TNGEDCO to accept.	Accepted.
140	147 to 161	Volume-II SECTION-B CIVIL WORKS	CIVIL WORKS:	2. Details of all the Civil works required are not mentioned in Tender clearly so it may be discussed in Pre-Bid meeting and finalized so that proper costing can be done by the bidders.	Pre bid meeting conducted on 29.11.2018.
141	148	Volume-II SECTION-B CIVIL WORKS clause no. 2.00 Page 148 of 161	**SECTION:B- CIVIL WORKS:** Scope of work-vi) "All civil works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project."	Please specify list of building works other than power house and valve house and furnish the detail drawings.	Not applicable.
142	148	Volume-II SECTION-B CIVIL WORKS clause no . 2.01 Page 148 of 161	"IN DISCHARGE CHAMBER AND PLACEMENT OF NEW MANIFOLDS & NOZZLES WITH NEW DESIGN"	Please furnish existing civil drawings and design documents of discharge chamber.	Drawings furnished.
143	149	Volume-II SECTION-B CIVIL WORKS clause no . 2.02 Page 149 of 161	CIVIL WORK FOR LAYING NEW RAIL TRACK/MODIFICATION OF EXISTING RAIL-TRACK OF 3 NOS. SINGLE PHASE TRANSFORMER	For civil works involved in MODIFICATION OF EXISTING RAIL-TRACK OF 3 NOS. SINGLE PHASE TRANSFORMER, please furnish existing civil drawings,details and design documents.	Site visit recommended.
144	152	Volume-II SECTION-B CIVIL WORKS clause no. 2.04 Page 152 of 161	IMPROVEMENT WORKS TO THE VALVE HOUSE AND POWER HOUSE	Kindly provide the complete civil structural drawings and design documents for the works involved as per the specification.	Site visit recommended.
145	152	Volume-II SECTION-B CIVIL WORKS clause no 2.5 a Page 152 of 161	"Civil foundations for equipment- The repair, refurbishment and modification/strengthening TG & auxiliary equipment foundation"	For civil works mentioned, please furnish all existing civil drawings and foundation design documents.	Drawings furnished.

146	154	Volume-II SECTION-B CIVIL WORKS clause no. 3.3(d) Page 154 of 161	CONCRETE AND REINFORCED CONCRETE STRUCTURE: "Steel reinforcement to be used shall be Fe415 grade or equivalent shall be used unless otherwise specified'	Fe-415 Grade of steel shall be replaced with Fe-500 grade of steel due to non availibility of the same for Reinforced concrete works.	Fe500 grade of steel also accepted.
147	154	Volume-II SECTION-B CIVIL WORKS clause no 3.4 Page 154 of 161	Design loads- Load throw loads	kindly elaborate type of load mentioned and relevant code.	Loads arising out of 100% load throw on account of tripping due to generator/ grid/turbine side faults and it's impact on the TG foundations
148	155	Volume-II SECTION-B CIVIL WORKS clause no 3.6 Page 155 of 161	QUALITY OF CONCRETE-(ii)-(h) Plain cement concrete M10 & M15	kindly specify the area of application for PCC M10 and M15.	During Reverse Engineering the existing TG Foundations have to be tested for strength and capacity and based the outcome of the test, suitable refurbishment work has to be carried apart from attending to cracks/defects.The quality of the concrete in the clause shall be ensured in appropriate places.
149	155	Volume-II SECTION-B CIVIL WORKS clause no 3.6 Page 155 of 161	QUALITY OF CONCRETE : "(ii) The modification/strengthening of existing foundation should be done as per the requirement in case any defect/crack is found.-7) For calculation purpose "Working Stress Design" or "Limit State Design" methods may be adopted, but design shall be consistent throughout."	Bidder understoods that in case of minor modification and repair works of existing Foundations, design calculations for strength and capacity of foundations is not required. Only in case of new founadtions Strength / serviceability check considering the static and dynamic loads of the equipment is required.Please confirm	During Reverse Engineering the existing TG Foundations have to be tested for strength and capacity and based the outcome of the test, suitable refurbishment work has to be carried apart from attending to cracks/defects
150	155	Volume II / 4.0 STRUCTURE AND FOUNDATION DESIGN: 4.1 STRUCTURE DESIGN / Page 155 of 161	"a) The design calculations for all the structures and foundations shall be furnished."	Bidder understoods that only in case of New civil structures,design calculations is required prior to submission of construction drawing. Please confirm.	The design calculations for all the structures and foundations primarily for TG foundatios/structures shall be furnished.

151	58	Clause 06.08.03.05.08	**Servomotors:** Each nozzle and deflector of the turbine shall be provided with common hydraulic servomotors having sufficient capacity to supply the maximum force necessary to open/close the nozzle/deflector under maximum operating head, at the minimum oil pressure.	Kindly note that in latest design, each nozzle have their own internal servo-motor, while deflectors can have both options i.e. a common servomotor for all deflectors or individual servomotor for each deflector. Kindly leave it to the bidder to choose the best feasible option. Please accept & confirm.	Each nozzle with own internal servomotor is acceptable and each deflector with its own servomotor is also acceptable.However it should suit the site conditions.
152	62	Clause 06.08.03.05.09.02	**K OIL SYSTEM K-1OIL PUMPING UNIT** Motor Driven main and stand by vertical screw oil pumps mounted onthe sump tanks	We propse screw/ gear / vane /piston type pump	Gear pumps/Axial Piston pumps is acceptable.
153		General	Pr□□□□D□□□□□□□ □S□r□□ □□□□	Please provide diameter of orifice & inlet & outlet coefficient of orifice including surge shaft drawing with plan drawing also.	Not available, Site visit recommended.
154		Vol-2-General	Synchronous speed fixed	We propose that the speed of the machine shall also be kept free which will be decided by the manufacturer in accordance with increased number of nozzles.	As per bidder's design.
155		NA	Supply scope of oil filtration system for Generator turbine & transformer	We understand that oil filtration system for Generator turbine & transformer is not in bidder scope.Kindly confirm.	Allfa laval S938 with all accessories shall be supplied for turbine LUB oil (It takes care of oil viscosity upto 700 Cst) or equivalent.

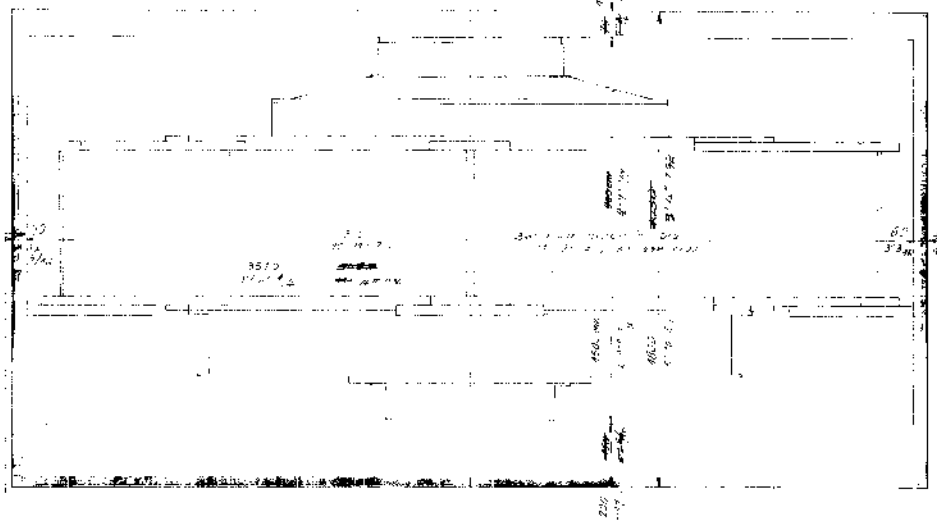
156			CREDIT FOR MORE CAPACITY:	Provision of additional credit/incentive for more capacity should be made in the tender documents.	Not feasible.

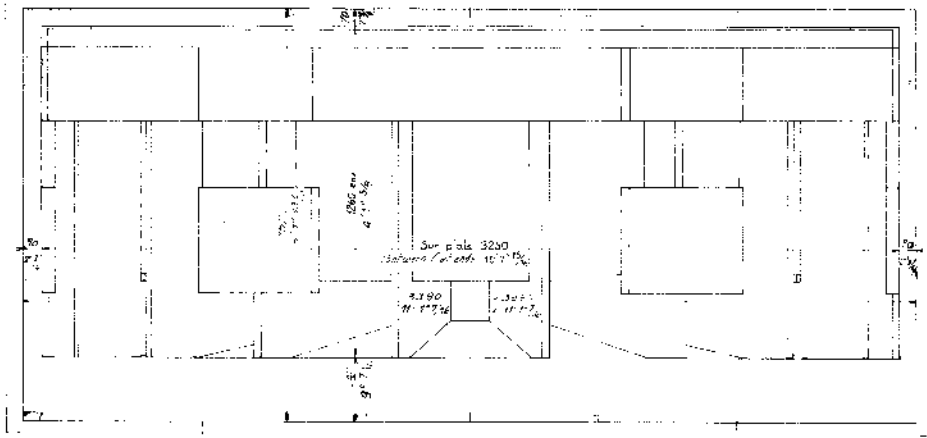
sd/xx 27.12.2018
CHIEF ENGINEER / HYDRO

N° 35-206670

Equipment interior
Transport ... Gross Weight 12 T
Upper girder transport - Gross Weight 12 T
Same hook spacing
Gauge SK n° 3435

Transport ... Gross Weight 12 T
Upper girder transport - Gross Weight 12 T
Gauge SK n° 3443
Gauge SK n° 3445





Tablier SK n° 3017 - Weight 9 F T 194-12

Tablier SK n° 3017 - Weight ... T

Hook SK n° 3017 - Weight ... T

Gauge ... 12'11"3/8

N° 35-206670

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

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Dess 31-1-66 Vérif

Approuvé

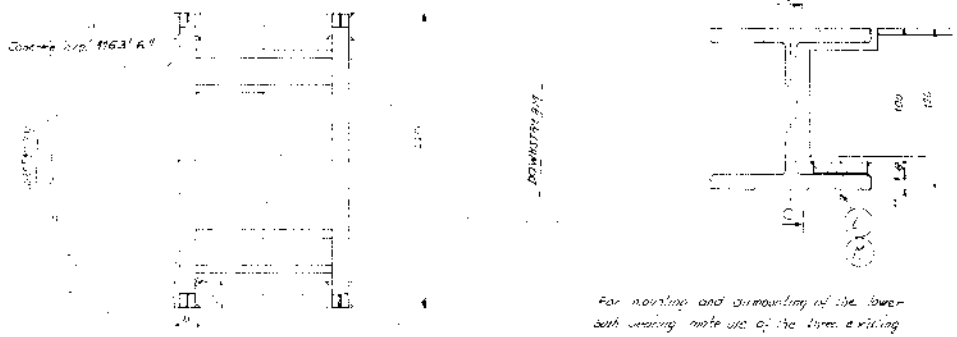
ALSTHOM – BELFORT

N° 35 - 206 670

N° 35 - 206 817

Floor Top view (scale 0,1E)

Cross-section BB (scales)



For mounting and dismounting of the lower bush bearing make use of the three existing "levey" inserts, pin in locate supplied by Alsthom"

Setting up of the bush bearing: weight when set up 8100 kg.

Operation No. 1. Through the access opening to level 1163'6" bring in the two half sleeves in mounting position, the working platform on its setup and resting on wedges see top view of the platform.

Operation No. 2 Setting of the connecting rods, ref. mark B, of the platform with pulleys up to level 1168 3"/8 approximately. Then bring the platform to a dead stop by wedging in connection to the guard bolts (edges "a").

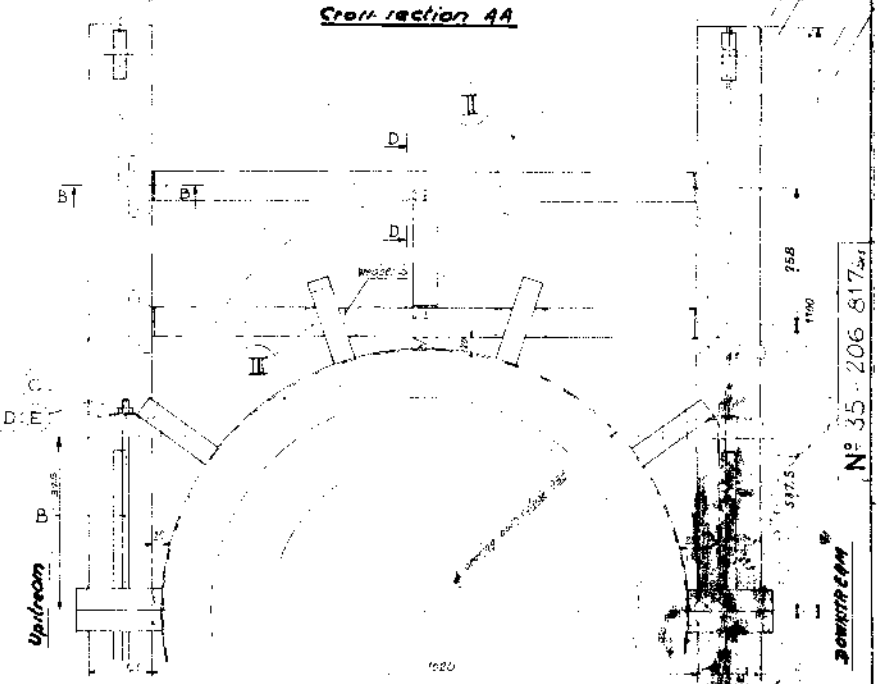
Operation No. 3 Set up the two half sleeves making use of rod ref. mark E. During this operation, wedges under the rod to prevent slumping of the bush bearing. Set the final bolts.

Operation No. 4 Lift the platform to the maximum and place the four connecting rods at equal intervals on the circumference. Set the bush bearing approximately at 530 mm of the face support on the sprocket. Place one rod after the other, placing rollers and fix the bush bearings on the bearings on the spider.

To dismount, operate in opposite direction



Cross section AA



N° 35 - 206 817

MADRAS STATE ELECTRIC
KODAYAR I POWER STATION

Setting-up of the lower bush bearing

Monture du coussinet inférieur

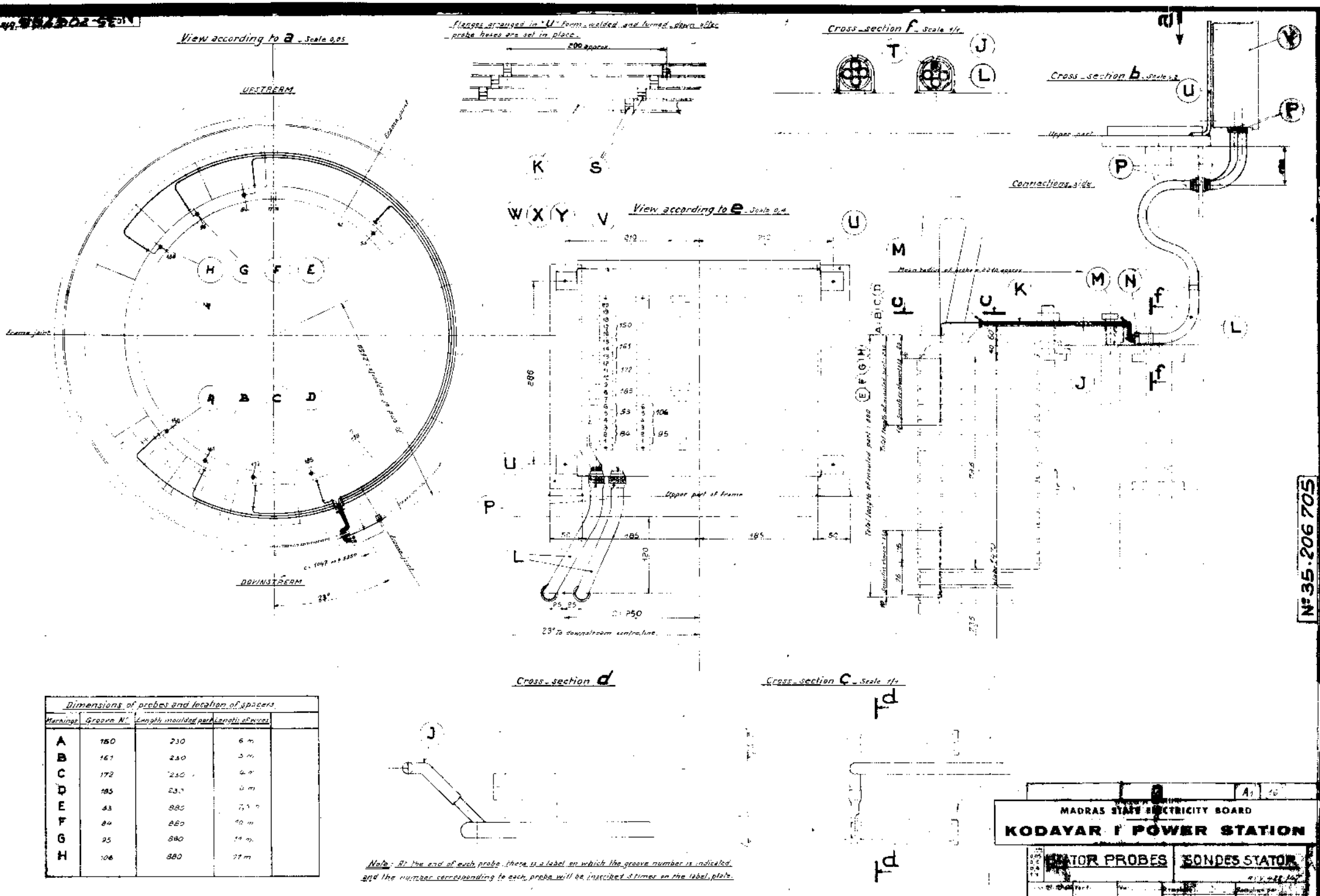
Dessiné 22.3.67 Vérifié ... Vu ...

Remplace ... Remplacé par ...

N° de classement ... Dessin numéro ...

ALSTHOM - BELFORT

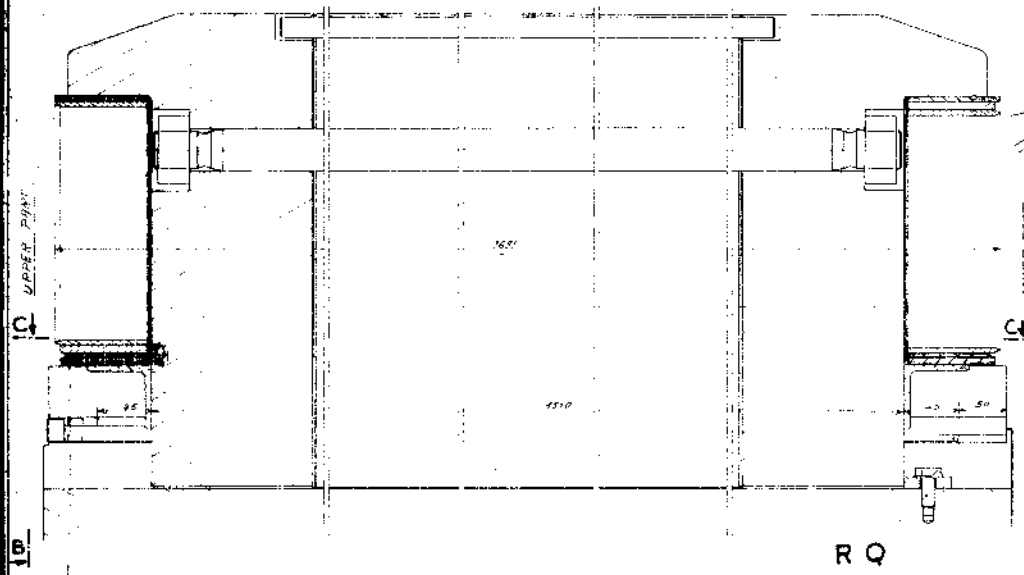
N° 35.206 817



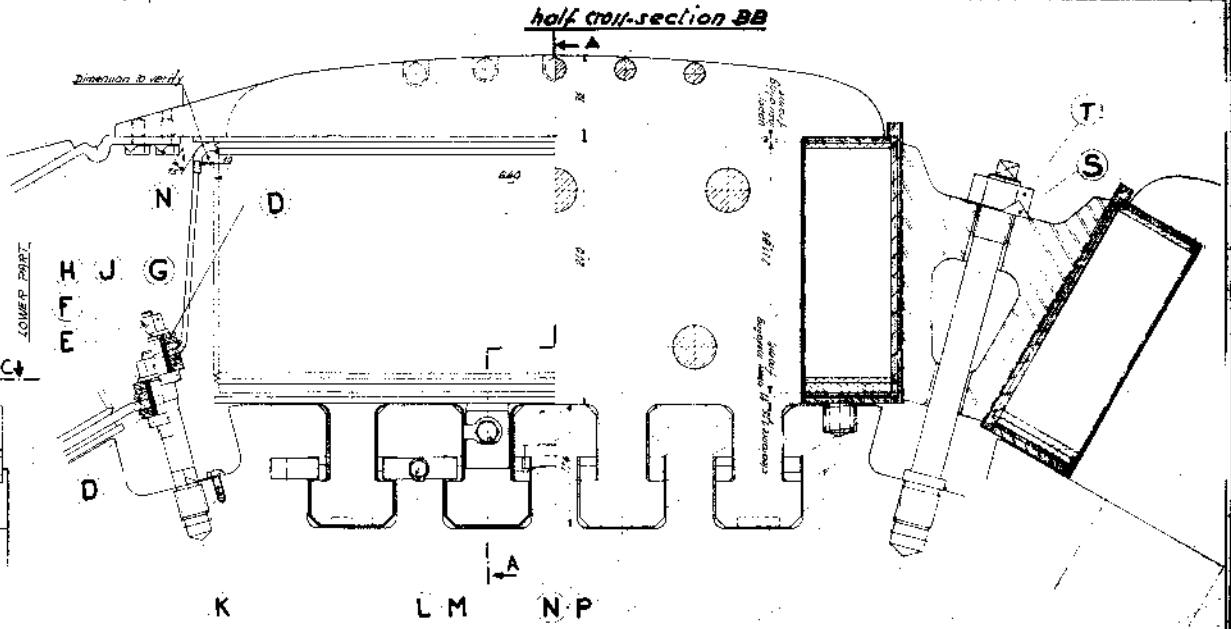
Dimensions of probes and location of spacers			
Markings	Groove N°	Length moulded part	Length of wire
A	150	230	6 m
B	161	230	5 m
C	172	230	4 m
D	185	230	3 m
E	53	880	13 m
F	84	880	10 m
G	95	880	11 m
H	106	880	12 m

N° 35.206 599 5/5

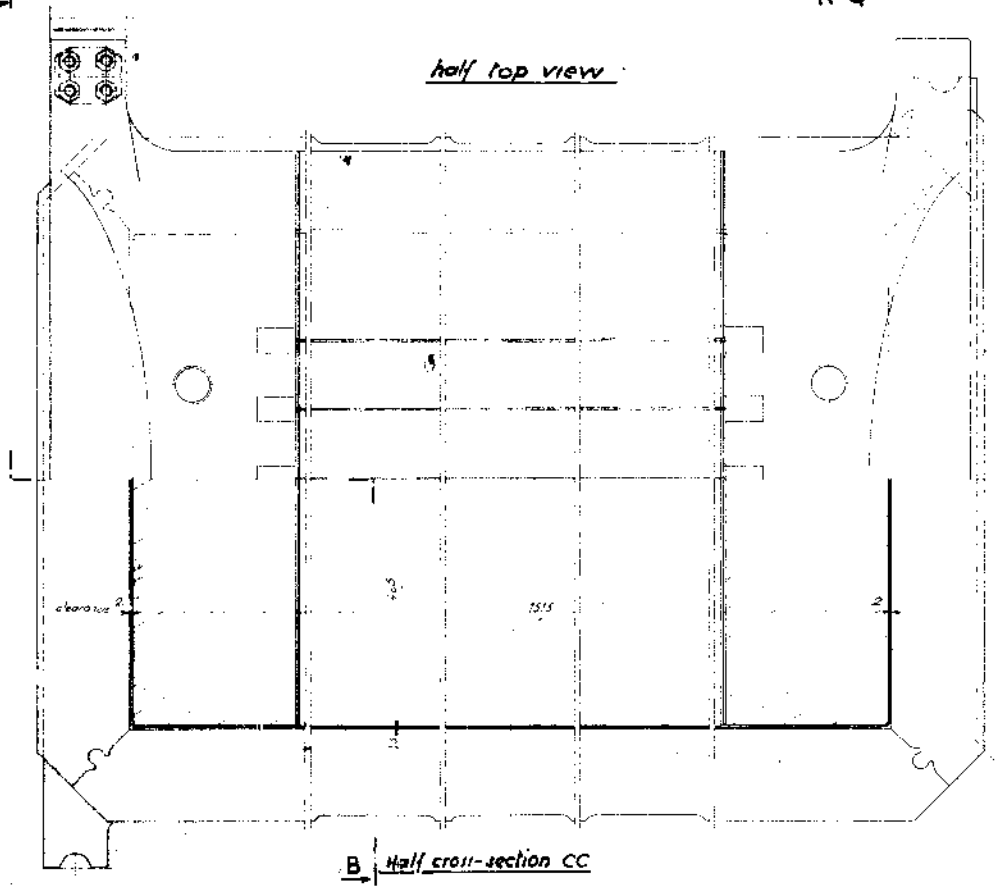
cross-section AA



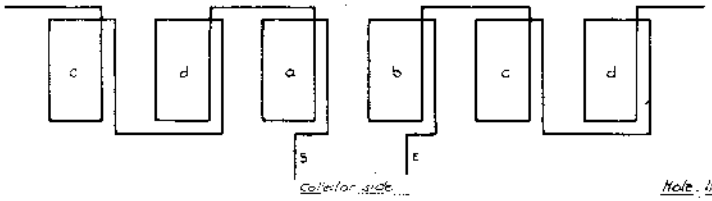
half cross-section BB



half top view



Diagram



141 volts - 1490 amps.

12 poles with one coil of 37,5 turns

Insulating material between turns : araldite thickness 0,4.

MD^2 of a complete pole (with frames, interpolar, wedges, connections, angle iron and top) 26100 lb/ft²

MD^2 of the 12 poles ... 313 200 lb/ft²

Maximum pressure to be exerted when mounting the coil on the pole : 963 t

Weight of a complete pole : 2940 kg

Note : the generator rotor winding must withstand, between copper and ground, a voltage of at least 2 900 volts for one minute after run away.

- Each pole completed will be weighed.
- When mounting, the poles will be arranged in order to obtain the best possible ballancing on the rim.
- The finishing varnish coating on the copper must be as thin as possible.

N° 35.206 599 5/5

A1 | 7

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

4/10	Pole assembly Inducer coil	Ensemble d'un pôle Bobines inductrices

Dessiné : S.S.T. | Vérifié : | Vu : | Remplace : | Remplacé par :

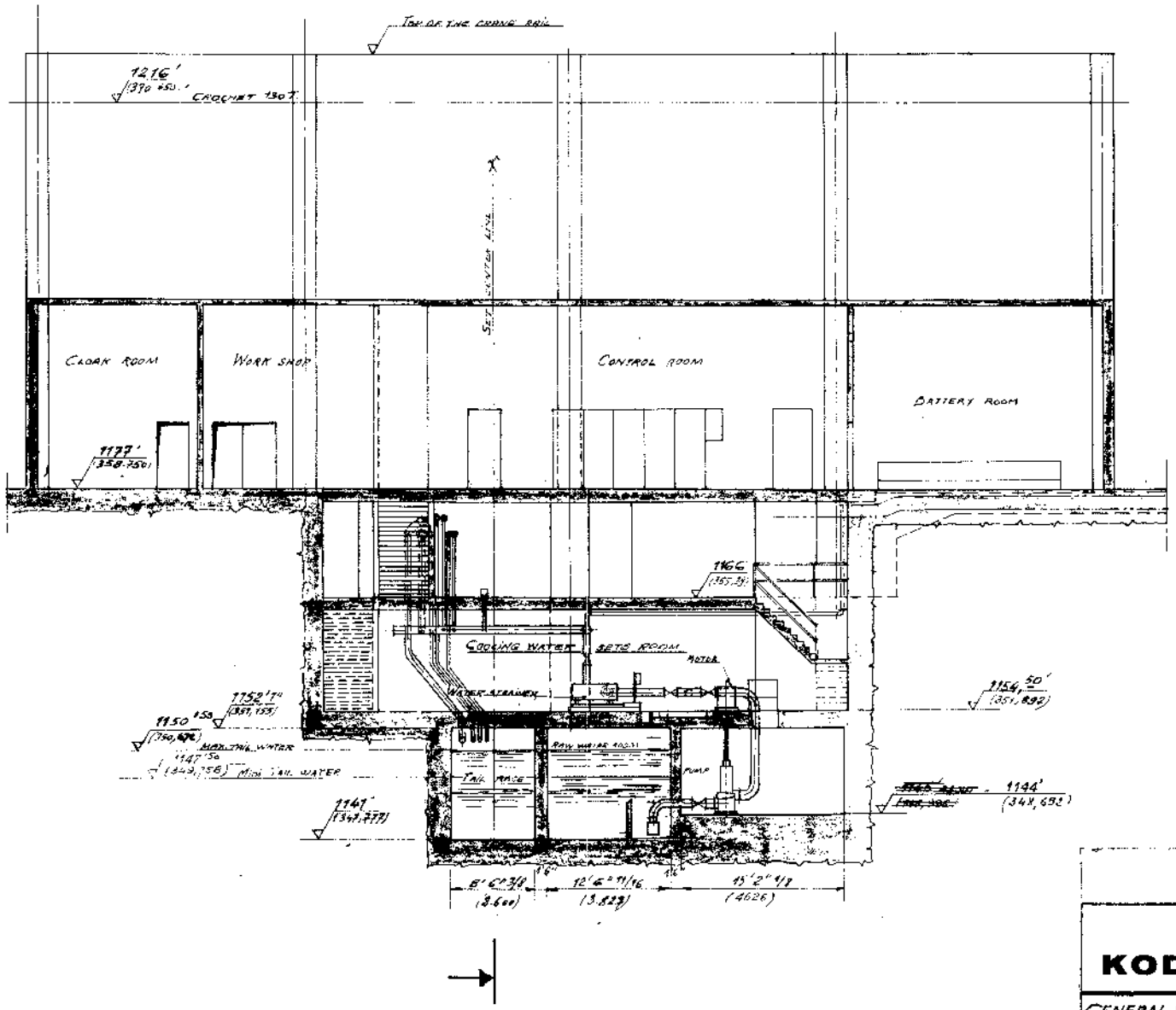
N° de classement : | Consulter aussi :

ALSTHOM - BELFORT

No. 35. 206 599

N° 7049725 Fo

TRANSVERSAL SECTION
SEE DRAWING 7049723



E1 | 1 | 6

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME
LONGITUDINAL SECTION VIEW
OF DOWN STREAM BUILDING

PLANS GÉNÉRAUX DE PRINCIPE
COUPE LONGITUDINALE
DU BATIMENT AVAL

Dessiné : DOURAN | Echelle : 1/100 | N°de Classt
Vérifié : | Service EREA2
Enregistré 3-12-65 | Cde N°: C/Ko Ba2

Rectifications following MSEB's letter Dt 2/7/66 (EH/P2/KOR 1/8) Drawing KOD 156 A/Mn and ALSTHOM note dt 17-10-66
Modifications (EH/AE/Adr - E. 729 (4) e

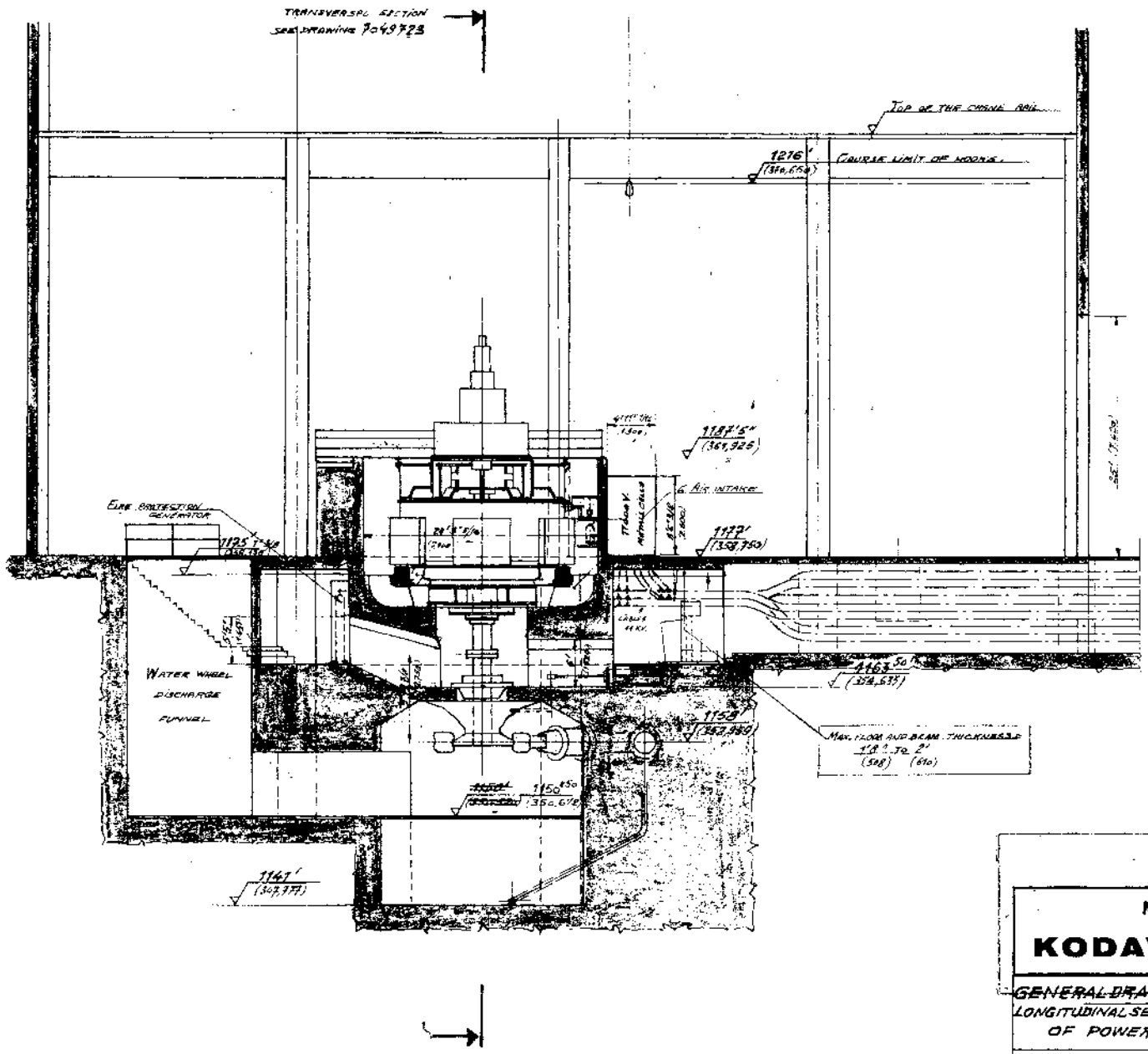
ALSTHOM 38, AVENUE KLÉBER PARIS

N° 7049725 F°

Nbre F°
Voir F°

N° 7049725 Fo

N° 7049724 F°



E1 | 1 | 5

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

~~GENERAL DRAWINGS FINAL SCHEME~~ PLANS GÉNÉRAUX DE PRINCIPE

LONGITUDINAL SECTION VIEW OF POWER STATION

COUPE LONGITUDINALE DE LA CENTRALE

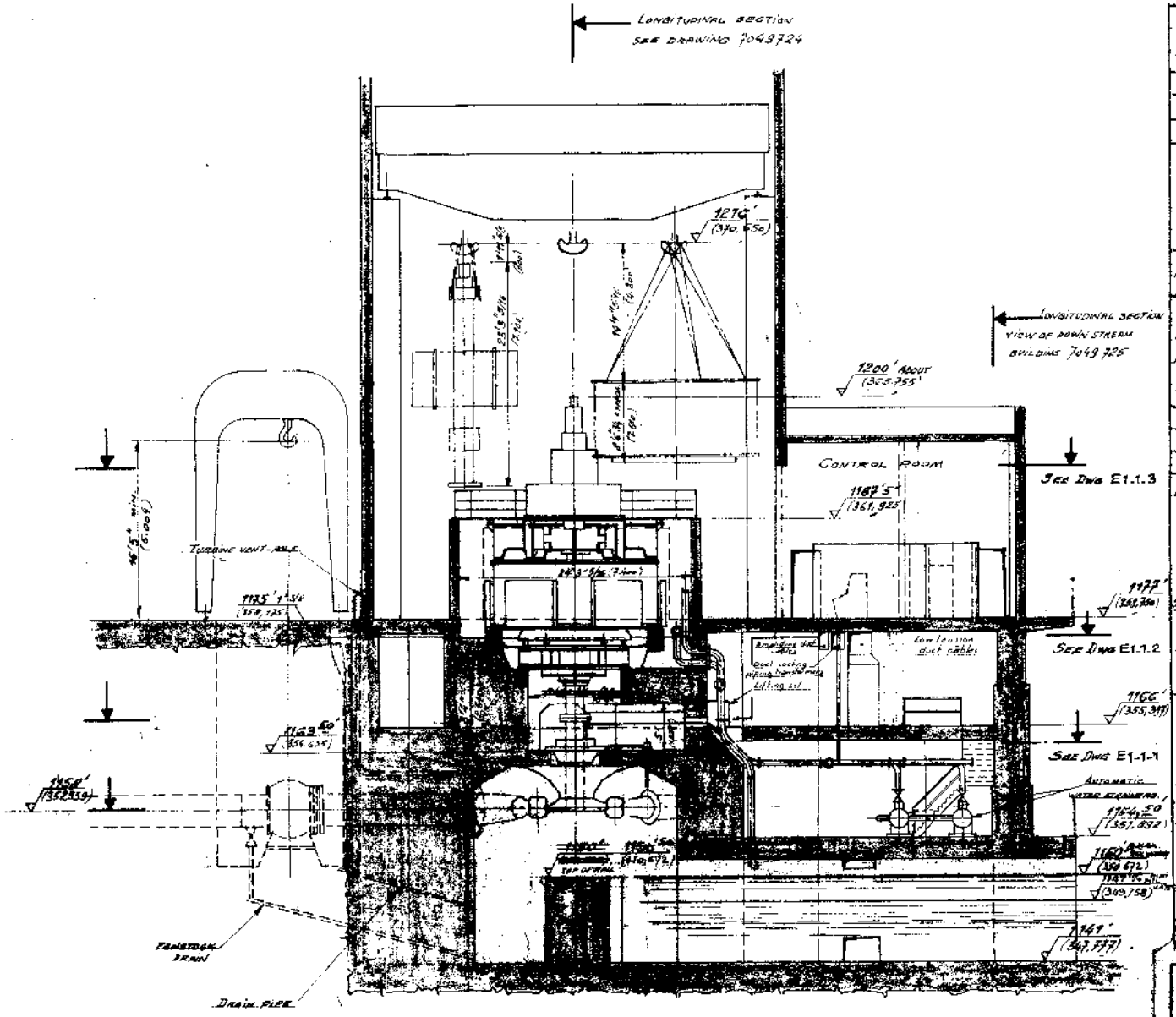
Dessiné : JOUAN. Echelle : 1/125 N°de Class
Vérifié : Service GREA/S
Enregistré : 5-12-65 Cde N° 67/80/81

Rectifications following M.S.E.B.'s letter dt 8/7/66 (EM/A2/KDR. T/a) Drawing 800 450. A/382 and ALSTHOM note dt 12-10-66

ALSTHOM PARIS 38, AVENUE KLEBER

N° 7049724 F°

N° 7049723 F°



NOTA (1)

	Normal case	Case of rotor lifting
Static loads on stator foundation plates :		
- Total	255 tons	120 tons
- On each foundation plate	42,5 tons	20 tons
Static loads on foundation plates of the lower spider :		
- Total	21 tons	156 tons
- On each foundation plate	3,5 tons	26 tons

ALL LOADS ARE INDICATED IN METRIC TONS

Repartition of the loads
Répartition des charges

Total weight to be supported by the upper bracket consisting of :	175 Tons	Poids total à supporter par le croisillon supérieur, constitué de :
- Generator rotor	110 Tons	- Rotor
- Thrust bearing with oil	11 Tons	- Pivot avec huile
- Upper generator housing	26 Tons	- Bâti supérieur
- Exciters	8 Tons	- Excitatrices
- Rotating parts of turbine	20 Tons	- Turbine (parties tournantes)
Loads on stator foundation plates		**Réactions sur les assises du stator**
Vertical reactions (6 foundations plates)		**Réactions verticales** (6 assises)
- Total static load on stator foundation plates (exclusive of loads due to turbine-runner and thrust bearing) (1)	255 Tons	Charge statique totale sur les assises du stator (roue turbine et pivot comprise)
- Static load on each foundation plate (1)	42,5 Tons	Charge statique par assise
These two loads should be multiplied by coefficient 2 to take the dynamic effects into account		Ces 2 charges sont à multiplier par le coefficient 2 pour tenir compte des effets dynamiques
Horizontal reactions		**Réactions horizontales**
- Normal torque due to the machine	117 Tons (1167 Tm)	Couple normal du groupe
- Maximum torque due to instantaneous symetrical short-circuit	106,5 Tons (1062 Tm)	Couple maximum en cas de court-circuit instantané symétrique
- Circumferential shearing force on each foundation plate =		Effort de cisaillement circonférentiel par assise du stator =
= For normal current	7,65 Tons	- Pour le courant normal
= For instantaneous symetrical short-circuit current	70 Tons	- Pour le courant court-circuit instantané symétrique
Reactions on the arms of the lower spider supporting generator braking and lifting jacks (6 arms)		**Réactions sur les bras du croisillon inférieur portant les vérins "freinage-levage"** (6 bras)
Vertical reactions		**Réactions verticales**
- Weight of rotating parts (generator, exciters and turbine rotating parts)	135 Tons	Poids des parties tournantes (rotor alternateur, rotor excitatrices et turbine)
- Static load per foundation plate of the lower spider in case of rotor lifting (1)	26 Tons	Charge statique par assise du croisillon inférieur en cas de soulèvement du rotor
- Vertical load per arm in case of braking	1 Ton about	Charge verticale par bras en cas de freinage
Horizontal reactions		**Réactions horizontales**
- Reaction due to friction when brakes are applied needs	0,3 Ton about	- Réaction due au frottement lors du freinage
- Total radial loads due to the resultant of the jets of the turbine at full load, and transmitted :		Charges radiales totales dues à la résultante des jets de la turbine à puissance maximum, et transmises :
= on the generator lower bearing and lower spider	185 Tons	= sur le palier inférieur alternateur et le croisillon inférieur
= on the support of the turbine bearing at level 1163'10"	126 Tons	= sur le support du palier turbine au niveau 1163'10"

E1 | 1 | 4

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

General drawings - Final scheme
Transversal section view of power station

Plans généraux de principe
Coupe transversale de la centrale

Dessiné : Jeyan | Echelle : 1/100 | N°s Cloné
Vérifié :
Enregistré : 3-12-1965 | Service EDE A.S | Cde N° 5/Gen/202

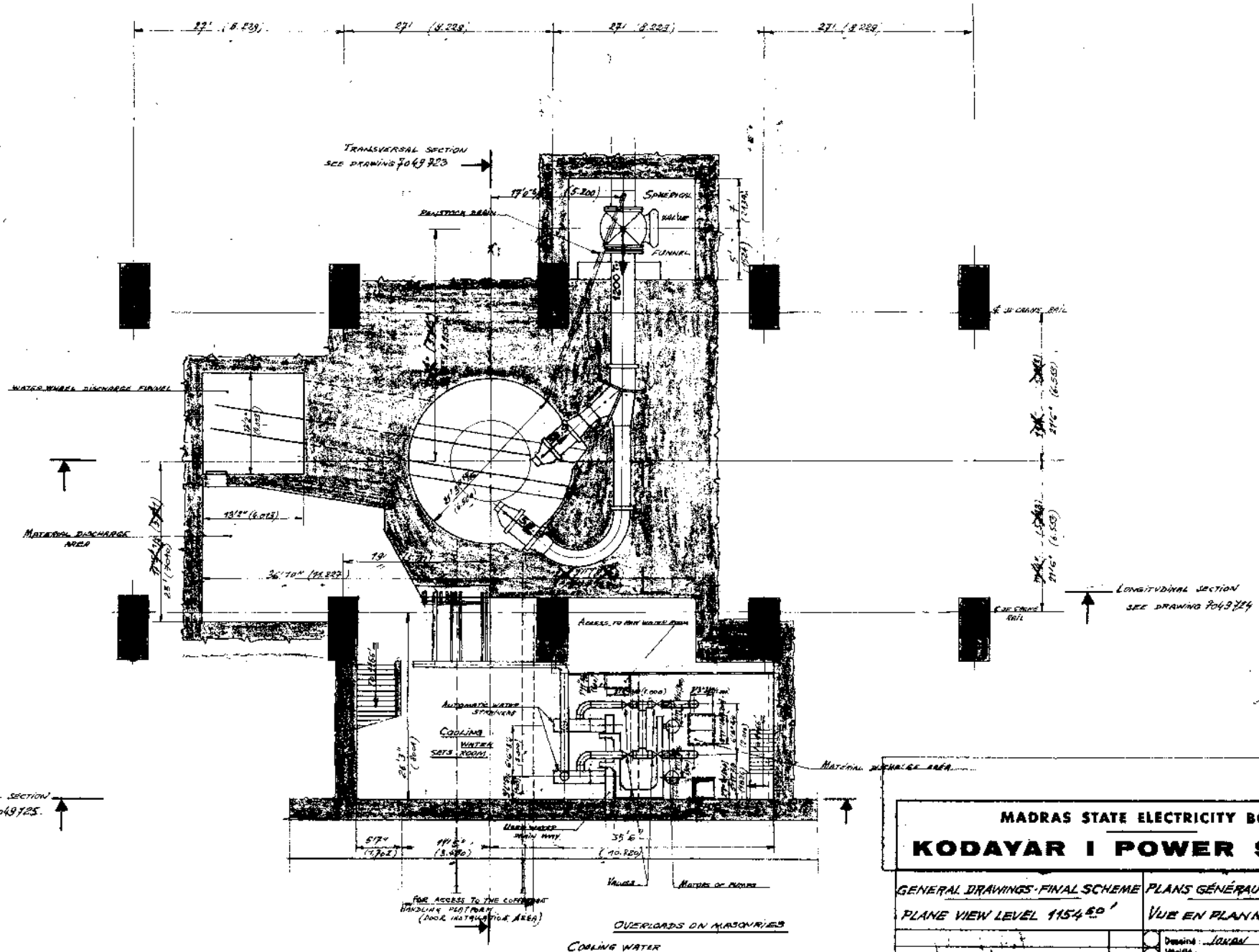
Rectifications following MSEB's letter dt 27/12/66 EM/AE/KDR-T/D/ drawing KOD.ESS.A/382 and ALSTHOM Note dt 19-10-66 — 19.12.66 B
Modification EM/AE/KDR-C 1993 (63) — 6.6.66 A

ALSTHOM PARIS 38, AVENUE KLÉBER

N° 7049723 F°

Fibre PP | B
Voir FF | A

N°7049722 F°



E1 | 1 | 1

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS · FINAL SCHEME
PLANE VIEW LEVEL 1154.50'

PLANS GÉNÉRAUX DE PRINCIPE
VUE EN PLAN NIVEAU 1154.50'

Dessiné : Jouan | Echelle : 1/100 | N°de Classt
Vérifié : | Service EDE. A3
Enregistré : 3.12.65 | Cde N° 5/1644 | I.2

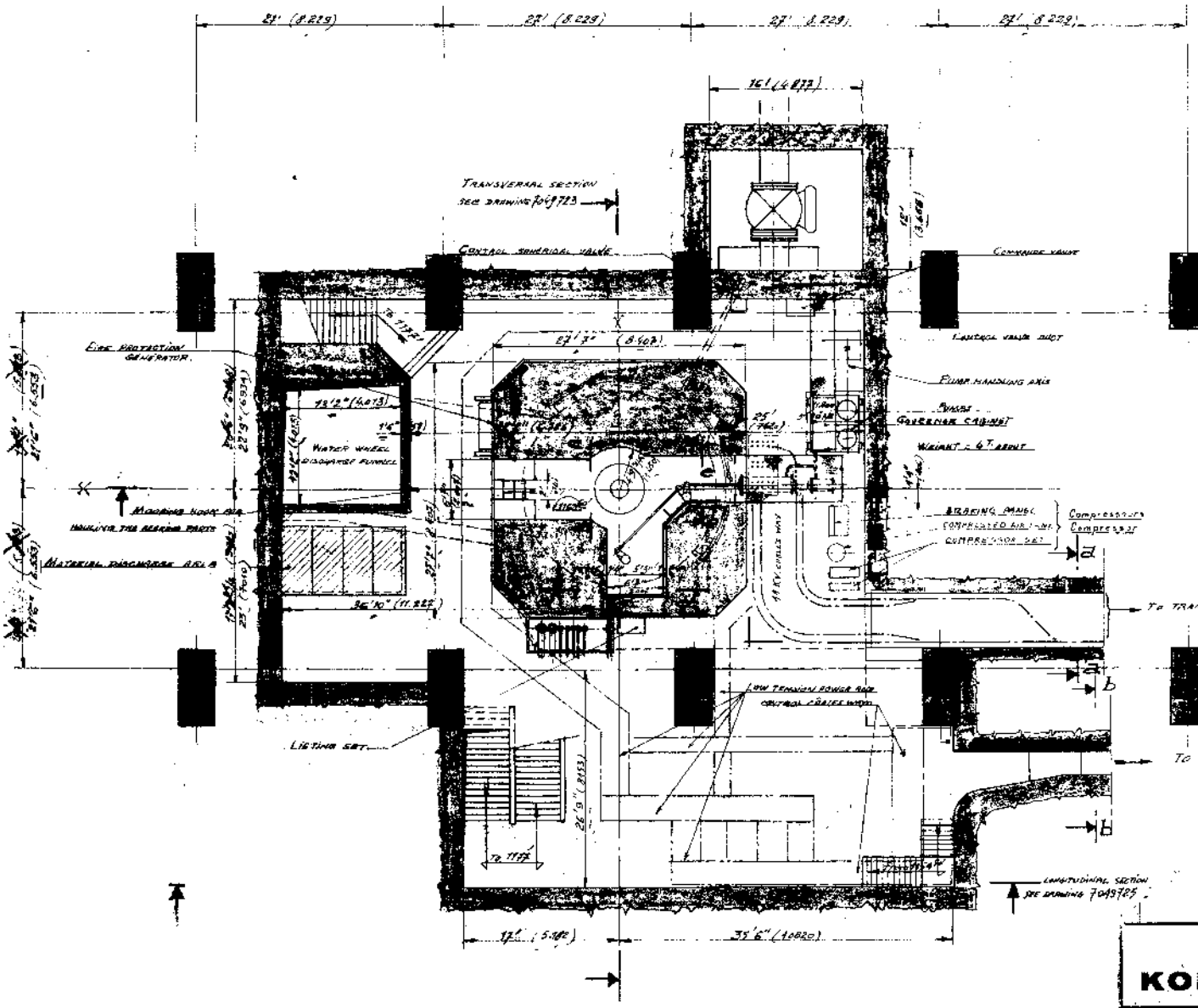
Rectifications following M.S.E.B.'s letter dt 27/7/66 (EN/A3/KDR. 1/8) drawing returned and ALSTHOM note dt. 19.10.66 — 19.10.66 — A

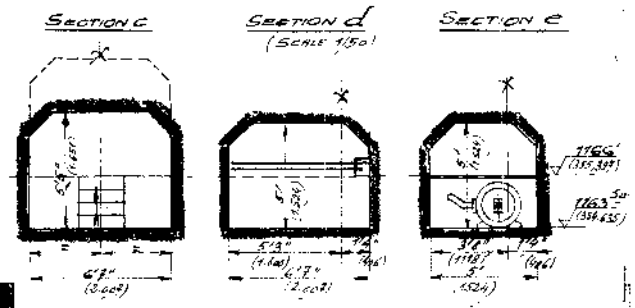
ALSTHOM PARIS 38 AVENUE KLEBER

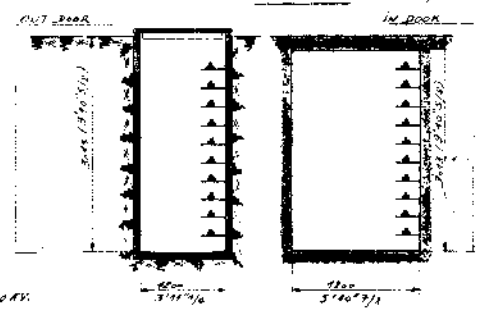
N° 7049722 F°

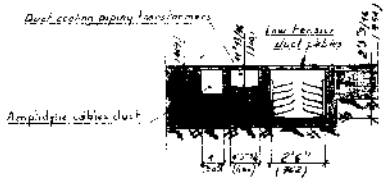
N°7049722 F°

N°7049721 F°









E1 | 1 | 2

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME

PLANE VIEW LEVEL 1166'

PLANS GENERAUX DE PRINCIPE

VUE EN PLAN NIVEAU 1166'

Dessiné : Jaubal | Echelle 1/50 | N°de Classt

Vérifié :

Enregistré : 3-12-66 | Cde N°

Service

T-3

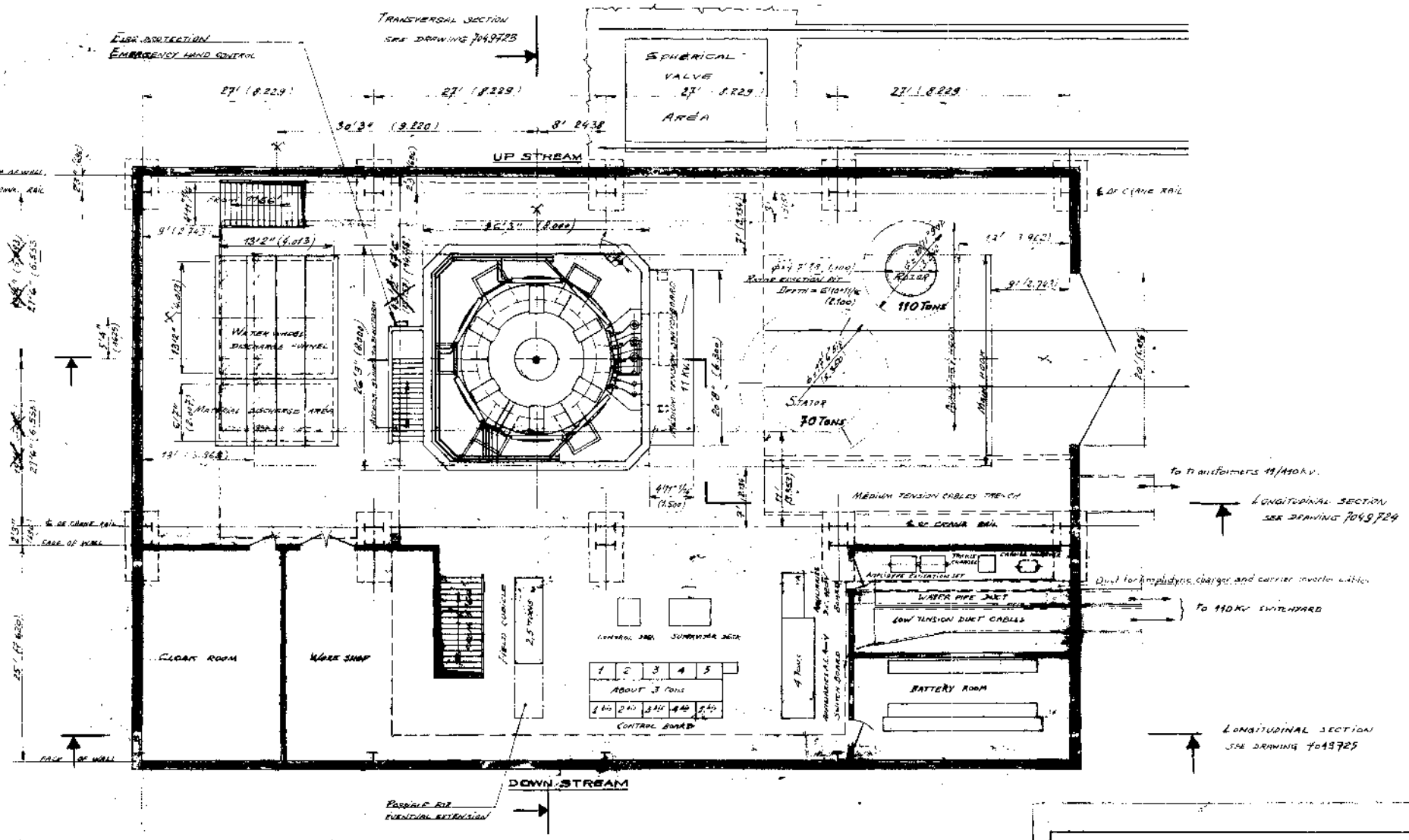
Rectifications following M.S.E.B's letter dt 2/12/66 (EE/AE/KDR. T/6) drawing No. 150.6/65 and ALSTHOM Note dt. 7-10-66

ALSTHOM PARIS 38, AVENUE KLEBER

N° 7049721 F°

N°7049721

N° 7049720



OVERLOADS ON MASONRIES

CONTROL ROOM = 1 TON/SQUARE METER
ERECTION AREA = PRINCIPAL WEIGHTS INDICATED
OTHER PARTS OF MACHINE ROOM = 3 TONS/SQUARE METER

E1 | 1 | 3

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME
PLANE VIEW LEVEL 1177'

PLANS GENERAUX DE PRINCIPE
VUE EN PLAN NIVEAU 1177'

Dessiné : KUMAR
Vérifié :
Enregistré 3-12-65
Echelle : 1/50
Service EEE (E)
Cde N° 5(1)/64
N°de Classt I-4

Rectifications following M.S.E.B.'s letter dt 27/11/65 [EE/(E)/KDA 1/6] drawing A0/1504 A/SAE 17.10.65

ALSTHOM PARIS 38, AVENUE KLÉBER

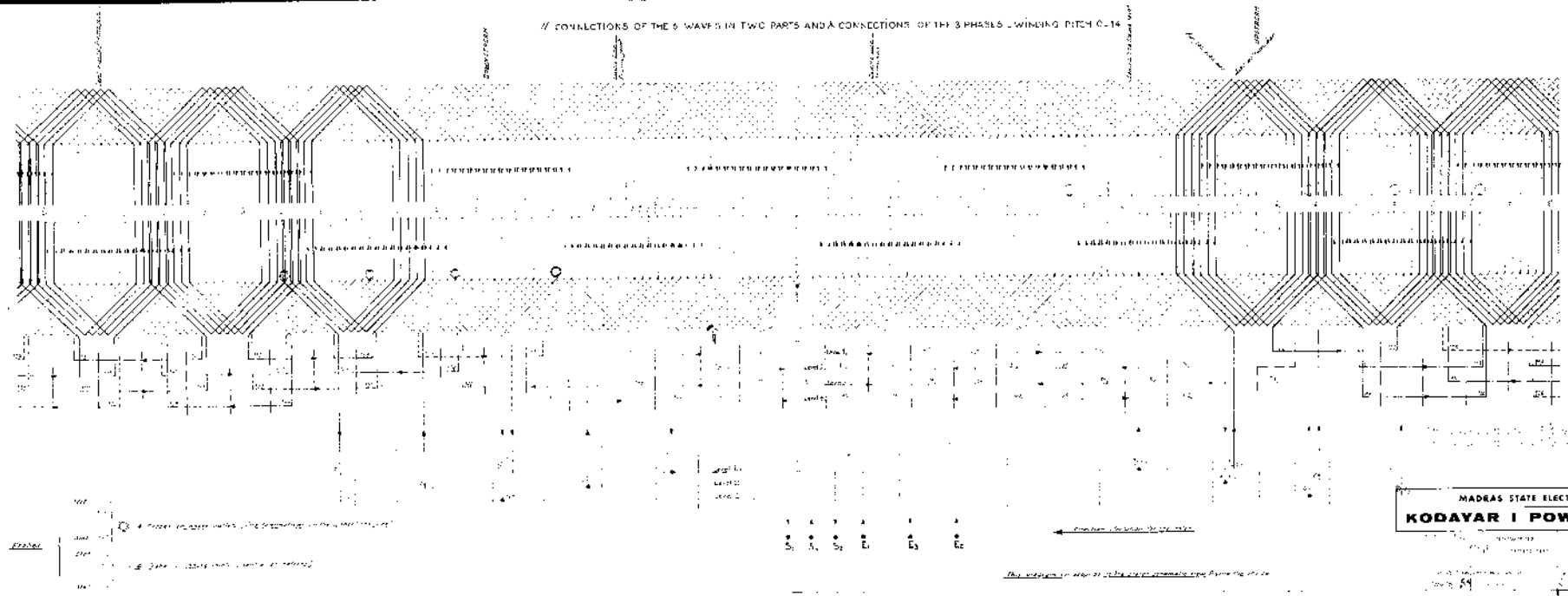
N° 7049720 F

Nbre F
Ver F

A

N° 7049720

// CONNECTIONS OF THE 6 WAVES IN TWO PARTS AND À CONNECTIONS OF THE 3 PHASES - WINDING PITCH 0-14



A1 | 24

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

ALSTHOM - BELFORT

N° 35-509197 Ad

N° 35-509197 Ad

N° 35.181.967 bis

A1	34	

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

CIM : 182 046 — Compressor 2 Z 76 35 UNIT

ECH 1/5 | DESSINE PAR A. Lam | LE 8.6.67 | VERIFIE PAR | LE

Ce plan, propriété de la Cie Spiros, NE PEUT ETRE CEDE NI REPRODUIT SANS SON AUTORISATION

MODIFICATIONS	DATES

Spiros — DEPUIS 1844 — SAINT DENIS

N° 35.181 967 bis

N°66140.10319D

Section A.
Coupe A.

Section B.
Coupe B.

Section C.
Coupe C.

Plane view.
Vue en plan.

Section D.
Coupe D.

Section E
Coupe E.

AVAL
DOWNSTREAM

AMONT
UPSTREAM

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

ALSTHOM

N° 9054599

Section A
Coupe A

Section B
Coupe B

Section C
Coupe C

Section S
Coupe S

Section E
Coupe E

Coupe D
Section D

Section H
Coupe H

Detail 4

STATOR
70 Tons

ROTOR
450 Tons

FOR THIS PART SEE DRAWING 9054591 EE. 4.7

POUR CETTE PARTIE VOIR LE N° 9054591 EE. 4.7

Section X
Coupe X

Section J
Coupe J

Detail 1

Detail 2

Detail 3

Section L
Coupe L

Section M
Coupe M

Section N
Coupe N

Section P
Coupe P

Section R
Coupe R

Sections W
Coupes W

Section Z
Coupe Z

Section T Coupe T

Section U Coupe U

OVERLOADS ON MASONRIES

22 1 4

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

CIVIL ENGINEERING GUIDE-DRAWINGS MAIN-WORK

PLANS GUIDE DE GENIE CIVIL GROS OEUVRE

Level +177. Plans and sections views

Niv. +177. Vues en plan et coupes

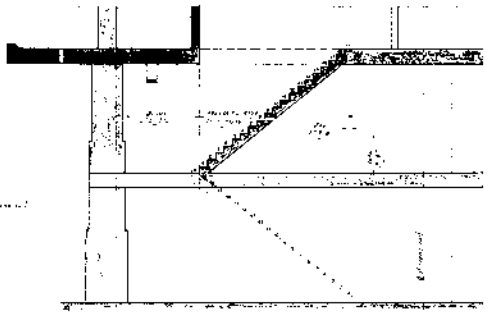
ALSTHOM

N° 9054 599 FI

N° 9054599

UPSTREAM
AMONT

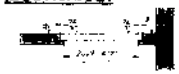
- COUPE A-A -
- SECTION A-A -



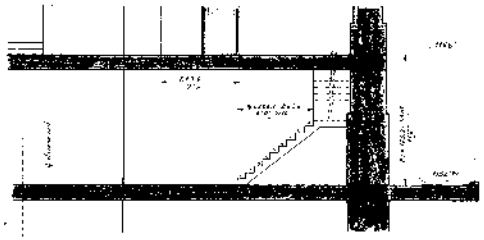
- COUPE B-B -
- SECTION B-B -

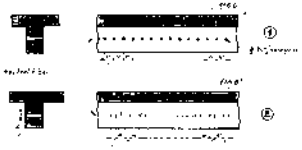


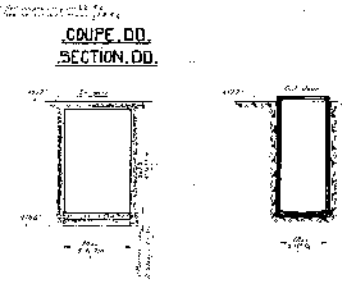
COUPE E.E.
SECTION E.E.



- COUPE C-C -
- SECTION C-C -

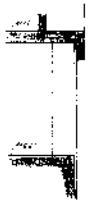


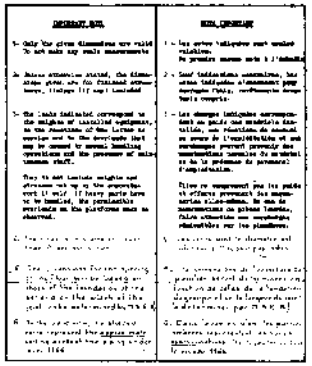




COUPE D.D.
SECTION D.D.

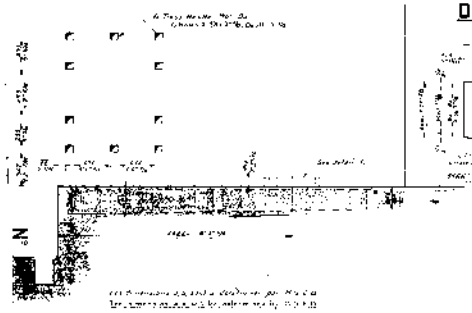
COUPE J.J.
SECTION J.J.



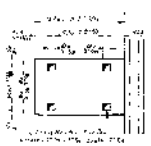


OVERLOADS ON MASONRIES

COUPE K.K.
SECTION K.K.

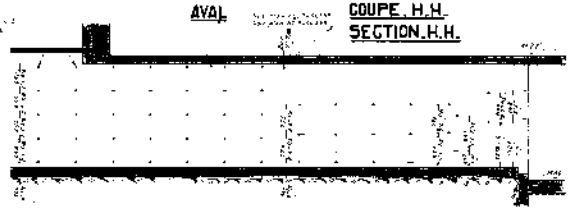


DETAIL 1.



DOWNSTREAM
AVAL

COUPE H.H.
SECTION H.H.



COUPE G.G.
SECTION G.G.



E2 | 1 | 3

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

CIVIL ENGINEERING GUIDE - DRAWINGS
TRAVAUX GENIE CIVIL

PLANS GUIDE DE GÉNIE CIVIL
GROS OEUVRE

(except 1166: Plans and section views) (sauf 1166: Vue en plan et coupes)

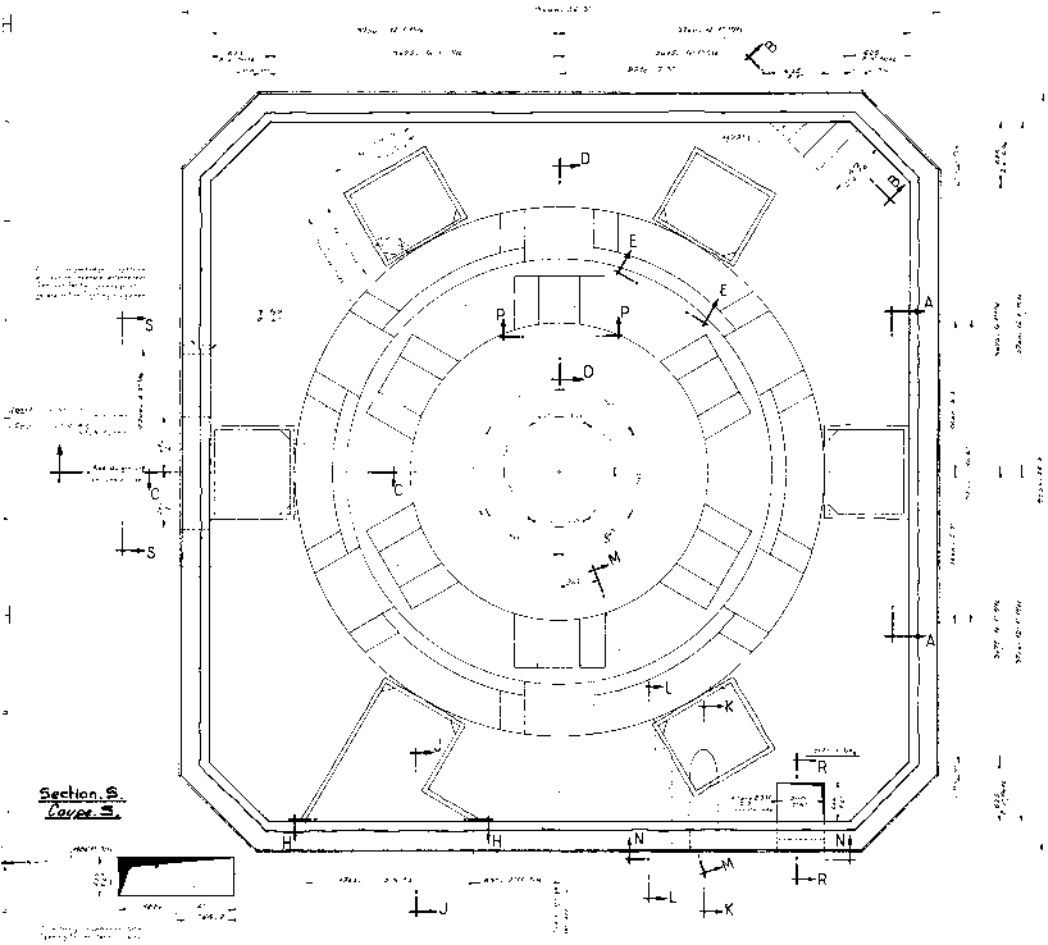
ALSTHOM
PARIS

N° 9x54598

1659506.N

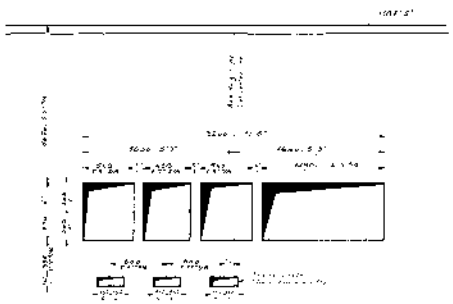
VUE EN PLAN. PLANE VIEW

AMONT - UPSTREAM

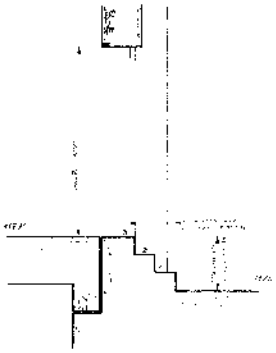


AVAL - DOWNSTREAM

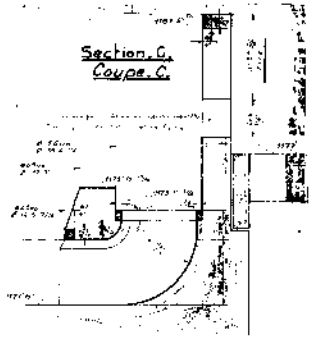
Section. A.
Coupe. A.



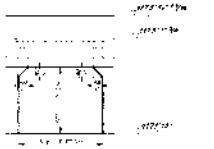
Section. B.
Coupe. B.



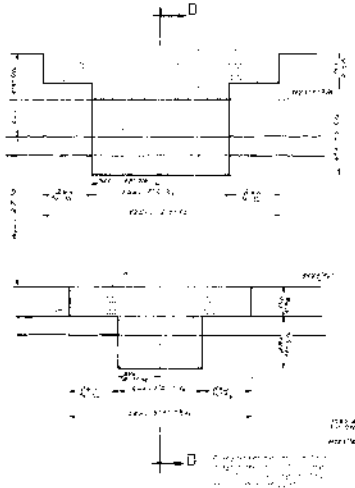
Section. C.
Coupe. C.



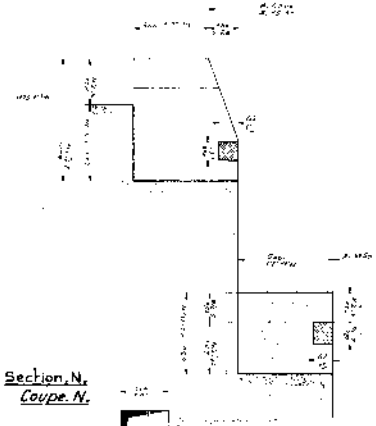
Section. E.
Coupe. E.



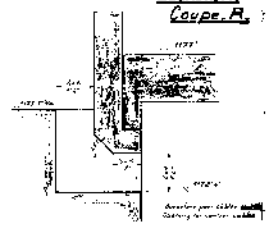
Section. P.
Coupe. P.



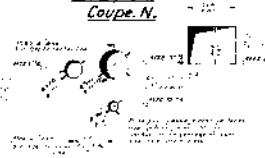
Section. D.
Coupe. D.



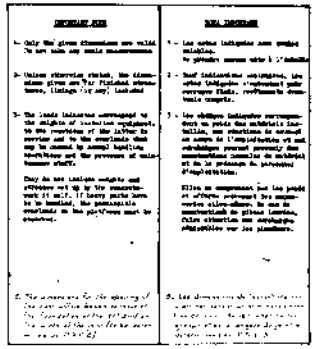
Section. R.
Coupe. R.



Section. N.
Coupe. N.



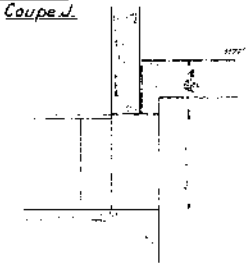
Section. S.
Coupe. S.



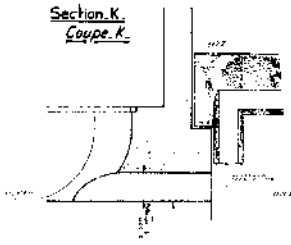
Section. H.
Coupe. H.



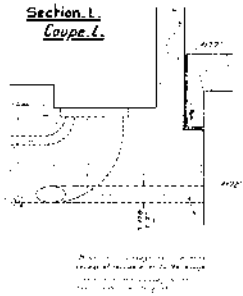
Section. J.
Coupe. J.



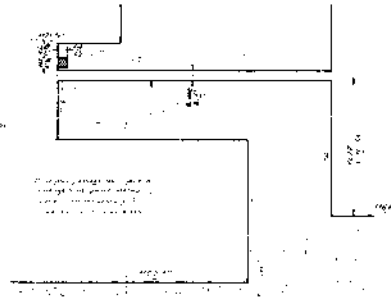
Section. K.
Coupe. K.



Section. L.
Coupe. L.

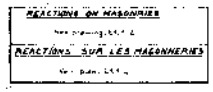


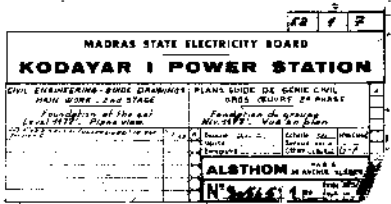
Section. M.
Coupe. M.



REACTIONS ON MASONRIES

REACTIONS SUR LES MAÇONNERIES

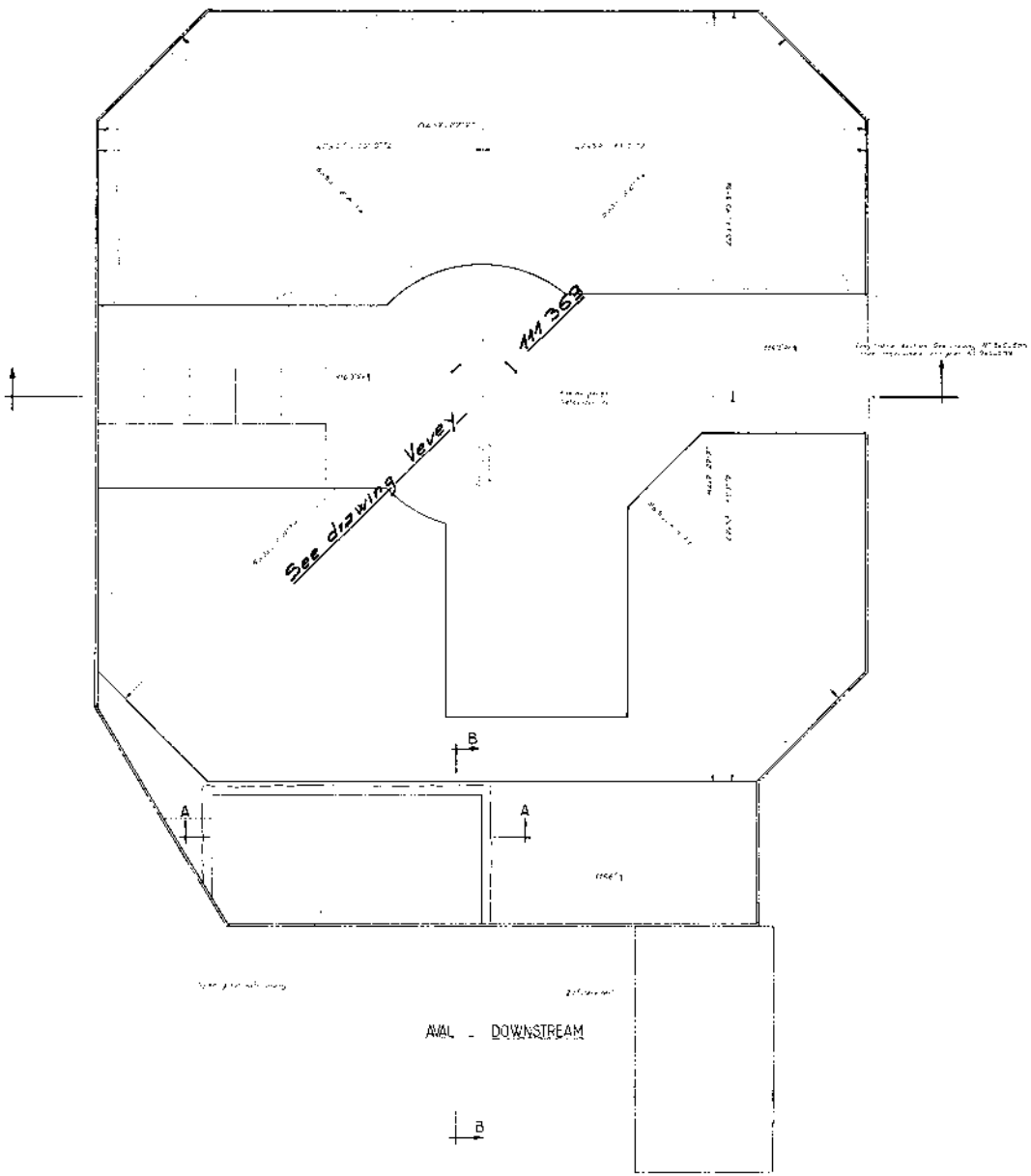




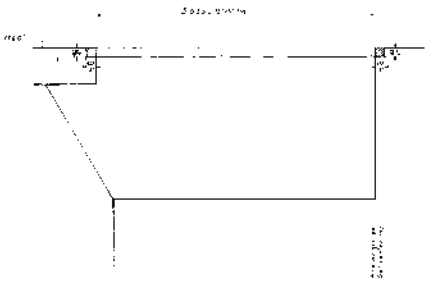
N°5459.N

0657506 N

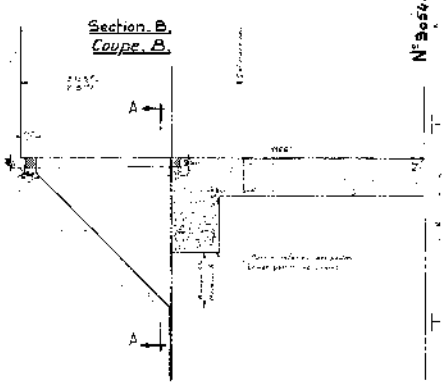
AMONT UPSTREAM



Section. A.
Coupe. A.



Section. B.
Coupe. B.



N° 9054 590 F

Pour le contenu de ce plan
cf. dwg Vevey 111363
Voir ce dessin concernant

Reference of this Drawing
See Drawing Vevey 111363
Voir ce dessin

DIVERSES NOTES	NOTA Generales
1- Only the given dimensions are valid. Do not make any scale measurements	1 - Las cotas indicadas son cotas validas. No procede tomar cotas a la escala
2- Unless otherwise stated, the dimensions given are for finished concrete. Tolerance ± 10 mm. Insulated	2 - Sauf indications contraires, les cotes indiquées s'entendent pour ouvrages finis, tolérance ± 10 mm. Isolé
3- The loads indicated correspond to the weights of installed equipments, to the reactions of the jibcrane in service and to the overloads. Work may be caused by normal handling operations and the presence of maintenance staff. They do not include weights and stresses set up by the occurrence of 1/2 mile. If heavy parts have to be handled, the probability constants on the platforms must be observed.	3 - Las cargas indicadas corresponden al peso de los materiales instalados, las reacciones en servicio de pescante de 1/2 tonelada y las sobrecargas previstas para mantenimiento (presencia de personal) y de la presencia de personal durante el montaje. Estas no comprenden los esfuerzos debidos al esfuerzo permanente del manipulación eventual. En caso de manipulaciones de piezas pesadas, hacer atención a las sobrecargas admisibles en las plataformas.
4- The dimensions for the opening of the trenches are given without the thickness of the protection of the walls and floors.	4 - Las dimensiones para la abertura de las zanjas son dadas sin el espesor de la protección de las paredes y suelos.

Existing provision for the addition of the turbine
Réserve de percement pour une turbine supplémentaire

	E2	1 6

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

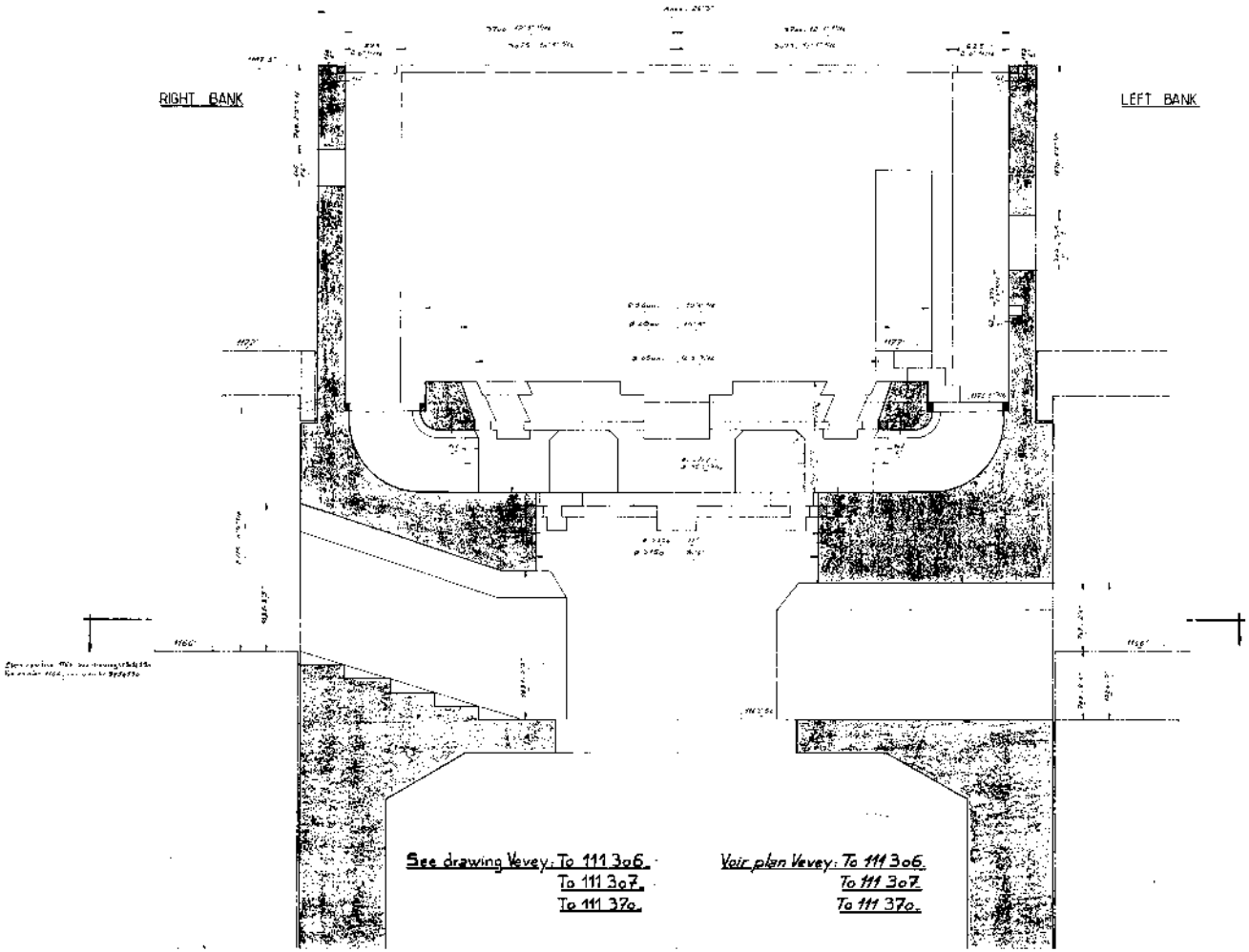
CIVIL ENGINEERING GUIDE-DRAWINGS
MAIN WORKS - 2nd STAGE
Foundations of the set (excl. HPBC) - Plans view

PLANS GUIDE DE GÉNIE CIVIL
GROS OEUVRE - 2e PHASE
Fondations du groupe
Nle HPBC - Vue en plan

ALSTHOM 38 AVENUE KLEBER PARIS

N° 9054 590 F

N° 5695756 N



See drawing Vevey: To 111 306.
To 111 307.
To 111 370.

Voir plan Vevey: To 111 306.
To 111 307.
To 111 370.

Reading corresponding to the centre of the concrete.
Relevé correspondant à l'axe du massif.

REACTIONS ON MASONRIES
See drawing E1-1-1
REACTIONS SUR LES MAÇONNERIES
Voir plan E1-1-1

E2 | 1

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATIO

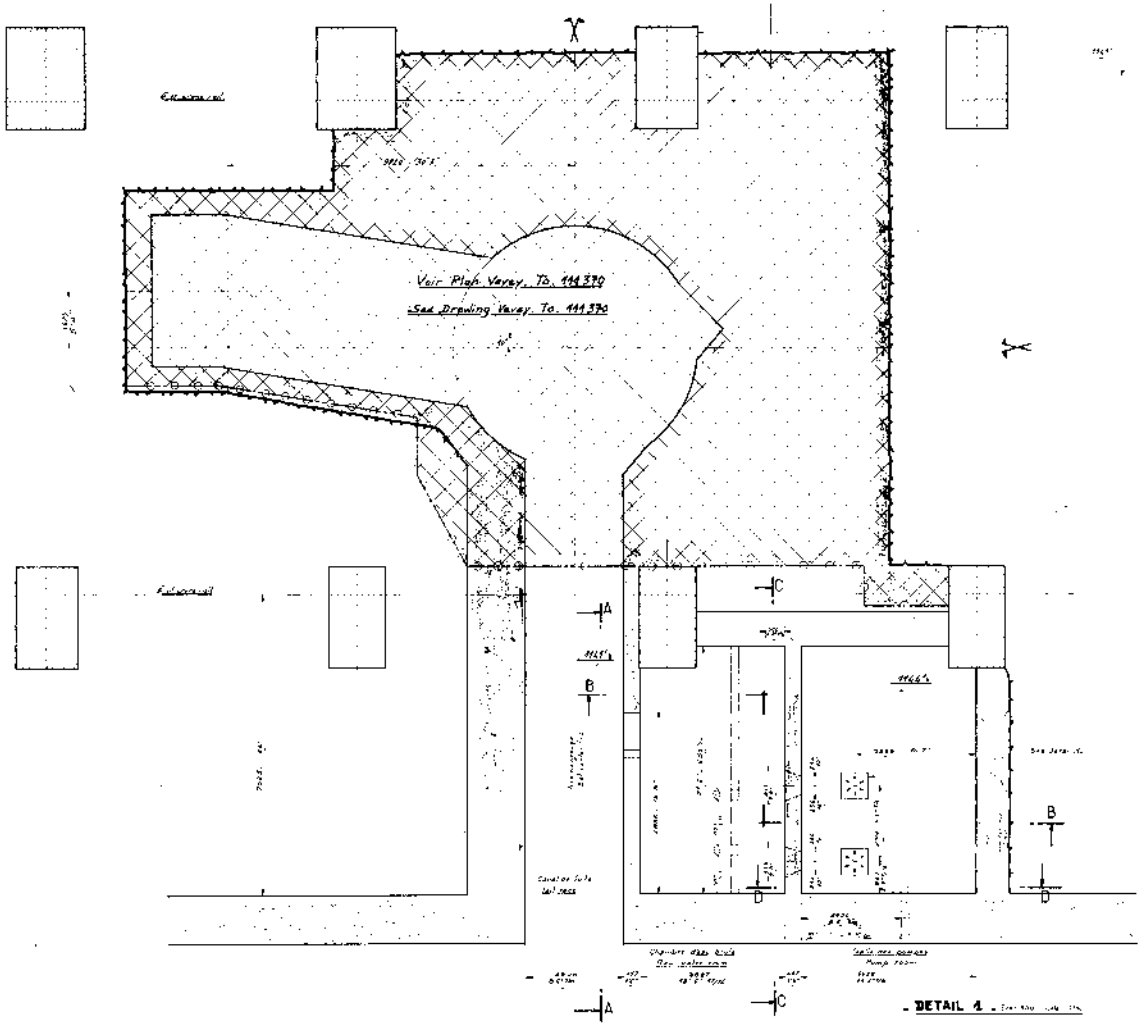
CIVIL ENGINEERING GUIDE-DRAWINGS
MAIN WORK. 2nd STAGE
Foundation of the unit
Longitudinal section

PLANS GUIDE DE GÉNIE CIVIL
GROS OEUVRE - 2e PHASE
Fondation du groupe
Coupe longitudinale

ALSTHOM PARIS

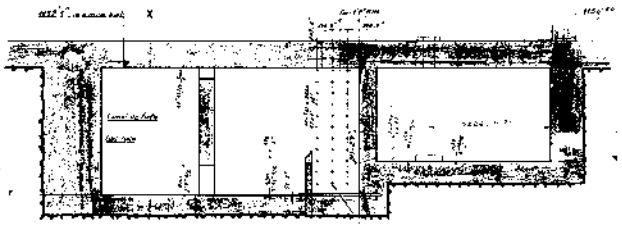
N° 9054 589 E1

UPSTREAM
AMONT

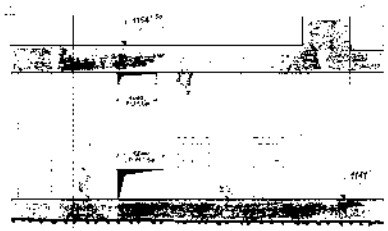


DOWNSTREAM.
AMONT.

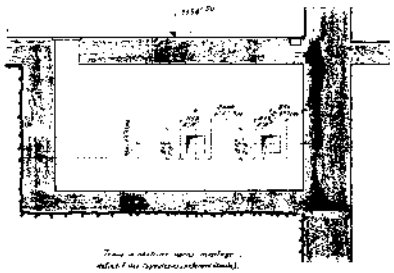
- COUPE B-B -
- SECTION B-B -



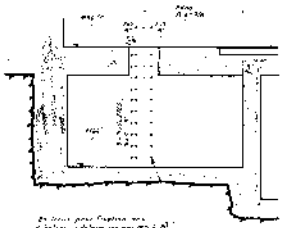
- COUPE A-A -
- SECTION A-A -



- COUPE C-C -
- SECTION C-C -



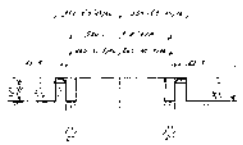
- COUPE D-D -
- SECTION D-D -



- DETAIL 1 -



- COUPE E-E -
- SECTION E-E -



E2 1 1

MADRAS STATE ELECTRICITY BOARD

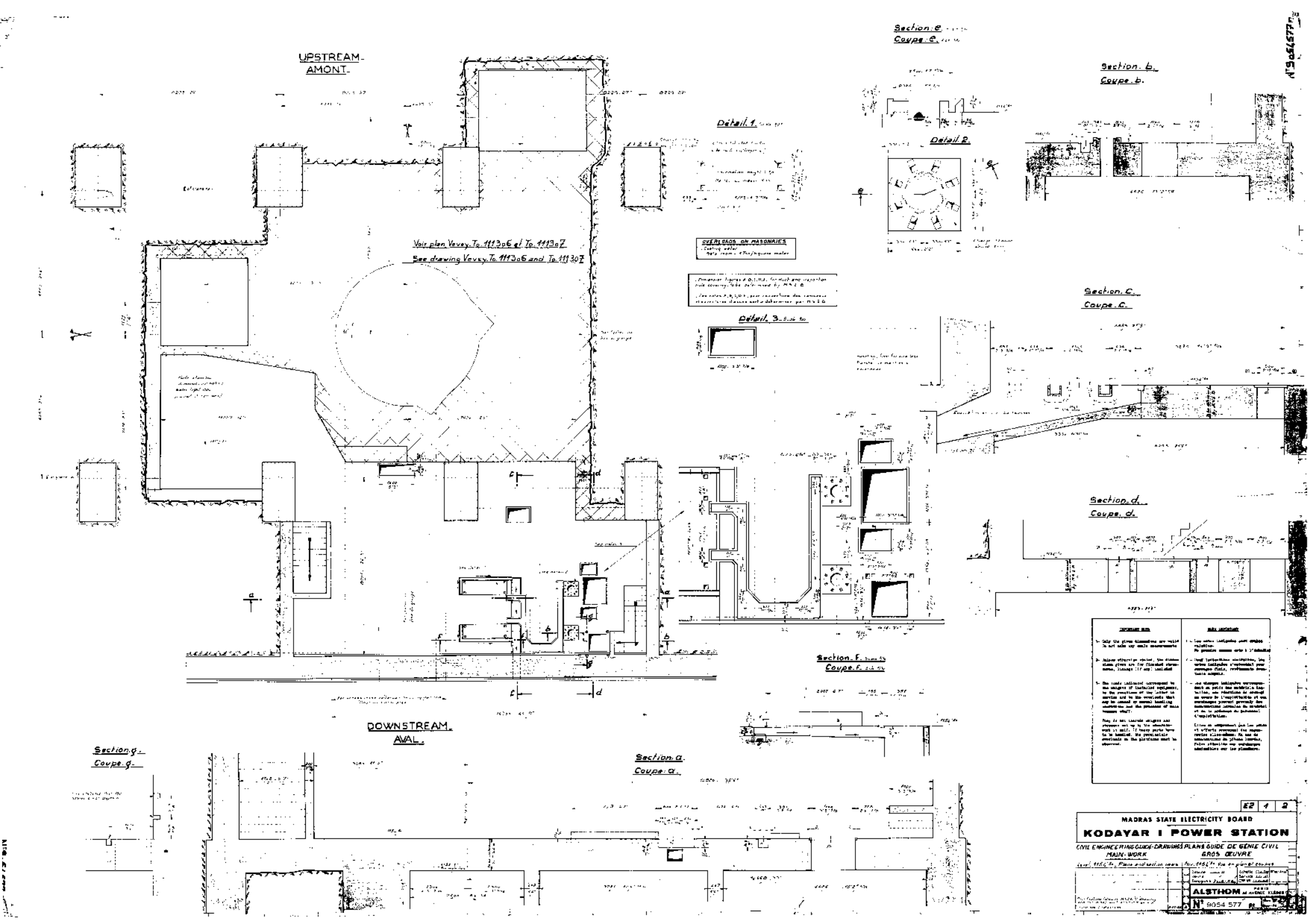
KODAYAR I POWER STATION

CIVIL ENGINEERING GUIDE-DRAWINGS
MAIN-WORKS
LEVEL 1150'10. Plans & section views

PLANS GUIDE DE GENIE CIVIL
GROS ŒUVRE
NIV. 1150'10. Vue en plan et coupes

ALSTHOM 38 AVENUE KLEBER PARIS

N° 9054578 FR


UPSTREAM-
AMONT-
Section. e.
Coupe. e.
Section. b.
Coupe. b.
Detail. 1.
Detail. 2.
Voir plan Vevey. Tg. 111306 et Tg. 111307
See drawing Vevey. Tg. 111306 and Tg. 111307
OVERLAPS ON MASONRIES
Section. C.
Coupe. C.
Detail. 3.
Section. d.
Coupe. d.
Section. F.
Coupe. F.
DOWNSTREAM.
AVAL.
Section. g.
Coupe. g.
Section. a.
Coupe. a.
MADRAS STATE ELECTRICITY BOARD
KODAYAR I POWER STATION
CIVIL ENGINEERING GUIDE-DRAWINGS PLANS GUIDE DE GENIE CIVIL
MAIN-WORK
GROS ŒUVRE
ALSTHOM
N° 9054 577

Développement sur rayon 925

Développement sur 925 ϕ

Vue sur le couvercle du pivot

AVAL

AMONT

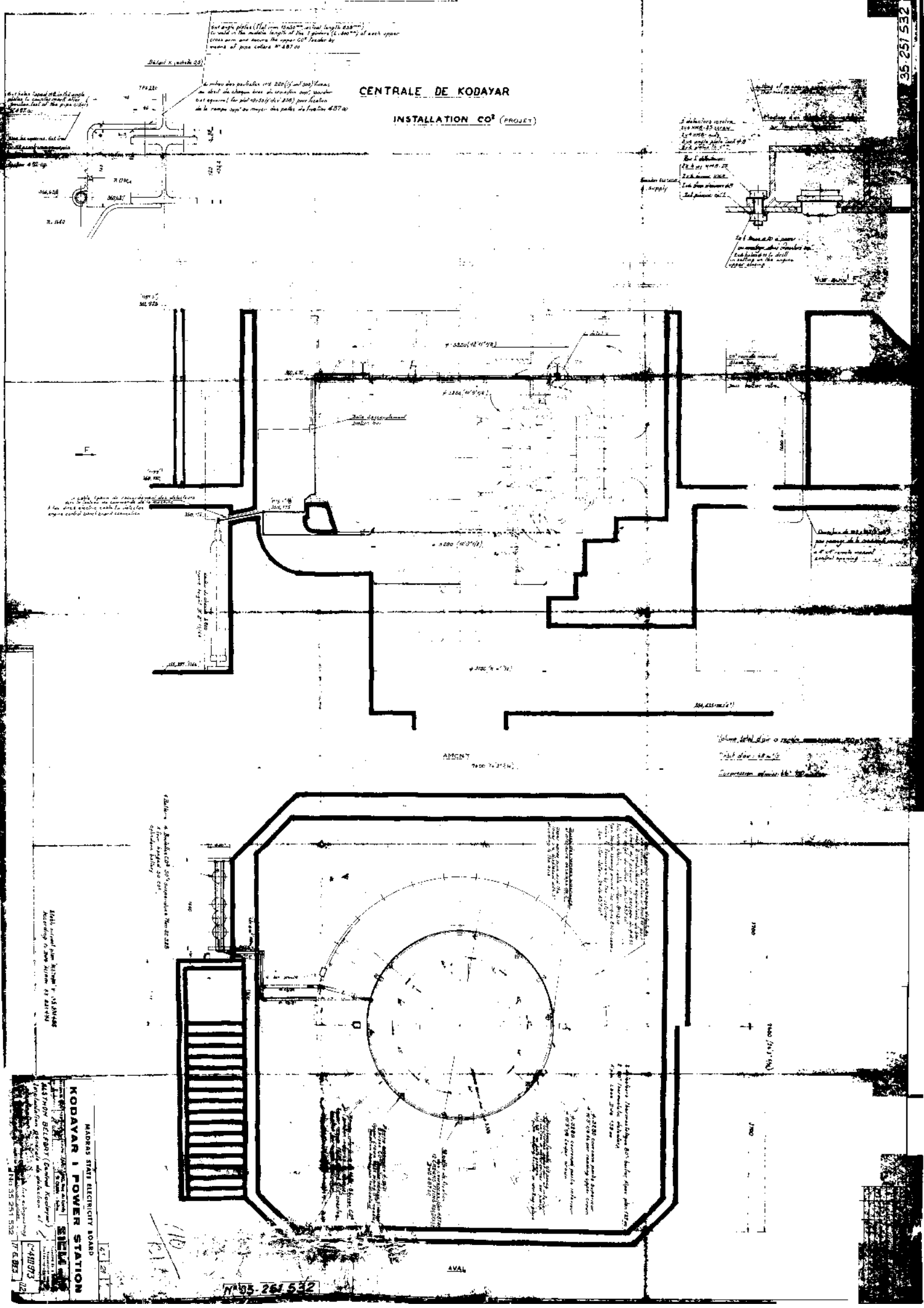
Poids total
Total weight ~ 8500kg

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

Ensemble

Assembly


CENTRALE DE KODAYAR
INSTALLATION CO² (PROJET)
AMONT
AVAL
KODAYAR I POWER STATION
MADRAS STATE ELECTRICITY BOARD
SIEMENS
35 251 532

MADRAS STATE ELECTRICITY
KODAYAR I POWER STATION
FAN ARRANGEMENT
Scale 1:50
No. 35-201 495

N° 35.251.494

Détail f.

Stator probes

Bearing. Pivot insulation control. patien.

Coolers Water temperature and flow control.

Détail r.

Bearing. Pivot thermostat and probes.

Thermostats. Détail g.

Bearing. Pivot Control

Détail s.

Détail h.

Water probe Détail a.

Thermometers Détail c.

Détail g.

Teletthermometer. Détail h.

Détail s.

Upstream

Water indicator Détail b.

Thermostat. Détail d.

Détail e. Connecting box

Downstream

Probe Détail k.

Teletthermometer. Détail l.

Internal bearing. Control

Détail n.

Healing résistances

Rotor grounding brusher

Excitation terminals Détail p.

Détail q.

Terminal strip I

Terminal strip II

Terminal strip III

Terminal strip IV

Terminal strip V

Terminal strip VI

Oil level Détail m.

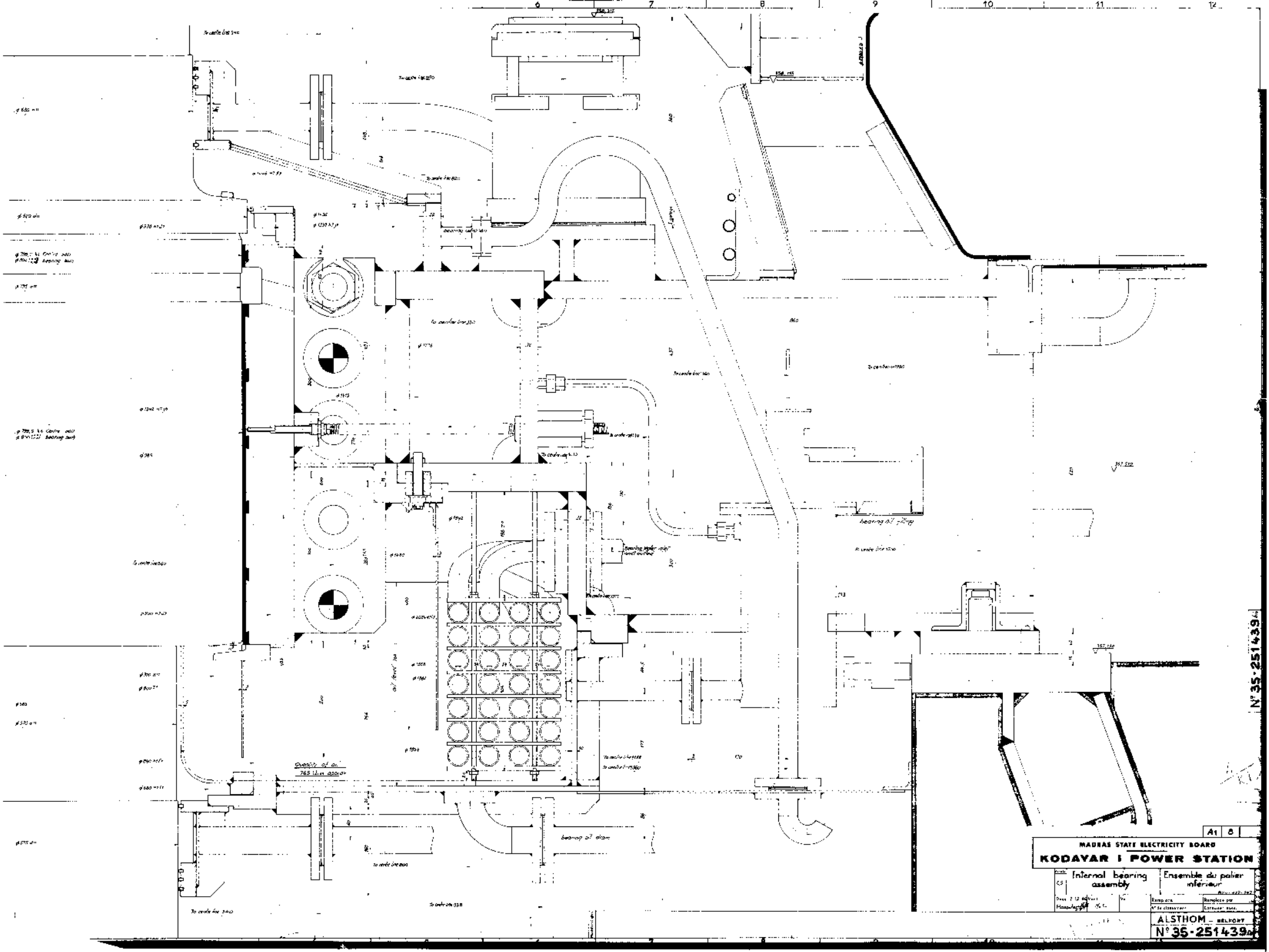
Thermostat. Détail j.

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

ALSTHOM

N° 35.251.494


Capacity of oil
765 Litres approx
bearing oil drain
bearing oil drip
A1 8
MADRAS STATE ELECTRICITY BOARD
KODAYAR I POWER STATION
Internal bearing assembly
Ensemble du palier inférieur
ALSTHOM – BELFORT
N° 35-251439

N 35-251419

View as per F1

Cross section AA

Collector side

Braking side

Upper part

Detail Z

Detail Y

Cross section BB

Cross section BB

View as per F1

détail B C D E

View as per F

détail A B C D

View as per F

Cross section EE

Cross section CC

Cross section DD

MD² of the rim : 165 500 kg.m²

The joint rings will be hot-mounted

For transporting the ring reference mark 8 will be dismantled

View as per F2

Collector side

Braking side

View as per F

Groove detail

N 35-251419

MADRAS STATE ELECTRICITY BOARD

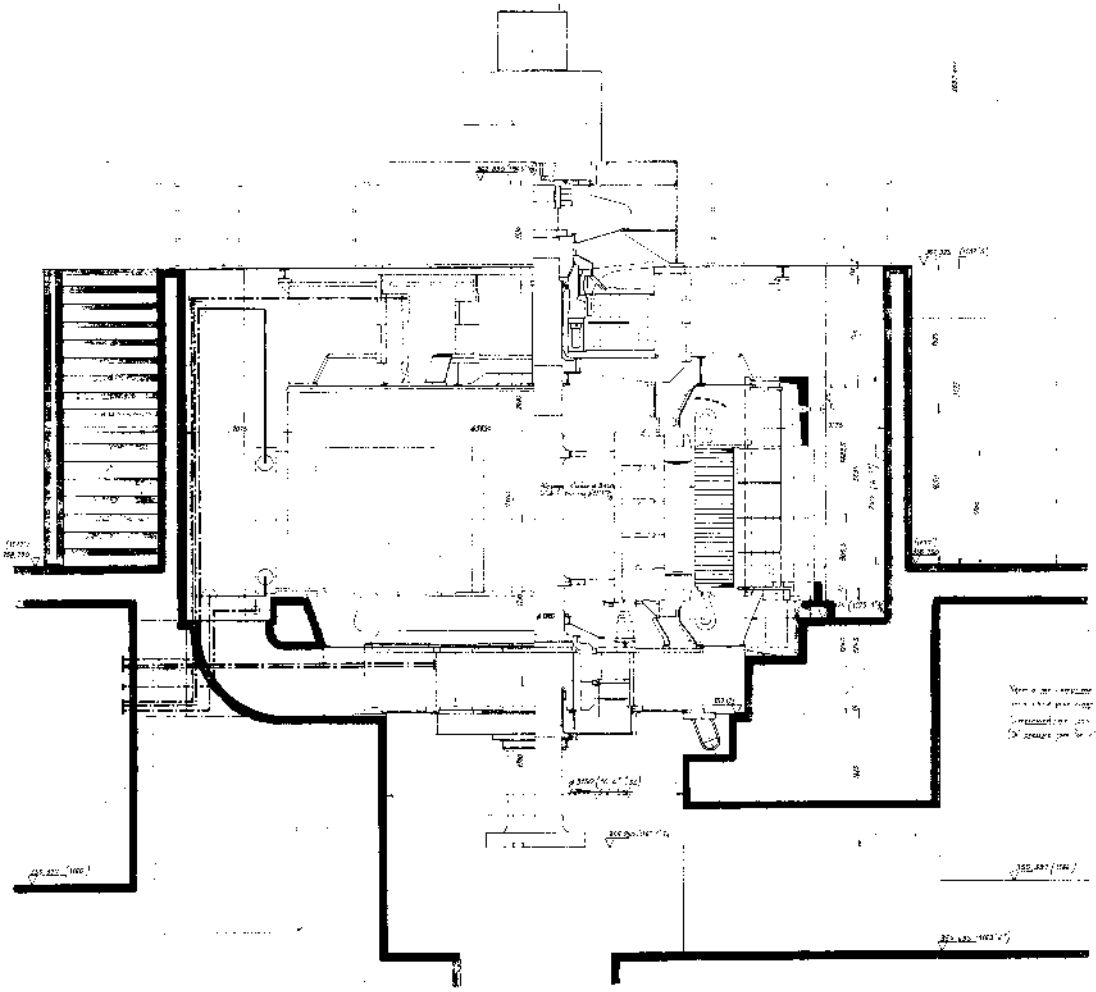
KODAYAR-I POWER STATION

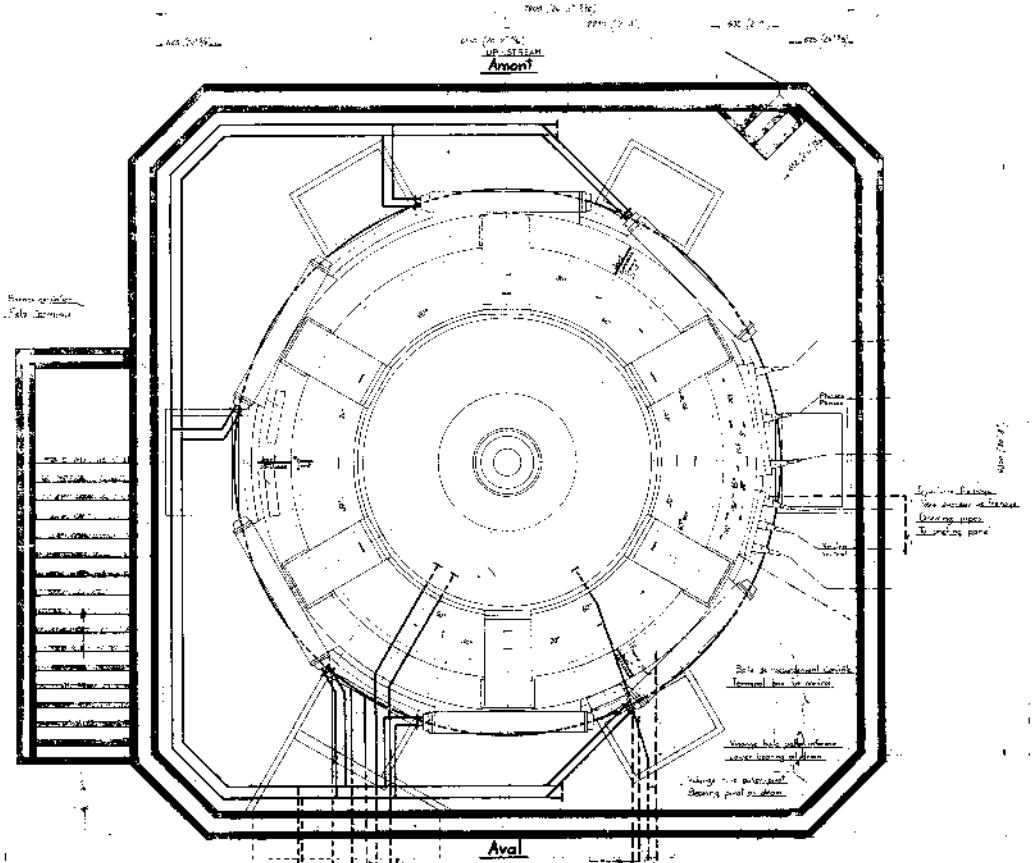
RIM ASSEMBLY

ENSEMBLE DE LA JANTE

No 35 251 419

N 35-251304





MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

PLANS DE CONSTRUCTION

GENERATOR DIMENSIONS

ENCOMBREMENT DE L'ALTERNATEUR

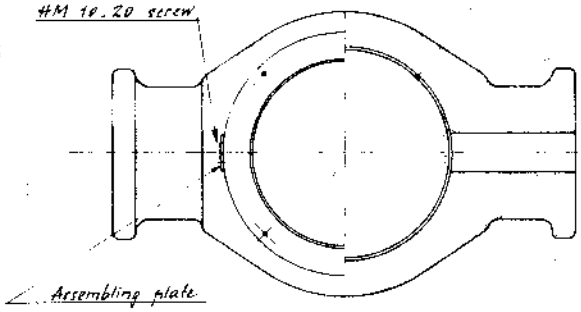
ALSTHOM

N° 35-251304

N° 35-251304

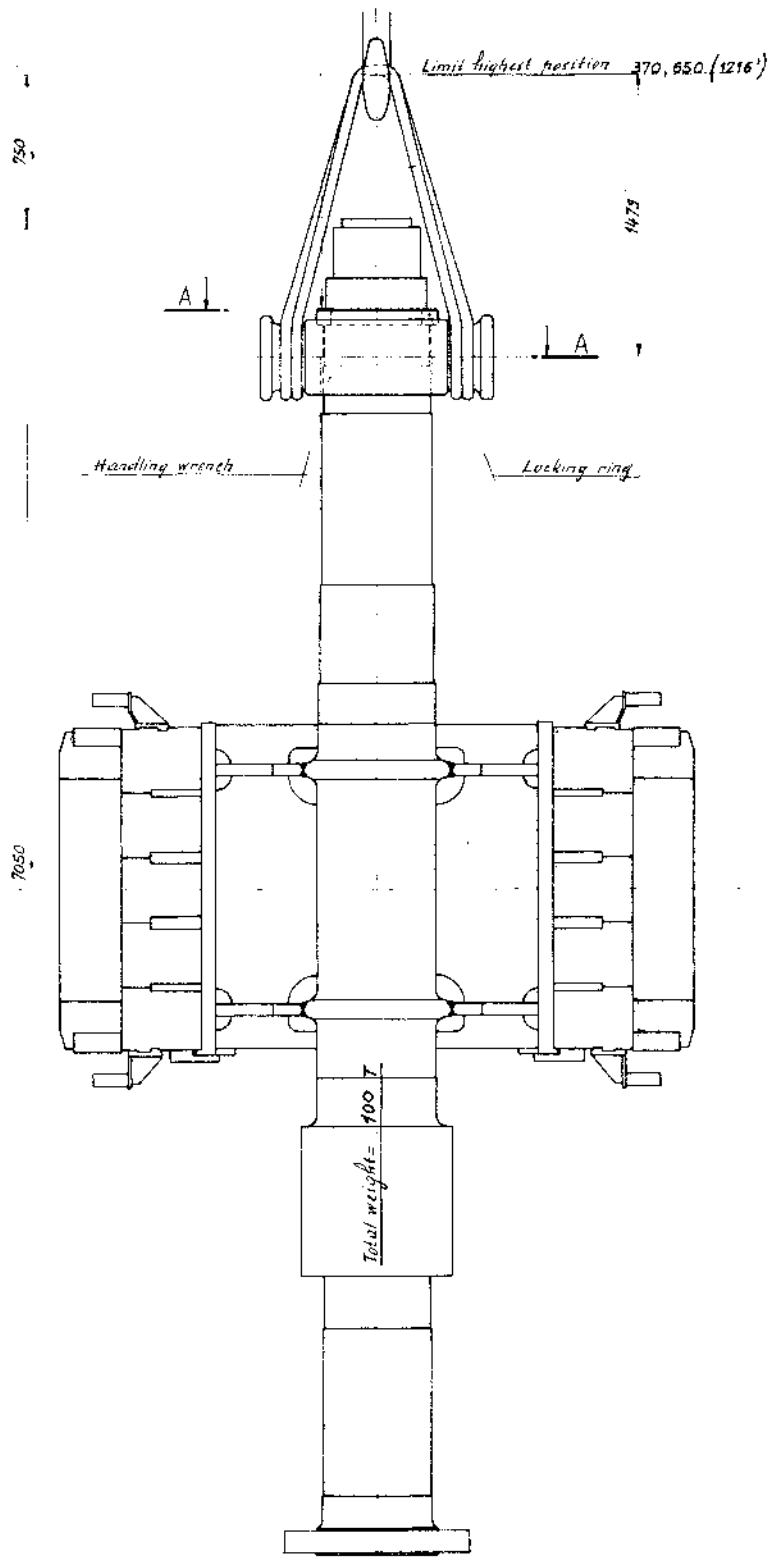
Modifications

Cross-section AA



Place between shaft and handling wrench 2 copper shims 0,8 mm thickness.

To avoid injuries of the shaft during handling place between shaft and locking ring, copper shims 1 mm thickness.



N° 35-181829.

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

Rotor handling

Manutention du rotor.

Dessiné	Vérifié	Vu	Remplace...	Remplacé par...	Consulter date...
Dress 9-3-67			N° de classement		
Raspiller	Vérifié				

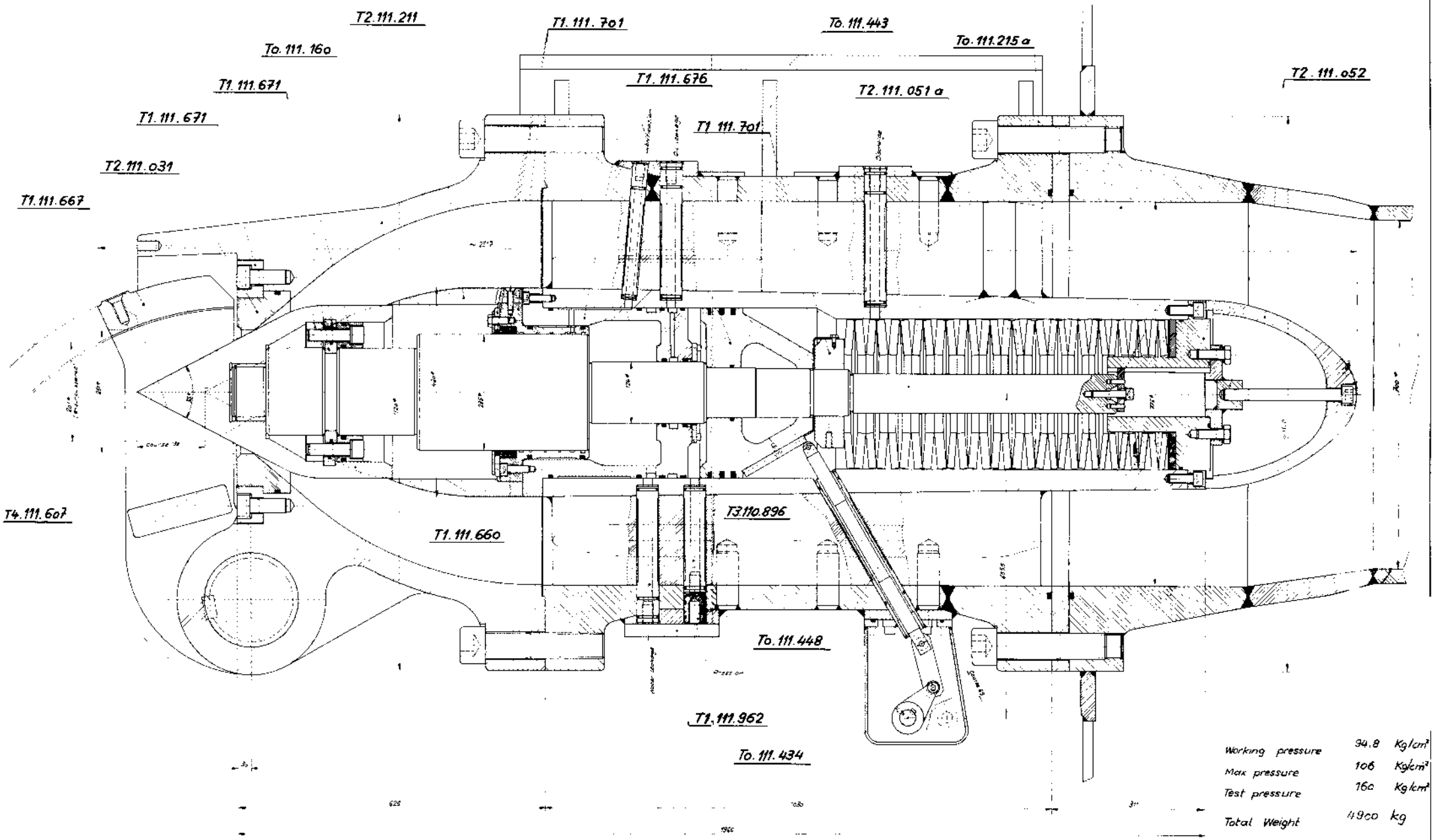
BVV-422-147

A4 | 2 | 2

ALSTHOM — BELFORT

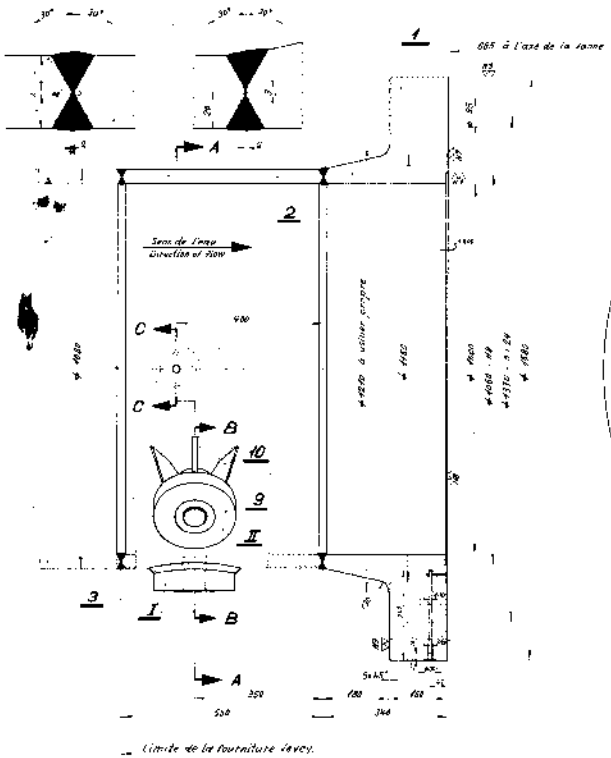
N° 35-181829 bis

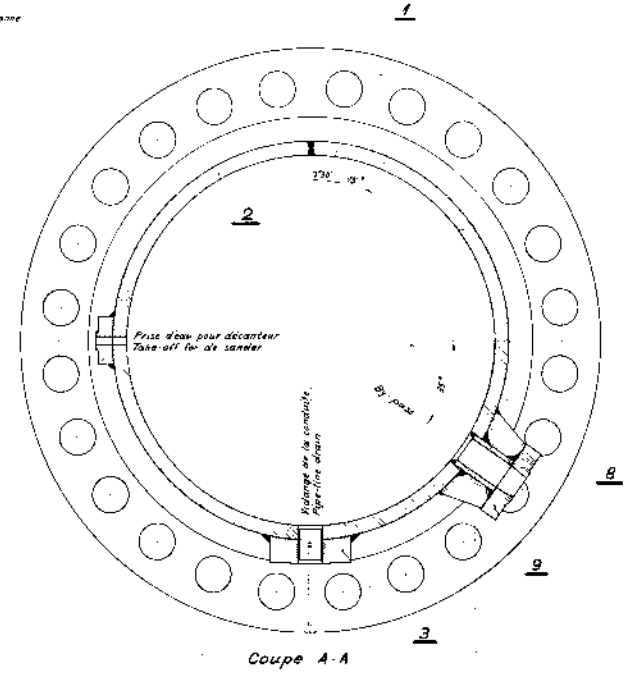
N° 35 - 181829 bis



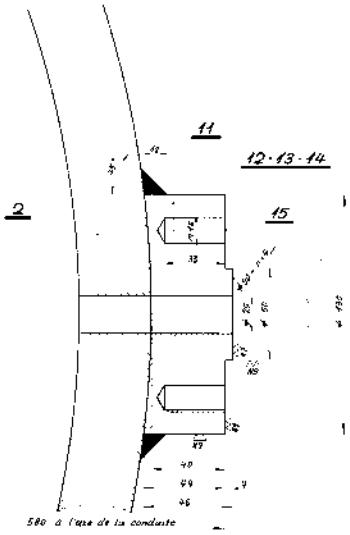
Injector Assembly

To.111.353

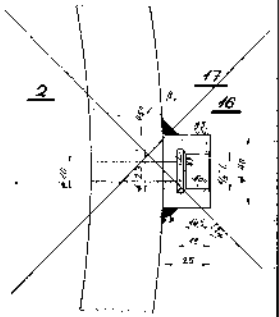




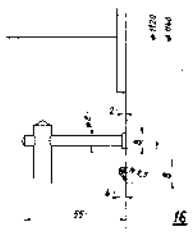
Coupe A-A

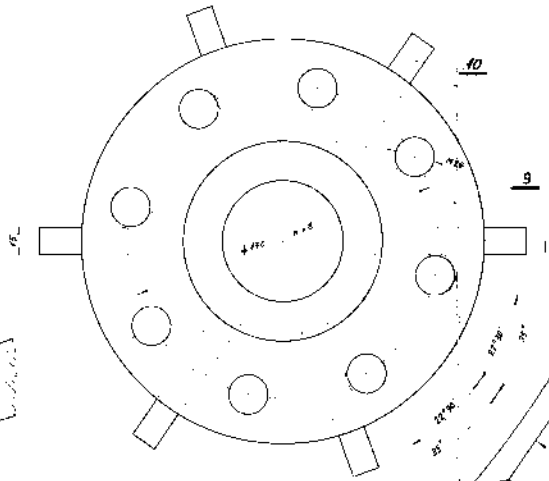


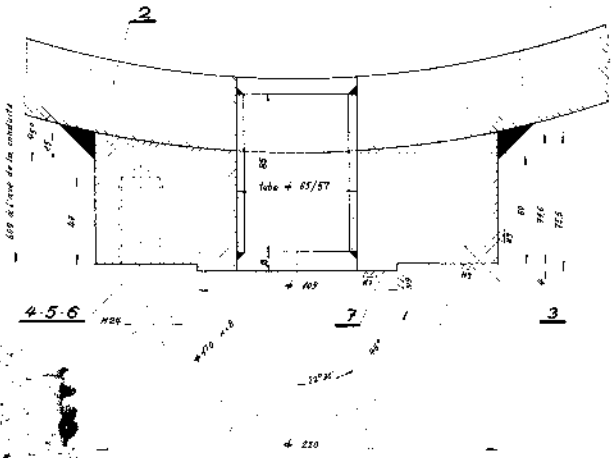
Coupe C-C



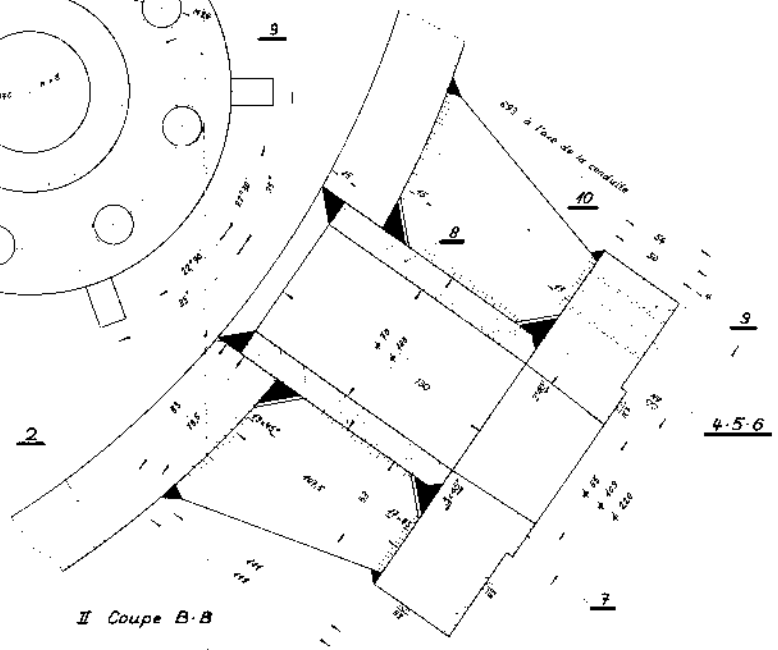
Coupe D-D







I Coupe B-B



II Coupe B-B

Poids total 2420 kg

Rep.	Nbre	Désignation	Matière	Poids
1	1	Joint plat en mousse 4x 6 ep 25		
1	1	Joint rond ϕ 5 x lg. 3800	19608	
1	1	Joint plat ϕ 21/50 x 0,5	Perbunan	
	4	Ecrou 6 pc. M 16 - 8.8d	4.381	
	4	Rondelle ressort ϕ 17/27 x 2,5	4.1532	
	4	Goujon M16 x 45 x 21 x 35	4.8 G	
	1	Boisage ϕ 80/490 x 98	4.372	
	1	Nervure 85 x 15 x 915	4.361	
	1	Bride ϕ 65/200 x 5k	4.372	
	1	Tube ϕ 70/100 x 150	4.3125	
2	2	Joint plat ϕ 66/105 x 0,75	Perbunan	
16	1	Ecrou 6 pc. M 20 - 8.8d	4.381	
16	1	Rondelle ressort ϕ 25/37 x 4	4.1532	
16	1	Goujon M24 x 62 x 32 x 46	4.8 G	
4	1	Boisage ϕ 86/130 x 215,5	4.372	
4	1	Cylindre 600 x 140 x 2388	4.372	
4	1	Bride ϕ 400/580 x 36	4.372	

Joints de rép. 69350/351
Rondelles caoutch. 69385 / 386

Vanne sphérique ϕ 4100 H 998 mm
Bride amont avec bout de tuyau
Upstream flange with pipe end

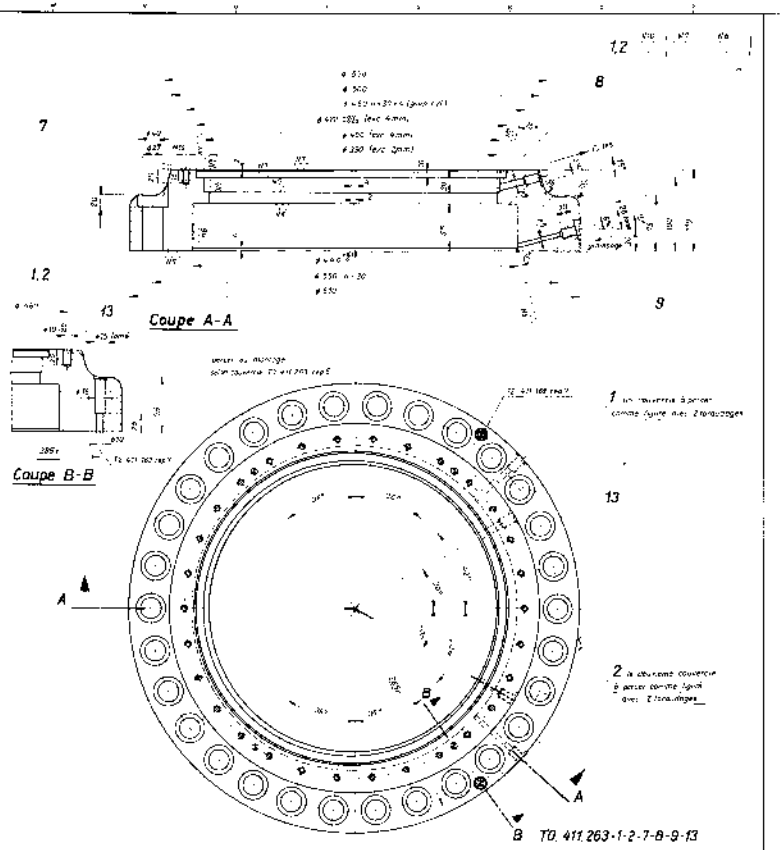
Echelle 1:5 / 1:1

30

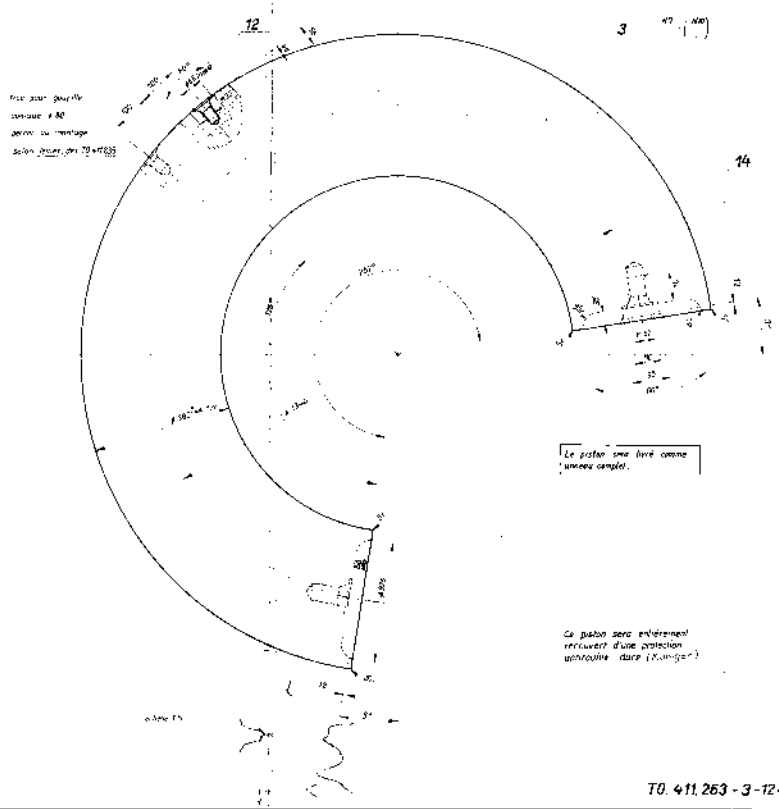
VEVEY

Ateliers de Constructions Mécaniques de Vevey SA

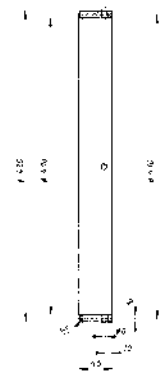
T0.411.320



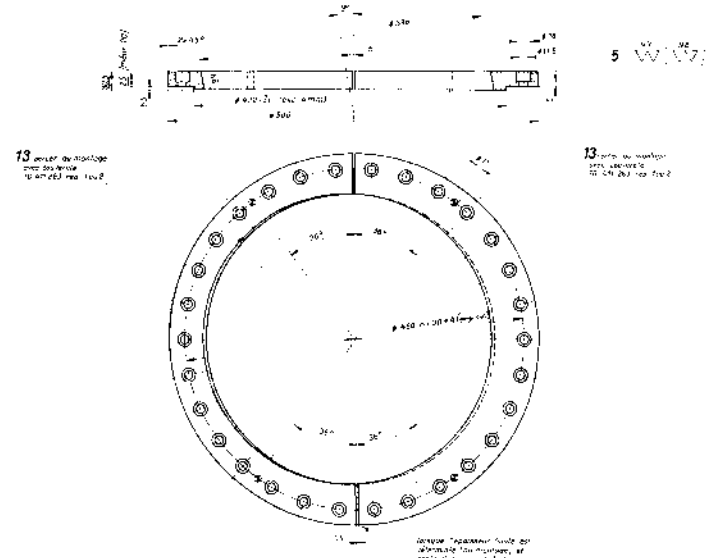
TO. 411.263-1-2-7-8-9-13



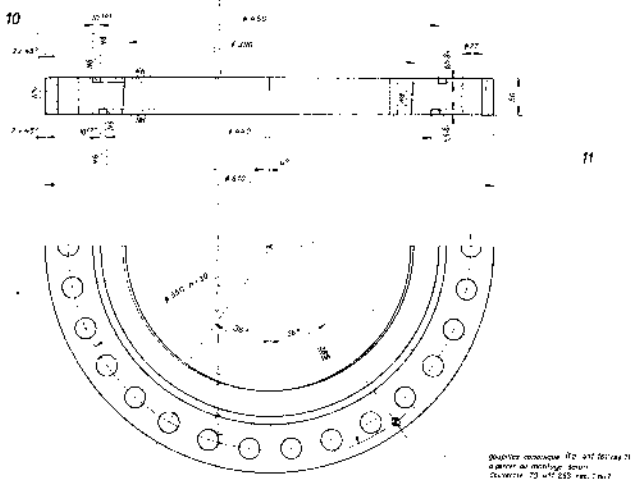
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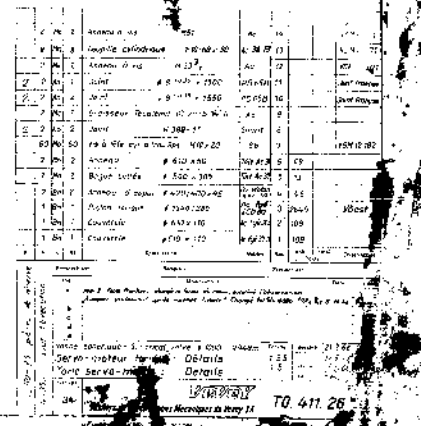
TO. 411.263 - 4



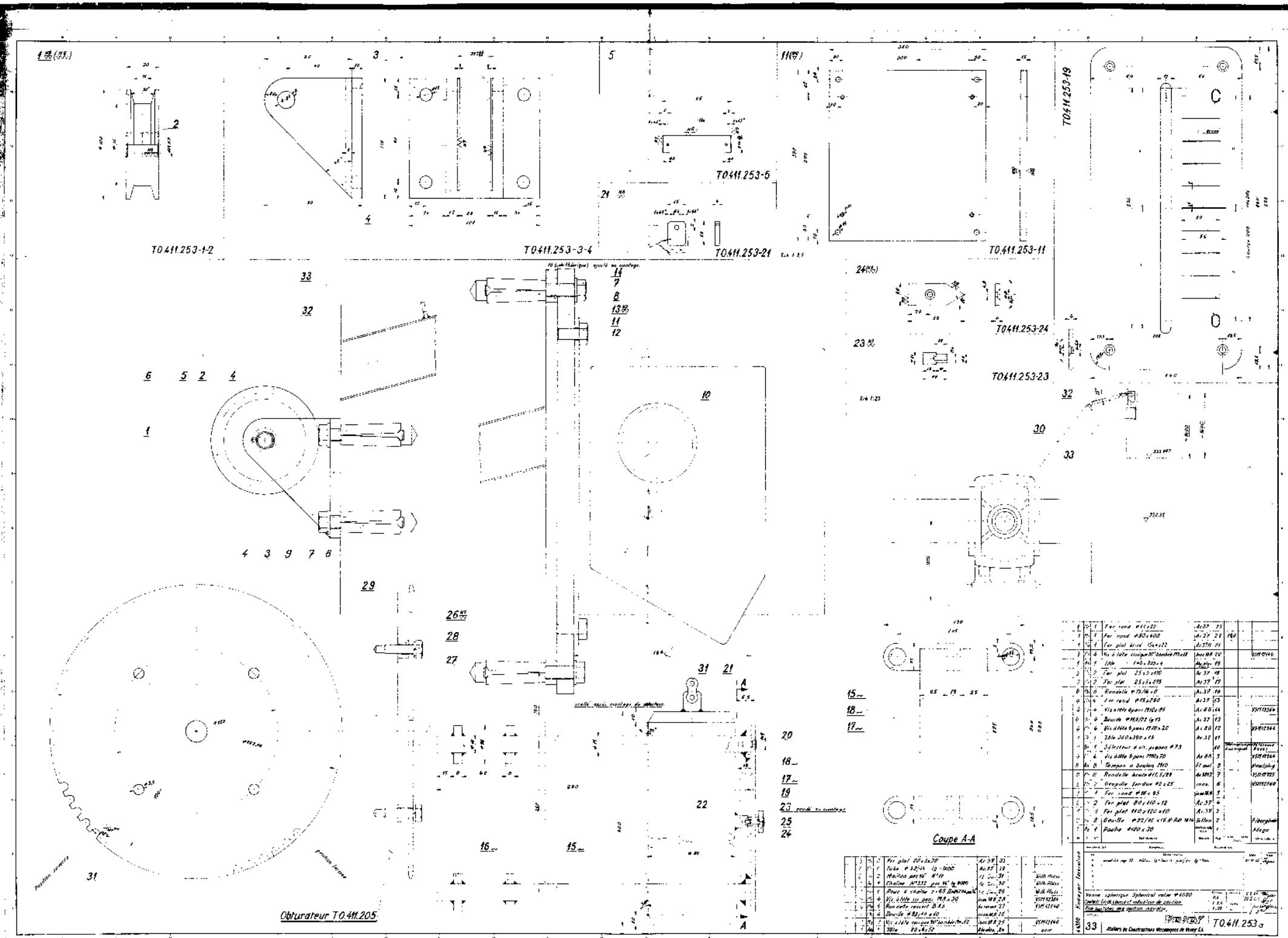
TO. 411.263 - 5

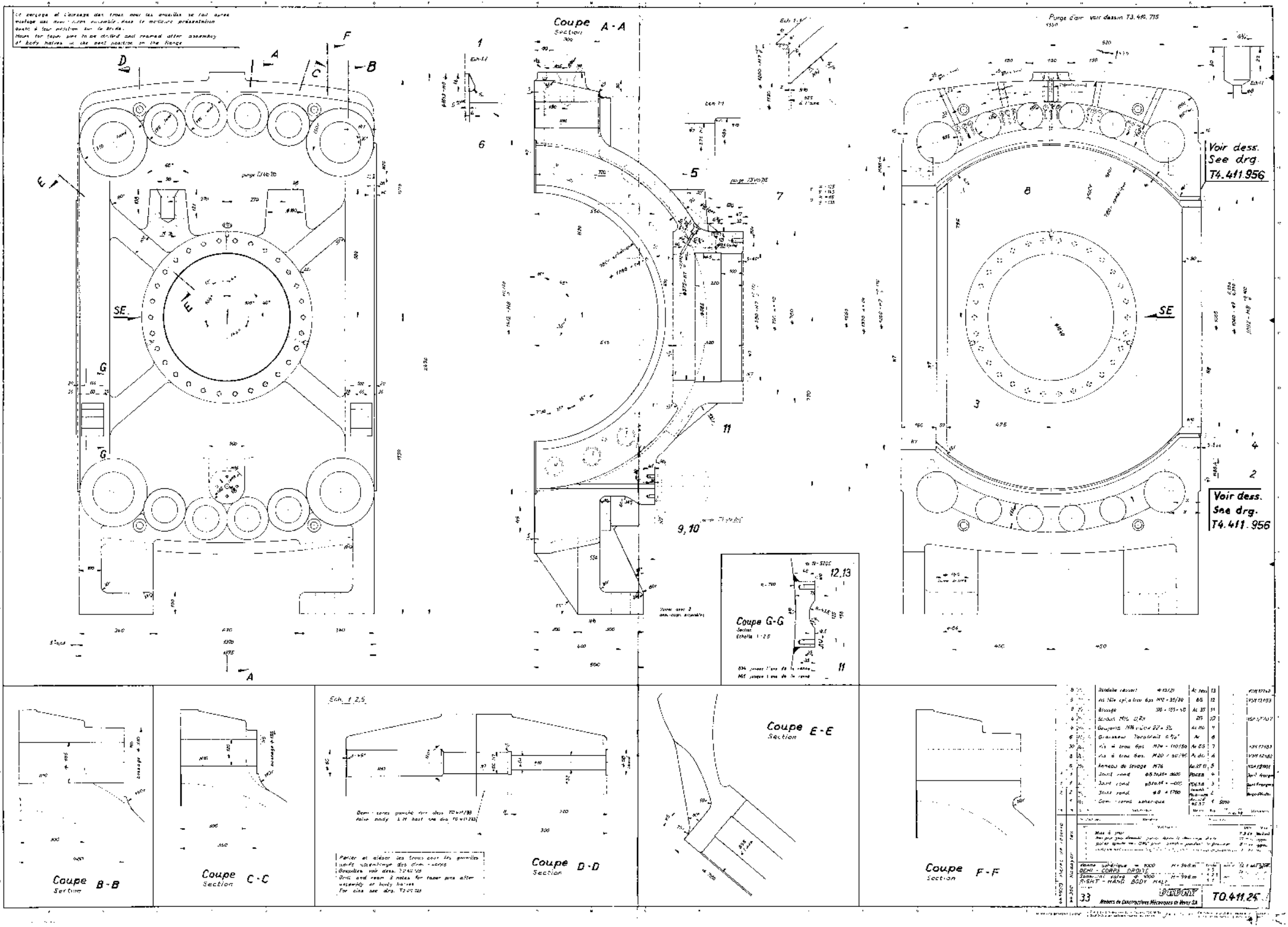


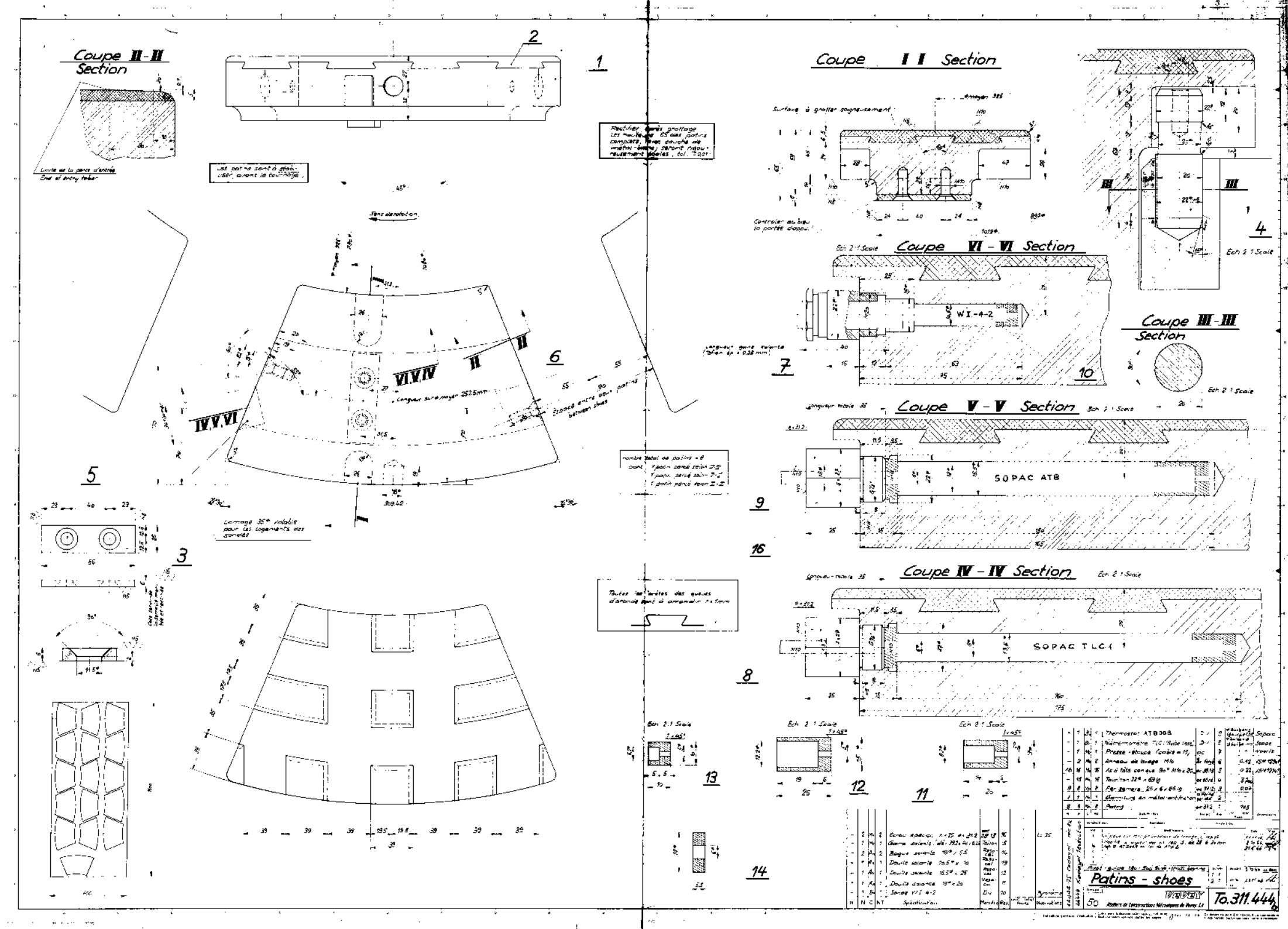
TO. 411.263-6-10-11

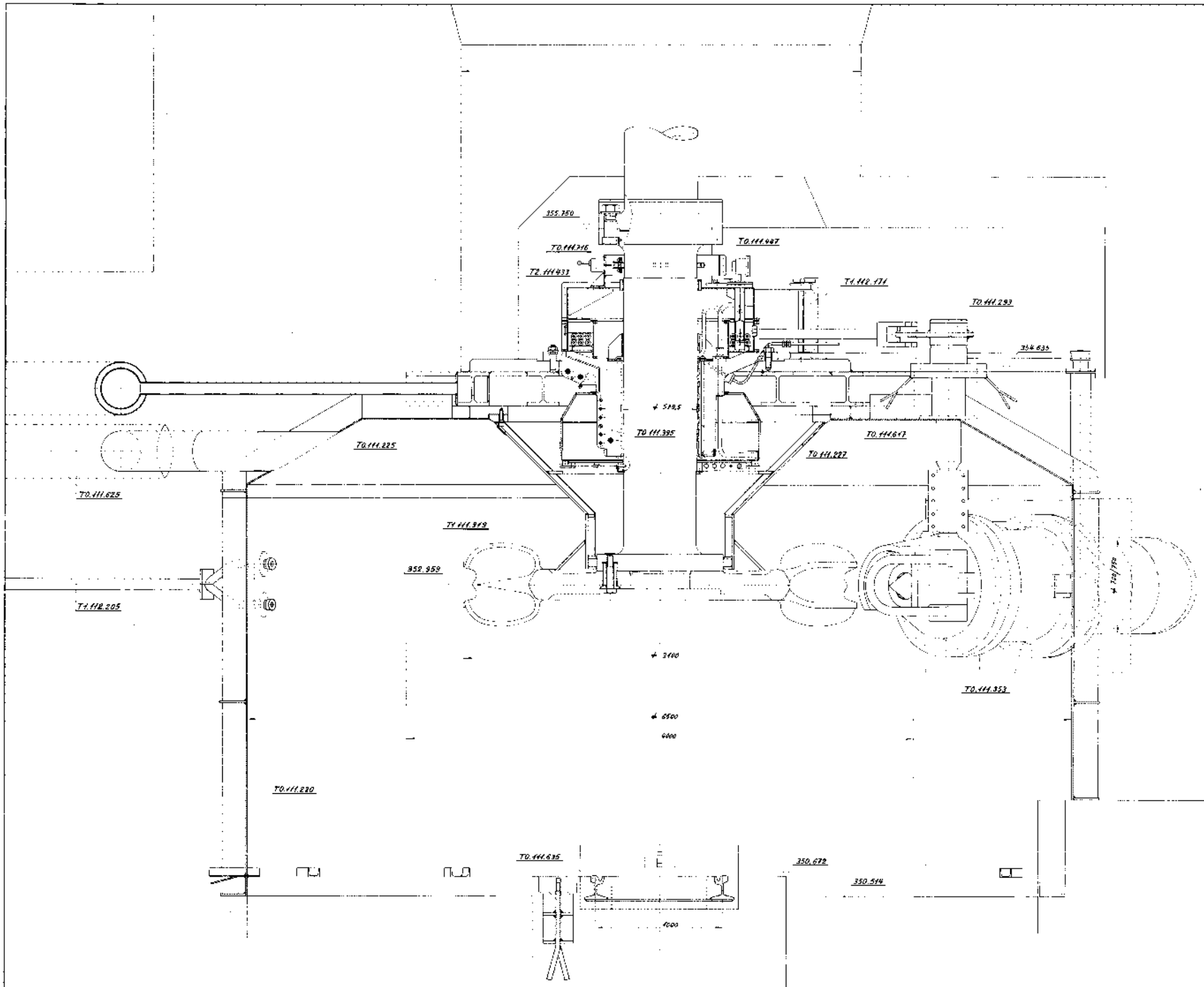


TO. 411.26


T0411.253-1-2
T0411.253-3-4
T0411.253-5
T0411.253-21
T0411.253-11
T0411.253-24
T0411.253-23
T0411.253-19
Coupe A-A
Obturateur T0411.205
T0411.253a


Coupe A-A
Section
Coupe G-G
Section
Échelle 1:2,5
Coupe B-B
Section
Coupe C-C
Section
Coupe D-D
Section
Coupe E-E
Section
Coupe F-F
Section
Voir dess.
See drg.
T4.411.956
Voir dess.
See drg.
T4.411.956
Purge d'air voir dessin T3.449.715
SE
SE
33
T0.411.24


Coupe II-II
Section
Limite de la zone d'entrée
End of entry taper
1
2
Rectifier après grattage. Les faces des 65 des patins comportent une couche de métal blanc, servant réparti uniformément, épaisseur 0,02 mm
Surface à gratter soigneusement
Coupe I I Section
Ø maxi 325
Ø mini
Contrôler au bleu la portée d'appui
Ø 319 +0,1
Ø 319,4
III
III
4
Ech 2 : 1 Scale
Coupe VI - VI Section
Ech 2 : 1 Scale
WI-4-2
7
10
Coupe III-III
Section
Ech 2 : 1 Scale
Sens d'enroulement
Ø maxi 325
Ø 319,4
VI.V.IV
II
II
IV.V.VI
Longueur sur moyen 252,5 mm
Ecartement entre patins
between shoes
6
7
Serrage 35° valable pour les logements des sondes
nombre total de patins = 8
dont : 1 patin carré selon 2-2
1 patin carré selon 3-3
1 patin percé selon 2-2
Coupe V - V Section
Ech 2 : 1 Scale
Longueur totale 35
9
16
50 PAC ATB
5
3
Coupe IV - IV Section
Ech 2 : 1 Scale
Longueur totale 35
Toutes les arêtes des queues d'aronde sont à arrondir R 1 mm
8
50 PAC TLC 4 1
Ech 2 : 1 Scale
Ech 2 : 1 Scale
Ech 2 : 1 Scale
12
11
13
14
Patins - shoes
To.311.444
50



CENTRALE de KODAYAR

Ensemble d'une turbine Pelton verticale

Caractéristiques

Puissance	88130 Ch.
Chute	948 m.
Vitesse	500 t/min.
Débit	7800 l/s.

KODAYAR POWER STATION

Assembly drawing of vertical Pelton turbine

Characteristics

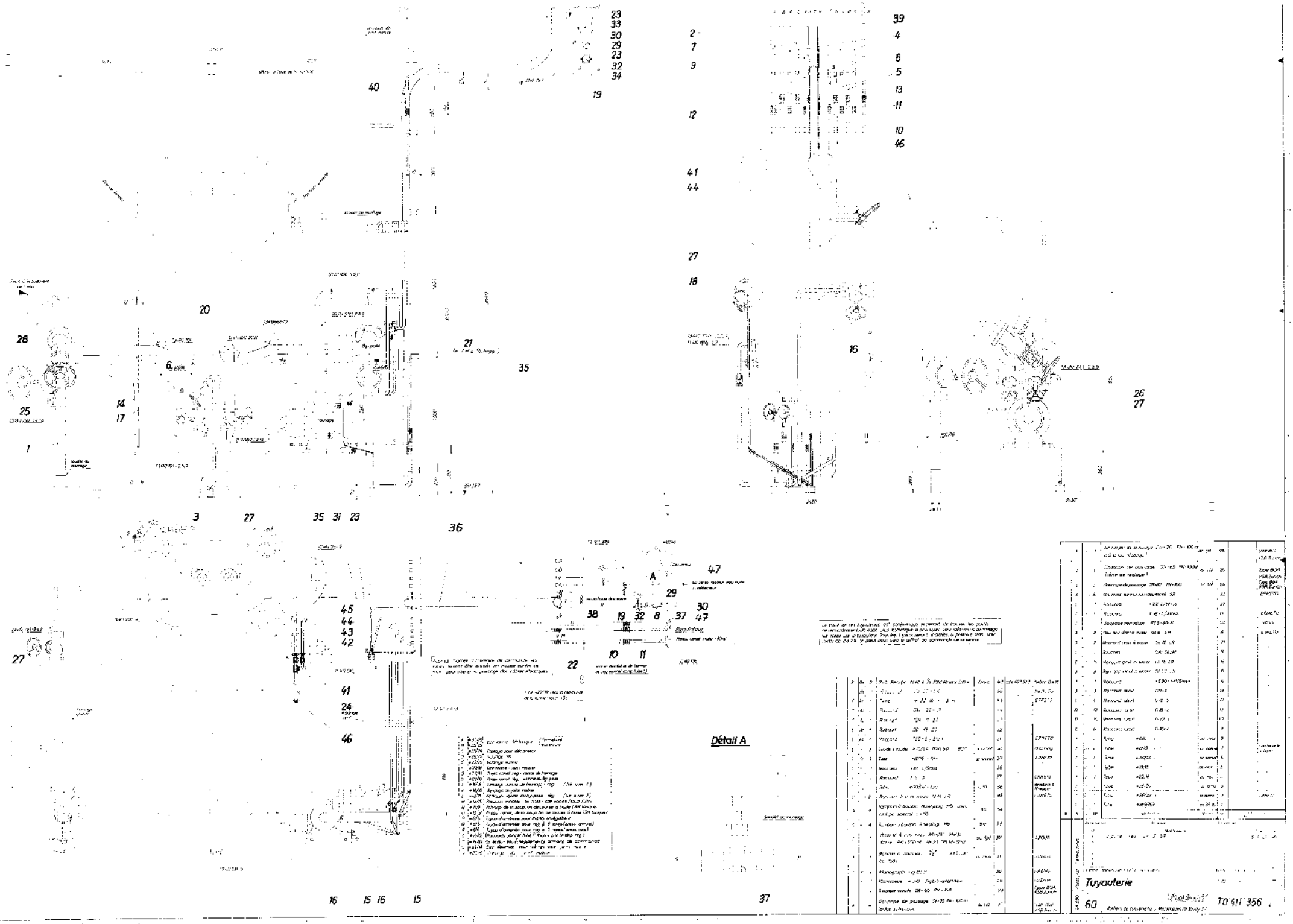
Output	88130 B.H.P
Head	948 m.
Speed	500 r.p.m
Discharge	7800 litres/sec.

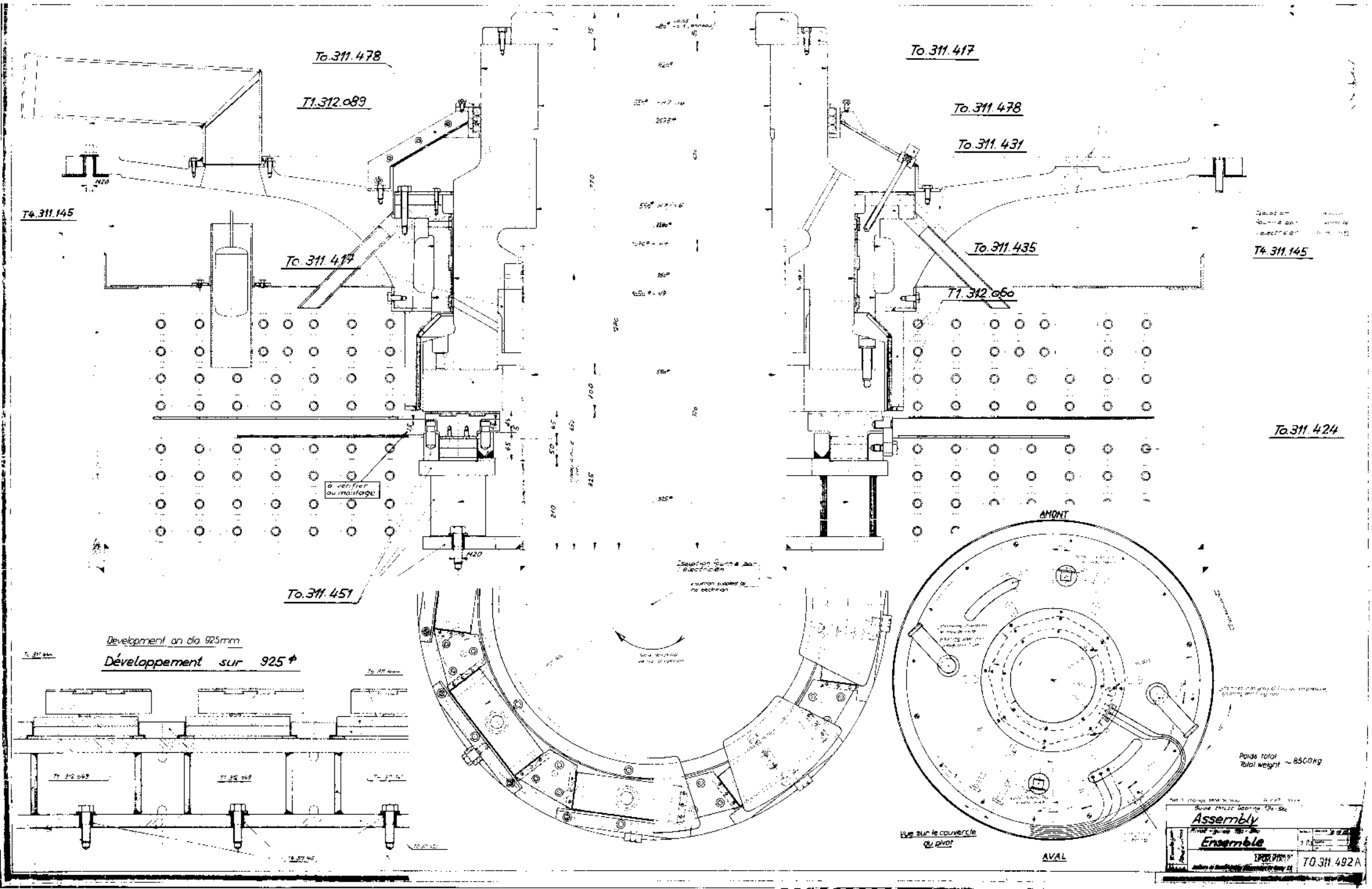
Kodayar Hydro

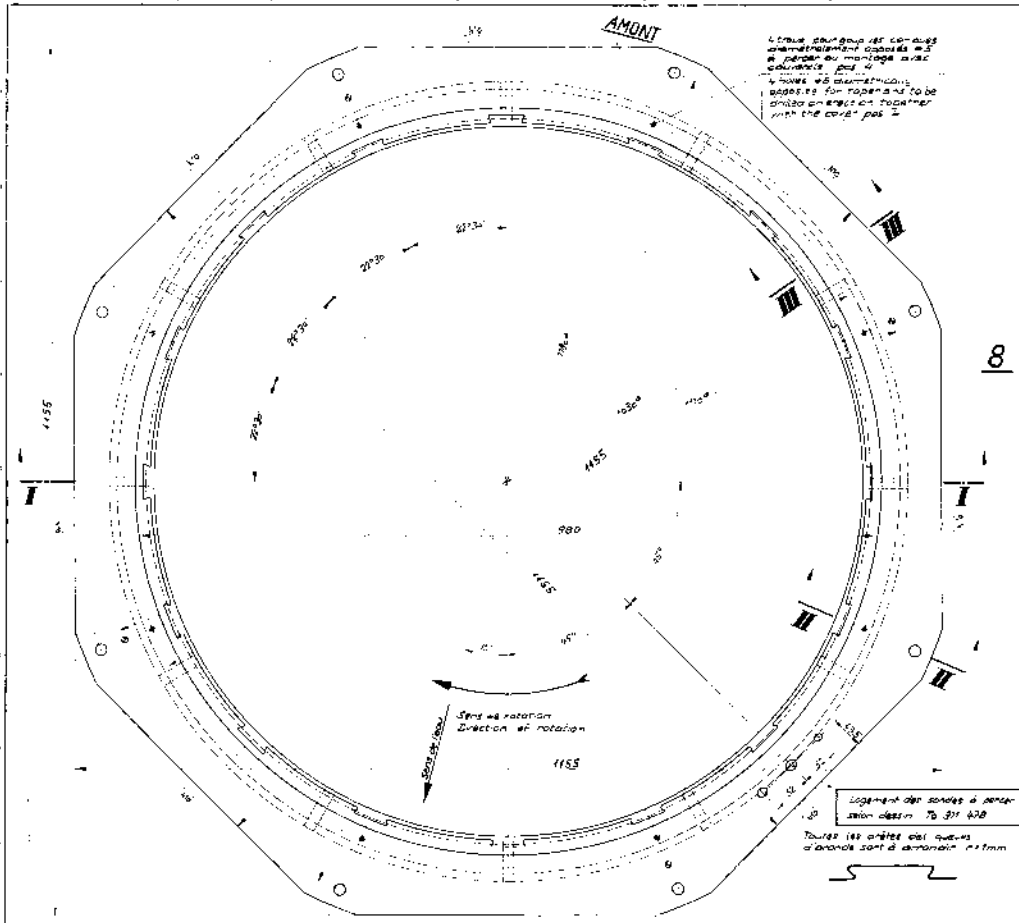
Turbine Pelton 4 jets — 88130 / 948 / 500 — 1.6.64 TdG

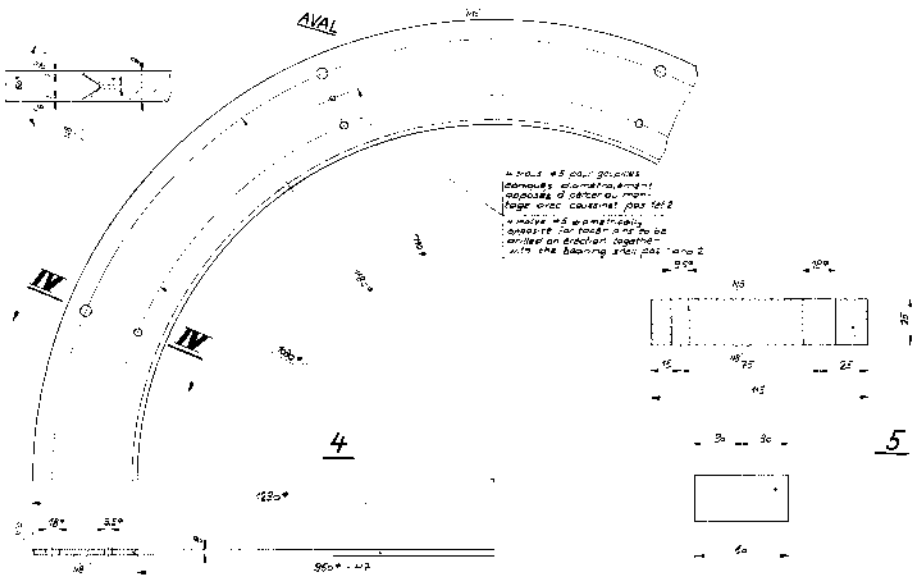
Ensemble de la turbine — Assembly drawing of turbine — 1-10

VEVEY — Ateliers de Constructions Mécaniques de Vevey S.A. — T0.111.574

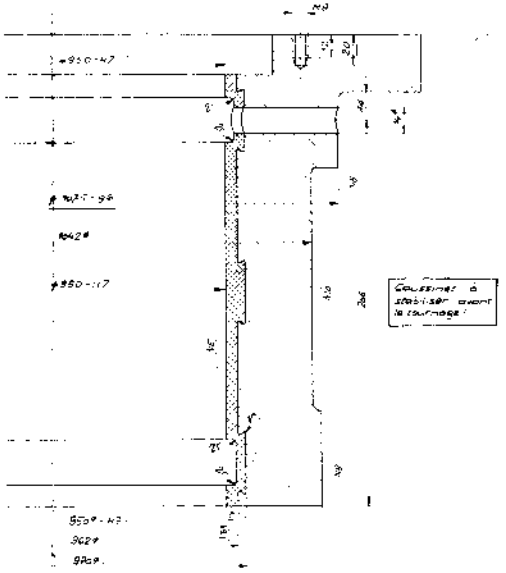

Détail A
Tuyauterie
60
TO 411 356

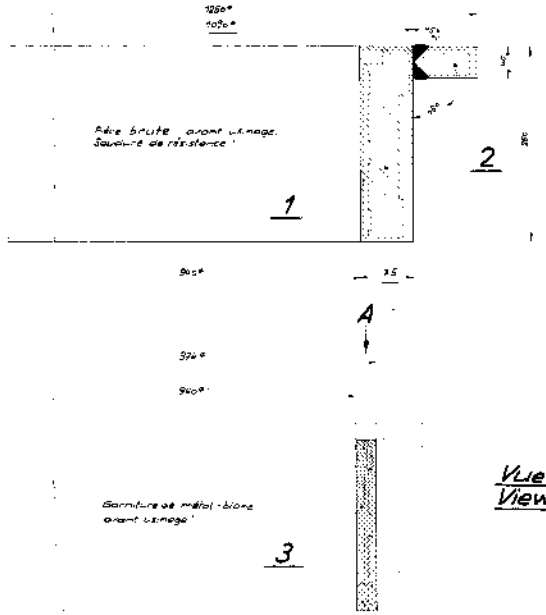

To.311.478
T1.312.089
T4.311.145
To.311.417
To.311.451
To.311.417
To.311.478
To.311.431
To.311.435
T1.312.060
T4.311.145
To.311.424
à vérifier au montage
AMONT
AVAL
Vue sur le couvercle du pivot
Développement sur 925 ϕ
Development on dia. 925mm
Poids total
Total weight ~ 850kg
Assemblage
Assembly
Ensemble
T0.311.492A

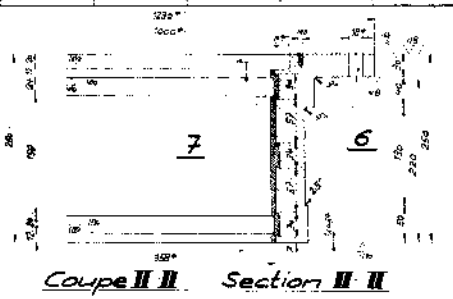




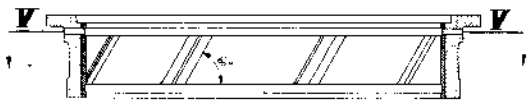
Coupe IV-IV Section IV-IV



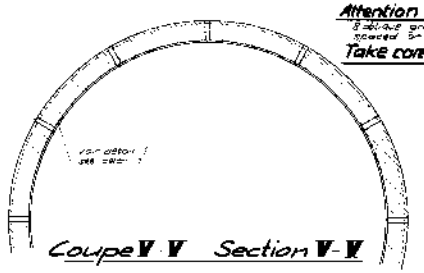




Coupe II II Section II-II



Coupe I-I Section I-I



Coupe V-V Section V-V

Attention à l'orientation
Take care with orientation



Détail 1
Detail 1



Vue de A
View from A

				Goupilles coniques m5 x 45					
				Vis à tête 6 pan us M12 x 45 x 20					
				Vis à tête 6 pan us M16 x 65 x 35					
				Pion plat 60 x 25 x 15					
				Coussinet 123b° / 95b° - 8					
				Garniture de métal-antifriction					
				Anneau 125b° x 109b° x 40					
				Anneau 76b° x 94b° x 25a					

Bearing shell
Coussinet
To.311.435b

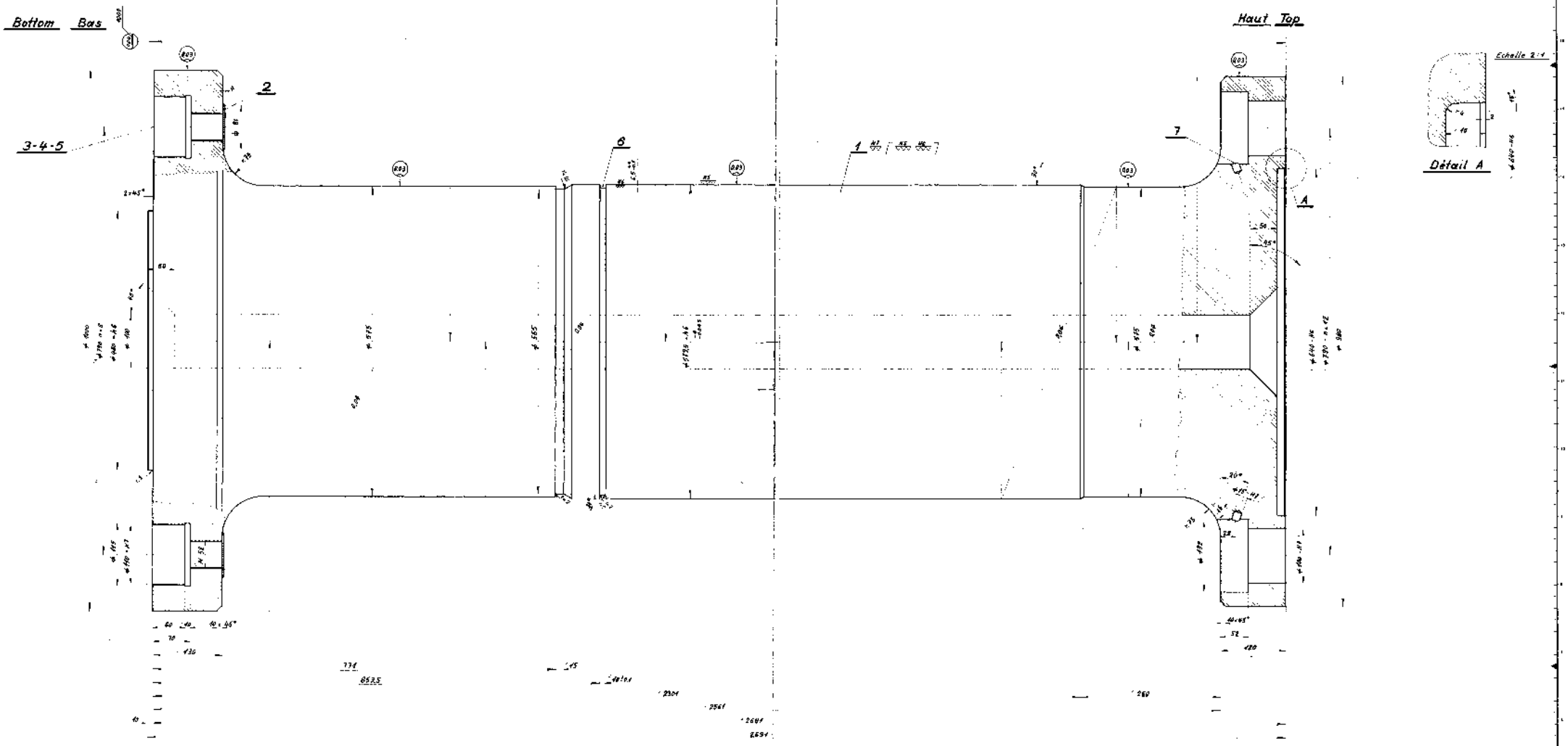
Bottom Bas

Haut Top

3-4-5

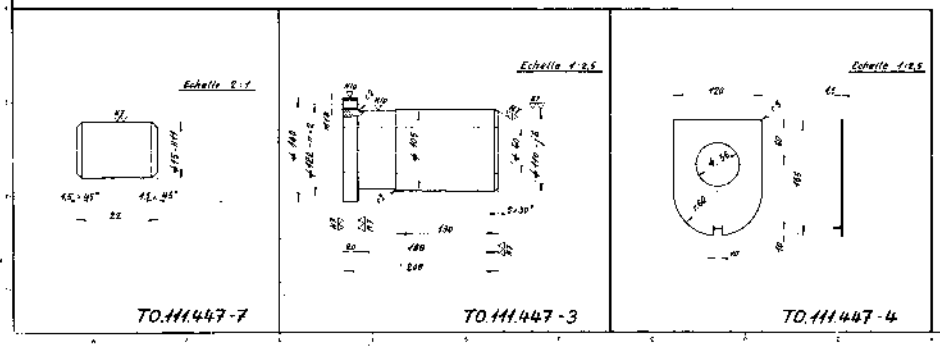
Détail A

Echelle 2:1



Poids total 6545 kg.

Les deux gabarits de perçage ⌀790 n=8. ⌀790 n=12 sont fournis par Vevey.



TO.111.447-7 TO.111.447-3 TO.111.447-4

Turbine FV 88000/900/5po
Arbre de la turbine
Turbine shaft

02

VEVEY

Ateliers de Constructions Mécaniques de Vevey SA

TO.111.447 c

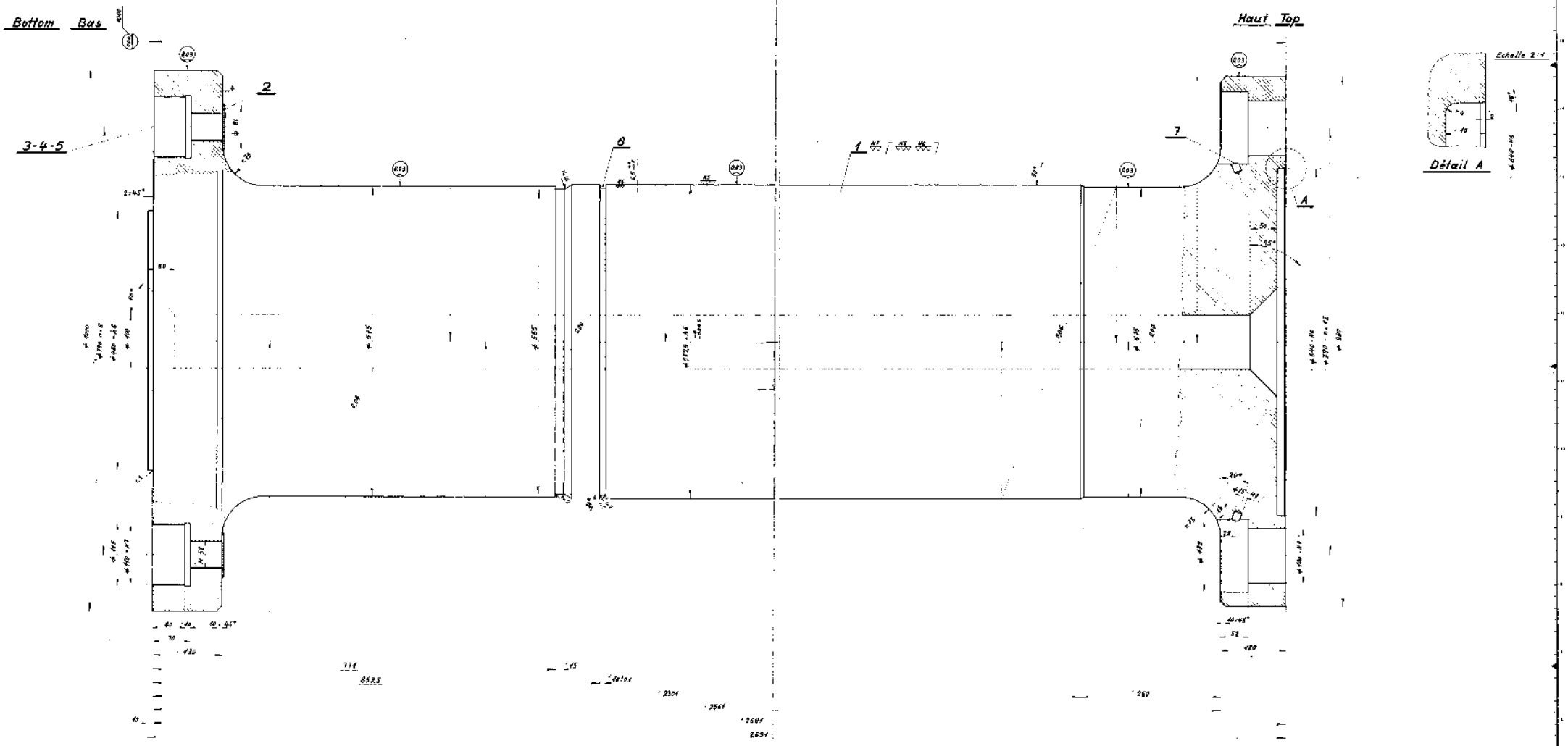
Bottom Bas

Haut Top

3-4-5

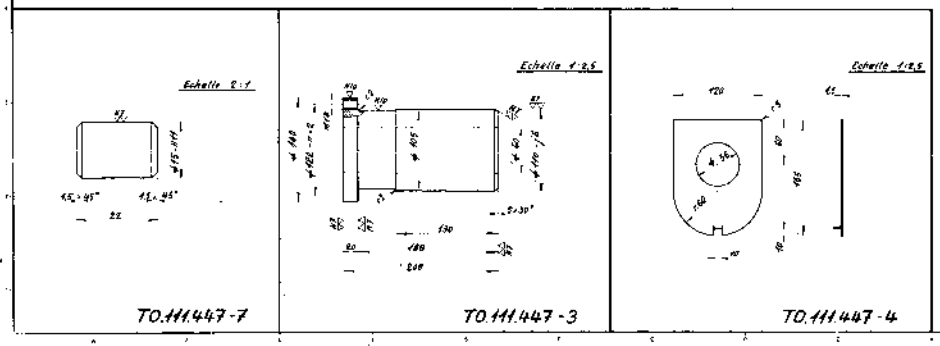
Détail A

Echelle 2:1



Poids total 6545 kg.

Les deux gabarits de perçage ⌀790 n=8. ⌀790 n=12 sont fournis par Vevey.



TO.111.447-7 TO.111.447-3 TO.111.447-4

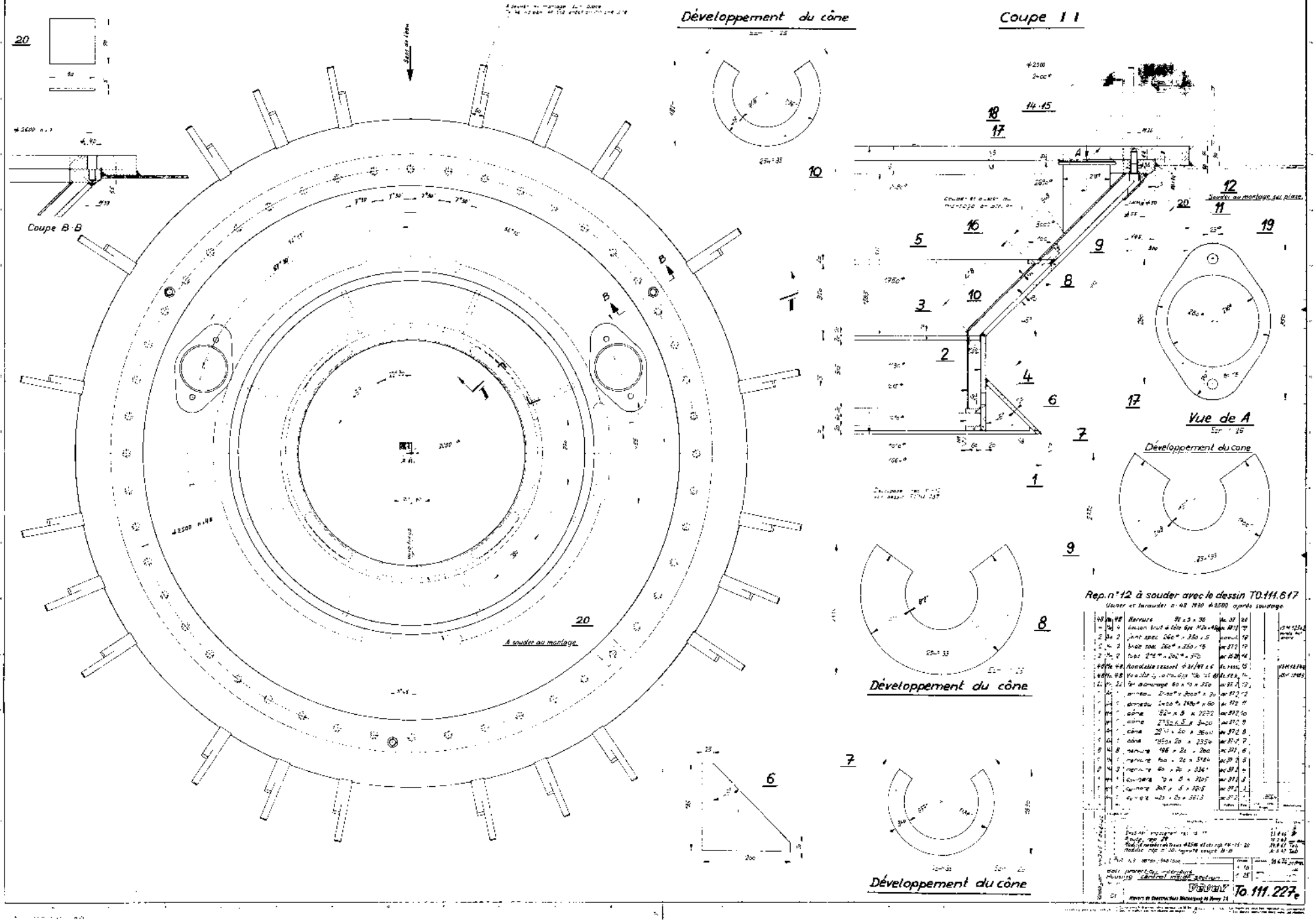
Turbine FV 88000/900/5po
Arbre de la turbine
Turbine shaft

02

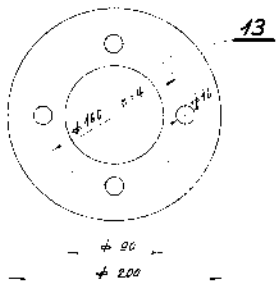
VEVEY

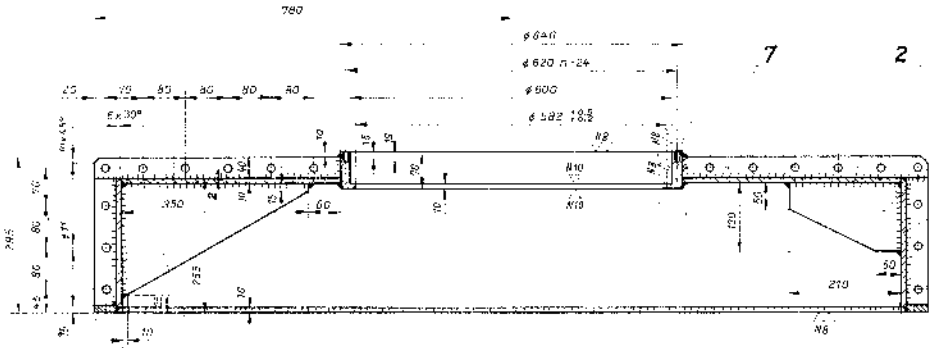
Ateliers de Constructions Mécaniques de Vevey SA

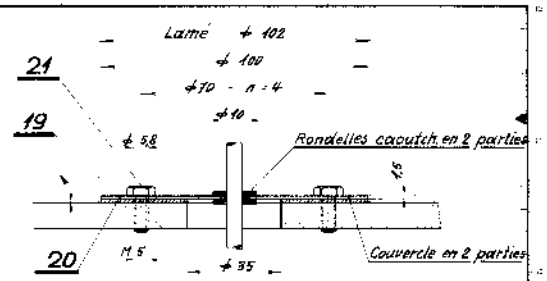
TO.111.447 c


Développement du cône
Coupe 11
Coupe B-B
Vue de A
Développement du cône
Développement du cône
Développement du cône
A souder au montage.
Rep. n°12 à souder avec le dessin T0.111.617
T0.111.227e

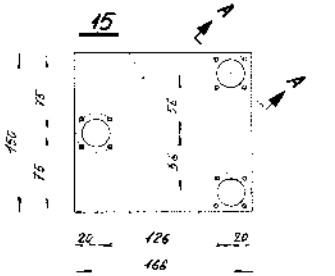
Echelle 1:2,5 Ep : 1

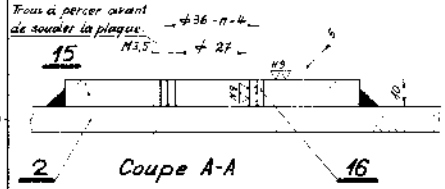




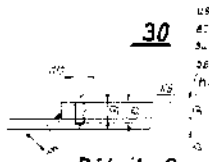


Détail B



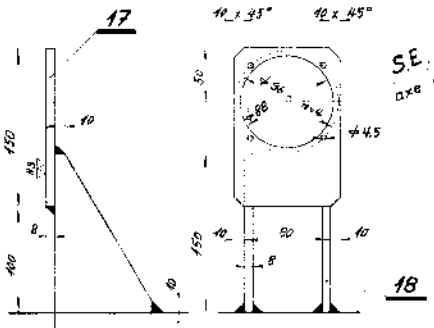


Coupe A-A

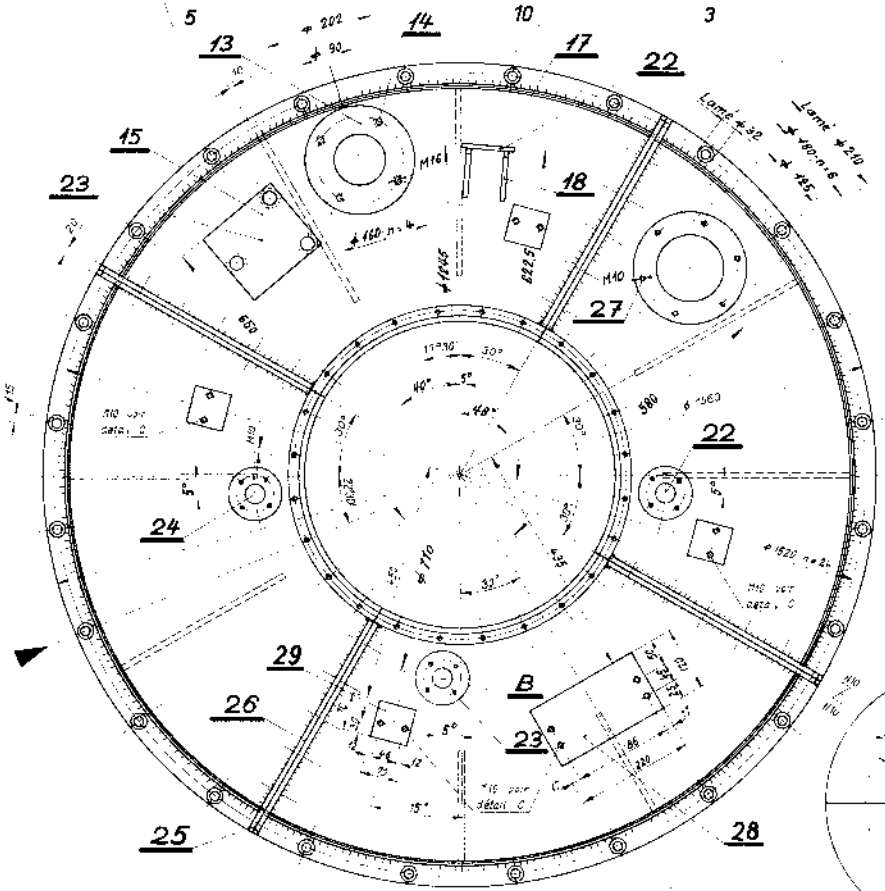


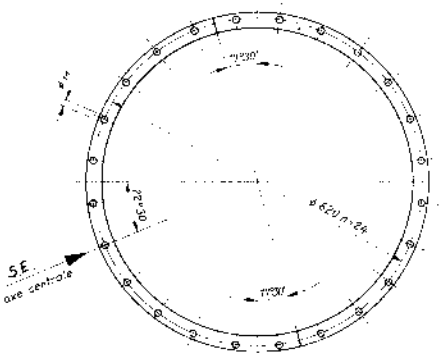
Usiner les rainures rep 28 et 31 soudés sur joints sur le couvercle et cuve. Percer avec dess 71 112 335 (ne pas traverser)

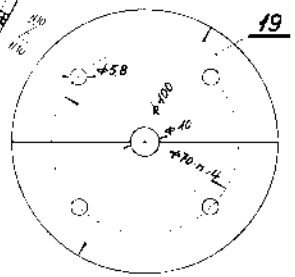
Détail C



S.E. axe centrale







			12	Ho 12	Vis à tête 6 pans	M5 - 12	Ac. 8 G	21							VSM 12362
			3	Mn 3	Joint plat	ϕ 100/35 x 1	Permanit	20							
			3	Mn 3	Couvercle en 2 parties	ϕ 100/10 x 15	Ac. 37	19							
			2	Mn 2	Nervure	90 x 8 x 150	Ac. 37	16							
			1	Mn 1	Plaque	100 x 8 x 150	Ac. 37	17							
			12	Ho 12	Vis à tête 6 pans	M 3,5 x 12	Ac. 8 G	16							VSM 12363
			1	Mn 1	Plaque	150 x 10 x 166	Ac. 37	15							
			4	Ho 4	Vis à tête 6 pans	M 16 - 60/35	Ac. 8 G	14							VSM 12366
			2	Mn 2	Joint plat	ϕ 200/90 x 1	Permanit	13							
		36	Ho	36	Ecrou 6 pans us	M 10 x 0,8 G	ac. 38 13	12							VSM 12709
		36	Ho	36	Vis à tête 6 pans us	M 10 x 30/25	ac. 86	11							VSM 12366
		1	Mn	1	Joint	ϕ 10 x 11,2 m	cord. sym	10							Afag dur
		24	Ho	24	Vis à tête à cyl. à trou 6p	M 10 x 25	ac. 8 G	9							VSM 12 193
		1	Ho	1	Couvercle en 2 pièces	ϕ 640/582 x 6	ac. 37.11	8	4						
		1	Ho	1	Bride	40 x 10 x 5600	ac. 37.2	7	17.6						
		2	Mn	2	Nervure	210 x 130 x 10	ac. 37.11	6	3.7						
		6	Ho	6	Nervure	350 x 210 x 10	ac. 37.11	5	18						
		1	Mn	1	Anneau en 4 pièces	ϕ 1500 / 1480 x 15	ac. 37.11	4	22.5						
		1	Mn	1	Anneau en 4 pièces	ϕ 640 / 582 x 70	ac. 37.11	3	23						
		1	Mn	1	Couvercle en 4 pièces	ϕ 965/640 x 10	ac. 37	2	106						
		1	Mn	1	Cylindr. en 4 pièces	ϕ 1480/1450 x 245	ac. 37.11	1	89						
N	N	C	NT		Sans Rubrique		Matière	Poids	unit.	total	Observations				

			4	Mn 4	Plaque	70/70 x 15	Ac. 37	29							
			1	Mn 1	Plaque	220/120 x 15	Ac. 37	28							
			6	Ho 6	Vis à tête 6 pans	M10 x 28	Ac. 8 G	27							
			4	Mn 4	Joint plat	50 x 1 x 455	Permanit	26							
			4	Mn 4	Joint plat	50 x 1 x 300	Permanit	25							
			12	Ho 12	Vis 6 pans us	M10 x 25	Ac. 8 G	30							

VSM 12364

			1	Bo 1	Sonde EDF	W1-4-2		24							
			1	Ho 1	Thermostat	AT 62		23							
			1	Bo 1	Téléthermomètre	TL 8		22							

Soparc. Soparc.

Remplace par. Remplacé par. Produit du.

Ind	Modifications	Date	Visa
c	Percé trou rep 28 et 30	27.5.67	

PV 1238 88/500 / 948 / 990

Couvercle cuve sup du palier

Cover for upper bearing reservoir

Groupes 03

VEVEY

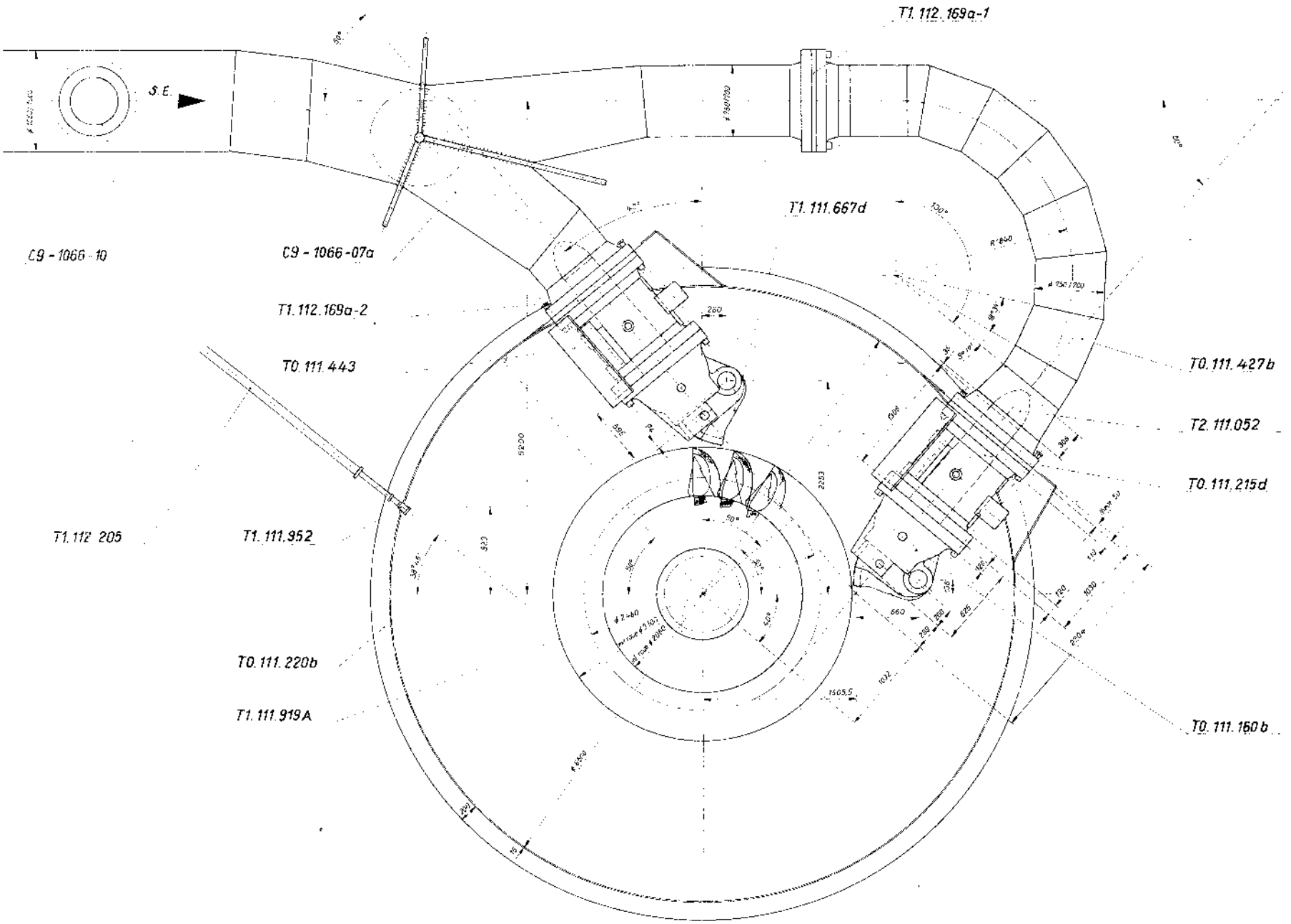
Ateliers de Constructions Mécaniques de Vevey S.A.

T1. 111. 948 a

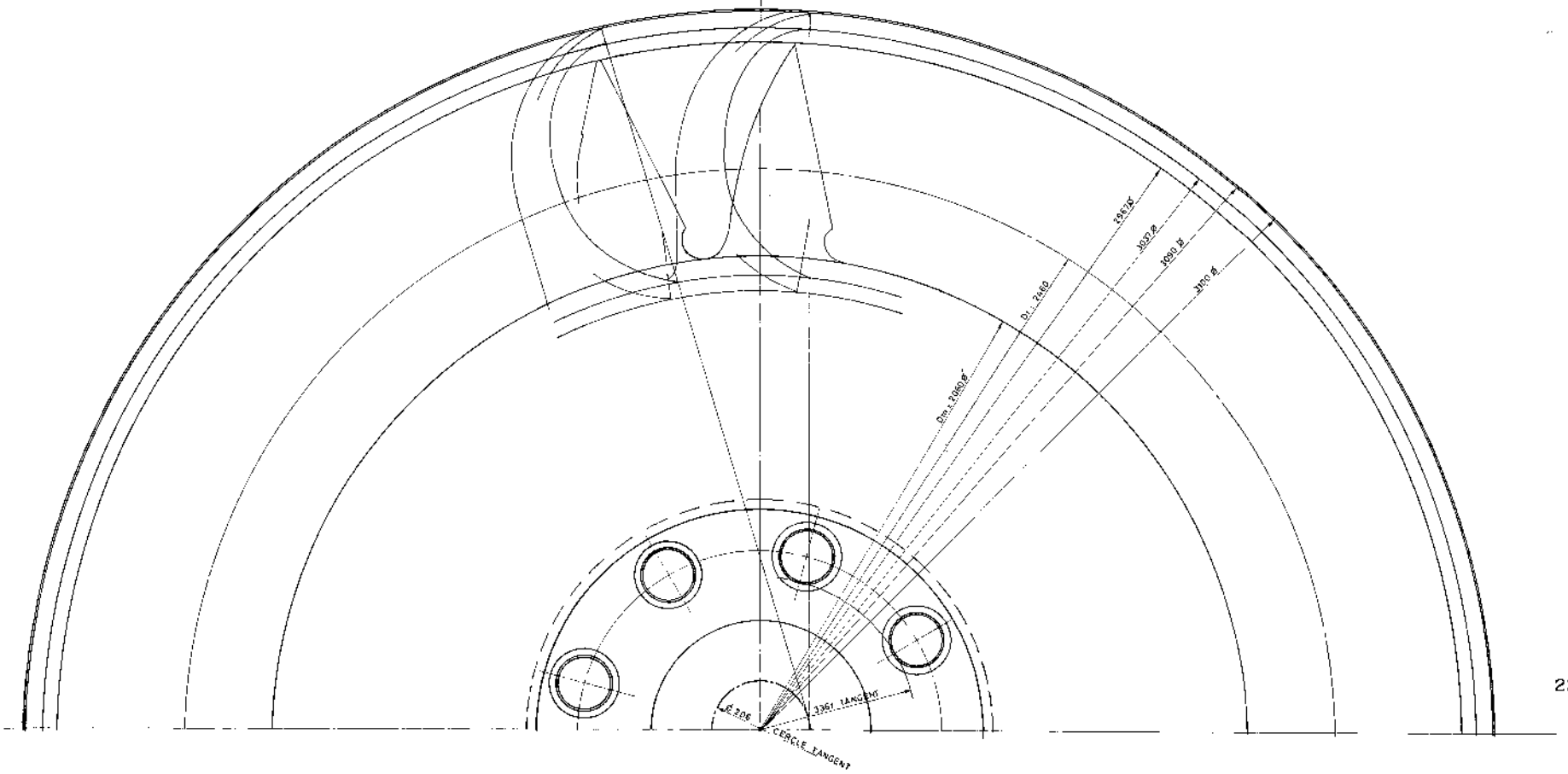
Echelle 1:5 dessiné 16.5.66

Ind. de révision

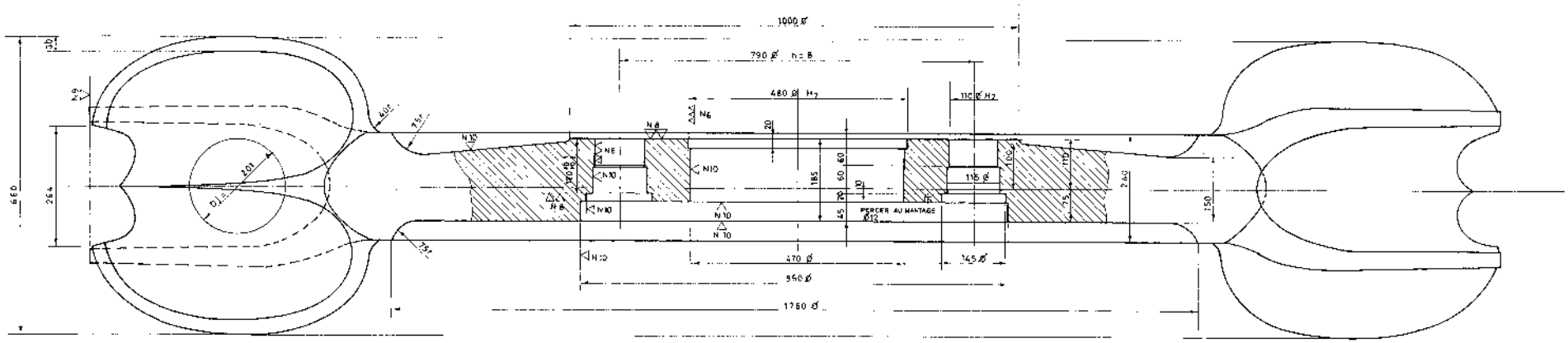
Ce plan ne peut être remis ni communiqué à des tiers sans notre autorisation spéciale écrite



Radoyage 44.3.95 Excavation	Turbine PV 1239 28°00'(948)500	échelle 1:20	17.7.69
	Installation Plan I Plan d'installation I		
	VEVEY Ateliers de Constructions Mécaniques de Vevey S.A.		T1.112.333



22 BUCKETS.

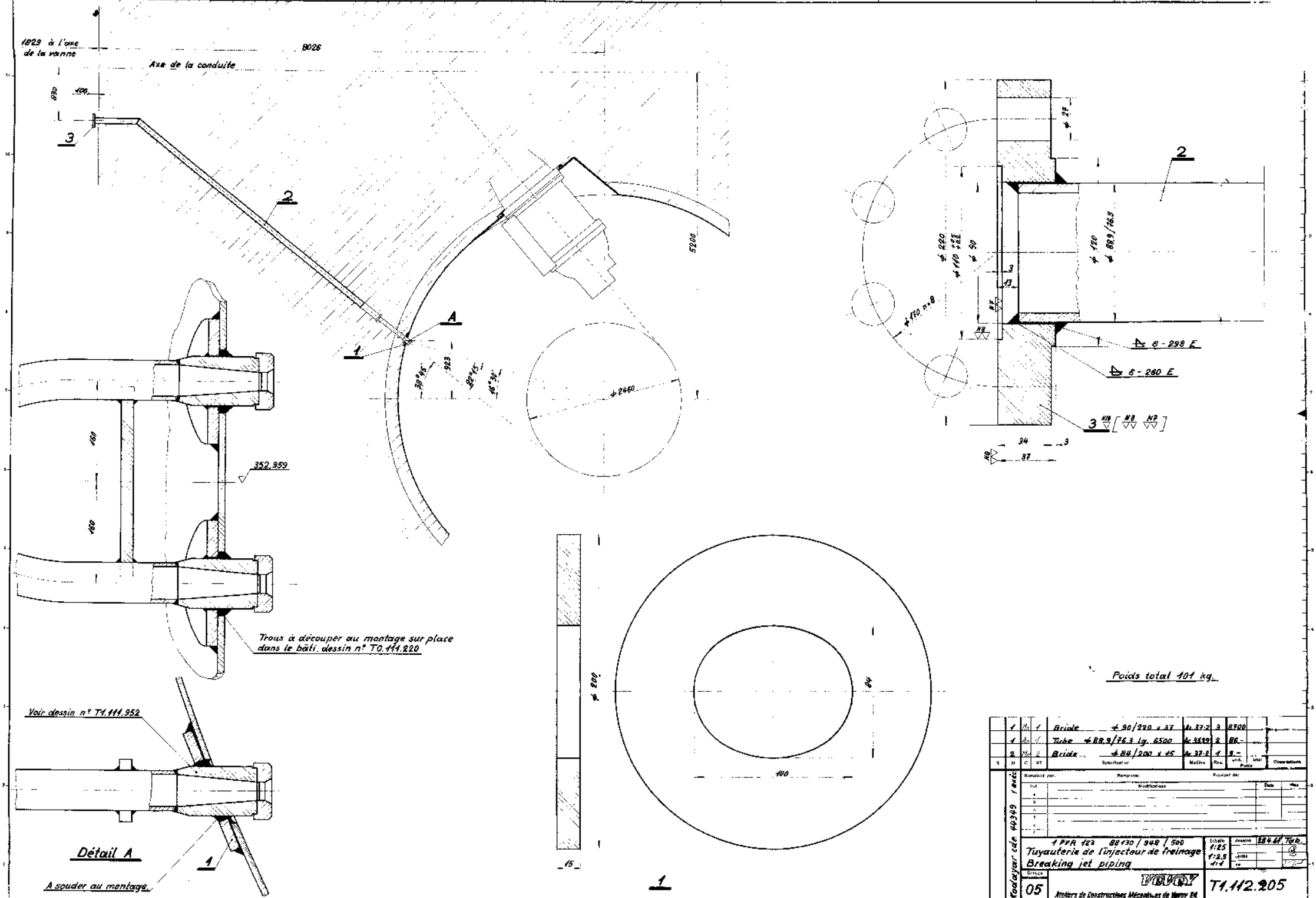


T1.111.919A

PELTON RUNNER

NOTE:
TRACED FROM M/S. VEVEY DRG.NO. T1.111.919A

TAMILNADU ELECTRICITY BOARD.	
SCALE	PELTON RUNNER
CIRCLE :	
DRAWN : M.P.	
TRACED : M.P.	
CHECKED:	SE/ HYDRO/ ELEC. DRAWING BRANCH.
DATE :	DRG NO.



Poids total 101 kg.

V	N	C	NT							
	1	No	1	Bride	ϕ 90/220 x 37	Nr. 37-2	3	8700		
	1	No	1	Tube	ϕ 88,9/76,3 lg. 6500	Nr. 3439	2	86.-		
	2	No	2	Bride	ϕ 84/200 x 15	Nr. 37-2	1	8.-		

Remplacé par: Remplace: Projet de:

Ind	Modifications	Date	Visa
a			
b			
c			
d			
e			

Rodaljar cde 40349 1 exc.

1 PVR 122 88130 / 948 / 500

Tuyauterie de l'injecteur de freinage

Breaking jet piping

Echelle 1:25 1:2,5 1:1

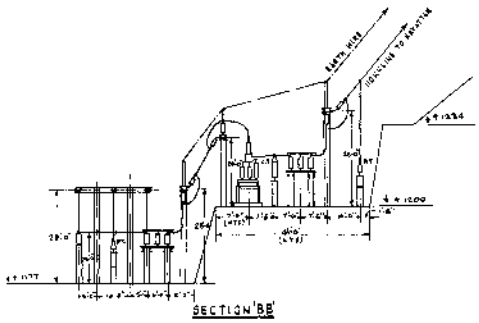
dessiné 284.61 Tob.

Groupe 05

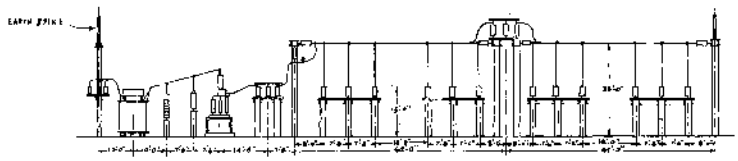
VEVEY

Ateliers de Constructions Mécaniques de Vevey SA

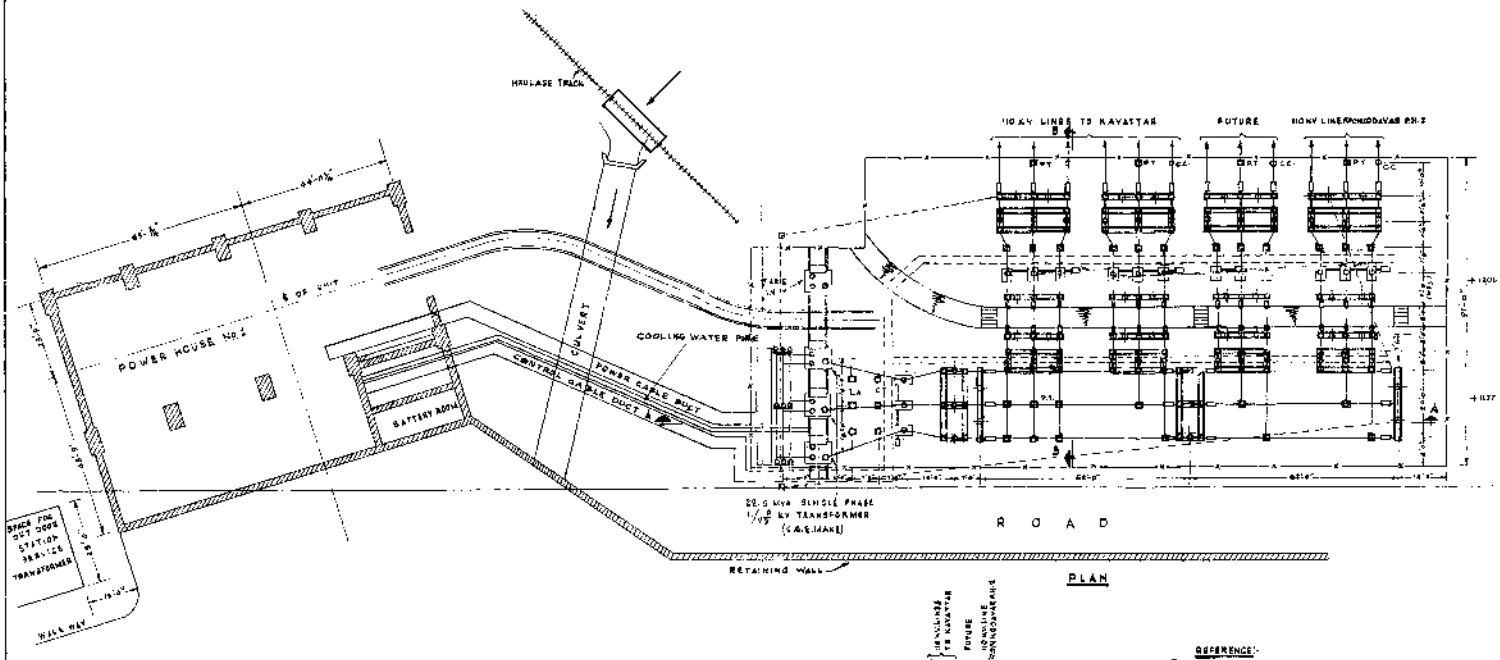
T1.112.205



SECTION 'BB'



SECTION 'A-A'



PLAN

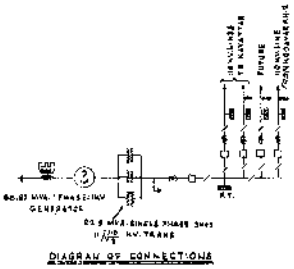


DIAGRAM OF CONNECTIONS

REFERENCE:-

- GENERATOR.
- POWER TRANSFORMER.
- POTENTIAL TRANSFORMER.
- CURRENT TRANSFORMER.
- OIL CIRCUIT BREAKER.
- ISOLATING SWITCH WITHOUT ARCING HORN.
- LIGHTNING ARRESTER.
- CARRIER COMMUNICATION.
- PROPOSED.
- FUTURE.

BILL OF MATERIALS

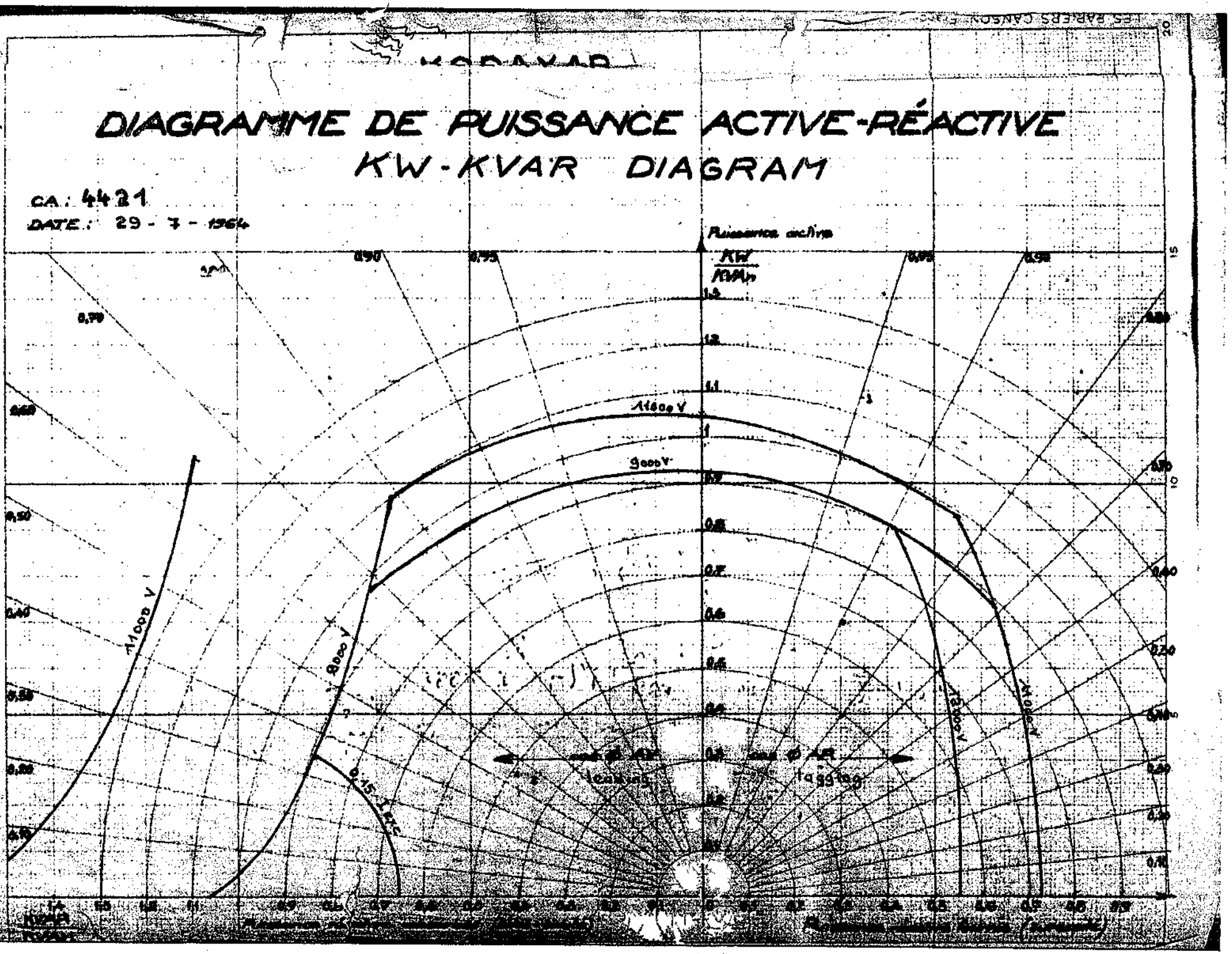
SL. No.	PARTICULARS	QTY	HOW ARRANGED
1.	22.5 MVA. 11/$\frac{22}{\sqrt{3}}$ KV. SINGLE PHASE STEP UP TRANSFORMERS	3 NOS	ORDERED UNDER SPECN. E. 712. (C).
2.	110 KV O.C.B. WITH CTS.	4 NOS	ORDERED UNDER SPECN. E. 712.
3.	110 KV POTENTIAL TRANS.	6 NOS	ORDERED UNDER SPECN. E. 712 (A).
4.	110 KV L.A.S.	1 SET	ORDERED UNDER SPECN. E. 816.
5.	66 KV. A.B. SWITCHES	8 NOS	METTUR WORKSHOP TO BE ORDERED.
6.	EARTH STRIPS.	—	FROM STORE.
7.	STRAIN AND POST INSULATORS.	—	
8.	R.C.C. POST 6 36' HIGH	—	AS PER DESIGN. TO BE ORDERED.
9.	BUS BARS.	—	INCLUDED IN SPECN. E. 890.
10.	PLCC EQPTS.		

S.E.T. (H) | A.C.E. | CHAIRMAN

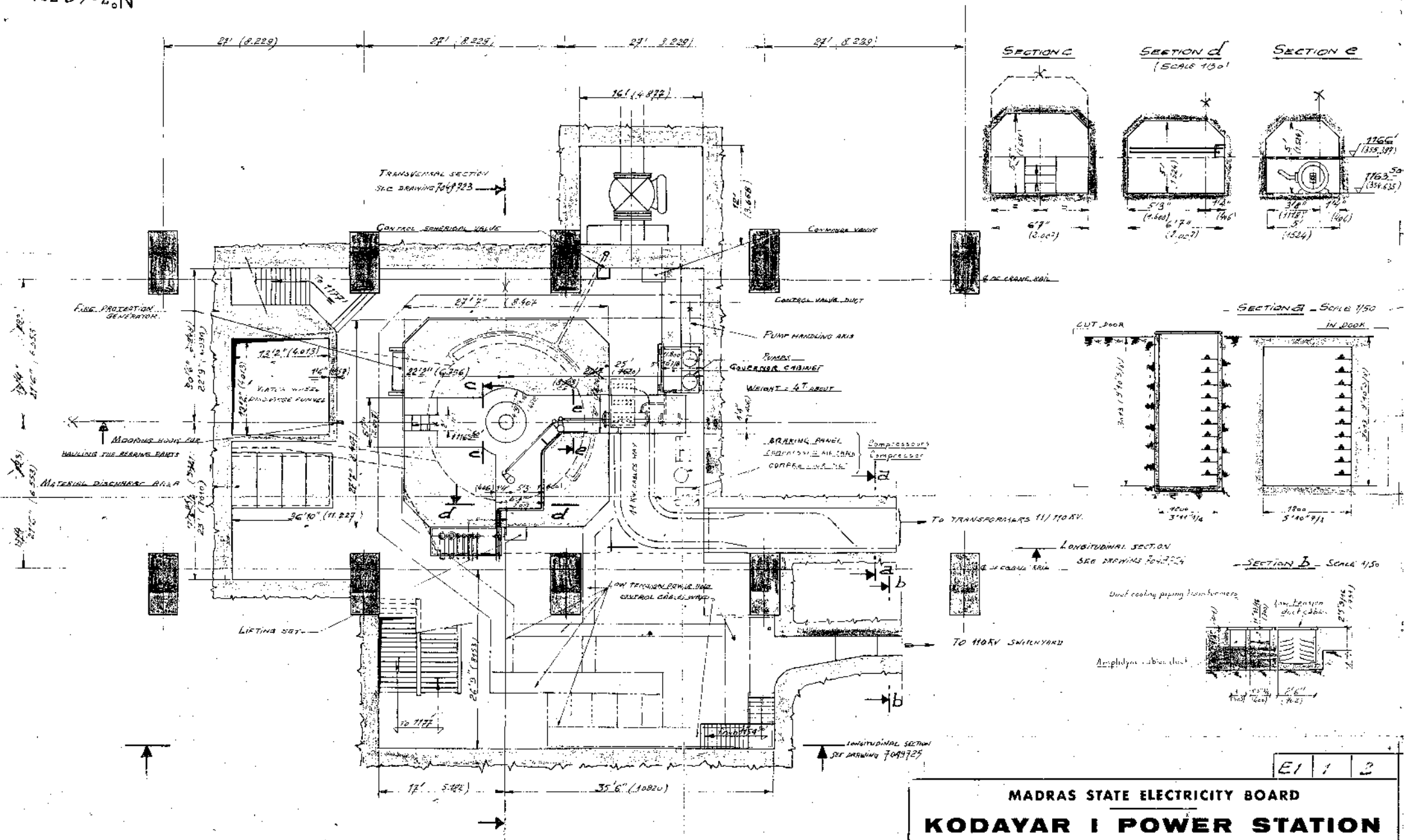
DRAWN	CHECKED	MADRAS STATE ELECTRICITY BOARD	DRG. No. KDR 1
V.K	[illegible]	KODAYAR H.E. SCHEME	SCALE: 1" = 20'-0"
TRACED	APPROVED	KODAYAR P. H. No. 1 TRANSFORMER YARD	DATE: 12-65
	S.M.E.		

DIAGRAMME DE PUISSANCE ACTIVE-RÉACTIVE
KW-KVAR DIAGRAM

CA: 4421
DATE: 29 - 7 - 1964



N°7049721



E1 | 1 | 2

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME

PLANE VIEW LEVEL 1166'

PLANS GENERAUX DE PRINCIPE

VUE EN PLAN NIVEAU 1166'

Dessiné : JAUAN. | Echelle : 1/100 | N°se Classt

Vérifié :

Enregistré : 3-12-65 | Service ERE-A | Cde N° 15/10 Re2 | T. 3

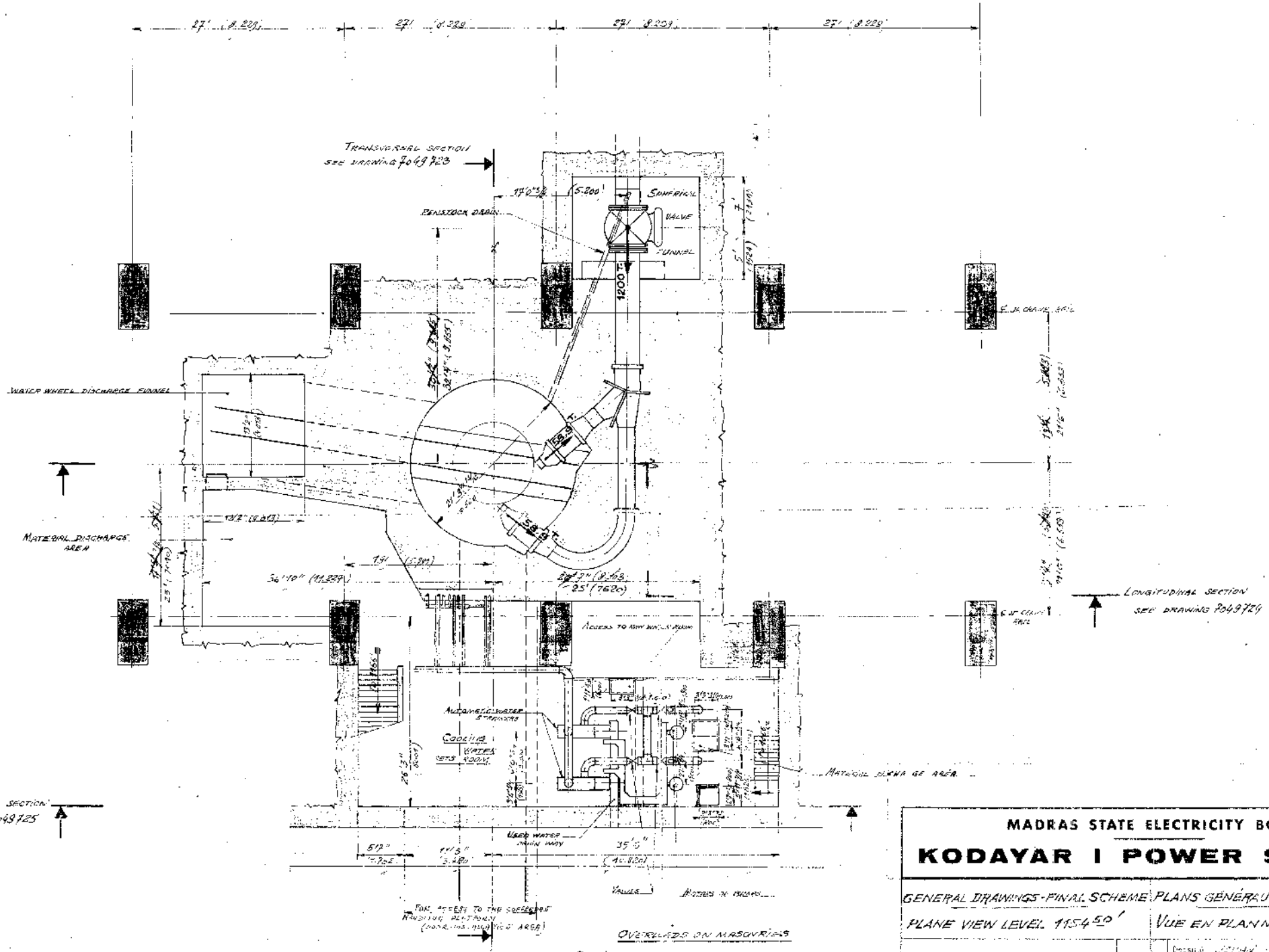
Rectifications following M.S.E.B.'s letter dt 2/7/66 (CH/12/JAN. 1/2) drawing No. 150.1/3201 and Addition Note dt 17-10-66 / Modifications afin faire M.S.E.B. ... 17 12 66

ALSTHOM PARIS 38, AVENUE KLÉBER

N° 7049 721 F° | Nbre Fe ... | Voir Fe ...

A

N°7049721



F1 | 1 | 1

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

GENERAL DRAWINGS-FINAL SCHEME PLANS GÉNÉRAUX DE PRINCIPE

PLANE VIEW LEVEL 1154'50" VUE EN PLAN NIVEAU 1154'50"

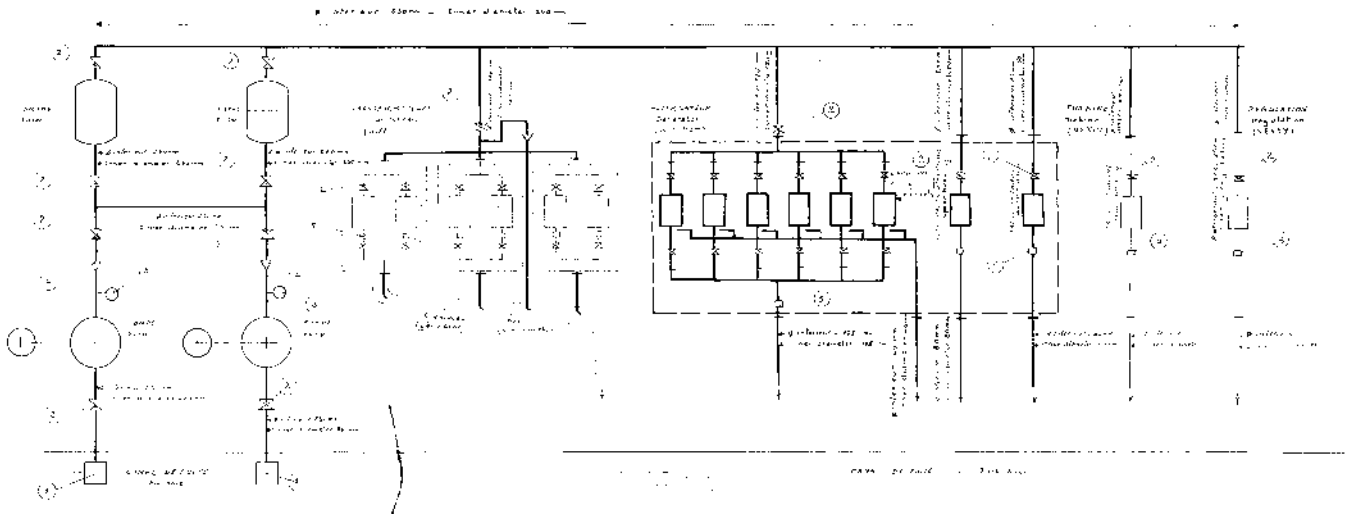
Dessiné ... Vérifié ... Enregistré ... Service ... Cde N° ... Feuille ...

Modifications concernant ... effectuées par ... et ALSTHOM suite à ...

ALSTHOM PARIS 38, AVENUE KLÉBER

N° 7049722 F°

N° 7049722 F



1	
2	
3	

N°9087910 F

E1 | 1 | 8

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

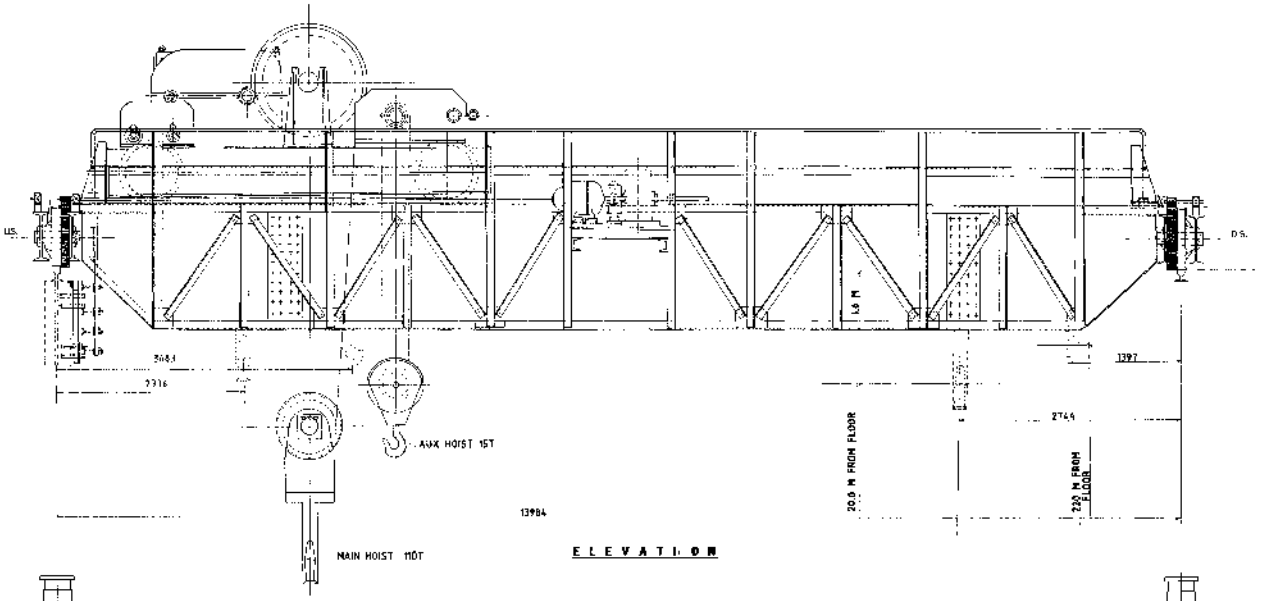
GENERAL DRAWINGS FINAL SCHEME — PLANS GENERAUX DE PRINCIPE

COOLING SCHEME — SCHEMA DE REFRIGERATION

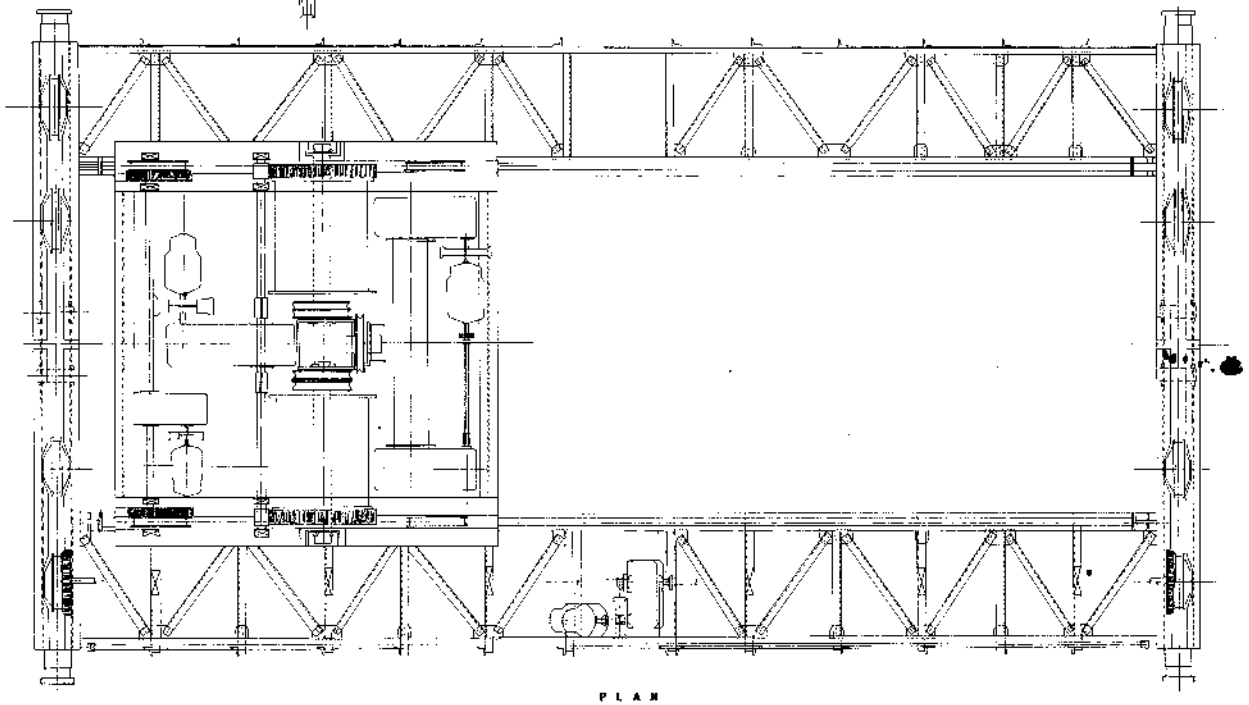
ALSTHOM

N°9087910 F

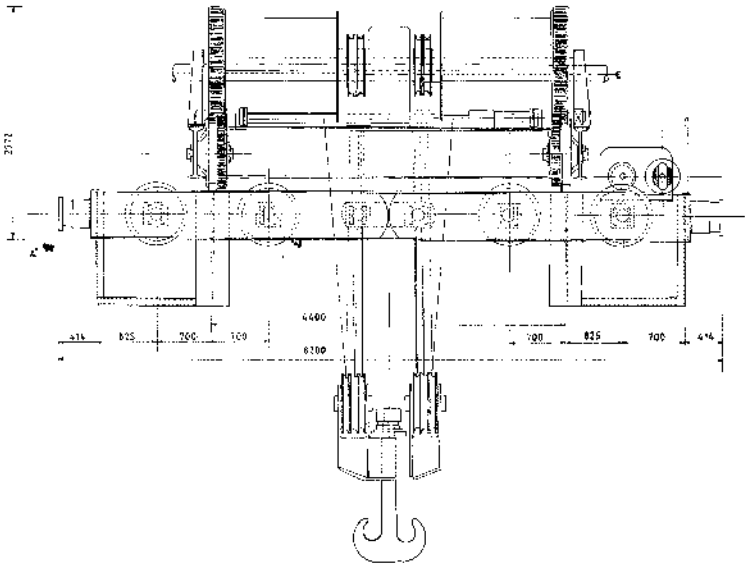
N°9087340 F



ELEVATION



PLAN



SIDE VIEW

TRACED FROM DWG No 10031 of SOUTHERN STRUCTURALS LTD. MADRAS-8.

TAMIL NADU ELECTRICITY BOARD	
DRAWN : A.J.	KODAYAR HYDRO ELECTRIC SCHEME
TRACED : A.J.E.	110 T/15T./x13984 MM EOT CRANE.
CHECKED : M.E.	GENERAL ARRANGEMENT
SCALE : 1:30	DRG.NO. DB/E-662 DRAWING BRANCH/ELECTRICAL.
DATE :	

CENTRALE DE KODAYAR I

ALTERNATEUR RYV 422-147

66667 kVA . 11000 Volts . 50 Hz . 500/315 tr/mn

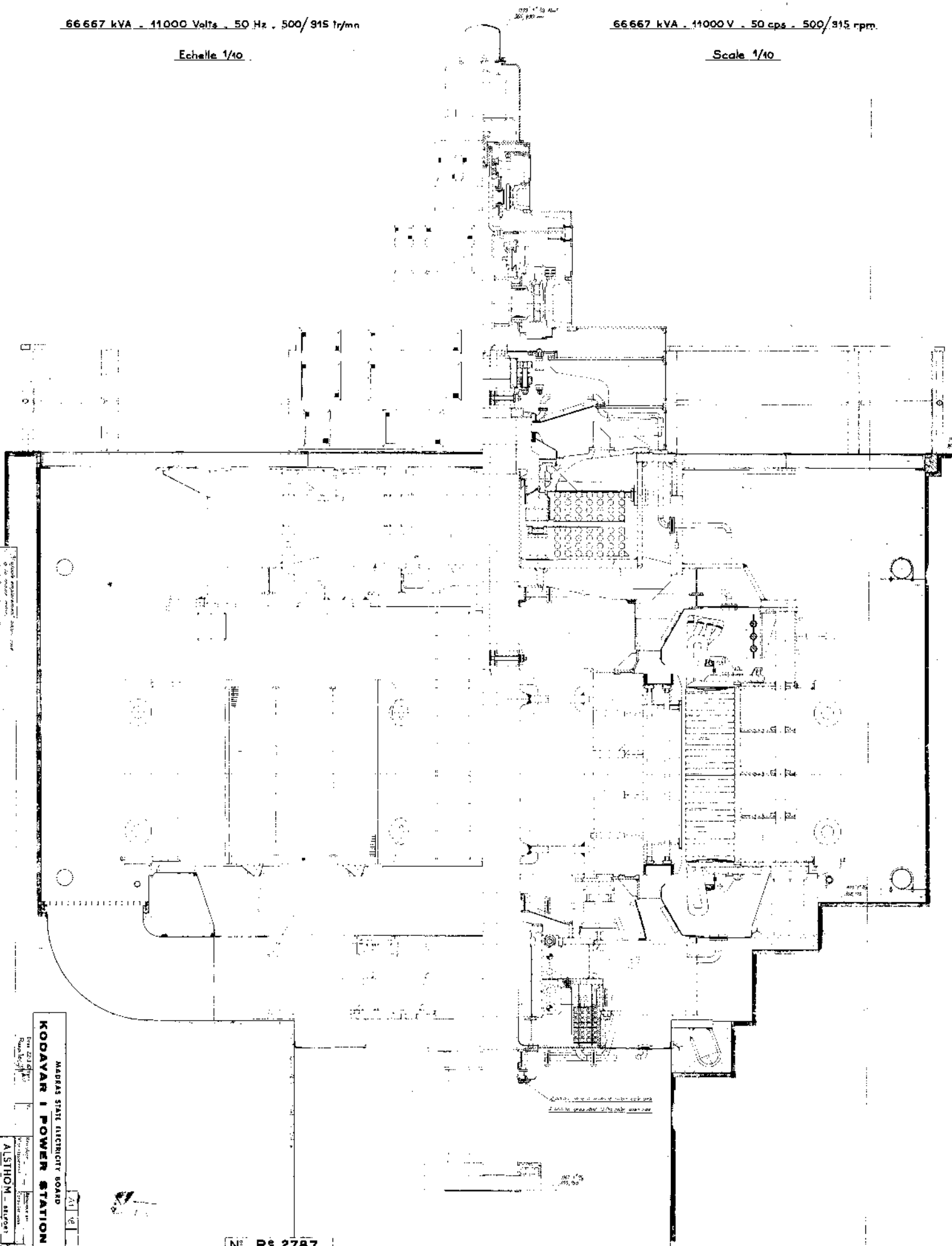
Echelle 1/10

KODAYAR I POWER STATION

GENERATOR RYV 422-147

66667 kVA . 11000 V . 50 cps . 500/315 rpm

Scale 1/10



MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

ALSTHOM

N° Re 2787

N° Re 2787

N° 35 206 588

For stapling of the requisite circuit in the Ballast welds, insert and intermediate steel (thickness 6.5) from Z to Y. the two sheets to remain in place in the fixing joint.

After erecting in the correct station, replace the 6.5 intermediate steel between Z and Y with its permissible tolerances (thickness 6.5) and the remaining sheets with same adjustments of 0.5 thickness on the Duomo joints.

Then tighten the joints.

After final assembly in the power station, the nuts will be secured by welding.

MADRAS STATE ELECTRICITY BOARD

KODAYAR I POWER STATION

SUPPLY AND ERECTION OF PENSTOCK AND TOWER STATION

RIVET 432 - 1967

Date 26.5.66

Ref.

Remplace

Remplacé par

N° au classement

Consulter avant

ALSTHOM – BELFORT

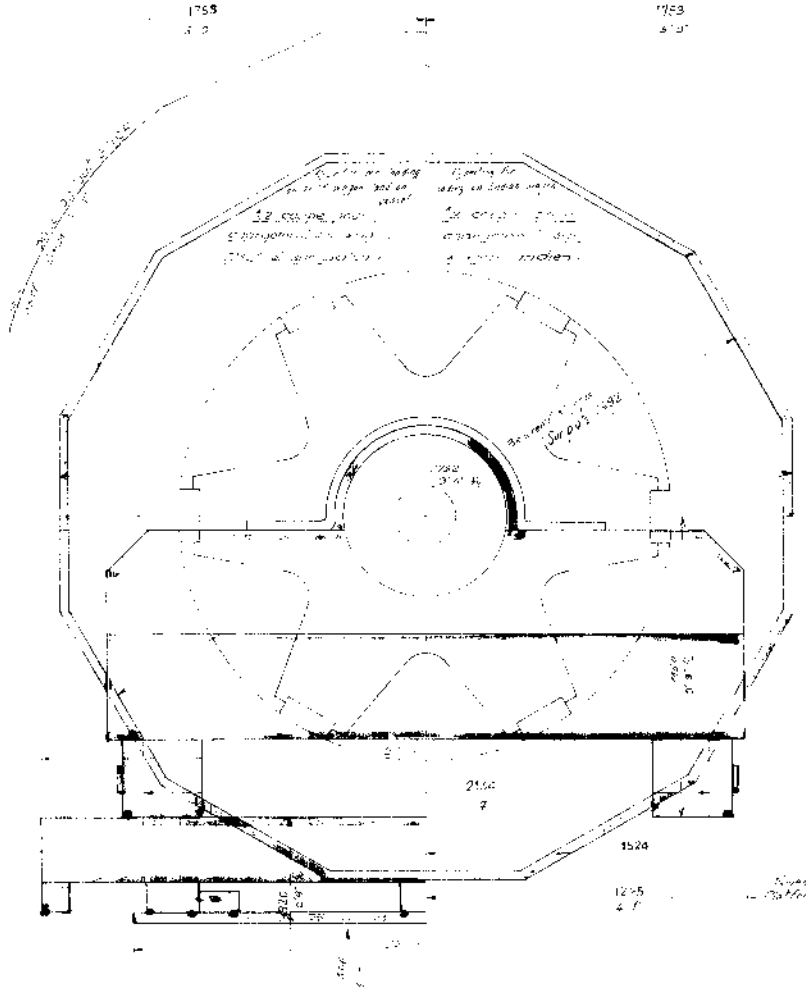
No. 35 206 588 bis

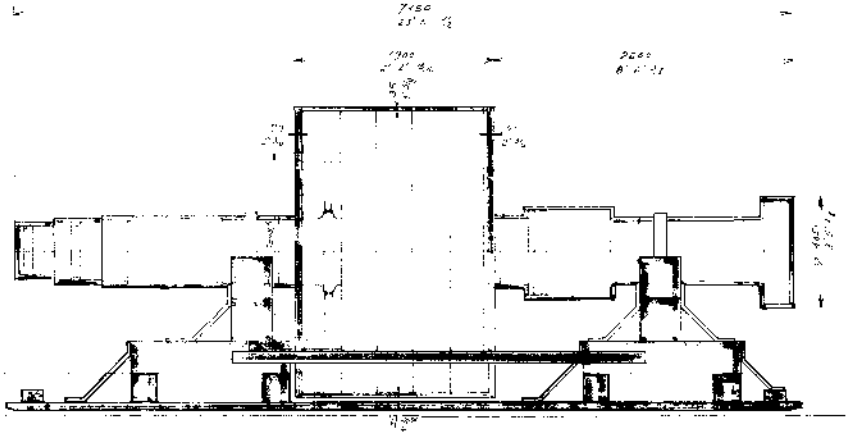
N° 35-206588 bis

N° 35-206672

Transport of rotor shaft with 2 discs
Transport arbre rotation avec 2 disques — Net weight / Poids net 46537

Original n° n°9549
Dessin n° n°9549





Partie inférieure du puits
Lower part of the upwelling cradle.

Pour déchargement sur wagon voisin à partir d'un conteneur sans démontage
For loading on Indian wagon, the rotor shaft with the upwelling cradle can be removed.

MADRAS STATE ELECTRICITY BOARD

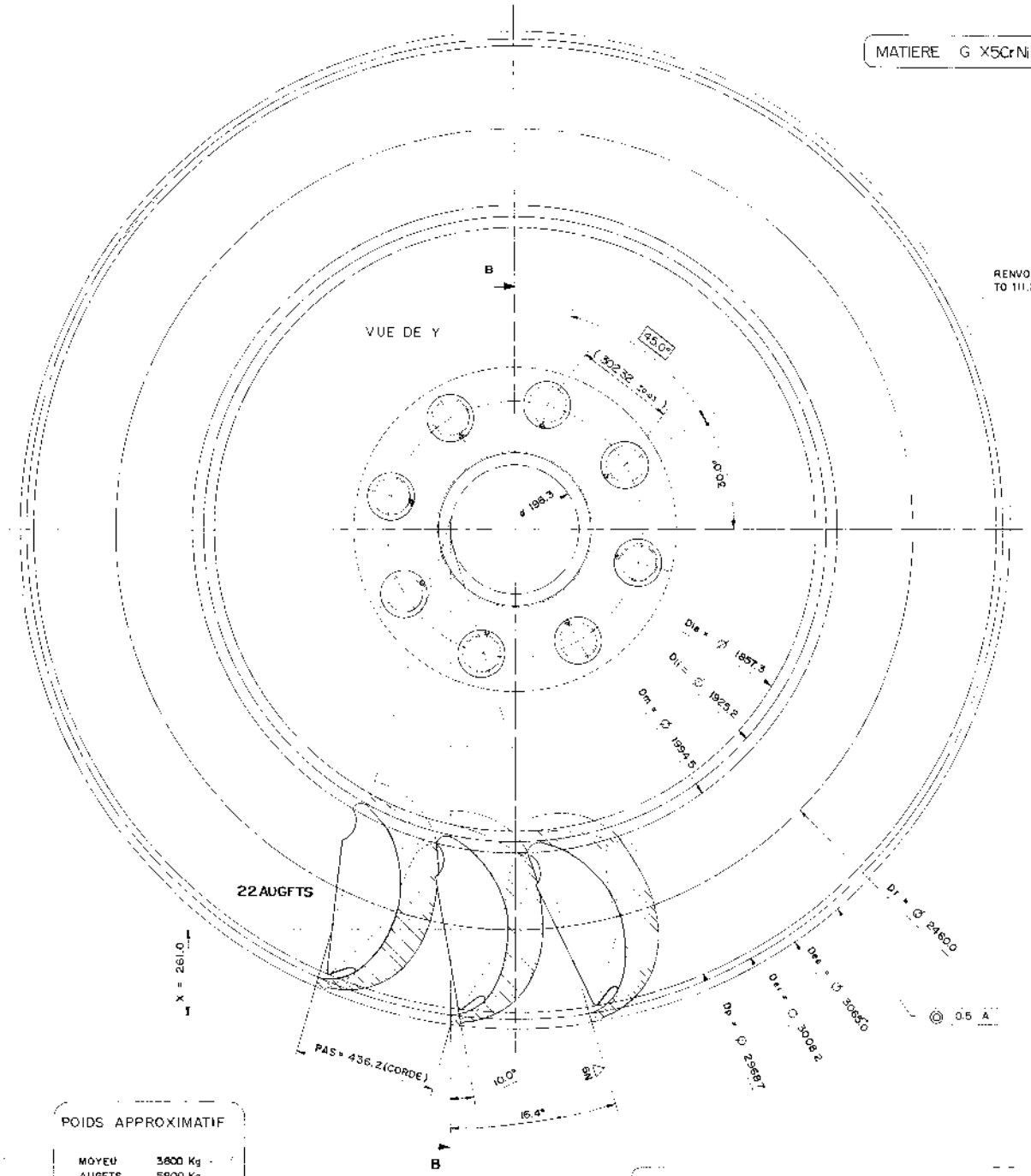
KODAYAR I POWER STATION

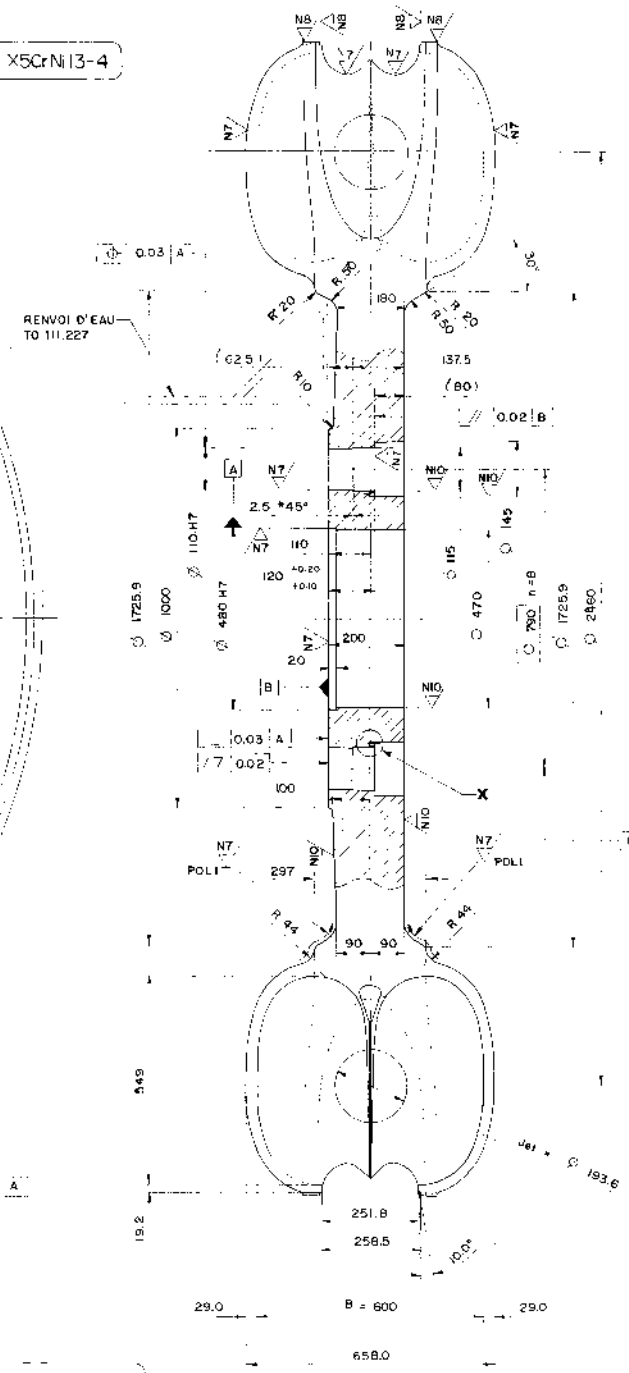
Transport of rotor shaft with 2 discs
Arbre avec disques pour transport en cradle

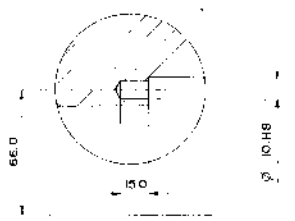
ALSTHOM — BELFORT

N° 35.206672

MATIERE G X5CrNi13-4







DETAIL X
Ech 1:1

TRACE D AUBAGE
H0.32 61352a
H0.32 61353a

CARACTERISTIQUES

F	65,130 MW
Hn	947.6 m
V	7.787 m³/s
N'	500 t/min

POIDS APPROXIMATIF

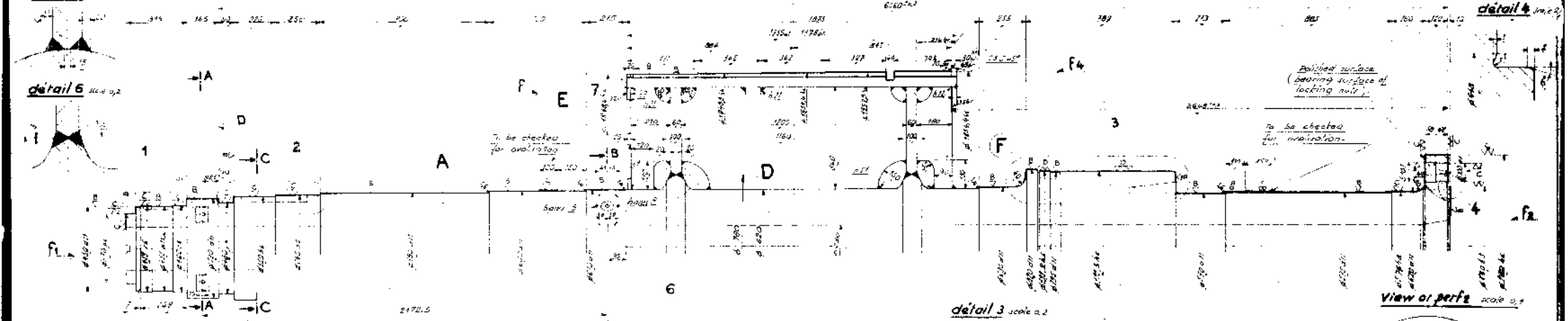
MOYEU	3800 Kg
AUGETS	5800 Kg
TOTAL	9600 Kg

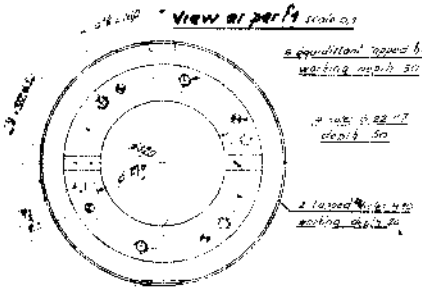
EQUILIBRAGE STATIQUE SELON ISO 1940/1 - CLASSE 6.3
BALOURD MAX. ADM. 440.gr sur ⌀3065

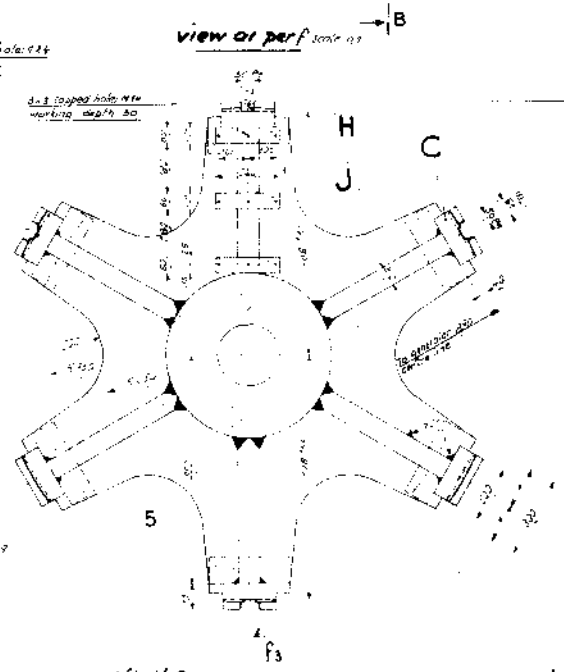
COUPE B-B

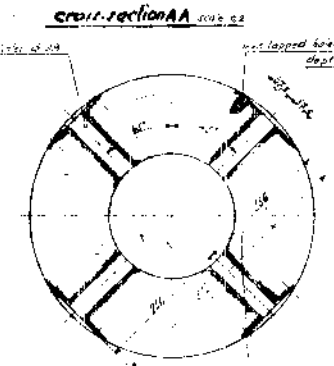
TAMIL NADU ELECTRICITY BOARD
KODAYAR POWER HOUSE. 1
HYDRO VEVEY S.A
SWITZERLAND
3:4 PELTON WHEEL
DRG.NO SF/H(F)/395/94
DATE 2-4-94

N° 35.206650

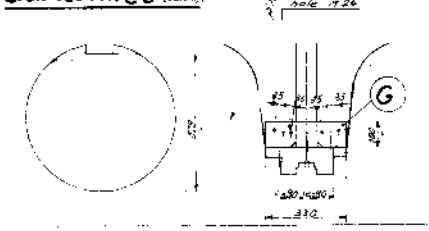


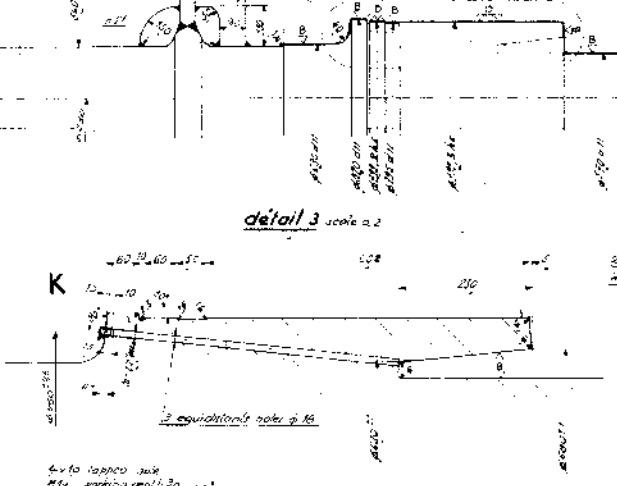


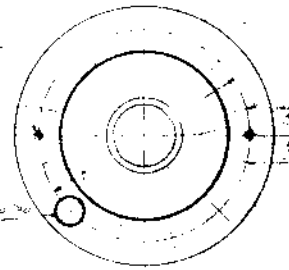


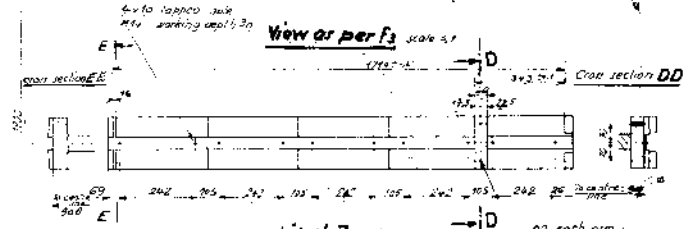


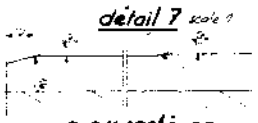


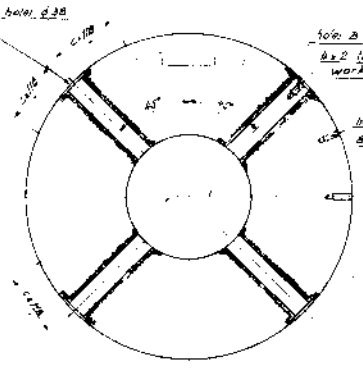












Annealing. The annealing will be made before machining the part

Inspection will be done by ultrasonic test

MD² 14700 kg.m²

N° 35.206650 bis

A1 | 3

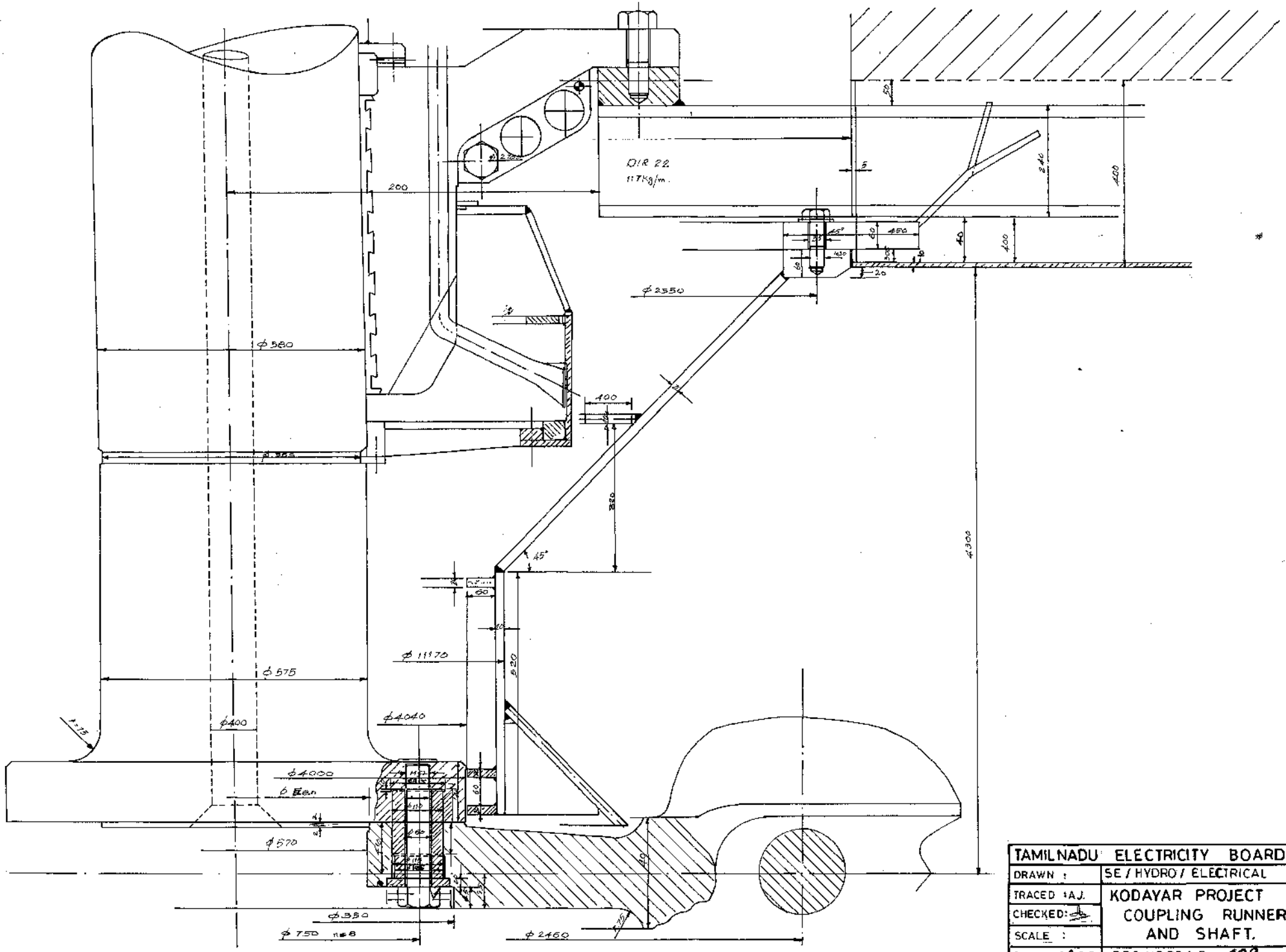
MADRAS STATE ELECTRICITY BOARD

KODAYAR 1 POWER STATION

Shaft and spider | Croisillon rotor

ALSTHOM

No. 35.206 650 bis

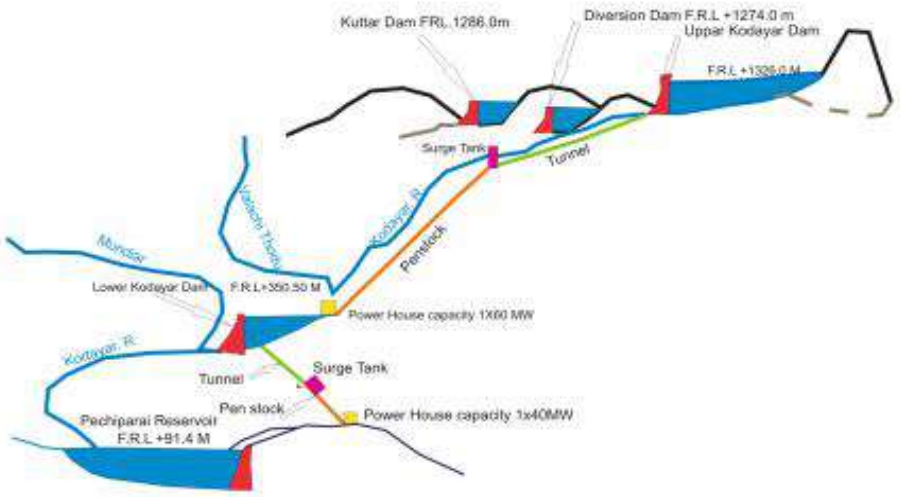


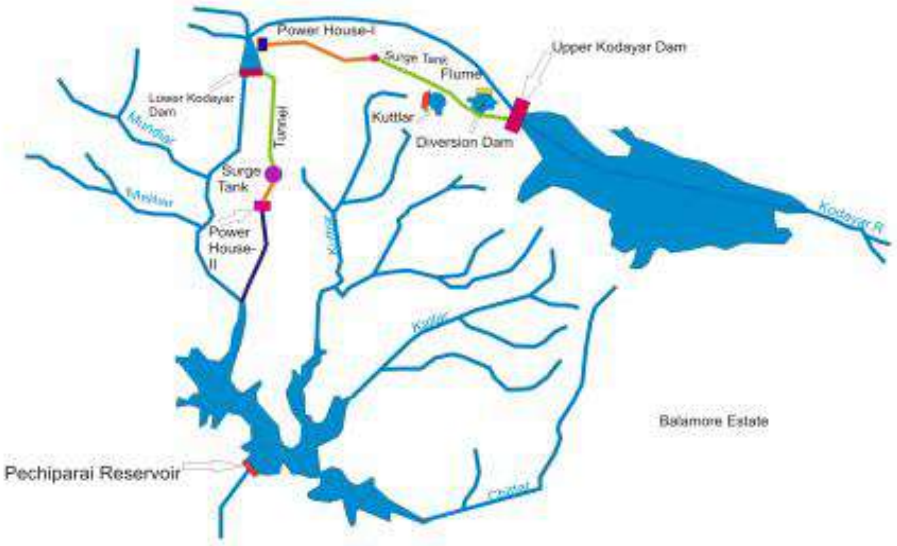
TRACED FROM DRG NO E-393 OF VEVEY

TAMILNADU ELECTRICITY BOARD	
DRAWN :	SE / HYDRO / ELECTRICAL
TRACED : A.J.	KODAYAR PROJECT
CHECKED:	COUPLING RUNNER AND SHAFT.
SCALE :	
DATE : 2.9.94	DRG NO: DB/ E - 402

R-20

TAMIL NADU
Index Plan & Elevation of Kodayar H.E Project





Govt.of India
Central Water Commission
Remote sensing Dte.


KODAYAR DAM - I
CATCHMENT AREA 1125 SQ.MLS 2914 SQ.KM
WATER SPREAD AREA 329 " 852 "
TOP LEVEL 4358 FEET 132832 METRES
CREST LEVEL OF SPILL WAY 4330 " 131978 "
SILL LEVEL OF SLUICE 423413" 129056 "
MAXIMUM WATER STORAGE 258980 "
MAXIMUM WATER LEVEL AND RESERVOIR LEVEL 4350 FEET 132580 "
DAM LENGTH 545 FEET
DAM TOP WIDTH 21 " 640 METERS
HEIGHT ABOVE BED LEVEL 217 " 6614 "
MAXIMUM FLOOD DISCHARGE 9069 CUBICS
TYPE OF DAM GRAVITY RUBBLE MISNORY
TOTAL COST OF DAM INCLUDING GATES 369 LAKHS
YEAR OF CONSTRUCTION 1963 70

TANGEDCO

TUTICORIN THERMAL POWER STATION CHEMICAL LABORATORY (Analytical / Test Report)

Sample : Kodayar Dam - 2 Water Sample

Sl.No	Test Conducted	January_18		February_18		March_18		April_18		May_18		June_18		July_18		August_18		September_18	
		Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery	Reservoir	Gallery
1	Conductivity in micro mhos/cm	18	235	20	185	28	165	22	210	23	320	32	430	27	515	22	332	21	385
2	pH	8	10	8.10	10.30	8.00	9.80	8.00	9.80	8.20	9.60	9	10.20	8.20	10.40	8	9.50	7.50	9.50
3	P- Value as $CaCo_3$ in mg/l	Nil	48	Nil	42	Nil	34	Nil	42	Nil	56	4	60	Nil	80	Nil	74	Nil	80
4	M- Value as $CaCo_3$ in mg/l	12	92	10	86	10	66	8	68	8	72	20	102	34	186	28	120	26	140
5	Total Hardness as $Caco_3$ in mg/l	8	72	8	70	8	58	10	76	10	80	24	88	16	100	10	96	14	104
6	Calcium Hardness as $Caco_3$ in mg/l	6	44	4	36	4	30	6	42	6	46	14	62	10	72	8	62	10	66
7	Calcium as CaO in mg/l	3.36	24.64	2.24	20.16	2.24	16.8	3.36	23.52	3.36	25.76	7.8	49.28	5.6	40.32	4.48	34.72	5.6	36.96
8	Magnesium Hardness as $Caco_3$ in mg/l	2	28	4	34	4	28	4	34	4	34	10	26	6	28	2	34	4	38
9	Chloride as Cl in mg/l	5.68	8.52	4.26	7.1	5.68	7.1	7.1	17.04	9.94	18.46	7.1	15.62	8.52	17.04	9.26	14.2	8.52	19.88
10	Silica as SiO_2 in mg/l	5.46	9.94	5.42	9.22	5.09	9.84	4.81	9.02	4.62	9.24	4.71	9.04	5.34	14.5	5.22	13.88	5.18	14.23
11	Sulphate as SO_4 in mg/l	Nil	12	Nil	8	Nil	10	Nil	12	Nil	14	Nil	18	Nil	18	Nil	16	Nil	16

CONTRACTOR		QUALITY ASSURANCE PLAN FOR STRUCTURAL & MECHANICAL EQUIPMENT	PROJECT	
ORDER NO. & DATE			PACKAGE NO.	
SUB - CONTRACTOR			PACKAGE NAME	
ORDER NO. & DATE				

INSTRUCTIONS FOR FILLING UP :

1 QAP shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.

2 Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

3 Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4 Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR

MFG : MANUFACTURER

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description
1.	Visual(Welding etc.)
2.	Dimensional
3.	Fitment & Alignment
4.	Physical Test(Sample)
5.	Chemical Test (Sample)
6.	Ultrasonic Test
7.	Magnetic Particle Test(MPT)
8.	Radiography test
9.	Dye Penetration Test
10.	Metallographic Exam.
11.	Welder's Qualification & Weld Procedure Test
12.	Approval of Test and Repair Procedure
13.	Heat Treatment
14.	Pressure Test
15.	Leakage test
16.	Balancing
17.	Vibration Test
18.	Amplitude test

Code	Description
19.	Sponge test
20.	Dust/Water Ingress test
21.	Friction Factor Test
22.	Adhesion Test
23.	Performance Test/ Characteristic curve
24.	No. Load/Free Running Test
25.	Load/Overload Test
26.	Measurement of speeds
27.	Accoustical test
28.	Geometrical Accuracy
29.	Repeatability and Positioning Accuracy
30.	Proving Test
31.	Surface Preparation
32.	Manufacturer's Test Certificates for bought out items
33	IBR/Other statutory agencies' compliance certificate

Code	Description
34.	Internal Inspection report by Contractor
35.	Hardness test
36.	Spark test for Lining
37.	Calibration
38.	Safety device test
39.	Ease of Maintenance
40.	Thickness measurement of Zinc coating

DOCUMENTS :

D1. Approved GA drawings
D2. Information and other reference drg / stamped drgs released for manufacture
D3. Relevant catalogues
D4. Bill of Material/ item no./ identification.
D5 Matchmark details
D6 Line/Layout diagram
D7 Approved erection procedures
D8 Unpriced sub P.O. with specification and amendments if any
D9. Calibration Certificate of all measuring instrument and gauges.
D10. Ordering Specification

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

for MECON (Stamp & Signature)

For CONTRACTOR / SUB - CONTRACTOR
(Stamp & Signature)

(Q . A . P . NO. TO BE ALLOTTED BY MECON)
NO. / / / M-
SHEET : OF

REV.

CONTINUATION SHEET **FORM NO. 11.20 (DQM) F-09, REV-0**

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

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For CONTRACTOR / SUB - CONTRACTOR
(Stamp & Signature)

(Q. A. P. NO. TO BE ALLOTTED BY MECON)
NO. / / / M-
SHEET : OF

REV.

FORM NO. 11.20 (DQM) F-10, REV-0

CONTRACTOR		**QUALITY ASSURANCE PLAN FOR ELECTRICAL EQUIPMENT**	PROJECT	
ORDER NO. & DATE			PACKAGE NO.	
SUB - CONTRACTOR			PACKAGE NAME	
ORDER NO. & DATE				

INSTRUCTIONS FOR FILLING UP :

1. QAP shall be submitted for each of the equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.
4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR

MFG : MANUFACTURER

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description
1.	Visual
2.	Dimensional
3.	Fitment & Alignment
4.	Physical Test(Sample)
5.	Chemical Test (Sample)
6.	Ultrasonic Test
7.	Magnetic Particle Test(MPT)
8.	Radiography test
9.	Dye Penetration Test
10.	Measurement of IR Value : a) Before HV Test b) After HV Test
11.	High voltage test/Dielectric test.
12.	Routine test as per relevant IS/other standard.
13.	Type tests as per relevant IS/ other standard.
14.	Impalse Test.
15.	Partial Discharge Test.
16.	Heat run test/Temp. rise Test.
17.	Enclosure protection Test.
18.	Calibration.
19.	Noise & Vibration.
20.	Test Certificates for bought out components.
21.	Tank pressure Test.
22.	Paint shade verification.
23.	Short time rating.
24.	Operation & functional check.
25.	Overspeed Test.
26.	Flame proof Test
27.	Clearance and creepage distance.
28.	Acceptance Tests as per relevant IS

DOCUMENTS :

- D1. Approved GA drawings
- D2. Approved single line / schematic diagram.
- D3. Catalogues / Approved data sheet
- D4. Approved bill of materials.
- D5. Unpriced P.O. copy.
- D6. Calibration Certificate of all measuring instrument and gauges

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

for MECON (Stamp & Signature)

For CONTRACTOR / SUB - CONTRACTOR (Stamp & Signature)

(Q. A. P. NO. TO BE ALLOTTED BY MECON)

NO. / / / E-

SHEET : OF

REV.

CONTINUATION SHEET **FORM NO. 11.20 (DQM) F-10, REV-0**

	EQUIPMENT DETAILS						INSPECTION AND TESTS								
							Raw Material and Inprocess stage Inspection			Final Inspection / Test by					
Sl. No.	Description (with equipment heading,place of use and brief specification)	Identification No.	Quantity No / M	Quantity T	Manufacturer's Name and Address	Expected Schedule of Final Inspn	MFR	CONTR	MECON	MFR	CONTR	MECON	Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards/IS/BS/ ASME/Norms and Documents	REMARKS/ SAMPLING PLAN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

for MECON (Stamp & Signature)

For CONTRACTOR / SUB - CONTRACTOR
(Stamp & Signature)

(Q. A. P. NO. TO BE ALLOTTED BY MECON)
NO. / / / E-
SHEET : OF

REV.

Form No. 11.20(DQM)F-05/2 Rev.0
Page No. 1 of 1

INSPECTION CALL PROFORMA

Inspection Call No. **Date :**

Project		**Purchaser**	
Contractor		**Contractor's Order No. & Date**	
Sub-Contractor with address, Fax & Ph. No.		**Place of Inspection with address, Fax & Ph. No.**	
Proposed Date of Inspection		**Name & Designation of Contact Person with Ph. No.**	
Manufacturer's Off-day			

List of items offered for inspection :

Item Identication No.	Item Description	Drawing No. with Revision	Drawing Approval Status A/AAN/INF	QAP No. & Status	Quantity (No./M) with tonnage		
					Total Ordered	Total Accepted	Offered

A = Approved, AAN = Approved as Noted, INF = Information Category

List of documents & Test Certificates enclosed in four (4) sets.

Description	Ref No. & Date	Description	Ref No. & Date

for Contractor/Sub-Contractor

RENOVATION, MODERNISATION & UPRATING OF KODAYAR POWER HOUSE-I FROM 1x60MW TO 1x70MW

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-470-600-C001

SECTION □D
GENERAL TECHNICAL SPECIFICATION

Customer

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD

BHARAT HEAVY ELECTRICALS LIMITED

NEW DELHI

SECTION – D comprises of sub-sections as mentioned below:

Sub-section D1: Earthwork in excavation and backfilling

Sub-section D2: Cement concrete (Plain and reinforced) and formwork

Sub-section D3: Carpentry and joinery

Sub-section D4: Roof and underground structures water proofing, insulation and allied works

Sub-section D5: Metal doors, windows, ventilators, louvers etc.

Sub-section D6: Glass and Glazing

Sub-section D7: Rolling Steel Shutter and Grills

Sub-section D8: Miscellaneous Metal

Sub-section D9: Masonry and allied works

Sub-section D10: Finish to masonry and concrete

Sub-section D11: Painting, Whitewashing, polishing

Sub-section D12: Floor finish and allied works

Sub-section D13: Sheet work in roof and siding

Sub-section D14: Suspended ceiling

Sub-section D15: Water supply, drainage & sanitation

Sub-section D16: Road & drainage

Sub-section D17: Fabrication of structural steelwork

Sub-section D18: Erection of structural steelwork

VOLUME: II B

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.0	SCOPE	3
2.00.00	GENERAL	3
3.00.00	EXECUTION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	19
5.00.00	RATES AND MEASUREMENTS	19
6.00.00	INFORMATION TO BE SUBMITTED BY THE BIDDER	20

STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 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) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including 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 tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

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

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

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

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall 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 shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal

area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

A□□□r□□□ □r□ □□□□□□□ □□□□□□□d □□d□r □□□ □□□□□ □□□ □□□□□r□□□

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□□ Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

□□ Hard Soil

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

□□Soft and Decomposed Rock

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
iv) any rock which in dry state may be hard, requiring blasting, but which

when wet becomes soft and manageable by means other than blasting.

d) Hard Rock (requiring blasting)

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and 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 the line, slopes and grades as shown on the drawings and/or as 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 they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In

case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out 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 (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. 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 engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In 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 protection works before the excavation will be

restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation 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 not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

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 instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said 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 the 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 at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation 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 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

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

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not 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 be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

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

* not to touch the magazine shoes on ground outside the clean floor.

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

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall 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 the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 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 his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the

cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. 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 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

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 etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

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 the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may 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.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures

and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are 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. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a 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 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

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

Sumps made for dewatering must be kept clear of the foundations. The engineer’s prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on

the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 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 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of 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 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 to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded 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.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

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

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree 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 surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

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 150mm, watered, rammed and compacted taking

care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be 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 the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation 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 around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 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.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension 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 are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction 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.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres from ground level, alround excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre from ground level, alround excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

e) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

f) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

g) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c & 5.2.0 d) or those actually excavated, whichever, are less, shall be measured for payment.

h) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to 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 the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes,

shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D2

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 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 Bar bending 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.

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 Performa 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 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.

d) Bar Bending Schedules

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 Performa, 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 same 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. 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

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert,

hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

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 in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

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. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per 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

e) Water proofing 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. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of

concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

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

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so 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. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable 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: Locations of joints, water stops and filler materials. 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 be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Proportioning of ingredients of concrete made 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 M-15 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.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

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. 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.

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 IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) 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.

b) 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.

c) 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-5 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 4 & 5 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 criteria, the former should be adopted.

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. Trial mix shall be carried out accordingly. 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.

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

Degree of workability	Slump in mm with 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

Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of 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.

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
Lean concrete	- 40 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

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.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

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, in-spite of all precautions, segregations does 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 in 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 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.

g) 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. Quality of water for curing shall be as per IS: 456.

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 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.

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, TMT 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 **optimized** Bar Bending Schedules 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. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

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 cutting, 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. Rebending 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 / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. 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. For High yield strength deformed bars, lap 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 as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler 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 "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

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. 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 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 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 at no extra cost.

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 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 centring 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 centring 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 centring 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 and 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 in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. 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

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. 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.

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.

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 fibreboard 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

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 levelled 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, levelling, 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 centrings 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 24 hours 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 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. 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 (iii)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 guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. 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 Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL 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 acceptance criteria will be as per 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 IS: 456. To control the consistency of concrete from every mixing plant, slump tests 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 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 IS: 456.

5.02.00 Acceptance Criteria

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

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

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 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm

in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc. If reinforcement steel issued is by BHEL to the contractor for use in reinforcement steel work, the unit rate shall include stacking of cut pieces/ scrap steel generated out of reinforcement steel work as per size (dia) for easy retrieval for further use.

c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in

pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired

surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under

this item itself.

7.00.00 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: 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: 702 - Indian Standard specification for industrial bitumen.

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

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 hard drawn steel wire fabric for concrete reinforcement.

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: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

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: 2571 - Code of practice for laying in-situ cement concrete floors.

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: 2750 - Indian Standard Specification for steel scaffoldings.

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: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

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: 3414 - Code of practice for design and installation of joints in buildings.

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: 3696 - Safety Code for Scaffolding and Ladders

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

IS: 4014 - Code of practice for steel tubular scaffolding.

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: 5256 - Code of practice for sealing joints in concrete lining on canals.

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

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

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

IS: 5816 - 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: 5892 - Indian Standard Specification for transit mixer and agitators.

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

IS: 6909 - Indian Standard Specification for Super sulphated 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: 7293 - Safety code for working with construction machinery.

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: 8041 - 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: 9012 - Recommended method for shortcreting.

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.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

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SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	6
5.00.00	RATES AND MEASUREMENTS	6

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in “Schedule of Item” for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,

holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

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SECTION – D

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C004

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE	12
4.00.00	I.S. CODES AND STANDARDS	12
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ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer’s

approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two lavers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fiber base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing By Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned

and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at leas 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect

of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a)	IS: 73	-	Paving Bitumen
b)	IS: 702	-	Industrial Bitumen
c)	IS: 1203	-	Methods of testing tar and bitumen
d)	IS: 1322	-	Bitumen felts for waterproofing and damp proofing.
e)	IS: 1346	-	Code of practice for waterproofing of roofs with bitumen felts.
f)	IS: 1609	-	Damp-proofing Treatment using Bitumen Felts – Code of Practice
g)	IS: 3067	-	Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
h)	IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

VOLUME: II B

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-999-600-C005

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	INFORMATION TO BE SUBMITTED	9
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ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardwares where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy

himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the

requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall by retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition frames shall be in Kg. Panelling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stops for both leaves.

   vi) Overhead door closure for both leaves.

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges - 3 Nos. on each leaf.

ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.

iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.

iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges - 3 Nos.

ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face

iii) 200mm anodised aluminum Pull handle - 1 No.

iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 12" peg stays - 1 No. per leaf

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

VOLUME: II B

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	I.S. CODES	4
5.00.00	RATES	5

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or beat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.

g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass

pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes were six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

VOLUME: II B

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-999-600-C007

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be

in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

VOLUME: II B

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-999-600-C008

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	7
4.00.00	IS CODES	8
5.00.00	RATES AND MEASUREMENTS	8

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundary shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of aluminium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make 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 or a moderate amount or reaming and slight

chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as

nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then $\pm$0.05mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye

sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02 Barbed Wire Fencing

The barbed wire shall be conform to IS:278 latest edition. The barded wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less then 13mm and not more than 18mm. The distance between two barbs shall be 75$\pm$12mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed

wire shall be of mild steel of not less then 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

   i) Permissible deviation from, straightness – 1 in 1000.

   ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanised Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanised Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.
Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
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MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone

showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be

laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in

approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the

full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be

kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50.

The brick aggregate shall be well graded, broken from well burnt or slightly overbumt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other paftem as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

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SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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5.00.0	RATES AND MEASUREMENTS	9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve

working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the

Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on

the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and

approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

VOLUME: II B

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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2.00.00	INSTALLATION	3
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5.00.00	RATES AND MEASUREMENTS	12

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II) Code of Practice for finishing of wood and wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

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SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C012

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Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesse rae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still `green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may very in thickness to provide necessary slopes.The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed
The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips

shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Seive No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled f or horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface ' of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like ‘Ironite’/ `Hardonate’ Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the

former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying
Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer’s trademark, the thickness, sizes, batch number, and date of

manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

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SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-999-600-C013

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	6

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF_2) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.

iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be

used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF_2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007	:	Code of practice for laying of asbestos cement sheets.
IS: 2527	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 1626	:	Specification for asbestos cement building pipes, gutters and fittings.
IS: 277	:	Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.

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SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

a) Plaster of Paris board (decorative)

b) Expanded polystyrene insulation board with plastic fascia.

c) Fibre Insulation board.

d) Bonded wooden particle board (Plain and decorative)

e) Glass fibre reinforced polystyrene sheets.

f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C " or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

VOLUME: II B

SECTION - D

SUB-SECTION – D15

WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-999-600-C015

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIAL	3
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	17
5.00.00	I.S. CODES	20
6.00.00	RATE AND MEASUREMENT	21

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:

a) Cast Iron pipe

b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)

c) Concrete pipe

d) Asbestos cement pipe

e) PVC pipe

f) Stoneware pipe

g) Vitrified pipe

h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) **European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium

plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) **Squatting type**

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll bolder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation

shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc.

Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-

syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient

turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and

shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to

be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 m dia whose top shall he provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt.XVI)	:	Laying of water and sewer lines, including appurtenant items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,

IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).
IS: 3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
IS: 4827	:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
IS: 4964	:	High-density polyethylene pipes for portable water supplies.
IS: 12701	:	Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes For Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of "Schedule of Items". Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
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Standard Technical Specification
For Road and Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided 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.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

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

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	± 25 mm
Sub-base	± 20 mm
Base course	± 15 mm
Wearing course	± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby

reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6

9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer.

The trees shall be cut into 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 the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness

for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the

pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	**Test method**	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV)	40 percent maximum
			or	
			IS : 5640**	
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV)	40 percent maximum
			or	
			IS : 5640 **	
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates

and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with

both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX

Aggregates Grading For 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio ning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately

transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D XVII

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, fittings, 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, low hydrogen electrode 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 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock

washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the

material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	**%**	**Remarks**
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulpher	0.03%	Max.
Chromium	10.80% to 12.50%	
Nickel	1.50%	Max.

Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the

store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 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.

2.12.02 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.

2.12.03 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.

2.12.04 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.

2.12.05 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.

2.13.00 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.

2.14.00 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.

2.15.00 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 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

Shearing, cropping, or sawing shall affect cutting. 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 1 125°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 proudness 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. 12 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. 13 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. 14 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. 12.00 Lacing bars

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

3. 13.00 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.

3.14.00 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.

3.15.00 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 interchange ability.

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 twice, 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, fittings, 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 blowholes, 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. 12 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.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary

operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’s rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the

foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for

welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection

marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
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SUB-SECTION – D 18

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 erecrtion shall install, free of cost to the Owne, 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 dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
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: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

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	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm 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 Cirders	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 gaps	At the time of setting of the expansion gaps, due 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.

HYDRO PROJECT ENGINEERING

KODAYAR HEP RMU (1 X 60MW)

PROPOSED DISTRIBUTOR DISMANTLING & ERECTION PROCEDURE

Reference drawing: - Civil Guidelines for Distributor, Erection & Dismantling (Drawing no: - 12000020960 rev 00, 11 sheets) , Arrangement of Distributor (Drawing no: - 02021020901) and Tools, Tackles & Erection devices for Distributor (Drawing no:- 02025120901)

1. Methodology

It is proposed to handle the new distributor segments through EOT crane hook by providing cut-outs at different locations at Floor at EL 358.75 M (Machine room). Reach of crane hook to floor at EL 355.397m shall be provided by making cut-outs at floor at EL 358.75 M. These cut-outs shall be filled later after distributor erection.

2. Process

I. Concrete cutting for removing/installing distributor

a. **At EL 355.397 M (Turbine/Generator floor**): - Concrete cutting profile required at this floor is marked in sheet -3 & relevant sections are marked in sheet – 4. Coordinates of the profile are given in sheet 11 of refereed drawing.
750 mm space is considered on both sides of distributor were site joint or support pedestal is coming, for welding requirement. For other places around distributor, 300 mm space is given. Local cuts shall be required in turbine housing for installing 2nd & 3rd Y branch of distributor.

b. **AT EL 358.75 M (Machine room) :_** Floor are marked in sheet 1 & 2 of referred drawing . Floor cut-outs A & B are proposed at this floor for creating approach of EOT crane hook to EL 355.397 floor.

II. Removal of existing nozzle & distributor

Existing nozzles shall be removed through runner removal passage at EL 350.672M . For distributor removal, first it should be cut into small segments across the cross-section. After that, distributor segments are to be lifted by EOT crane hook to the floor at EL 355.397M. From were these segments will be taken out through material handling hatch (2000 x 4000) at EL 358.75M.

III. Construction of concrete pedestals of distributor

10 pedestals shall be required for supporting the distributor. These pedestals shall be constructed at a distance of about 1500mm (tentative) below distributor C.L. Location and sizes of pedestals shall be incorporated later after finalization of distributor drawing.

IV. Erection of new distributor (See Sheet 10 of the drawing)

Distributor segments shall be lowered to floor at EL 355.397M through material handling hatch. Thereafter, these segments will be lowered to the pedestals through crane hook. Local arrangement at site shall be done to handle the distributor segments from material hatch to the location were the segment is required to be placed as per Drawing "Arrangement of distributor (02021020901) ". Cut-outs are proposed at floor at EL 358.75M for creating crane hooks approach to EL 355.397.

V. Sheet 8 & 9 :-

These 2 sheets are showing the handling of distributor segments 2 & 3. In order to avoid concrete cutting pf barrel above 355.397, these segments are lowered to the pit from the position as shown and to pushed to the location above support pedestals.

VI. Concreting

After erection and testing of distributor, cavity at EL 355.397 M shall be filled with concrete. Some portion of new distributor is coming above EL floor at EL 351.892 M (MIV floor) . Concrete cover of minimum 800 mm is to be provided all along the exposed distributor as shown in sheet 8 of the drawing.

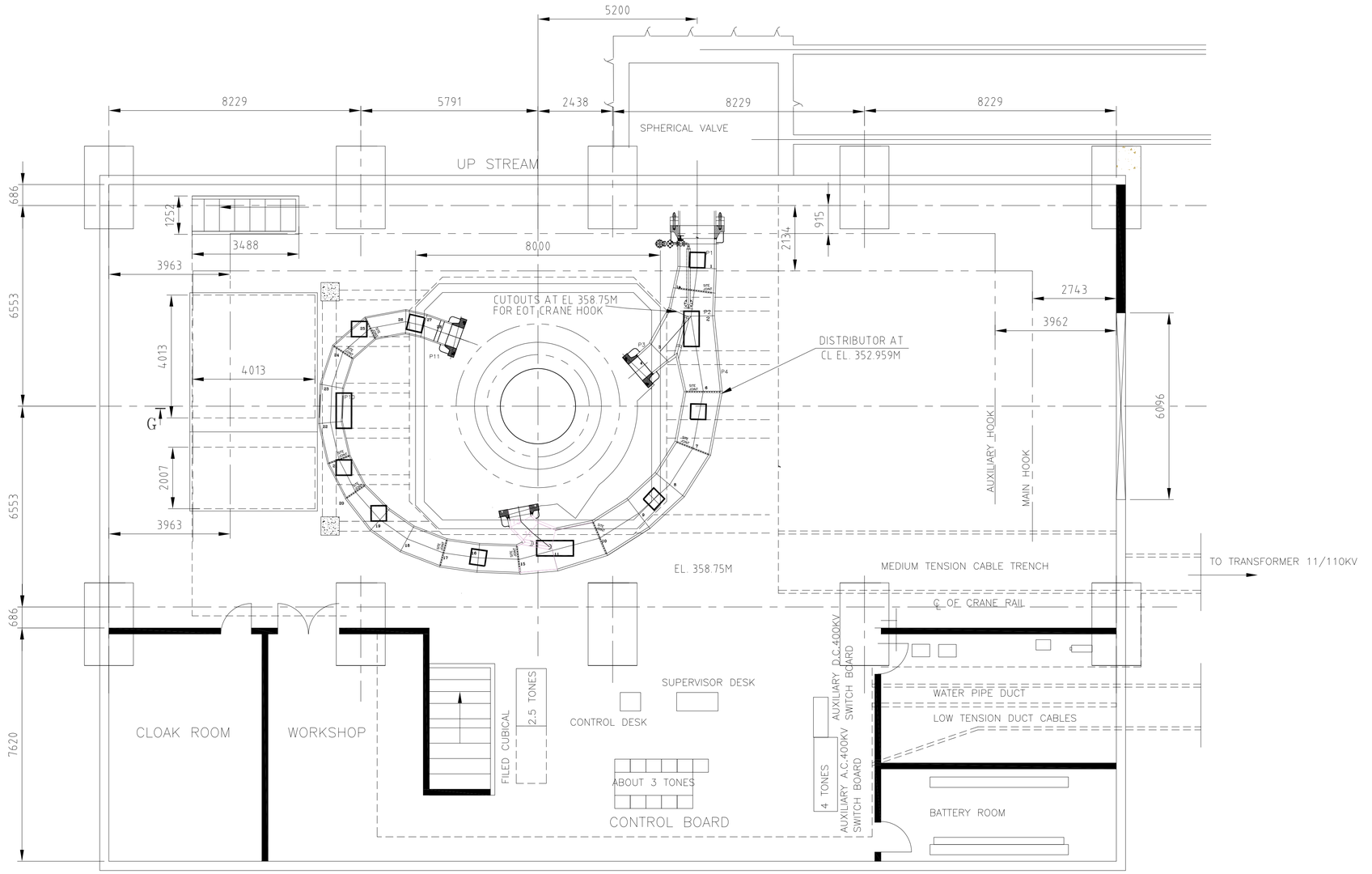
Note: - This document and drawing 'Civil Guidelines for Distributor erection & Dismantling Drawing no 12000020960 rev 00, 11 sheets is intended for showing the concrete cutting profile and cut outs for distributor dismantling/election. For installation & handling of distributor drawing 'Arrangement of Distributor' (dwg no- 02021020901) to be referred.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



PLAN AT EL 358.75M

DETAILS OF CUTOUTS REQUIRED AT EL 358.75M IN POWER HOUSE FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

REV.	DATE	ALTERED
		CHECKED
ZONE		APPD.

REV.	DATE	ALTERED
		CHECKED
ZONE		APPD.

REV.	DATE	ALTERED
		CHECKED
ZONE		APPD.

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB-VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO.

SUB-VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 01 | NO. OF SHT. 11

A1 SIZE

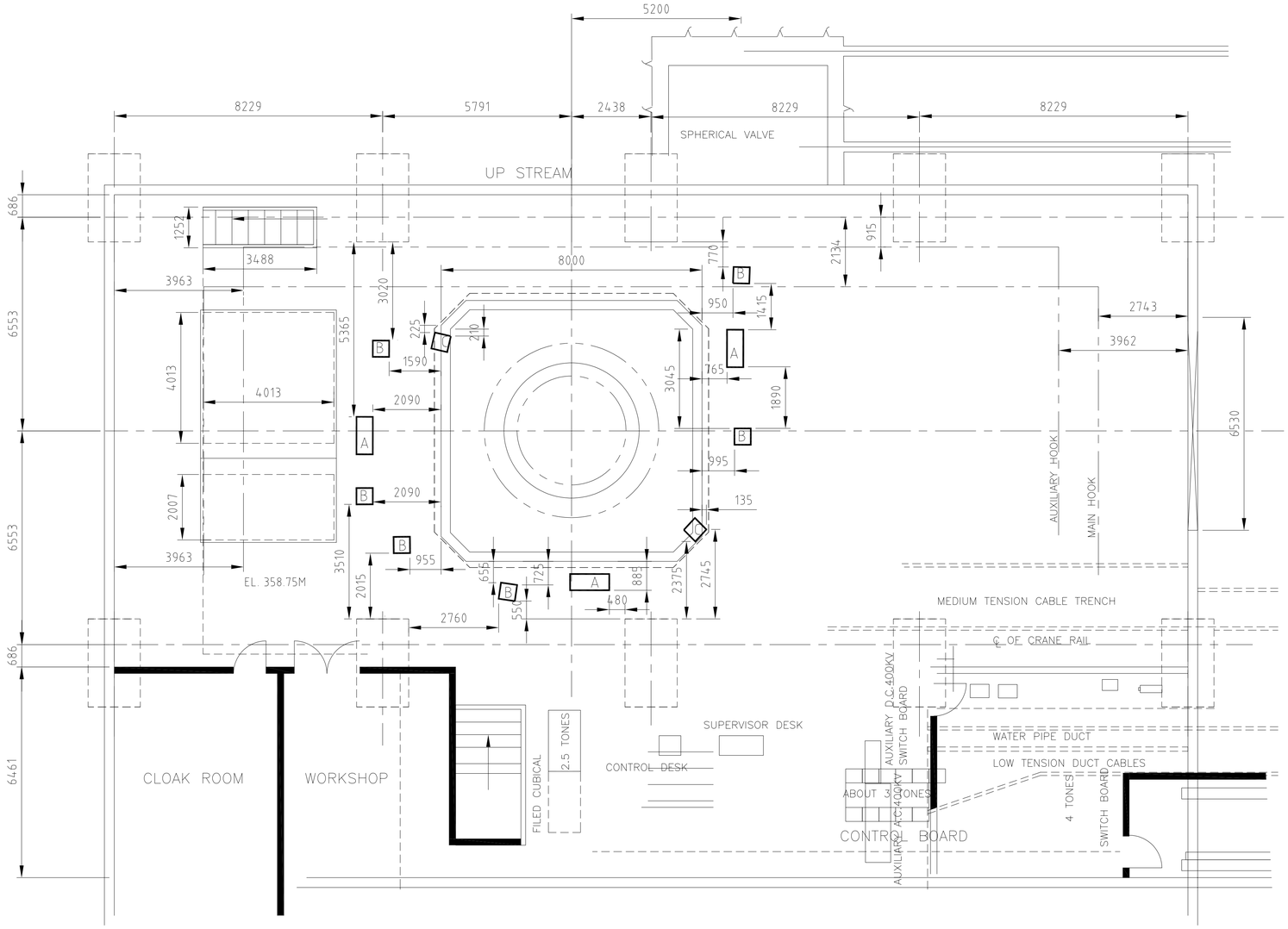
REF. DRG. NO. | SCH. & DATE | INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

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PLAN AT EL 358.75M
DETAILS OF CUTOUTS REQUIRED AT AT EL 358.75M FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

CUTOUT–A :– CUTOUT 500X1200 AT FLOOT AT EL358.75M FOR EOT CRANE MAIN HOOK FOR LIFTING DISTIBUTOR SEGMENT

CUTOUT–B :– CUTOUT 500X500 AT FLOOR AT EL358.75M FOR EOT CRANE HOOK SLING FOR LIFTING DISTRIBUTOR MAKE UP SEGMENT

CUTOUT–C :– CUTOUT FROM EL358.75M TO WL 355.397 FOR EOT CRANE HOOK SLING FOR LIFTING DISTRIBUTOR MAKE UP SEGMENT

(LOCATION AND SIZES OF CUTOUTS ARE TENTATIVE AND SHALL BE FINALIZED AFTER DETAIL ENGINEERING)

REV.	DATE	ALTERED
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REV.	DATE	ALTERED
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		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD. BHOPAL

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	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

DRG. NO.

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 02 | NO. OF SHT. 11

A1 SIZE

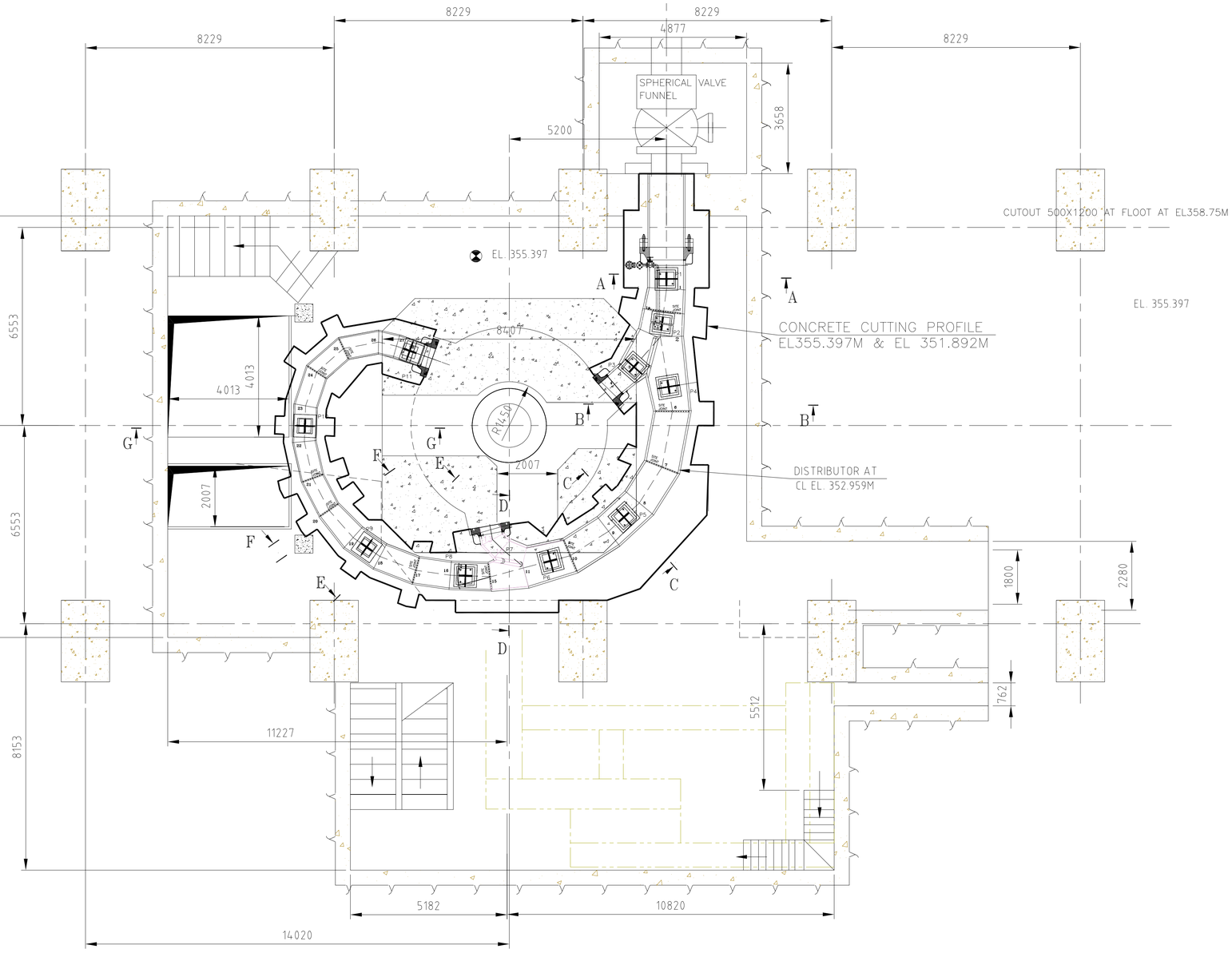
SIGN. & DATE | BPE DRG. NO. | INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

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PLAN AT EL 355.397M

DETAILS OF CONCRETE CUTTING PROFILE , REQUIRED AT EL 355.397M FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

REV.	DATE	ALTERED
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REV.	DATE	ALTERED
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		APPD.
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REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB-VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB-VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 03 | NO. OF SHT. 11

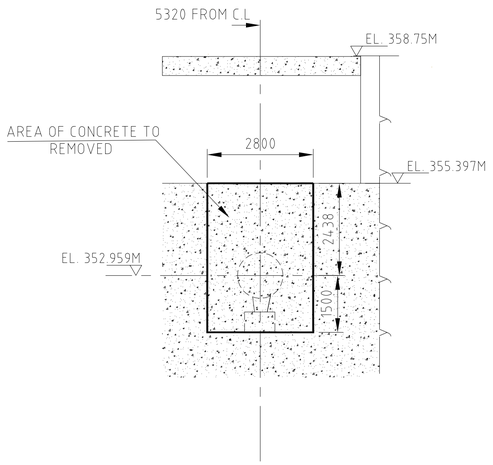
A1 SIZE

FIRST ANGLE PROJECTION

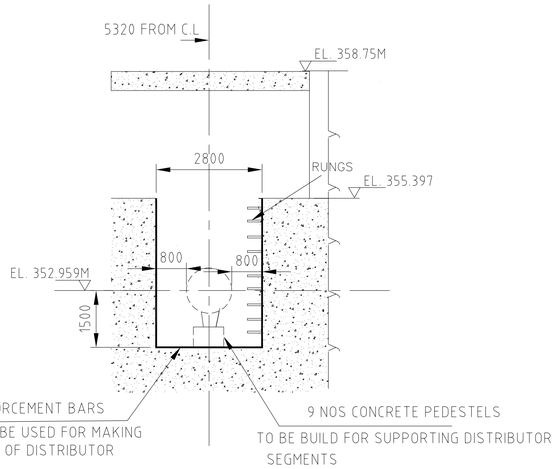
(ALL DIMENSIONS ARE IN mm)

DRG. NO.

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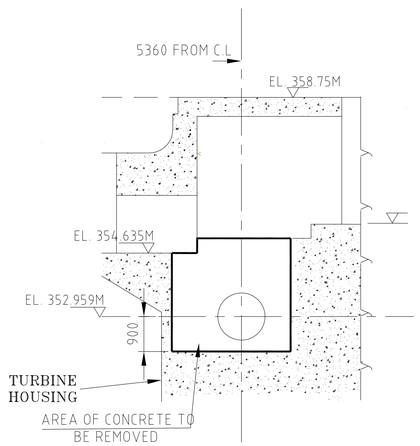


SECTION– AA

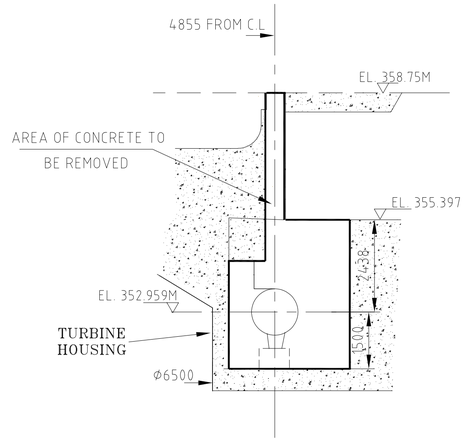


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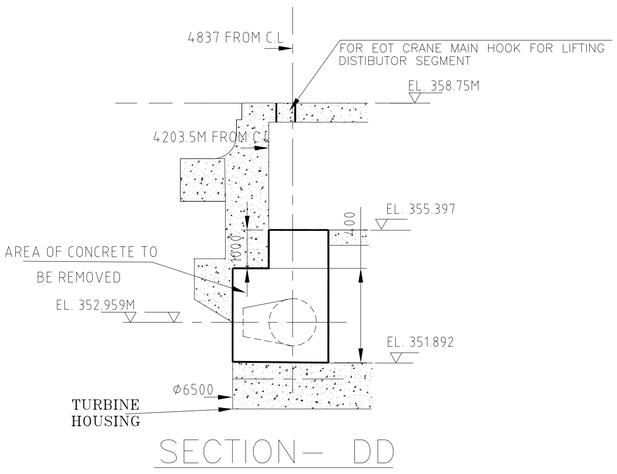
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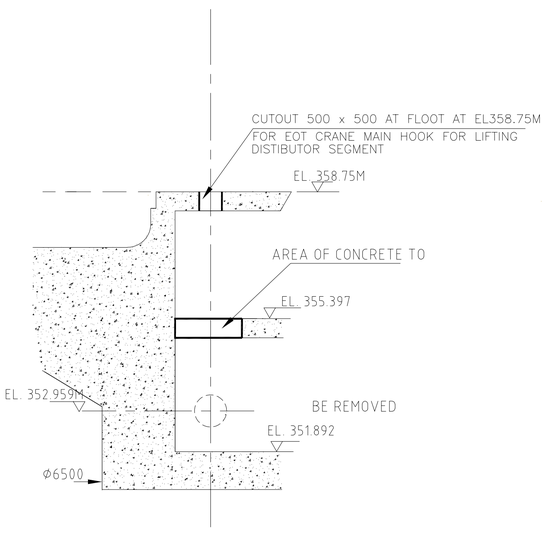
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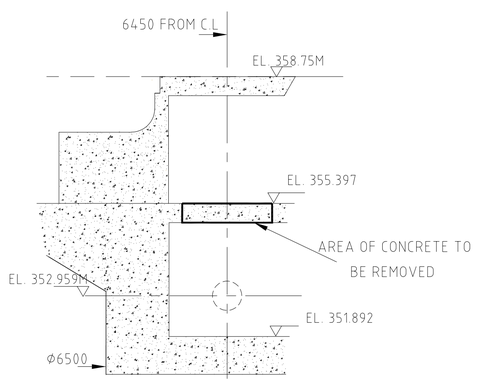
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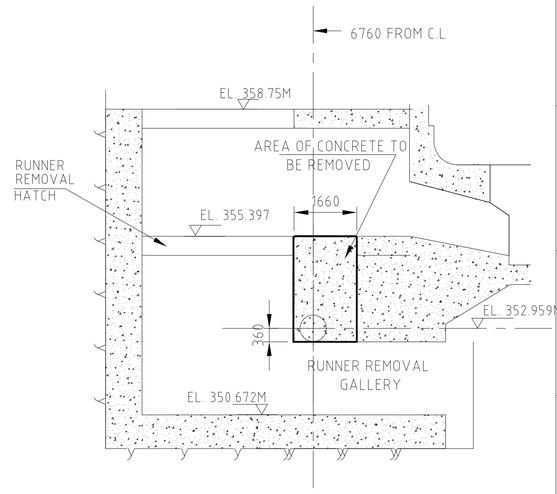
SECTION– DD



SECTION– EE



SECTION– FF



SECTION– GG

NOTES:–

1) THIS DRAWING IS INTENDED FOR FINALIZING THE PROCESS OF DISMANTLING OF EXISTING DISTRIBUTOR AND ERECTION OF NEW ONE.
2) DIMENSIONS OF CONCRETE CUTTING PROFILE ARE INDICATIVE AND SHALL BE REVIEWED AFTER FINALIZATION OF DISTRIBUTOR DESIGN BY TURBINE DIVISION,
3) CONCRETE CUTTING PROFILE INSIDE THE BARREL IS TENTATIVE AND TO BE FINALIZED LATER AFTER MEASUREMENT OF BARREL INSIDE DIMENSIONS AFTER MACHINE DISMANTLING.

CONCRETE CUTTING AT EL 351.892M
ABOUT 400 DEEP (SEE SECTION EE & FF)

REV.	DATE	ALTERED
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REV.	DATE	ALTERED
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		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 04 | NO. OF SHT. 11

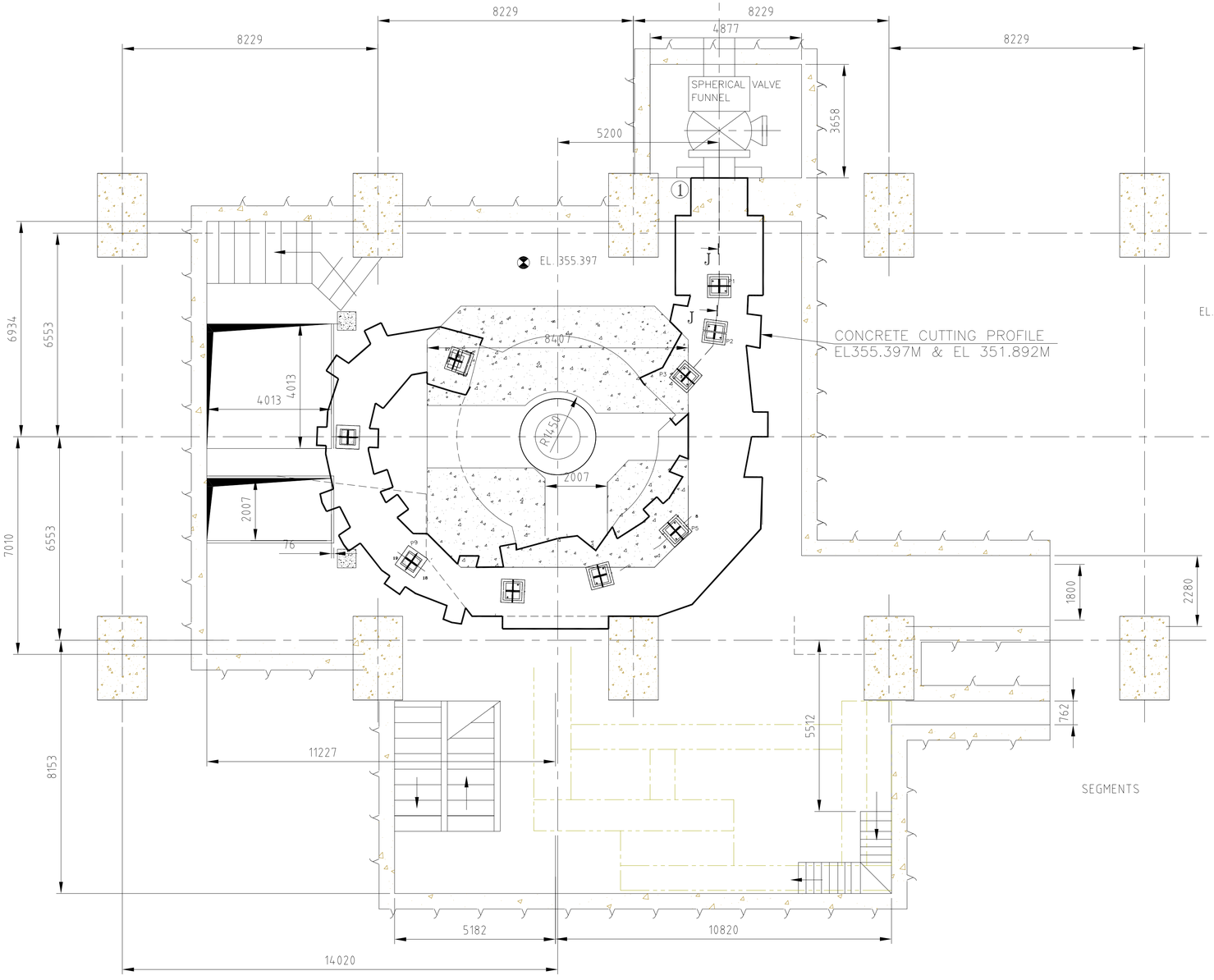
A1 SIZE

INVENTORY NO. | SIGN. & DATE | REF. DRG. NO.

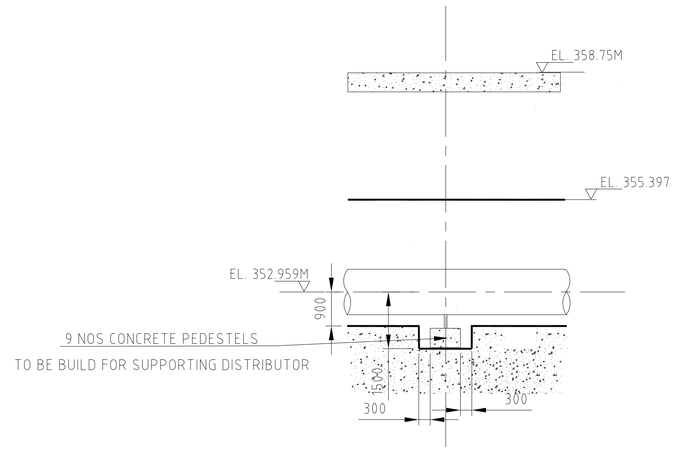
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.



PLAN AT EL 355.397M



SECTION– JJ

(AFTER REMOVAL OF CONCRETE)

TYPICAL VIEW AROUND ALL PEDESTALS (EXCEPT P9)

DETAILS OF CONCRETE CUTTING PROFILE , REQUIRED AT EL 355.397M FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD. BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 05 | NO. OF SHT. 11

A1 SIZE

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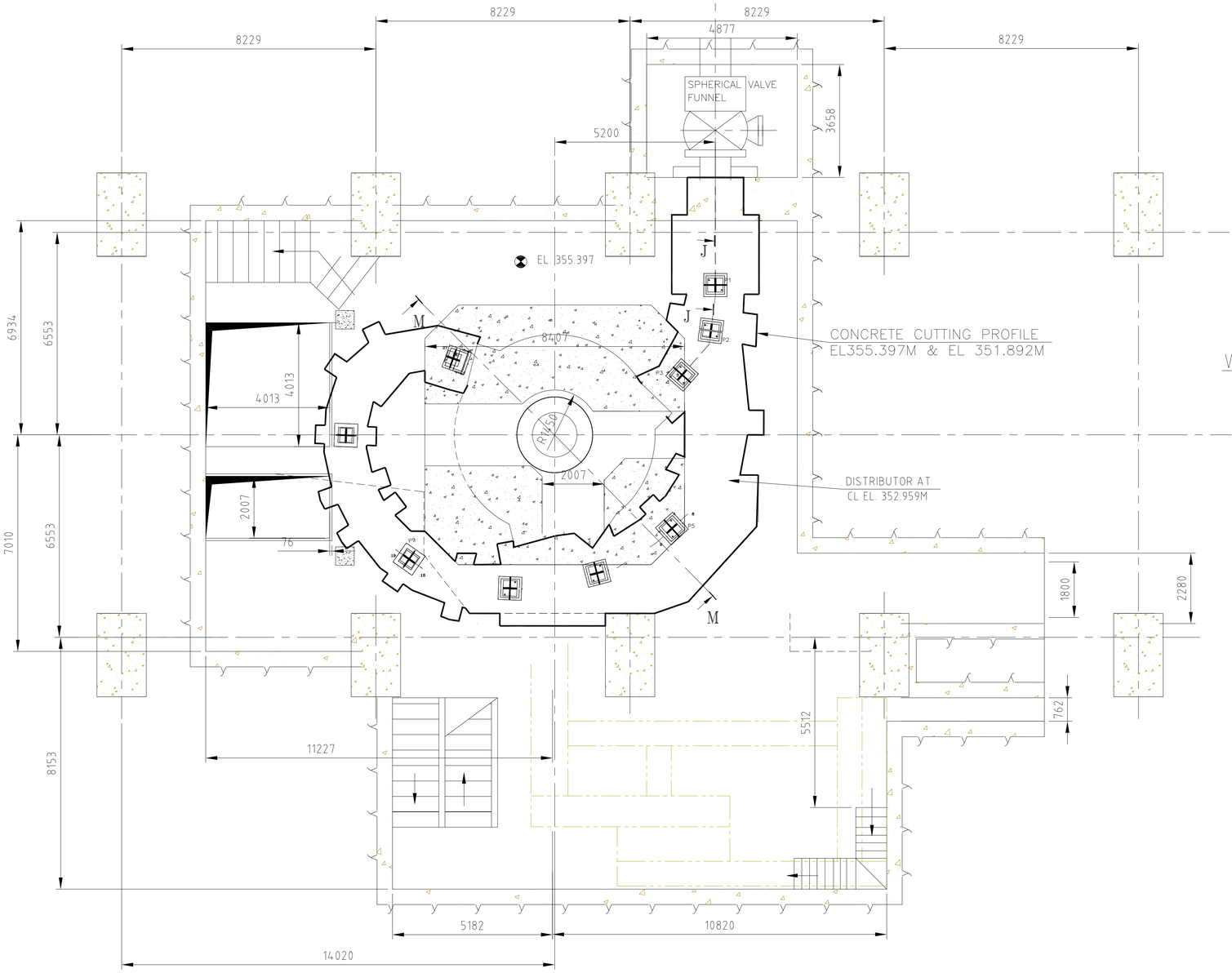
SIGN. & DATE | REF. DRG. NO. | WORK NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

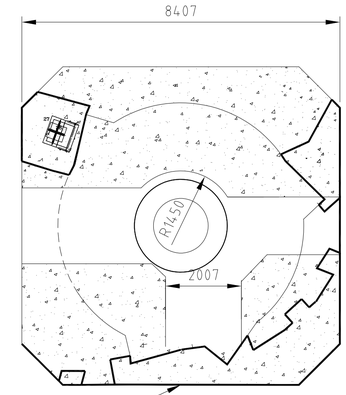
DRG. NO.

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

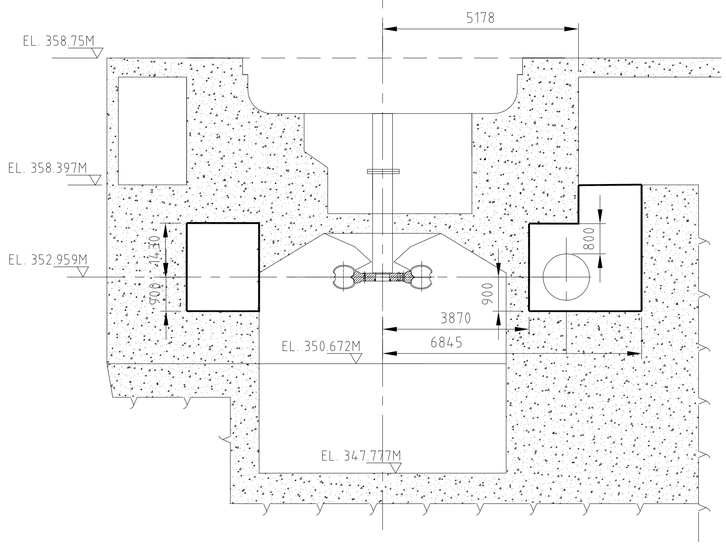


PLAN AT EL 355.397M

DETAILS OF CONCRETE CUTTING PROFILE BELOW BARREL AT EL 355.937M
(SHOWING PORTION OF BARREL ABOVE EL 355.397M WHICH WILL REMAIN OVERHANG
AFTER CONCRETE CUTTING



PROFILE OF BARREL ABOVE EL 355.397M
WHICH WILL REMAIN OVERHUNG AFTER CONCRETE CUTTING



SECTION–MM

(AFTER CONCRETE REMOVAL)

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 06 | NO. OF SHT. 11

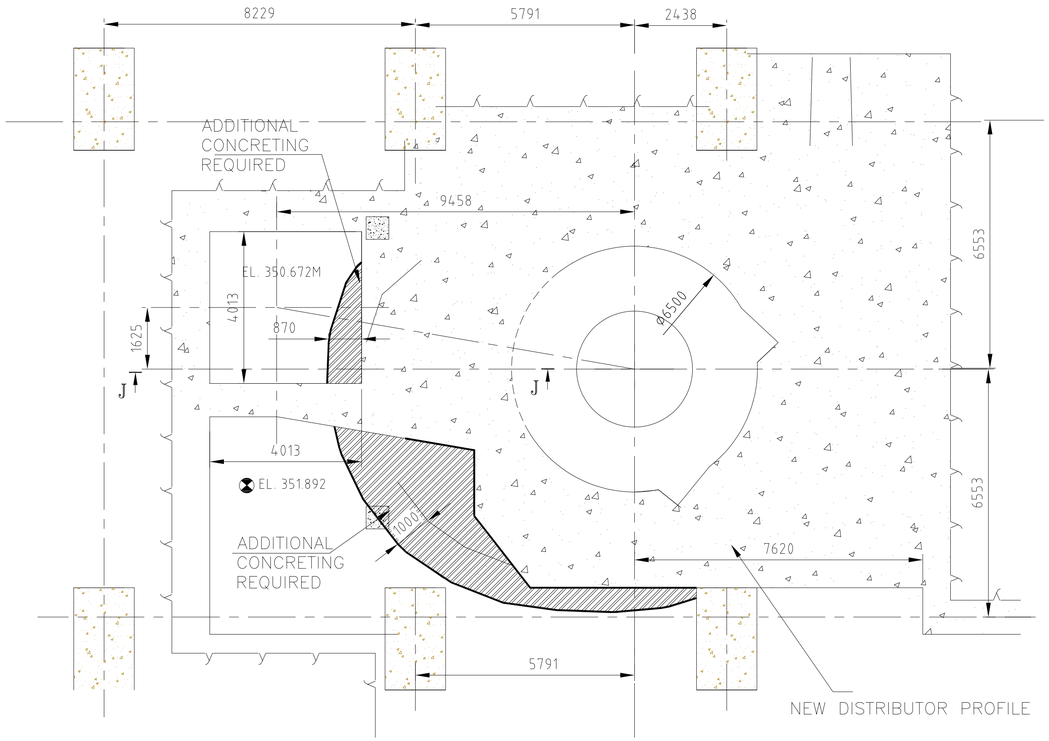
A1 SIZE

FIRST ANGLE PROJECTION

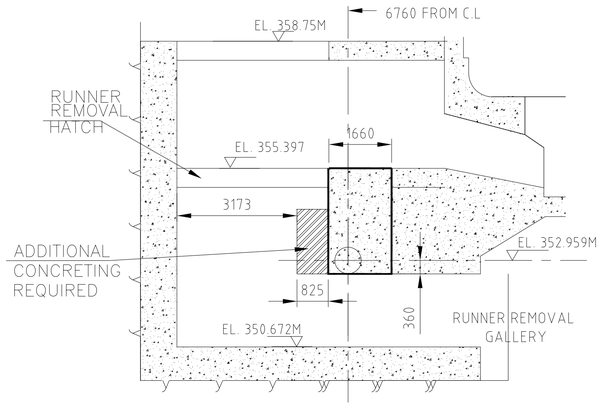
(ALL DIMENSIONS ARE IN mm)

DRG. NO.

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



DETAILS OF CONCRETING REQUIRED AROUND DISTRIBUTOR AT EL 351.892M



SECTION– JJ

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD. BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 07 | NO. OF SHT. 11

A1 SIZE

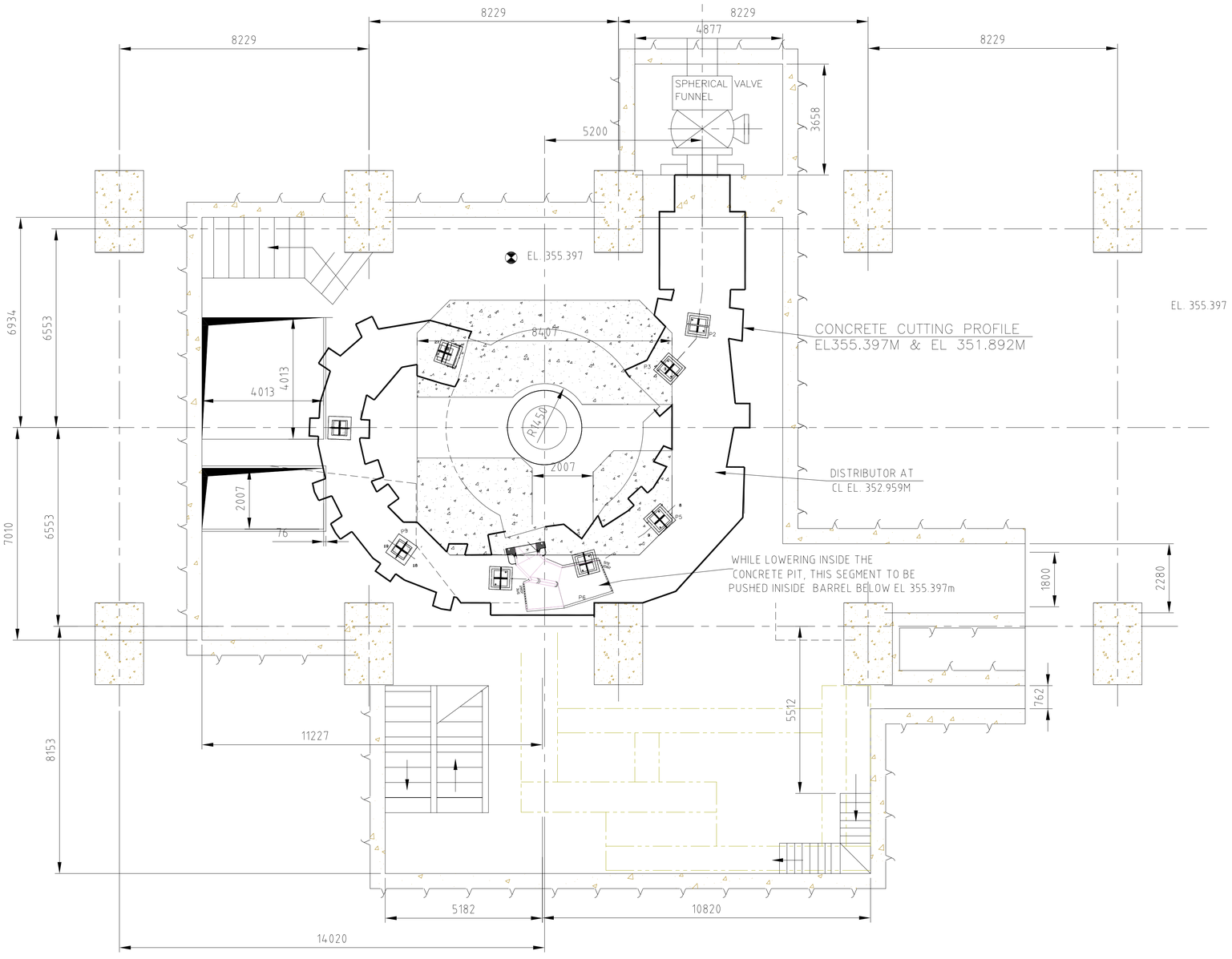
INDENT/WORK NO. | SIGN. & DATE | RET. DRG. NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



PLAN AT EL 355.397M

HANDLING OF DISTRIBUTOR Y BRANCH –2

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 08 | NO. OF SHT. 11

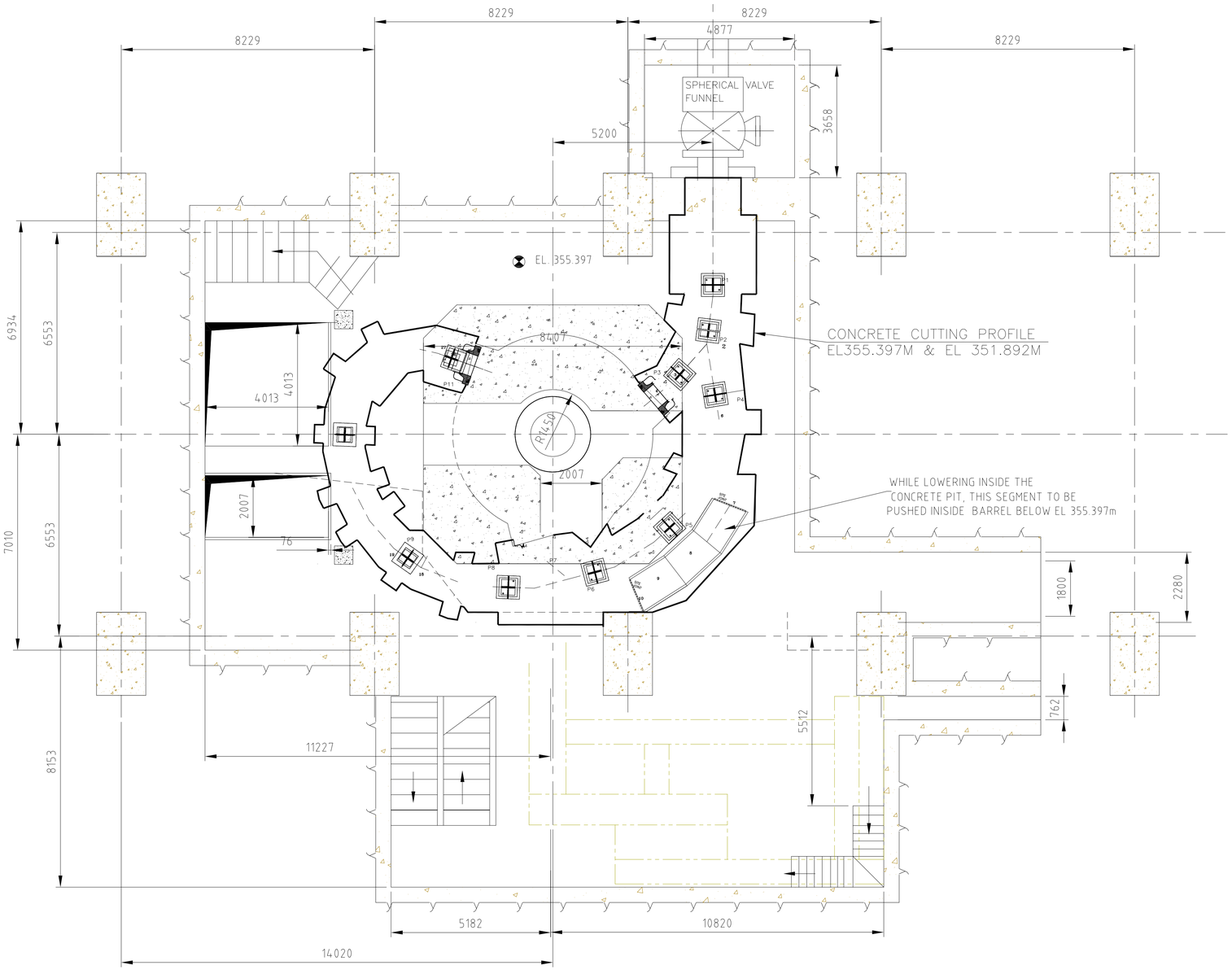
A1 SIZE

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



PLAN AT EL 355.397M

DETAILS OF CONCRETE CUTTING PROFILE , REQUIRED AT EL 355.397M FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB-VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB-VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 09 | NO. OF SHT. 11

A1 SIZE

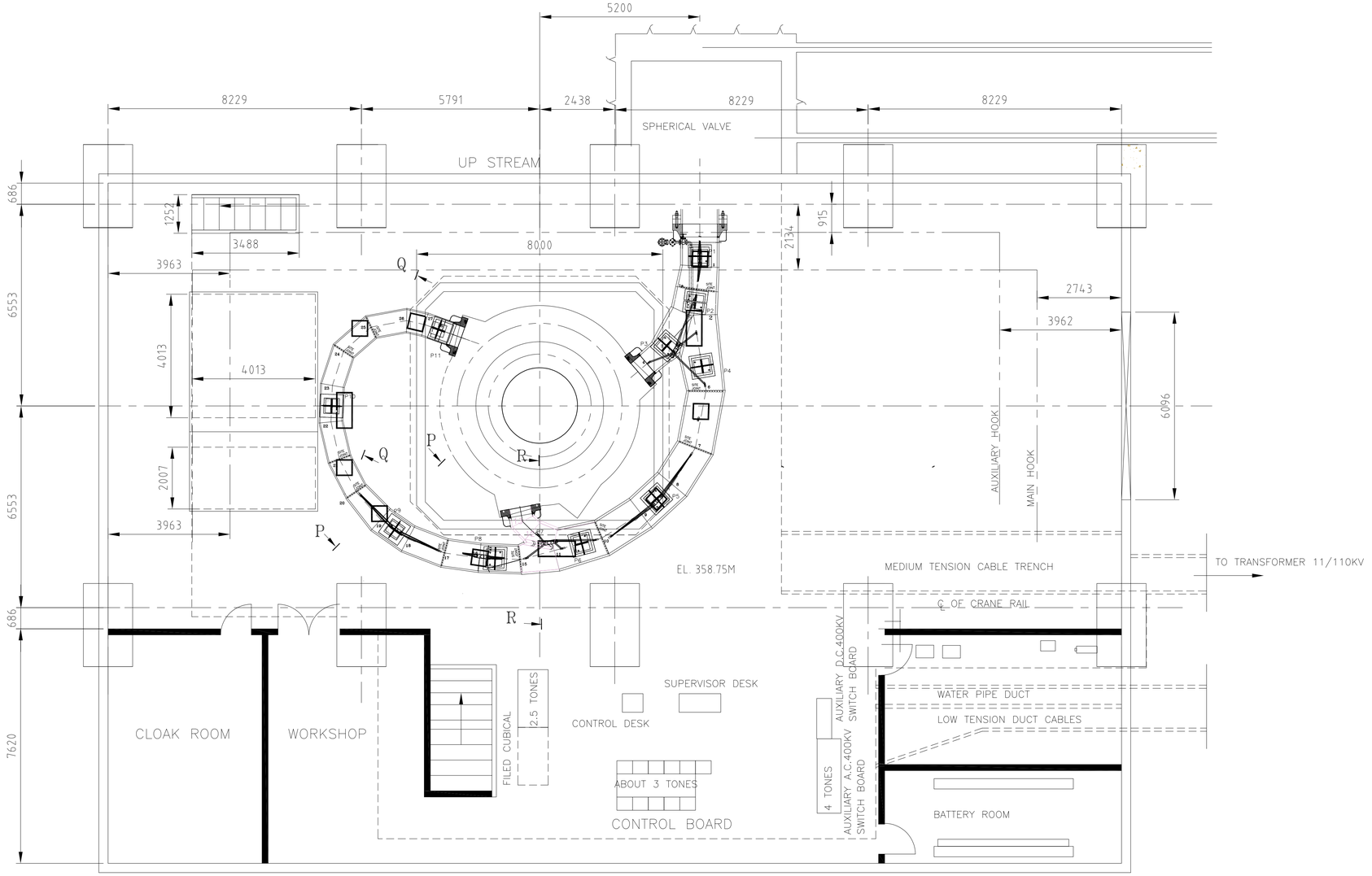
INVENTORY NO. | SIGN. & DATE | REF. DRG. NO.

FIRST ANGLE PROJECTION

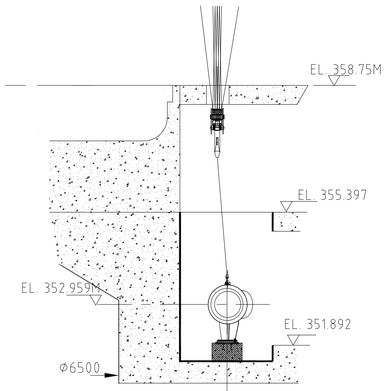
(ALL DIMENSIONS ARE IN mm)

DRG. NO.

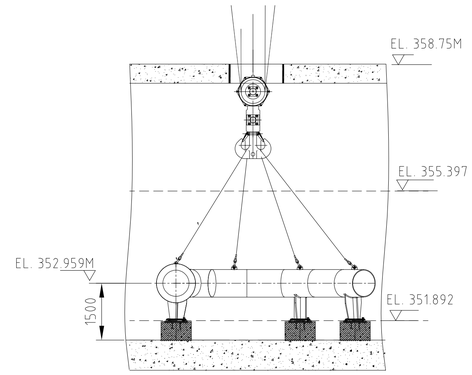
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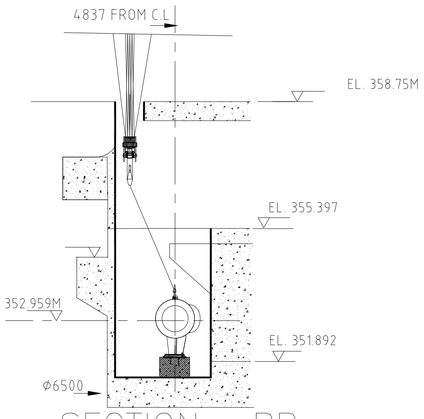
PLAN AT EL 358.75M



SECTION– PP



SECTION– QQ



SECTION– RR

SKETCH SHOWING HANDLING OF DISTRIBUTOR SEGMENTS DURING ERECTION

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD. BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15.07.21	
	CKD	SHAILESH		15.07.21	
	APPD	R.S		15.07.21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE 1:80

BHEL DRG. NO. 12000020960 | REV. 00

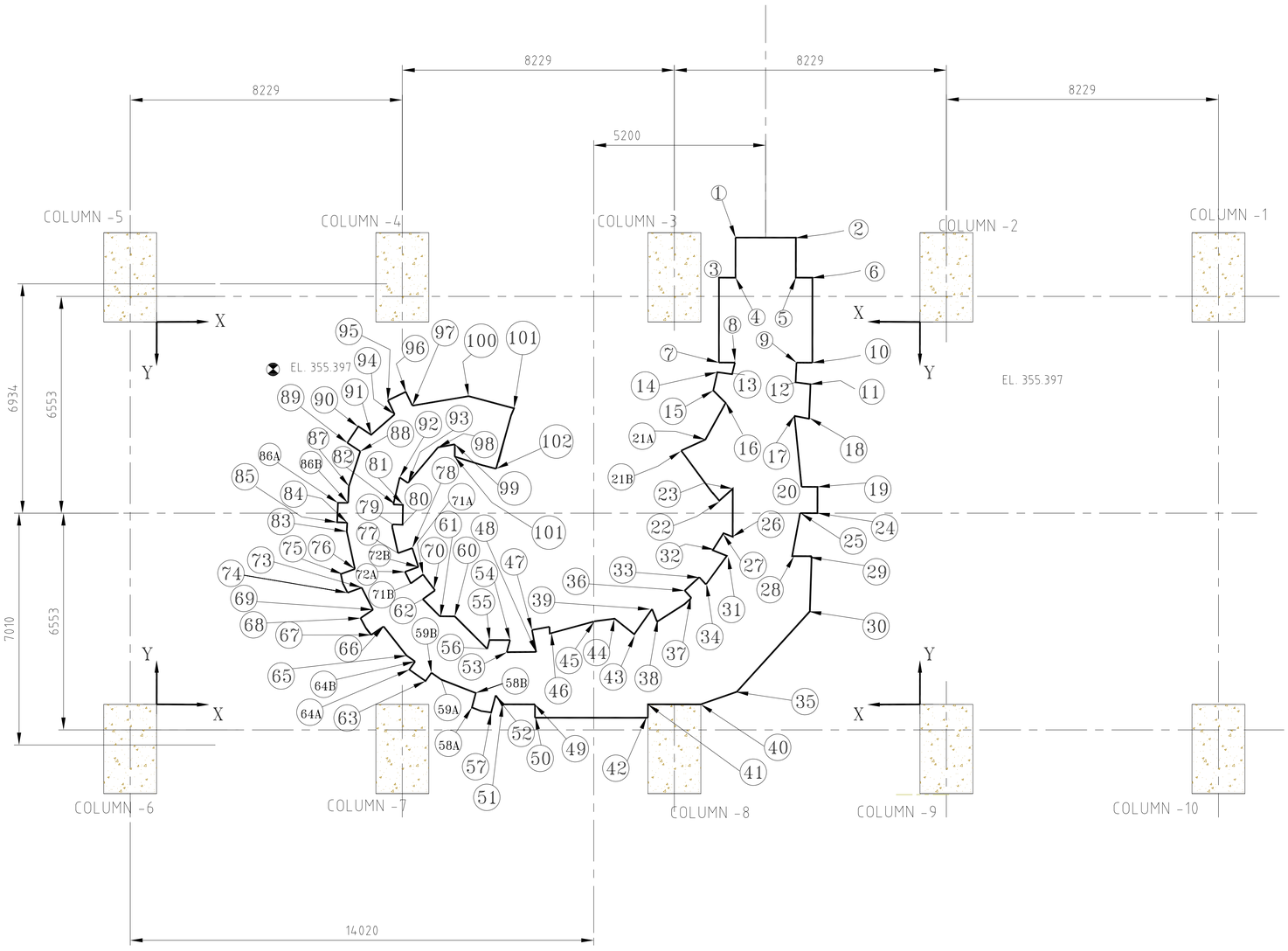
SHEET NO. 10 | NO. OF SHT. 11

A1 SIZE

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.



COORDINATES OF POINTS 1 TO 25 WITH REFERENCE TO COLUMN–2

POINT NO	X	Y
1	5580	-2551
2	3755	-2551
3	6079	-1340
4	5579	-1340
5	3755	-1340
6	3255	-1340
7	6079	1228
8	5597	1228
9	3737	1230
10	3255	1230
11	3312	1884
12	3760	1826
13	5682	1579
14	6130	1520
15	6250	2074
16	5878	2445
17	3797	2842
18	3354	2926
19	3100	4985
20	3579	4985
21A	6485	3555
21B	7222	3891
22	6068	5404
23	5663	5041
24	3100	5780
25	3604	5780

COORDINATES OF POINTS 26 TO 45 WITH REFERENCE TO COLUMN–9

POINT NO	X	Y
26	5664	5070
27	5941	5173
28	3866	4479
29	3279	4479
30	3329	2830
31	5841	4489
32	6268	4654
33	6676	3843
34	6465	3634
35	5538	380
36	7118	3438
37	6914	3217
38	7951	2496
39	8106	2881
40	6629	0000
41	8229	0000
42	8229	-405
43	8641	2117
44	9234	2590
45	9852	2503

COORDINATES OF POINTS 46 TO 85 WITH REFERENCE TO COLUMN–6

POINT NO	X	Y
46	11891	2141
47	11352	2247
48	11477	1577
49	11442	000
50	11442	-404
51	10463	000
52	10253	260
53	10591	1577
54	10687	1945
55	10067	1945
56	9998	1679
57	10117	-244
58A	9537	-94
58B	9651	344
59A	8611	747
59B	8301	955
60	9017	2660
61	8566	2660
62	8050	3178
63	8133	704
64A	7642	1049
64B	7816	1296
65	7554	1471
66	6863	2353
67	6490	2100
68	6167	2605
69	6545	2863
70	8418	3446
71A	8056	3925
71B	7688	3656
72A	7508	4005
72B	7917	4154
73	6202	3530
74	5775	3375
75	5570	3947
76	5997	4094
77	7303	4570
78	7729	4725
79	7129	5442
80	7438	5431
81	7415	6030
82	7158	6041
83	5750	5224
84	5760	5493
85	5461	5505

COORDINATES OF POINTS 86 TO 103 WITH REFERENCE TO COLUMN–5

POINT NO	X	Y
86A	5483	5456
86B	5790	5456
87	5813	4967
88	6156	3913
89	5767	3656
90	6090	3170
91	6487	3413
92	7350	4701
93	7602	4867
94	7196	2792
95	6993	2372
96	7542	2129
97	7737	2531
98	8511	3790
99	9017	3698
100	9433	2243
101	10807	2611
102	10266	4435

PLAN AT EL 355.397M

COORDINATRS OF OF CONCRETE CUTTING PROFILE , REQUIRED AT EL 355.397M FOR REMOVAL OF EXISTING DISTRIBUTOR AND ERECTION OF NEW DISTRIBUTOR

REV.	DATE	ALTERED / CHECKED / APPD.
ZONE		

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD. BHOPAL

DEPT. CODE		NAME	SIGN	DATE	NO. OF VAR
HPE 415	DRN	T.KHAN		15/07/21	
	CKD	SHAILESH		15/07/21	
	APPD	R.S		15/07/21	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE

BHEL DRG. NO. 12000020960 | REV. 00

SHEET NO. 11 | NO. OF SHT. 11

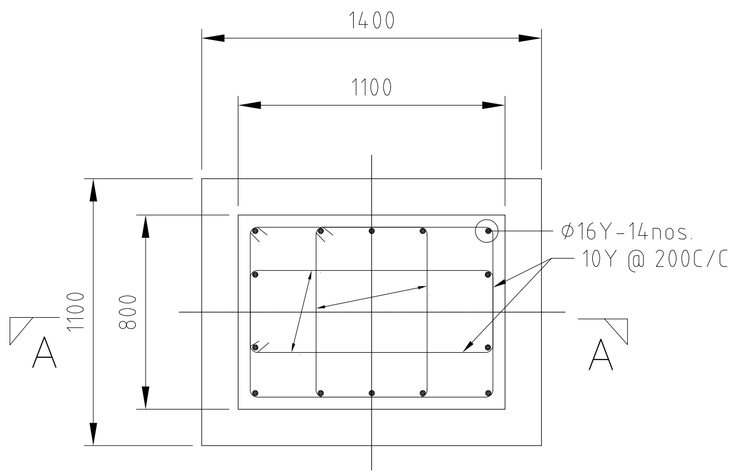
A1 SIZE

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

FIRST ANGLE PROJECTION

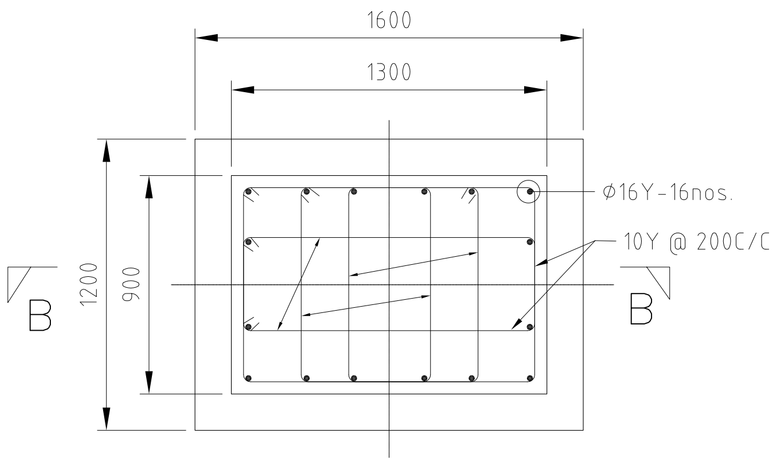
(ALL DIMENSIONS ARE IN mm)

DRG. NO.



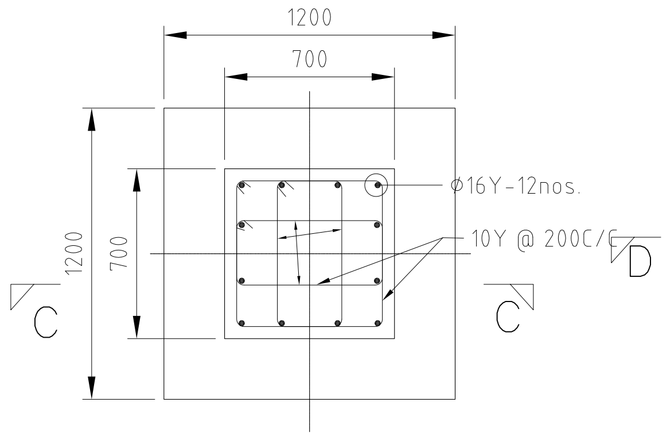
PEDESTAL MARKED P1

FOOTING MARKED F1



PEDESTAL MARKED P2

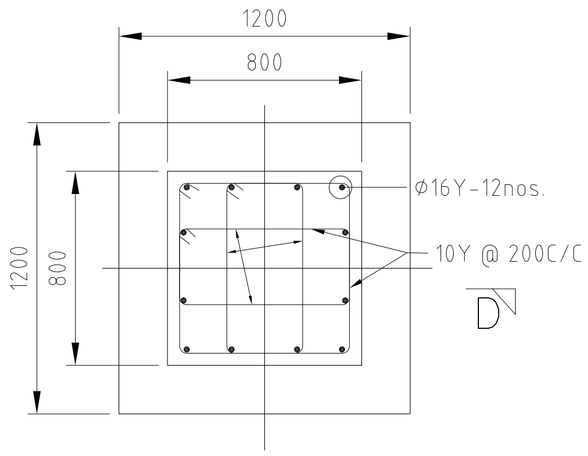
FOOTING MARKED F2



PEDESTAL MARKED P3,

P7, P9, P10, P11

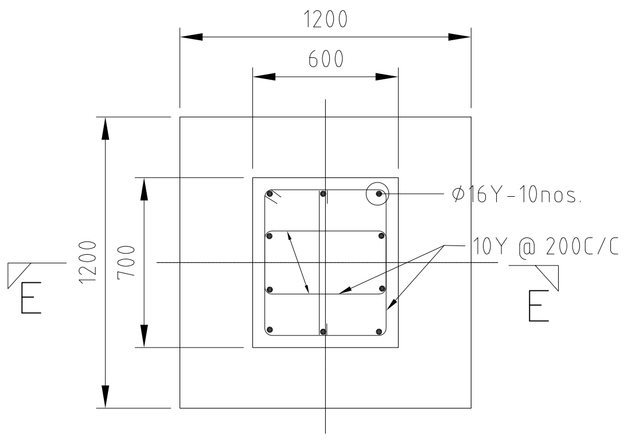
FOOTING MARKED F3



PEDESTAL MARKED P4,

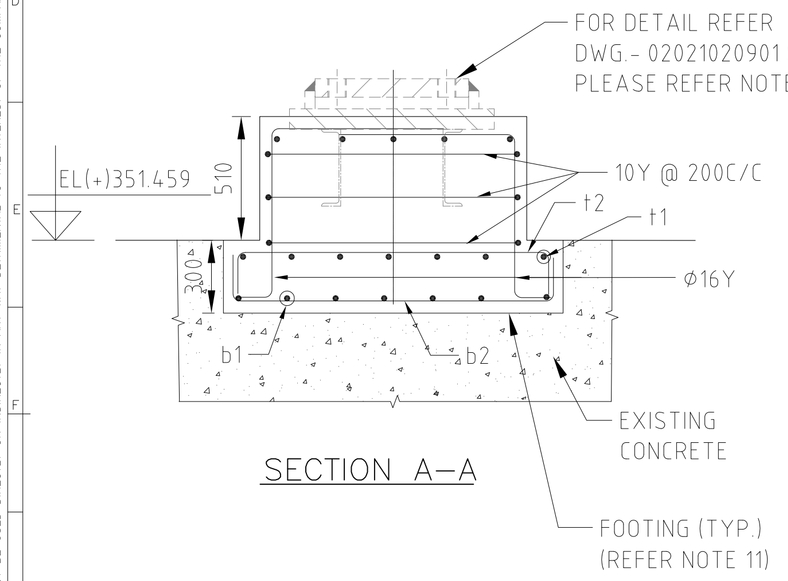
P5, P6

FOOTING MARKED F4

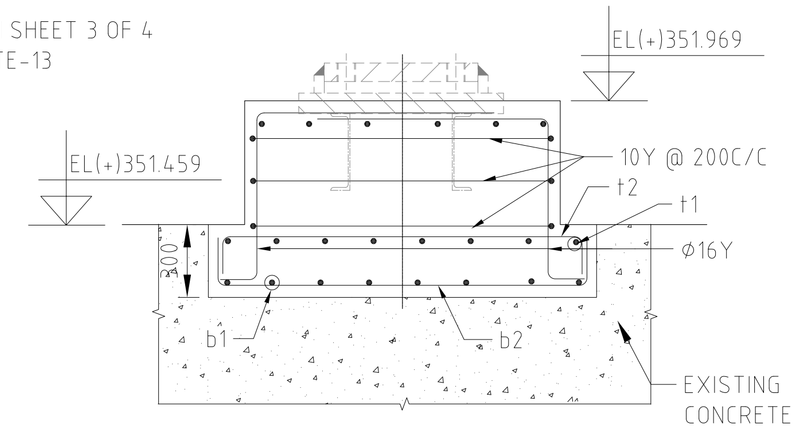


PEDESTAL MARKED P8

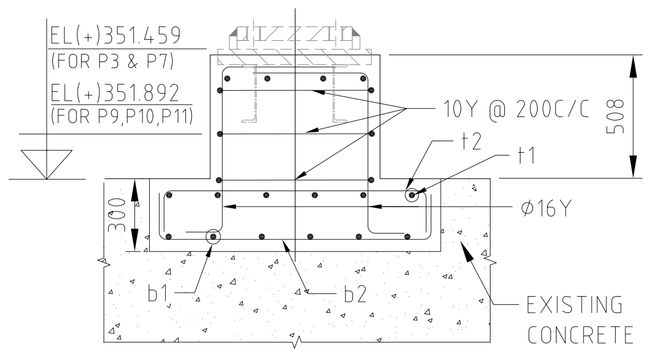
FOOTING MARKED F5



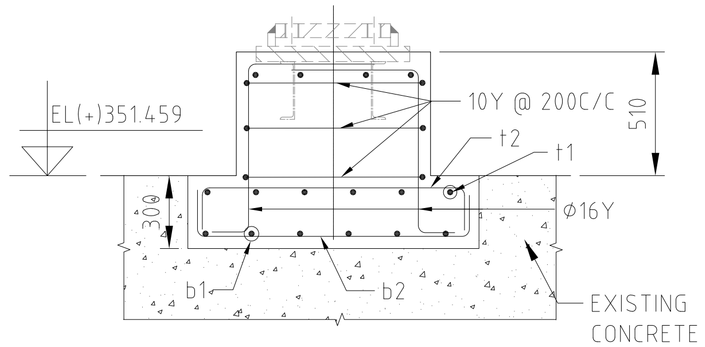
SECTION A–A



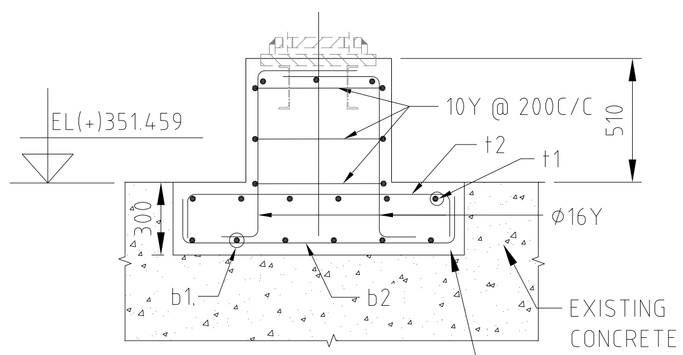
SECTION B–B



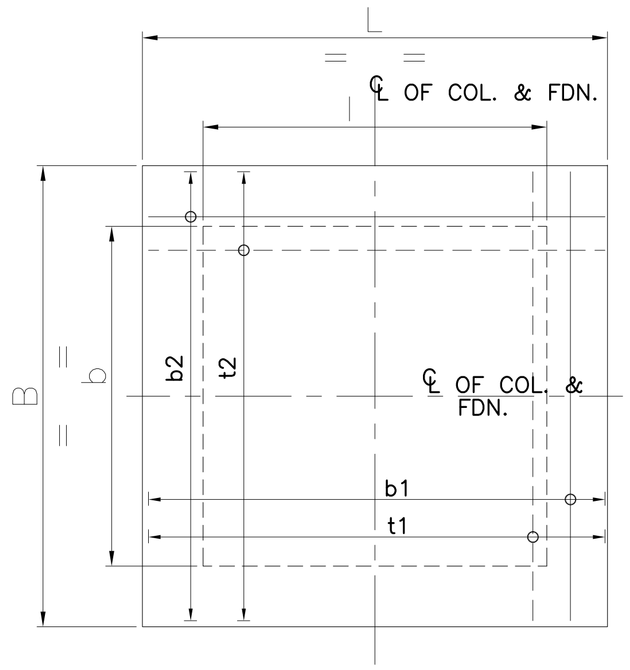
SECTION C–C



SECTION D–D



SECTION E–E



TYP. REINF. DETAILS OF FOOTING

NOTES: –

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, TECHNICAL SPECIFICATIONS AND SCHEDULE OF ITEMS.
2. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
3. ALL MATERIAL, QUALITY TESTING, STORAGE, FORM WORK, CONCRETE MIXING, PLACEMENT OF REINFORCEMENT & CONCRETE, WORKMANSHIP, SAFETY, ETC. SHALL CONFORM TO IS:456 & THE TECHNICAL SPECIFICATIONS.
4. REINFORCED CONCRETE USED SHALL BE OF GRADE M30 CONFORMING TO IS:456–2000.
5. REINFORCEMENT BARS USED SHALL BE TMT STEEL BARS FE500 CONFORMING TO IS:1786 WITH MIN. 14.5% ELONGATION
6. MINIMUM CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS:–

	SIDES	TOP	BOTTOM
(a). FOUNDATION	50MM	50MM	50MM
(b). PEDESTAL	50MM	50MM	––

7. ALL HOOKS, BENDS AND LAPS OF REINFORCEMENT BARS SHALL CONFORM TO IS: 2502 – (LATEST REVISION) UNLESS OTHERWISE NOTED.
8. LAPS SHALL BE STAGGERED AS FAR AS POSSIBLE. MINIMUM LENGTH OF LAP SHALL BE FIFTY (50) TIMES DIAMETER OF BARS UNLESS NOTED OTHERWISE.
9. DEVELOPMENT LENGTH, Ld SHALL BE 50 TIMES DIAMETER OF BARS UNO.
10. REINFORCEMENTS MAY SUITABLY BE ADJUSTED AT SITE, IF REQUIRED, TO CLEAR POCKETS, ANCHOR BOLTS ETC.
11. DISMANTLING OF EXISTING CONCRETE FOR INCORPORATING FOOTING SHALL BE DONE AS PER SITE CONDITIONS.
12. THE SURFACE OF EXISTING CONCRETE SHALL BE ROUGHED AND PROVIDED SUITABLE CHEMICAL TREATMENT FOR BONDING OF OLD AND NEW CONCRETE(AS PER RECOMMENDATION OF MANUFACTURER) BEFORE PLACING FRESH CONCRETE.
13. CARE SHALL BE TAKEN TO PROVIDE ALL THE EMBEDMENTS, BLOCK OUTS AS PER RELEVANT MECHANICAL DRAWING BEFORE CONCRETING.
14. IN CASE ANY OPENING IS ENCOUNTERED BELOW PEDESTALS, SUITABLE TEMPORARY SUPPORT FOR PEDESTAL SHALL BE INSTALLED.

R1 15. CORNER BARS (4NOS.) OF ALL PEDESTALS TO BE LAP BONDED WITH 16ø REBAR (4NOS. IN EACH PEDESTAL). REBAR SHALL BE ANCHORED IN EXISTING CONCRETE.

ENGINEERING REFERENCE DRAWINGS : –

1. 0–20210–20901 SHEET NO 1,2,3,4 – ARRANGEMENT OF DISTRIBUTOR
2. 12000020960 SHEET NO. 1,2,3,4,5,6– CIVIL GUIDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

LEGENDS

1. FFL ----------FINISH FLOOR LEVEL
2. TOG ----------TOP OF GROUT
3. TOC ----------TOP OF CONCRETE
4. PL ----------PLATE
5. U.N.O. ---------- UNLESS NOTED OTHERWISE.
6. ℄ ----------CENTER LINE
7. TYP. ----------TYPICAL

IMPORTANT NOTE:

CUTTING OF EXISTING REINFORCEMENT TO BE AVOIDED AND EXISTING REINFORCEMENT DETAILS TO BE SHARED WITH DESIGNER BEFORE TAKING UP THE WORK.

FOOTING SCHDULE

FOOT. MKD.	FOOTING SIZE			BOTTOM REINFORCEMENT		TOP REINFORCEMENT	
	L	B	D	BOTTOM (b1)	BOTTOM (b2)	TOP (t1)	TOP (t2)
F1	1400	1100	300	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C
F2	1600	1200	300	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C
F3	1200	1200	300	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C
F4	1200	1200	300	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C
F5	1200	1200	300	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C	12Y @200 C/C

PLAN OF MANIFOLD PEDESTALS AND FOOTINGS

(REFER DRAWING NO. –02021020901 SHEET 1 OF 4 FOR LOCATION AND ORIENTATION)

REV.	DATE	ALTERED / CHECKED / APPD.	ZONE
01	04.03.23	ALTERED SKS / CHECKED SD / MKP / APPD. DKM	REVISED AS PER LATEST INPUTS.

NOTE:- Scan QR code for checking the latest revision status of the drg.

CUSTOMER : TANGEDCO

PROJECT: KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

	NAME	SIGN	DATE
DRN	SKS		10.10.2022
CKD	PUNAM/MKP		10.10.2022
APPD	SP		10.10.2022

NO. OF VAR

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE: CIVIL DRAWING FOR MODIFICATION WORKS
GA & RC DETAILS FOR MANIFOLD PEDESTALS

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE

BHEL DRG. NO. PE–DG–470–600–C001 | REV. 01

SHEET NO. 01 | NO. OF SHT. 04

A1 SIZE

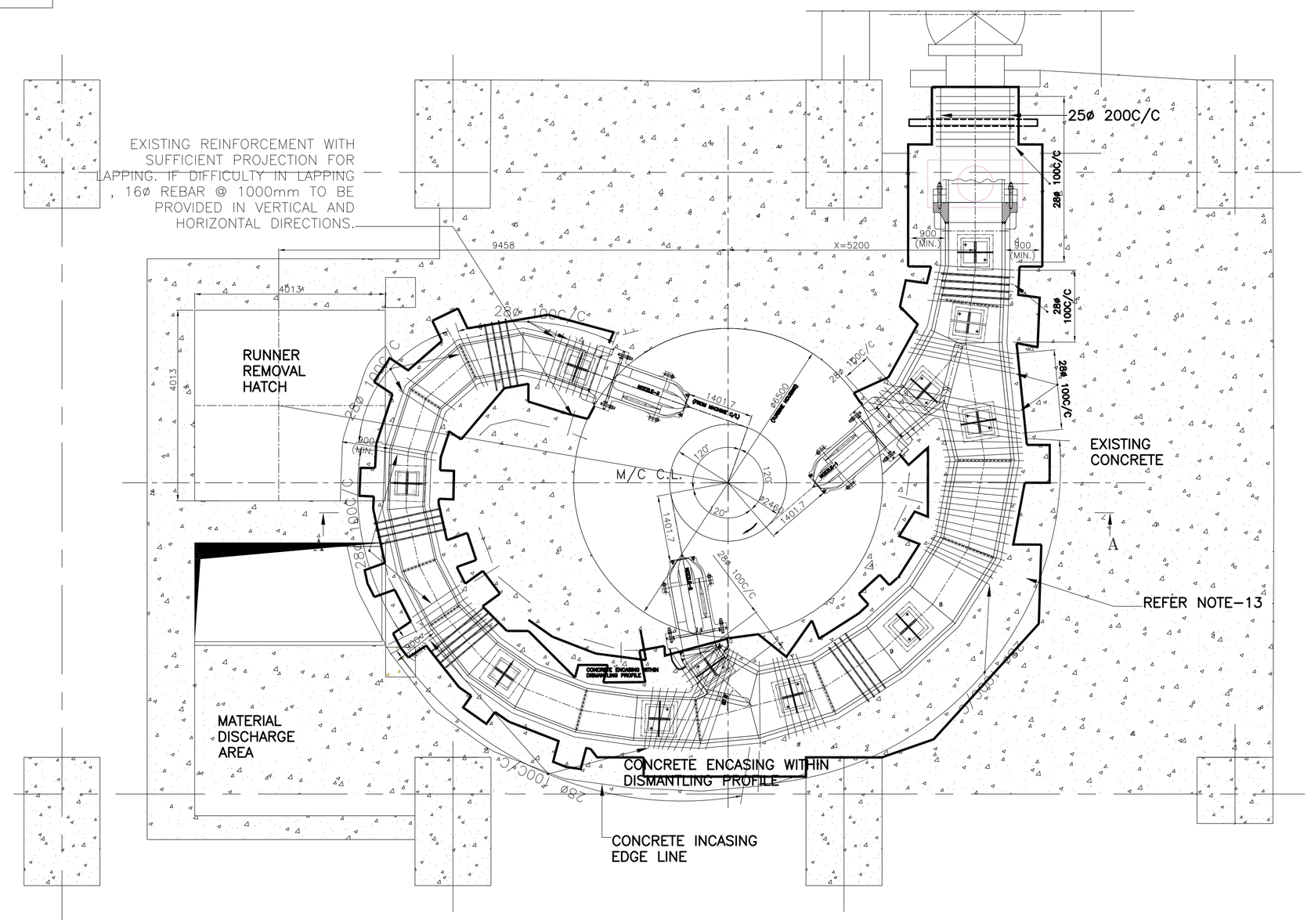
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REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

FIRST ANGLE PROJECTION

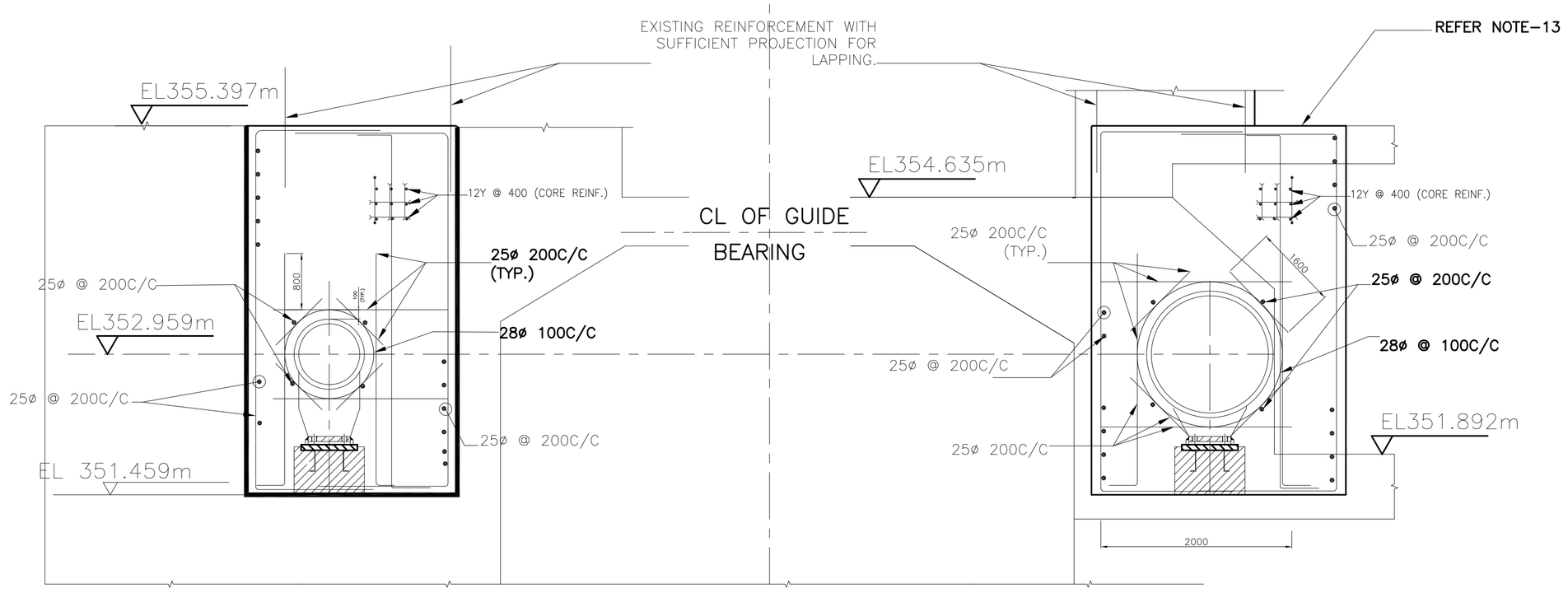
(ALL DIMENSIONS ARE IN mm)

DRG. NO.



PLAN VIEW

PLAN AT EL 352.959m



SECTION-A-A

NOTES: -

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, TECHNICAL SPECIFICATIONS AND SCHEDULE OF ITEMS.
2. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
3. ALL MATERIAL, QUALITY TESTING, STORAGE, FORM WORK, CONCRETE MIXING, PLACEMENT OF REINFORCEMENT & CONCRETE, WORKMANSHIP, SAFETY, ETC. SHALL CONFORM TO IS:456 & THE TECHNICAL SPECIFICATIONS.
4. REINFORCED CONCRETE USED SHALL BE OF GRADE M30 CONFORMING TO IS:456-2000.
5. REINFORCEMENT BARS USED SHALL BE HYSD TMT STEEL BARS FE500 CONFORMING TO IS:1786 WITH MIN. 14.5% ELONGATION
6. ALL HOOKS, BENDS AND LAPS OF REINFORCEMENT BARS SHALL CONFORM TO IS: 2502 - (LATEST REVISION) UNLESS OTHERWISE NOTED.
7. LAPS SHALL BE STAGGERED AS FAR AS POSSIBLE. MINIMUM LENGTH OF LAP SHALL BE FIFTY (50) TIMES DIAMETER OF BARS UNLESS NOTED OTHERWISE.
8. DEVELOPMENT LENGTH, Ld SHALL BE 50 TIMES DIAMETER OF BARS UNO.
9. REINFORCEMENTS MAY SUITABLY BE ADJUSTED AT SITE, IF REQUIRED, TO CLEAR POCKETS, ANCHOR BOLTS ETC.
10. CARE SHALL BE TAKEN TO PROVIDE ALL THE EMBEDMENTS BLOCKOUTS AS PER RELEVANT MECHANICAL DRAWING BEFORE CONCRETING.
11. DISTRIBUTOR ASSEMBLY TO BE KEPT IN PRESSURISING CONDITION(AT 50% OF TEST PRESSURE DURING CONCRETING- TILL HARDENING (MIN. 3 DAYS).
12. THE SURFACE OF EXISTING CONCRETE SHALL BE ROUGHED AND PROVIDED SUITABLE CHEMICAL TREATMENT FOR BONDING OF OLD AND NEW CONCRETE(AS PER RECOMMENDATION OF MANUFACTURER) BEFORE PLACING FRESH CONCRETE.
13. CONCRETE CUTTING PROFILE SHALL BE AS PER DRAWING "CIVIL GUIDE LINES FOR DISTRIBUTOR ERECTION & DISMANTLING", DRAWING No.12000020960. CUTTING OF EXISTING COLUMNS & BEAMS. MUST BE AVOIDED. CUTTING OF EXISTING BARREL TO BE MINIMISED TO THE EXTENT POSSIBLE.
14. IF ANY CRACK IS OBSERVED IN DISMANTLED CONCRETE SURFACE , CEMENT GROUTING TO BE DONE.
15. MINIMUM CORE REINFORCEMENT PROVIDED IN DRAWING. IF EXISTING CORE REINFORCEMENT IS HIGHER , THE SAME SHALL BE PROVIDED.

ENGINEERING REFERENCE DRAWINGS :-

1. 0-20210-20901 SHEET NO 1,2,3,4 - ARRANGEMENT OF DISTRIBUTOR
2. 12000020960 SHEET NO. 1,2,3,4,5,6- CIVIL GUIDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

LEGENDS

1. FFL ----------FINISH FLOOR LEVEL
2. TOG ----------TOP OF GROUT
3. TOC ----------TOP OF CONCRETE
4. PL ----------PLATE
5. U.N.O. ---------- UNLESS NOTED OTHERWISE.
6. ℄ ----------CENTER LINE
7. TYP. ----------TYPICAL

IMPORTANT NOTE:

CUTTING OF EXISTING REINFORCEMENT TO BE AVOIDED AND EXISTING REINFORCEMENT DETAILS TO BE SHARED WITH DESIGNER BEFORE TAKING UP THE CONCRETING WORK. HOWEVER IF EXISTING REINFORCEMENT TO BE CUT SUFFICIENT PROJECTION TO BE LEFT FOR LAPPING. LAP LENGTH SHALL BE 10ø IF BY WELDING.

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REF. DRG. NO.

SIGN. & DATE

INVENTORY NO.

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ZONE		

REV.	DATE	ALTERED / CHECKED / APPD.
ZONE		

REV.	DATE		
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CUSTOMER :

TANGEDCO

PROJECT

KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

	NAME	SIGN	DATE
DRN	SKS		10.10.2022
CKD	PUNAM/MKP		10.10.2022
APPD	SP		10.10.2022

NO. OF VAR

SUB-VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE

CIVIL DRAWING FOR MODIFICATION WORKS

GA & RC DETAILS FOR MANIFOLD ENCASING

DRG. NO.

*

SUB-VENDOR NAME | WEIGHT (kg) | SCALE

BHEL DRG. NO. PE-DG-470-600-C001 | REV. 01

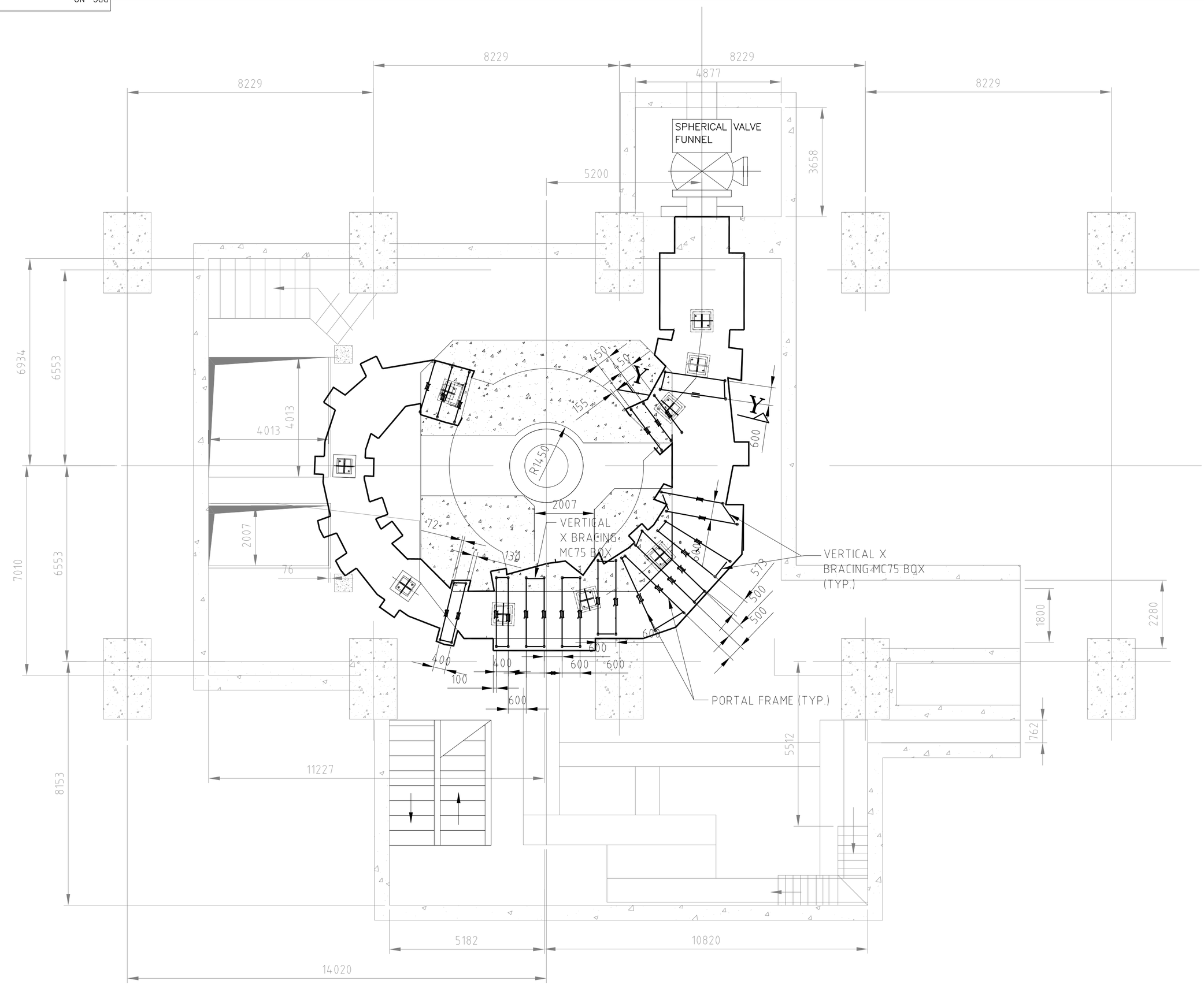
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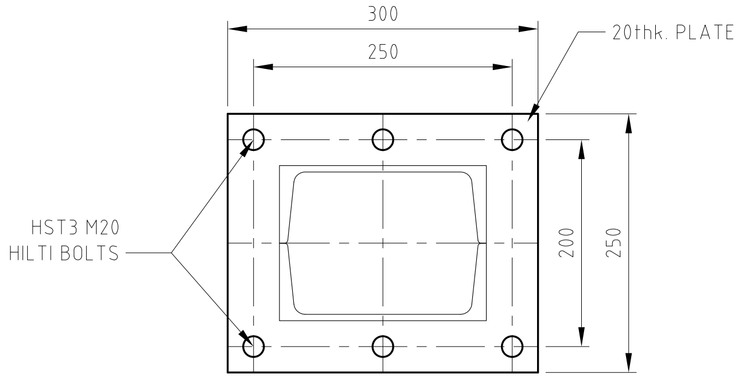
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

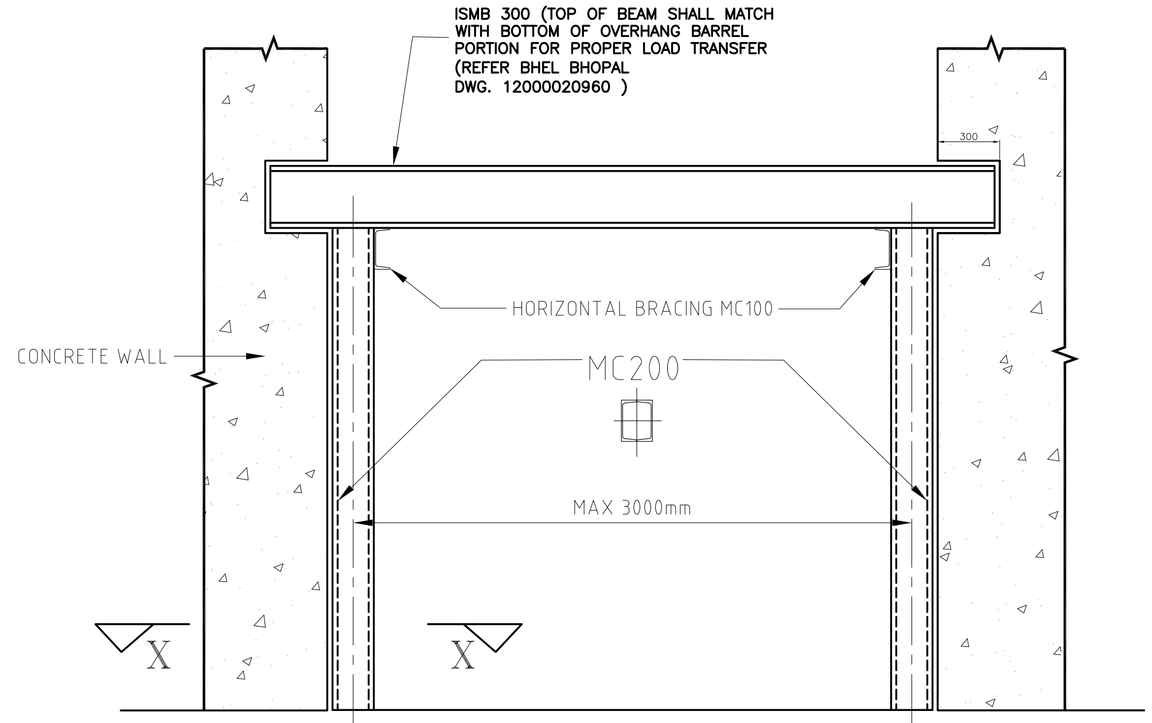
DRG. NO.



SUPPORTING DETAIL FOR BARREL OVERHANG
DURING CONCRETE DISMANTLING WORK



SECTION X–X



SECTION Y–Y
TYPICAL PORTAL FRAME DETAIL

NOTES:–

1) CONCRETE DISMANTLING WORK SHALL START ONLY AFTER REMOVAL OF COMPLETE MACHINE.
2) DISMANTLING WORK SHOULD BE AS MINIMUM AS POSSIBLE.
3) CONTROLLED DISMANTLING TO BE DONE TO AVOID OVER DISMANTLING AND FORMATION OF CRACKS IN REMAINING CONCRETE BLOCK AND OVERHEAD BARREL PART.
4) SUPPORTING OF OVERHANG OF CONCRETE BARREL BLOCK FROM BOTTOM TO BE DONE WITH STEEL PORTAL FRAMING AS SHOWN.
5) AFTER COMMENCING DISMANTLING WORK NOT MORE THAN 300mm OF OVERHANG OF BARREL TO BE KEPT UNSUPPORTED. PORTAL FRAME SUPPORT SHALL BE PLACED BELOW OVERHANG IMMEDIATELY AFTER COMMENCEMENT OF DISMANTLING WORK.
6) PORTAL FRAME SUPPORT SHALL BE PROVIDED PROGRESSIVELY ALONG WITH DISMANTLING WORK AND MAXIMUM SPACING OF PORTAL FRAME TO BE KEPT NOT MORE THAN 600mm C/C.
7) PORTAL FRAME TO BE TIED WITH HORIZONTAL BRACING AND VERTICAL 'X' BRACING PROGRESSIVELY WITH PLACEMENT AS SHOWN IN DWG.
8) ALL STEEL MEMBERS OF PORTAL FRAMES AND BRACING TO BE KEPT TILL COMPLETION AND COMPLETE STRENGTH GAINING OF NEW CONCRETE WORK.
9) WHERE EVER EXISTING SLAB OVERHANG LIKELY TO BE FORMED NECESSARY SUPPORTING WITH H–FRAME OR CUP LOCK SYSTEM OR ANY OTHER SUITABLE SYSTEM TO BE DONE BEFORE COMMENCEMENT OF ANY DISMANTLING WORK.
10) NO EXISTING BEAM AND COLUMN TO BE DISMANTLED.
11) STRUCTURAL STEEL SHALL BE OF GRADE E250 AS PER IS2062.

REFERENCE DWGS:–

1) 12000020960 SHEET 1 TO 10 ----CIVIL GUIDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING.

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INVENTORY NO. | REF. DRG. NO. | SIGN. & DATE

REV.	DATE	ALTERED
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		APPD.
ZONE		

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		CHECKED
		APPD.
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CUSTOMER :

TANGEDCO

PROJECT

KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

	NAME	SIGN	DATE	NO. OF VAR
DRN	SKS/SN		02.03.2023	
CKD	SABYA/MKP		02.03.2023	
APPD	DKM		02.03.2023	

SUB–VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE

CIVIL DRAWING FOR MODIFICATION WORKS
SUPPORTING DETAIL FOR BARREL OVERHANG DURING CONCRETE DISMANTLING WORK

DRG. NO. *

SUB–VENDOR NAME | WEIGHT (kg) | SCALE

BHEL DRG. NO. PE–DG–470–600–C001 | REV. 00

SHEET NO. 03 | NO. OF SHT. 04

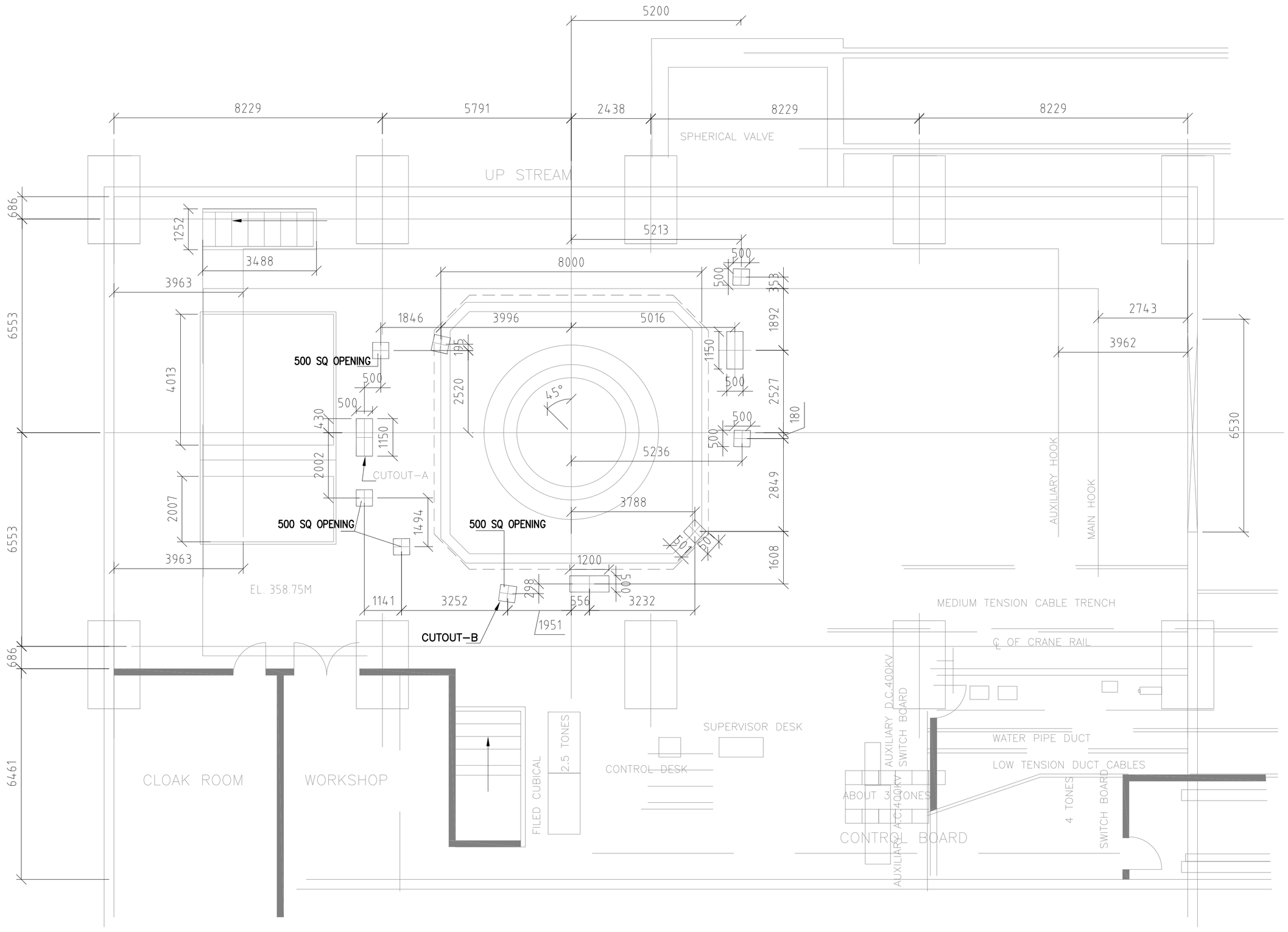
A1 SIZE

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO.

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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



FLOOR CUTTING PLAN AT EL 358.75M

NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, TECHNICAL SPECIFICATIONS AND SCHEDULE OF ITEMS.
2. ALL DIMENSIONS ARE IN MM & ELEVATIONS IN METERS UNLESS STATED OTHERWISE.
3. NO DIMENSIONS FROM THIS DRAWING ARE TO BE SCALED OFF AND ONLY FIGURED DIMENSIONS SHALL BE FOLLOWED.
4. CHECK ALL DIMENSIONS, CO-ORDINATES & ELEVATIONS IMMEDIATELY. REPORT ANY DISCREPANCIES CONFLICTS OR ERROR FOR CLARIFICATION PRIOR TO COMMENCING WORK.
5. REINFORCED CONCRETE USED SHALL BE OF GRADE M30 CONFORMING TO IS: 456-2000.
6. REINFORCEMENT USED AT SITE SHALL BE GRADE Fe 500 (TMT) CONFORMING TO IS:1786 WITH MINIMUM ELONGATION OF 14.5%.
7. MINIMUM CLEAR CONCRETE COVER TO REINFORCEMENT SHALL BE AS FOLLOWS UNLESS NOTED OTHERWISE :
   SLAB BOTTOM : 25 MM.

REFERENCE DRAWING:

1. 12000020960 CIVIL GUDELINES FOR DISTRIBUTOR ERECTION AND DISMANTLING

IMPORTANT NOTES:-

1. CONCRETE CUTTING AT FLOOR OPENING LOCATIONS SHALL BE DONE IN CONTROLLED WAY TO AVOID OVER CUTTING.
2. DURING CUTTING OF FLOOR OPENING LOCATIONS EXISTING REINFORCEMENT SHALL BE KEPT IN SUCH A WAY THAT SUFFICIENT PROJECTION IS LEFT FOR WELDING OF NEW REINFORCEMENTS WITH EXISTING REINFORCEMENTS.
3. AFTER COMPLETION OF EQUIPMENT ERECTION WORKS ALL FLOOR OPENINGS SHALL BE CLOSED WITH NEW CONCRETING.
3. LAP LENGTH OF 10d SHALL BE PROVIDED FOR WELDING OF REINFORCEMENTS.
4. AFTER WELDING NEW REINFORCEMENTS WITH EXISTING REINFORCEMENTS CONCRETING SHALL BE DONE TO CLOSE THESE OPENINGS WITH SUITABLE FORMWORK/SHUTTERING.
5. THE SURFACE OF EXISTING CONCRETE SHALL BE ROUGHED AND PROVIDED SUITABLE CHEMICAL TREATMENT FOR BONDING OF OLD AND NEW CONCRETE(AS PER RECOMMENDATION OF MANUFACTURER) BEFORE PLACING FRESH CONCRETE.
6. SUITABLE FLOOR FINISH SHALL BE PROVIDED AT OPENING LOCATIONS.

NOTE:- Scan QR code for checking the latest revision status of the drg.

REV.	DATE	ALTERED
		CHECKED
		APPD.
ZONE		

REV.	DATE	ALTERED
		CHECKED
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ZONE		

REV.	DATE	ALTERED
		CHECKED
		APPD.
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CUSTOMER :

TANGEDCO

PROJECT

KODAYAR HYDROELECTRIC PROJECT [1X70MW]

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

	NAME	SIGN	DATE
DRN	SN		04.03.23
CKD	SD / MKP		04.03.23
APPD	DKM		04.03.23

NO. OF VAR

SUB-VENDOR DRG. NO. | PO REF | NO. OF ITEMS

TITLE
CIVIL DRAWING FOR MODIFICATION WORKS
FLOOR CUTTING PLAN AT EL 358.75M

DRG. NO.
*

SUB-VENDOR NAME | WEIGHT (kg) | SCALE

BHEL DRG. NO. PE-DG-470-600-C001 | REV. 00

SHEET NO. 04 | NO. OF SHT. 4

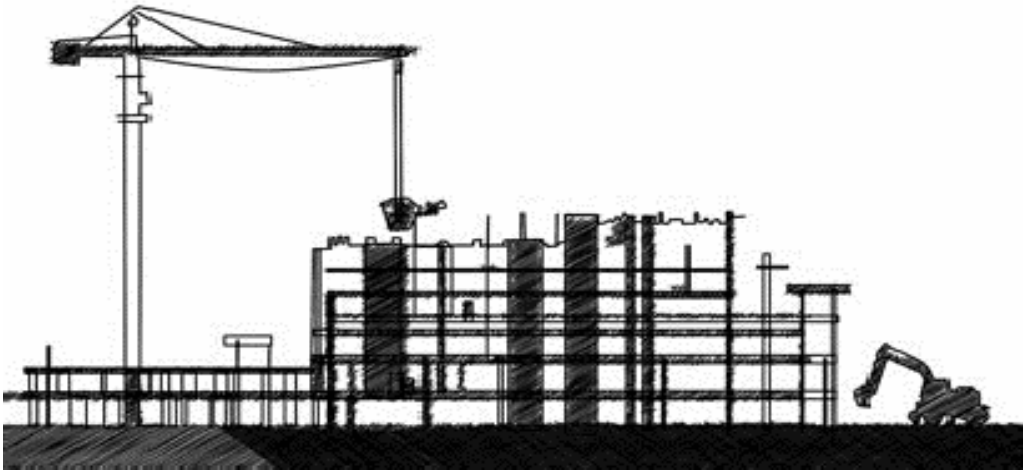
A1 SIZE

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

HSEP14

Health, Safety & Environment Plan for Site Operations by Subcontractors





Bharat Heavy Electricals Limited, Power Sector
Regd. Office: BHEL House, Siri Fort, New Delhi – 110049, www.bhel.com

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SECTION A

CRITICAL RESOURCES FOR HSE IMPLEMENTATION

1. SHARING OF OPERATING COSTS OF FACILITIES

TABLE A.1

SN	FACILITY
1	Ambulance with 24 hr. First Aid Trained Driver (Specs in Annexure A)
2	Operation of Medical center, Nurses, Medical Consumables etc. (Specs in Annexure A)
3	Training Center Consumables
4	Water sprinkling for dust suppression
	(Others:)

Note:

i. Responsibility of operation of above facilities shall rest with BHEL
ii. Operating cost of the above shall be deducted from subcontractors on 'proportional to contract' value basis. Sample deduction table enclosed as Annexure A.1
iii. "Contract value" defined above & subsequently in the document shall be considered as "Awarded contract value".
iv. No overhead cost/ enabling cost of BHEL shall be levied on the contractors for common facilities.
v. These running costs shall be recovered from all the available subcontractors at site for the complete operational duration of the site
vi. No overheads shall be charged on shared operating costs

2. RESOURCES TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

TABLE A.2

SN	ITEM	SPECIFICATIONS
1.	HSE DISPLAYS, Posters and signage	Annexure B
2.	HSE Tools/ Equipment/ Devices	Annexure C
3.	Rest Sheds for Workers	Annexure D
4.	Labor Colony	Annexure E
5.	Toilets (Latrines & Urinals) - in Site and Labor Colony	Annexure F
6.	Fire Extinguishers	Annexure G

Note:

In case subcontractor fails to provide the required resources, same will be procured and deployed by BHEL with applicable overhead on total procurement cost

3. ESTABLISHMENT OF COMMON FACILITIES

In green field projects BHEL shall arrange and provide the following facilities which shall be used by all subcontractors for their employees and workers. These shall be

i. Medical Centre
ii. Safety park with facilities of audio-visual training & vertigo test center.
iii. No cost shall be deducted from the subcontractors for the structure part only.
iv. The running cost with basic inputs already mentioned at Point 1 above shall be shared by all contractors.
v. The sub-contractors shall be required to ensure participation in trainings, medical checkup and vertigo test as per the guidelines laid in this document and required as per statutory HSE requirements.

vi. However, in projects where in these facilities are not provided by BHEL, subcontractors shall ensure the training, medical/ vertigo test of all workers at site in consultation and guidance of BHEL HSE team at site in line with provisions of this document.

vii. The overall onus of compliance to HSE practices pertaining to training, medical checkup including vertigo test shall lie on the subcontractor only.

4. CRITICAL REQUIREMENTS W.R.T. EQUIPMENT & PPES

i. Conventional Hydra crane with carriage in front shall not be permitted. Pick & carry tyre mounted Front Cabin mobile crane (FX or TRX/ NextGen series of 'ESCORT" or equivalent make) shall only be permitted.

ii. Any Heavy equipment (cranes, winch machines, etc.) shall be deployed only after pre-safety Inspection by safety dept. Valid AMCs/ Fitness/ other statutory clearances as per local rules shall be required to be submitted before mobilizing the equipment at site.

iii. All other Hand tools and power tools should not be older than 5 years.

iv. For Chimney passenger lift, winch to have double drum rope for passenger and double safety devices must be used. Winch should not more than 3 years old and winch rope must be inspected with valid certificate from competent authority within 6 months and should meet the IS standard 9507 provision of OLR and push back button arrangement or dead man switch.

v. Gate pass for all the lifting T&Ps and construction machinery/ equipment shall be made after obtaining written acceptance (Pre-entry Safety Clearance) from BHEL Site Safety Department after physical verification and checking all requisite documents/ compliance to Safety norms

vi. All motor vehicles should have valid registration certificate, insurance, Pollution under control (PUC) and fitness certificate as per Motor Vehicle Act 2020. The certificates should be pasted in the glass from inside.

vii. PPEs shall be from reputed manufactures viz. 3M, Udyogi, Karam, Frontier, Freedom, Honeywell, Liberty, Bata, Nomex, Acme, Unicare, Life Gear or equivalent. In case Subcontractor recommends any other name the same can be approved at site level by the Construction manager & Site HSE

viii. For height work, where fall could result in death or disability, a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) shall be mandatorily provided by the subcontractor, failing which, a penalty of INR 10000 per case will be imposed. In addition, there should be constant supervision for such critical height work. Any non-erection activities at height eg. Housekeeping etc. shall also fall under the category of height work

ix. **Scaffold Tagging**

Scaffolds being erected, modified or dismantled must be tagged as suitable for use. Tagging shall be done with standard tag holder. Scaffolding tag should be certified by scaffolding inspector having valid certificate.

- **GREEN** scaffold tag- shall be fixed when scaffold is complete and safe for use, signed and dated by the scaffolding competent person daily.
- **RED** scaffold tag – to be fixed if scaffold is in some way defective and cannot be used or is still under erection.
- **YELLOW** scaffold tag – to be fixed if scaffold is in under construction/ maintenance.



FIG. A.4.1 SAMPLE SCAFFOLD TAGS AND TAG HOLDER

x. **T&P Color Coding:**

a. Inspections and tests shall be documented by means of color coding which shall verify that inspections or testing are current and that all receptacles, portable Power tools, Lifting Tools & Tackles have been inspected and tested as required. The color codes used on the project shall be:

GREEN	BLUE	YELLOW	PURPLE
January	April	July	October
February	May	August	November
March	June	September	December

TABLE. A.4.2: T&P COLOR CODES

b. The cycle of colors shall be Quarterly as a minimum or as decided by BHEL. The color code tape / Sticker shall be clearly visible to designate the period for which the inspections and tests were conducted.

c. Following the initial inspection, the equipment must be color-coded quarterly as per color-coding instructions that will be issued by the subcontractor.

d. Fire extinguisher with the current month color-coding inspection sticker must be provided and secured in the platform.

e. All slings shall be regularly inspected in accordance with the requirement of the project for frequent and periodic inspections and discard immediately if they fail to meet the minimum requirements of the project.

f. The Subcontractor's HSE Officer shall ensure that all PPE is inspected prior to its issue. He is to ensure all subcontractor personnel are using safe and proper PPE equipment. Regular

inspections on the PPE shall be carried out and personnel not adhering to those inspections shall be removed immediately from the site.

g. A Ten (10) day interval period shall be given into each monthly color code change. During this Ten (10) day period either color shall be acceptable.

xi. **T&P Tagging:**

All deployed Wire Rope Slings, Chain Pulley Blocks, Hooks, slings etc. shall be Tagged using aluminum or any other metal tag with punching.

5. HSE PERSONNEL TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

5.1. NUMBERS OF HSE PERSONNEL (APPLICABLE FOR EACH WORK SHIFT)

Number of HSE Officers and Supervisors shall be in proportion to number of workers as per Table A.6 below

TABLE A.5

No. of Workers	No. of HSE Supervisors	No. of HSE Officers
Up to 100	1	1
101 to 250	2	1
251 to 500	4	1
501 to 1000	6	2
1000 to 2000	6+ One additional supervisor up to every additional 250 workers	3
2000-3000	10+ One additional supervisor up to every additional 250 workers	4
3000-4000	14+ One additional supervisor up to every additional 250 workers	5

5.1.1. DEPLOYMENT PLAN

i. Above requirement is for every shift for each unit.

ii. The dynamic deployment plan of Safety manpower at various locations containing names, areas, time periods, shifts etc. shall be submitted to BHEL for approval by subcontractor

iii. BHEL may modify the deployment plan based on nature and volume of jobs, Risks and hazards associated etc.

iv. For less than 20 workers HSE Officer is not mandatory. In case the number of workers exceed 20 for 3 consecutive months, HSE Officer is to be engaged. The HSE Officer shall be deployed for a minimum period of 6 months even if the number of workers fall below 20 in any month subsequent to deployment. If within that 6-month period, the number of workers is more than 20 for at least 3 months, the deployment duration of HSE Officer will extend further 6 months after completion of previous 6-month period.

v. For Site Material Management/ Handling (Loading/ Unloading) contracts, 1 no. HSE Officer shall be required irrespective of the total manpower deployed.

vi. HSE Officers/Supervisors of all the vendors may be required to report directly to BHEL HSE Officer at site & shall comprise as a total team for handling all HSE issues. However, each safety officer/ agency shall be individually responsible for the safe execution of work in their respective areas.

5.2. Qualification & Experience Requirements Of HSE Personnel

5.2.1. HSE Officer

First HSE Officer to be mandatorily as per Option I as under and shall be designated Senior HSE Officer. In case of non-availability of HSE Officers with Option I configuration, the subsequent HSE Officers can be as per Option II below with recorded reasons and approval of Site Construction Manager of BHEL. All these deviations should be reported to Region HSE and PSHQ HSE.

A. Option I

i. possesses a recognized degree in any branch of engineering or technology or architecture and had a practical experience of working in a building or other construction work in a supervisory capacity for a period of not less than two years or possesses a recognized diploma in any branch of engineering or technology and has had practical experience of building or other construction work in a supervisory capacity for a period of not less than five years;

ii. possesses a recognized degree or diploma in industrial safety with at least one paper in construction safety (as an elective subject/ part thereof);

iii. has adequate knowledge of the language spoken by majority of building workers from the construction site in which he is to be appointed.

B. Option II:

Graduation Degree in Science with Physics & Chemistry and degree or diploma in Industrial Safety (All Degrees/ Diploma from any Indian institutes recognized by AICTE or State Council of Technical Education of any Indian State) with practical experience of working in a building, plant or other construction works (as HSE Officer, in line with Indian Factories Act, 1958 or BOCW Act, 1996) for a period of not less than five years

Note:

i. HSE Officer as per Option II shall be valid only on availability of Senior HSE Officer as per Option I at site.

ii. In case of resignation of the Senior HSE Officer, the same has to be replaced within 15 days else all subsequent HSE Officers as per Option II (in case of multiple HSE Officers with a single agency) shall not be considered as valid.

iii. The penalty shall be deducted considering non-availability of any HSE Officer at site.

5.2.2. HSE Supervisor: Either of X or Y below

X. Recognized Degree in any branch of Engineering OR Diploma in any branch of engineering with at least one-year construction experience

OR

Y. A recognized graduation Degree in Science (with Physics & Chemistry) or a recognized diploma in Engg. or Tech.

Additional requirements for option (Y) above

i. Trained in fire-fighting as well as in safety / occupational health related subjects, with:
ii. Minimum Two years of practical experience in construction work environment or in the field of safety and

Note:

i. Option a above is by default, b is under special approval from Site HSE & Construction manager
ii. In both cases the candidate should possess requisite skills to deal with construction & fire safety related day-to-day issues.

5.3. HSE In-Charge

In case there is more than one HSE Officer with any subcontractor, one of them, who is senior most by experience & meets qualification as per option 1 as mentioned in clause 2.1 A above (in HSE discipline), may be designated as HSE In-charge who will be the nodal point of contact on HSE matters.

5.4. Supporting Staff To HSE Team

i. Supporting Staff shall include scaffolders, scaffolding inspectors, riggers, skilled and unskilled manpower
ii. Subcontractor shall provide adequate number of workers as and when required, in order to attend and comply to Safety observations raised by BHEL/ Customer.

5.5. Availability And Penalty For Non-Deployment

i. The subcontractor shall submit the certificates of qualification & experience of HSE manpower before deployment for BHEL to assess suitability as per requirement detailed in this document
ii. In case of rejection, subcontractor shall arrange additional candidates and submit resume to BHEL. Penalties will be applicable during the period of non-deployment in such cases as well.
iii. Subcontractor shall ensure physical availability of safety personnel at the place of specific work locations.
iv. The Subcontractor shall deploy the HSE Officers as per the site's requirement. Non-deployment shall lead to stoppage of the work and final decision shall rest with Site HSE & Construction manager.
v. The Subcontractor shall prepare an organization chart identifying the areas of operations, responsibilities and reporting structure of all safety personnel for each shift and submit the same to BHEL.
vi. The subcontractor shall deploy sufficient HSE Officers, supervisors, as per numbers & qualifications mandated in this Section since mobilization of first batch of manpower and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty at following rates:

Non-deployment of HSE Officer –	Rs. 75,000 per man-month
Non-deployment of HSE Supervisor –	Rs. 50,000 per man-month

vii. Penalty shall be collected for the period of non-availability of safety personnel after allowing a grace period of 15 days for finding a replacement. The same shall be deducted on pro-rata basis till the required manpower is deployed.

viii. In case of abnormal delay & frequent rejections of candidates proposed by the subcontractor, BHEL shall exercise the right to deploy the safety manpower & deduct the amount from subcontractor's running bill with applicable overheads. In such cases also, the provision of logistics, transportation, food and other logistical support to the HSE personnel shall be in the scope of subcontractor in addition to the salary. After deployment of manpower by BHEL, the penalty for non-deployment specified above shall not be applicable.

6. COMPETENCY OF OPERATORS/ DRIVERS OF CRANE, WINCH, LIFTING/ CONSTRUCTION EQUIPMENT ETC.

i. The Operators/ Drivers of crane, winch, construction/ lifting equipment etc. shall be experienced and have valid driving license for the class of vehicle / machinery as applicable (like Crane/ Forklift/ Rig, Construction equipment driving license etc.).

ii. Minimum HMV driving license is required for all heavy equipment/ heavy vehicle (trailer/ Hyva /dumper /TM) operators at site.

iii. The subcontractor shall certify competence of these persons in writing as and when they are posted at site.

iv. Crane, Winch, Construction & lifting equipment operator should have certificate on subject course or experience certificate in employer letterhead.

v. Where state is providing license for operating crane, tractor and other construction vehicles, same to be ensured.

Note: In case the statutory requirements i.e. State or Central Acts and / or Rules as applicable like the Building and Other Construction Workers' Regulation of Employment and Conditions of Service- Act,1996 or State Rules (wherever notified), the Factories Act, 1948 or Rules (wherever notified), etc. are more stringent than above, the same shall be followed.

7. In case of any stringent requirement of BHEL's customer over and above the specifications mentioned in current document, the same shall also be required to be complied at site by subcontractor.

8. REFERENCES

The Safety Rules for Construction & Erection as outlined hereunder, while setting out a broad parameter of safety norms, are not exhaustive. The subcontractor and his agencies are advised to refer to the following statutory provisions as amended from time to time for details and strict compliance therewith.

8.1. FOR GREENFIELD PROJECTS

a) Building and Other Construction Workers (regulation of employment and conditions of service) Act, 1996 (briefly referred to as BOCW Act),
b) Building and other construction workers (regulation of employment and conditions of service) Central Rules, 1998 (briefly referred to as BOCW Rules) as adopted by the various State Governments,

8.2. For Expansion, Modification, Alteration and, Or Construction Activity Within An Existing Plant Operating As Per Approved Site Plan Under The Factories Act

a) Factories Act, 1948,
b) Factories Rules, as adopted by the various State Governments
c) BOCW Act
d) BOCW Rules
e) In case a new act/ statutory guideline/ modification/ consolidation of acts is implemented the same shall be required to be adhered by the subcontractor.
f) The latest amendment of the above-mentioned acts/ rules shall be followed at site.

9. BHEL POWER SECTOR HSE MANAGEMENT SYSTEM

The Systems and procedures of BHEL Power Sector HSE Management System shall be implemented by the subcontractor, including:

- HSE Procedure for Register of OHS Hazards and Risks
- HSE Procedure for Register of Environmental Aspects and Impacts
- HSE Procedure for Register of Regulations
- HSE Procedure for Training and Awareness
- HSE Procedure for Emergency Preparedness and Response Plan
- HSE Procedure for Permit to Work
- HSE Inspection and Other Formats

Note:

i. BHEL reserves the right to revise/ update these systems and procedure as per requirement to address any changing HSE needs

ii. BHEL will provide hard / soft copies of applicable HSE Procedures, Work Permits, Operational Control Procedures, Inspection/ Other Formats etc. that are necessary for ensuring safe work to the successful bidder at Site. It is the responsibility of the subcontractor to ensure availability of these documents before commencing work at site.

iii. The subcontractor can get soft copies of these documents from respective Region SCT/ HSE for reference. The signed hard copies of the same shall not be required to be submitted along with tender document

iv. Subcontractor shall use the Digital (Web & App-Based) HSE management Software Systems provided by BHEL whenever provided. In case not provided, hard copy systems will continue to be used. All information technology resources (Computers, mobile phones, mobile data, internet access etc.) for the use of such systems shall be ensured by the subcontractor.

10. CLEARANCE OF MONTHLY RUNNING BILLS SUBJECT TO SAFETY COMPLIANCE

i. The monthly running Bills of the subcontractor shall be released subject to compliance to HSE requirements as per checklist in Annexure H
ii. BHEL site HSE Head and Package In-charge shall be authorized to issue the clearance
iii. Site Construction Manager of BHEL shall be the final authority on the matter.

11. HSE PERFORMANCE EVALUATION

i. Subcontractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
ii. The HSE evaluation shall be based on HSE Performance Evaluation System of BHEL covering the contractual, statutory and regulatory requirements of HSE.
iii. BHEL shall reserve the right to use these performance scores for evaluating bidder's capacity for future tenders
iv. If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job, provided the execution performance is satisfactory.

12. HSE PENALTIES

i. Nonconformity of safety rules and safety appliances will be viewed seriously and BHEL has right to impose fines on the subcontractor for every instance of violation noticed.
ii. As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per following format.
iii. Following are the applicable penalties for various Safety violations:

Sub: MEMO for Penalty for non-compliances in Safety

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

S. No	Nature of Non - Compliance	Penalty (in INR)	Remarks
A. System Violations			
1	Working without valid Work Permit/ HIRA/ Method Statement / JSA	2000	Per case
2	Controls as per Work Permit/ HIRA/MS/JSA not ensured	2000	Per case
3	Reported Safety Violations Not Closed within Stipulated Time	1000-10000	Per case
4	Absence of required Subcontractor Officials (Site Head, HS Head) in Safety Reviews/Meetings	5000	Per case
5	Not providing required PPEs (Safety Harness, Lifeline, Safety Net, Fall arrestor, Safety Helmet, Gloves, Shoes etc.) for the work by subcontractor	2000	Per case
B. Competency/ Training/ Induction Violations			

1	Incompetent personnel deployed for specialized jobs like height work, hot work, rigging, vehicle operation etc. (without valid license/ certificate etc.)	3000	Per case
2	Work without induction training & medical check	2000	Per case
3	Height Work without Vertigo Test and height work training	2000	Per case
C. PPE Violations – Height Work			
1	Not wearing/ hooking Double Lanyard Safety Harness while working at height (> 1.2 meters) or not anchoring to lifeline	1000	Per case
2	Not Providing Lifeline for height work	3000	
3	Unsafe platforms – without Top, Mid Rails and Toe-Guards for Height Work	3000	
4	Not providing secondary means of fall protection for height work (Safety Nets, Retractable Fall Arrestors etc.)	3000	Per case
D. PPE Violations – General			
1	Not wearing safety helmet	1000	Per case
2	Wearing of helmets without chin straps	1000	Per case
3	Not Wearing safety shoes	500	Per case
4	Not wearing gloves	500	Per case
6	Not using grinding goggles/ face shield during grinding/ cutting	2000	Per case
E. Electrical Safety Violations			
1	Broken/ exposed wires/ cables	2000	Per case per day
2	Electrical plug not used for connection/ hand machines	1000	Per case per day
3	Not using proper ELCBs for electrical equipment	2000	Per case per day
4	Improper earthing of welding & Other electrical machines (Lack of double earthing, improper/ untested earth pit etc.)	2000	Per case per day
5	Not using 24 V supply for lighting in confined spaces	2000	Per case
6	Cables haphazard/ blocking way/ not organized properly	1000	Per case per day
F. Lifting & Rigging Violations			
1	Using Sling/ Chain Pulley Block and other Small T&Ps without proper, traceable Tag and Test Certificate	2000	Per T&P per day
2	Using damaged slings or not slinging properly	2000	Per T&P per day
3	Use of lifting equipment without having valid Test certificate	5000	Per equipment per seven days
4	Lifting hooks used without latches	2000	Per hook per day
5	Not effectively barricading area below lifting activity	5000	Per case
6	Using untrained/ unqualified rigger	5000	Per case
G. Housekeeping			
1	Non-removal of scrap from platforms	5000	Per Event Per location per 7 days
2	Not conducting scheduled housekeeping drives	5000	Per drive
H. Hot Work Safety Violations			
1	Gas cutting without flash back arrestor at both ends	5000	Per machine per incidence
2	Gas cutting at height without fire blanket	2000	Per event

3	Not keeping gas cylinders vertically	2000	Per event
4	Lifting cylinders without cage or rolling of cylinders	2000	Per incidence
5	Leakage in gas cylinder	2000	Per incidence
I. Vehicle Safety/ Operation			
1	Not having valid driving license for the type of vehicle/ T&P	2000	Per driver per incidence
2	Two-wheeler entry in construction area	2000	Per vehicle
3	Using Hydra for material movement at site in unsafe manner	2000	Per case
4	Using Two Hydra in Tandem for material movement without proper precautions as per OCP	2000	Per case
5	Vehicles, Hydras, Cranes, Dumpers and Earth Movers not having automatic back horns linked to gear	2000	Per Equipment per day
6	Not providing proper hard barricades around excavations/ unpermitted areas	5000	Per location per day
7	Not using guide rope while transporting material using Hydra or Cranes	2000	Per event
8	Over speeding	5000	Per case
9	Using Conventional Hydra crane	50000	Per day /crane
J. Accidents/ Incidents/ Near Misses			
1	Non-reporting of Near Miss/ Incident	20000	Per case
2	Major Accident – Worker unable to resume work within 48 hrs	100000	Per incident
3	Fatal Accident	500000	Per incident
K. Miscellaneous			
1.	Not providing the facility (drinking water, rest shed, labor colony etc. as per the specifications/ requirement)	5000	Per month per violation
2.	Not nominating the required number of workers for training as per plan	5000	Per incidence
3.	Lack of proper arrangement for disposal of sewage/ waste water/ effluents etc.	10000	Per incidence

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.):

_____
_____
_____

Penalty Amount:

1. Rate as per above chart
2. No. of Persons/ machine/ event/ labor
3. No. of times the same error is repeated: Repetition factor
4. Total Penalty= 1. X 2. X 3. =

Witnessed by:

(Sub- Subcontractor representative) (BHEL representative)

Signature _____

_____

Name _____

_____

Distribution: 1 Copy: to Sub- subcontractor Site In-charge,
1 Copy to Site Construction Manager (BHEL)
1 Copy to Site Finance

Note:

i. In case the amount of penalty imposed by BHEL's Client on BHEL for Safety violation/ incident due to or in the area of the subcontractor is more than those indicated above, same shall be imposed back-to-back on the subcontractor. However, in case such an amount is less than the specified above, penalty amount indicated above shall be imposed on the subcontractor.

ii. For same violation only one penalty (higher of the two mentioned below) shall be applicable
   a. Penalty imposed by BHEL's Customer over BHEL.
   b. Penalty as indicated in current document.

iii. For repeated violation for the same equipment/ location, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

iv. For repeated fatal incident in the same Unit incremental penalty shall be imposed: The subcontractor will pay 2 times the previously paid penalty in case there is repeated major/ fatal incident under the same subcontractor for the same package in the same unit.

v. Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above.

vi. If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.

vii. The penalty amount shall be recovered by BHEL Finance department from subcontractors from the RA/Final bill.

13. PUNITIVE ACTIONS FOR "CRITICAL SAFETY VIOLATIONS":

"Critical Safety Violations" include:

i. Not wearing required PPEs when provided and not following safe work procedure

ii. Taking unnecessary risks especially in height work, hot work, radiation work, lifting activity

iii. Coming to work under influence of sedatives like alcohol, drugs etc.

iv. Coming to work without ID Card/ Gate Pass (if provided)

v. Intimidating/ threatening at work

vi. Using cell phones during height work, hot work, lifting activity, driving.

In case any worker carries out any of the critical safety violations as above, BHEL reserves the right to enforce punitive action in following manner:

First Offence:	1 Punch on Gate Pass/ Induction Card/ ID Card etc. and 1-hour HSE Training. With one day off from duty
Second Offence:	2 Punches and 2-hours HSE Training with one day off from duty

Third Offence:	3 Punches and the worker will be dismissed. Gate pass to be confiscated

In case any employee of subcontractor carries out any of the critical safety violations as above, subcontractor Site In-charge shall issue warning letter to concerned employee with copy to BHEL

Note:

i. For above violations, guilt of the worker/ employee has to be established through appropriate evidences and records maintained.

ii. If worker/ employee has not been given the required PPEs and safety equipment by the agency and/or not facilitated by the agency to follow safety rules, he/ she will not be considered liable but the agency will be penalized as per penalty provision in this document. In such cases, the subcontractor shall not pass the penalty over to the worker/ employee through wage deduction etc.

iii. These critical safety violations and their consequences shall be shared with all workers and employees during induction and other training programs/ meetings, toolbox talks etc.

iv. Gate Pass shall have provision of Tagging as indicated above

v. The appellate authority (only for final dismissal) in this case shall be the BHEL Site In-charge whose decision shall be final on the matter and binding on all parties.

14. LEGAL IMPLICATIONS

Any legal Costs incurred by BHEL, on account of accidents taking place in the activities of the subcontractor, shall be debited to the subcontractor on actual cost basis.

For any accident occurring at site to any worker/ employee of the subcontractor leading to legal implications to BHEL Employee/ Management shall be safeguarded by BHEL legal department. All legal expenses incurred by BHEL on this account shall be recovered from the subcontractor. The accident also includes fire, loss of property or life at site.

15. HSE REVIEW MEETING

i. Subcontractor Site In-charge and HSE In-charge shall attend the HSE Review Meeting as and when called by BHEL.

The indicative agenda points are given below:

a) Implementation of earlier MOM points
b) Compliance Status of HSE Observations
c) Incidents & Near Misses, their Root Causes and Actions Taken
d) HSE performance review
e) HSE inspection findings
f) HSE audit and CAPA
g) HSE training
h) Health check-up camp
i) HSE planning for the erection and commissioning and installation activities in the coming month

j) HSE reward and promotional activities

ii. MOM on the discussion along with HSE observations will be circulated to the subcontractor for action.

iii. The subcontractor shall close the observations to the satisfaction of BHEL within stipulated time frame

16. OTHER REQUIREMENTS

i. If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps and the cost shall be debited to the subcontractor with applicable overheads.

ii. If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.

iii. In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.

iv. The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.

v. The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

vi. The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.

vii. BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.

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

17. MEMORANDUM OF UNDERSTANDING:

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

Memorandum of Understanding

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

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

M/s……..have gone through and understood all the HSE requirements of the contract including HSE manpower, tools & equipment, systems & procedures, and agree to fulfill the same as a minimum. Any additional resources and support required for ensuring fulfillment of HSE Objectives shall be provided by subcontractor at no extra cost.

M/s…….. agree that in case they fail to comply to the HSE requirements as stipulated in the contract, BHEL shall have the right to implement the same and the cost shall be recovered from the subcontractor with applicable overheads.

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

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

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

M/s…….. agree that the subcontractor shall seek HSE clearance as per BHEL format before each RA bill as mentioned in clause no. 9. The penalty amounts for not providing Safety manpower and various Safety violations have also been reviewed and agreed.

M/s…….. agree to share the HSE Costs (running costs) of common facilities created by BHEL on proportional to contract value basis as calculated at Site by BHEL.

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

Name :

Place & Date:

SECTION B

OPERATIONAL REQUIREMENTS

1. PURPOSE:

1.1. The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.

1.2. This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents in complementary manner.

1.3. Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy wherein the relevant statutory guidelines supersedes this document, the same shall be followed.

1.4. In case there's any specific HSE requirement from BHEL's Client, not explicitly indicated in this document the same shall be required to be fulfilled as per the decision of BHEL Site construction manager.

2. SCOPE:

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

3. OBJECTIVES AND TARGETS:

i. To achieve "Zero Incident at Site"
ii. 100% compliance to all legal/statutory requirements related to EHS.
iii. 100% Health, Safety and Environmental Induction training attendance for all workers.
iv. 100% High Risk activities to be carried out only after approved Method Statement, HIRA / Aspect-Impact / JSA / OCP and Permit to Work are implemented.
v. 100% PPEs compliance in high and medium risk activities.
vi. 100% incident reporting, recording and reviewing for corrective actions.
vii. Regular Safety Reviews to assess HSE program compliance and closure of any recognized gaps to improve safety management and incident prevention
viii. Prevent injury and ill health of all workers at site ('Workers' refers to all personnel including managerial, supervisory, professional, technical, clerical and other workers including contract laborers)
ix. Prevent pollution to environment
x. Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
xi. Ensure protection of environment of the work site.
xii. Comply at all times with the relevant statutory and contractual HSE requirements.
xiii. Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
xiv. Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.

xv. Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
xvi. Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
xvii. Establish effective communication on HSE matters with all relevant parties involved in the Project works.
xviii. Ensure that all work planning considers all persons that may be affected by the work.
xix. Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
xx. Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
xxi. Ensure continual improvements in HSE performance.
xxii. Ensure conservation of resources and reduction of wastage.
xxiii. Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
xxiv. Ensure timely implementation of correction, corrective action and preventive action. The subcontractor shall also comply with HSE Targets stipulated by BHEL from time to time.

4. BHEL HEALTH, SAFETY & ENVIRONMENT POLICY:

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, subcontractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

Chairman & Managing Director/ BHEL

5. ILLUSTRATIVE RESPONSIBILITIES OF SUBCONTRACTOR EMPLOYEES

5.1 HSE - A LINE RESPONSIBILITY

i. HSE is a “Line Responsibility”.
ii. The term "Line" includes management, Executives, Supervisors, Foremen, and Workers who are part of the workforce. Line is to be fully involved in HSE Planning & Implementation with the aid and advice of HSE organization.
iii. “Line”, having control of resources and manpower is responsible for overall implementation of HSE Systems and closure of HSE observations.

5.2 SITE IN -CHARGE:

i. Shall sign Memorandum of Understanding (MoU)
ii. Shall ensure availability of all necessary resources required for implementation of HSE at Site
iii. Shall engage qualified HSE Officer(s) and supervisors (s)
iv. Shall adhere to the rules and regulations mentioned in this code, practice very strictly in area of work in consultation with concerned engineer and the safety coordinator.
v. Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
vi. Shall not engage any employee below 18 years.
vii. Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job.
viii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
ix. Shall ensure closure of all HSE non-conformities reported by BHEL or observed during internal inspection by providing appropriate resources in a timely manner.
x. Shall ensure the implementation of provisions of applicable acts and rules pertaining to HSE.
xi. Shall ensure availability of updated (Hazard Identification and Risk Assessment) Register for the area of activity
xii. Shall ensure availability of Method Statements & Job Safety Analysis for all hazardous activities
xiii. Shall ensure necessary controls to minimize risk in all applicable hazardous activities including Height Work, Hot Work, Lifting & Rigging, Confined Space, Maintenance, excavation, Radiography, Loading/ Unloading, Drilling/ Blasting etc.
xiv. Shall ensure implementation of HSE requirements mentioned in this document and as specified in the BHEL HSE management System including training, inspection, awareness, reporting etc.
xv. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
xvi. Shall ensure a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) for preventing fall from height
xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.

xviii. Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
xix. Shall ensure that Horseplay is strictly forbidden.
xx. Shall ensure that adequate illumination is arranged during night work.
xxi. Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
xxii. Shall ensure display of adequate signage/posters on HSE.
xxiii. Shall ensure that mobile phone is not used by workers while working.
xxiv. Shall ensure conductance of HSE audit, mock drill, medical camps, induction training and training on HSE at site.
xxv. Shall ensure full co-operation during HSE audits.
xxvi. Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
xxvii. Shall ensure good housekeeping.
xxviii. Shall ensure adequate valid fire extinguishers are provided at the work site.
xxix. Shall ensure availability of sufficient number of toilets (preferably bio-toilets) /restrooms and adequate drinking water at work site and labor colony.
xxx. Shall ensure adequate emergency preparedness.
xxxi. Shall be member of site HSE committee and attend all meetings of the committee
xxxii. Power source for hand lamps shall be maximum of 24 v.
xxxiii. Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available
xxxiv. To record all incidents including near miss and report to BHEL and to ensure analysis & corrective actions for the same
xxxv. Shall conduct weekly Safety Walks in the work area and record the findings.
xxxvi. Construction of Canteen at Site, Office Infrastructure: Printer, PC, Fire Extinguishers etc.
xxxvii. Shall analysis HSE Performance regularly in work area and take steps to improve the same
xxxviii. Shall ensure stoppage of work in case of unacceptable Safety hazards

5.3 HSE OFFICER:

i. Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
ii. Facilitate inclusion of safety elements into Work Method Statement and creation of Job Safety Analysis (JSA)
iii. (HSE Head) To prepare deployment plan of HSE personnel for all shifts, so as to ensure constant supervision of all areas. The plan to be submitted to BHEL
iv. Highlight the requirements of safety through Tool-box / other meetings.
v. Help concerned HOS to prepare Job Specific instructions/ JSA for critical jobs.
vi. Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
vii. Advice & co-ordinate for implementation of HSE Systems & Procedures.
viii. To stop work in case of any critical safety violation until the violation is cleared
ix. Convene HSE meeting & minute the proceeding for circulation & follow-up action.

x. Plan procurement of PPE & Safety devices and inspect their healthiness.
xi. Report to BHEL on all matters pertaining to status of safety and promotional program at site level.
xii. Facilitate administration of First Aid
xiii. Facilitate screening of workmen and safety induction.
xiv. Conduct fire Drill and facilitate emergency preparedness
xv. Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
xvi. Apprise BHEL on safety related problems.
xvii. Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
xviii. Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
xix. To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
xx. Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
xxi. Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters.

5.4 HSE SUPERVISOR:

i. All requirements as per 5.1
ii. To monitor allotted area for Safety violations, take required action and inform the concerned Safety Supervisor / Officer
iii. To assist HSE Officer

5.5 PACKAGE IN-CHARGES, ENGINEERS & ALL EMPLOYEES:

i. To be aware of, get involved in and ensure implementation of all HSE related Systems and Procedures including but not limited to:
   a. BHEL HSE Management System including HSE Procedures and OCPs, HIRA, JSA etc.
   b. Work Permit System
   c. Emergency Preparedness Response Plans
   d. Contractual HSE requirements
   e. Legal Requirements
   f. Penalty System
   g. Training requirements
ii. To ensure that the persons engaged in respective area follow the safety rules like using appropriate PPEs.
iii. To develop Method Statements and ensure availability of Job Safety Analysis for all activities in scope
iv. To ensure that the reported HSE non-conformities in the work area are resolved immediately before resuming work
v. To record all incidents including near miss and report to BHEL.

vi. To adopt safe working practices at all times and act as role model for Safety
vii. To take immediate corrective action actions in case any non-conformity is observed on product / process / system with respect to Occupational Health, Safety and Environment.
viii. In case any particular activity / work has extremely high consequential risk or high environmental impact, same shall be brought to the notice of BHEL Package In-charge before starting the work.
ix. To interfere/ stop work as & when identified unsafe.
x. To maintain & promote improved level of house-keeping all the time at site.
xi. To support/co-operate with audit team members as & when safety audits are carried out.
xii. To involve in investigation, if any incident occurs in his work area.
xiii. To participate in safety promotional programs
xiv. To attend the safety committee meeting, if member/invitee
xv. To ensure that only fit T&Ps and qualified persons are engaged for all activities.
xvi. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
xviii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent authorities.

6. HSE PLANNING BY SUBCONTRACTOR:

6.1 HAZARD ANALYSIS & RISK ASSESSMENT (HIRA), METHOD STATEMENT (MS) & JOB SAFETY ANALYSIS (JSA):

i. Subcontractor shall identify all OHS Hazards and Risks applicable to all activities in scope and plan & implement the required control measures. HIRA Register shall be maintained.
ii. Subcontractor shall develop Method Statements & Job Safety Analysis documents for all hazardous activities in scope and ensure the required control measures. Job Safety Analysis is to be attached along with any Work Permit request

6.2 REGISTER OF REGULATIONS:

Subcontractor shall prepare a register of applicable rules and regulations in the scope and plan to ensure compliance.

HIRA Register, Method Statements, Job Safety Analysis and Register of Regulations are dynamic documents and shall be revised (as applicable):

i. At fixed frequency of 3 months
ii. Addition/ deletion/ modification of a process/ activity
iii. After an accident/ incident
iv. After any change in applicable rules/ regulations/ laws.

6.3 MONTHLY HSE PLAN COVERING THE FOLLOWING AS A MINIMUM SHALL BE PREPARED AND SUBMITTED TO BHEL FOR APPROVAL:

i. HSE Trainings covering all activities/ hazards/ workers

ii. HSE Inspection Plan covering all areas/ activities/ equipment/ hazards

iii. HSE Activities: Safety walks, Awards, housekeeping, reviews etc.

Note: Online/ App-based system shall be used for HSE Planning and Implementation/ Update whenever provided by BHEL otherwise Hard-copy based system shall continue

6.4 Monthly HSE Planning & Review of HSE Activities along with BHEL:

Monthly planning and review of HSE activities shall be carried out by subcontractor as per provided **format** jointly along with BHEL

7. Mobilization Of Machinery/Equipment/Tools By Subcontractor:

i. Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.

ii. As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable. Inspection by Third Party competent person shall be arranged:
   a. Before first time use at site
   b. After carrying out any modification
   c. After repairs subsequent to involvement in any accident/ incident

iii. As a further measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and comply with legislative and owner requirement, inspection as per provided format shall be arranged by in-house expert / competent authority (preferable) for acceptance. The equipment considered for this purpose shall include all those in the T&P list in the tender document.

8. Mobilization of Manpower by Subcontractor:

i. As a measure to ensure that manpower being mobilized to the construction site is fit and competent for safe working, screening arrangement shall be made by the sub-subcontractor to ensure competency and fitness through following measures:

a) **Medical Checkup:** Examination of medical fitness shall be conducted through qualified medical professional for all workers to be deployed as per provided **format**. For height workers, vertigo (height phobia) test to be carried out as qualification criteria as per Annexure K and recorded in provided **format**.

b) **Induction Training**: Induction training of all workers to be ensured as per **provided procedure and format**. Training evaluation to be carried out and training to be repeated if not passed

c) Only on successfully meeting above criteria, permanent gate passes to be issued

ii. The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.

iii. The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.

iv. Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.

v. Appropriate accommodation to be arranged for all workmen in hygienic condition.

vi. Cost of contractual, statutory and regulatory requirements like Training, medical checks, PPEs etc. shall not be transferred to the workers and such activities shall be considered as part of the job.

9. Provision of Personal Protective Equipment (PPEs):

i. Personnel Protective Equipment (PPEs), shall be provided by the subcontractor to all workers as per requirement of the job.

ii. The choice of PPEs to ensure multiple (at least more than 1) means of protection against any hazard. All applicable safety precautions for a job shall be ensured notwithstanding the duration or perceived importance of the task.

iii. The applicability of PPEs shall be as per the concept of Hierarchy of controls, i.e.:

iv. Elimination->Substitution->EngineeringControls->AdministrativeControls-PPEs

v. Relying solely on PPEs without ensuring necessary controls to be strictly avoided.

vi. The following matrix recommends usage of minimum PPEs against the respective job.

Activity	Type of Protection						Remarks, if any
	Hand	Eye	Ear	Body	Respiratory	Others	
Gas Welding & Cutting	LG	WG	-	LA	*SCBA/ OLBA	-	* for confined space
Electric Arc Welding	LG	HMWS	-	LA	*SCBA/ OLBA	-	* for confined space
Rigging	CG	SG	-				--
Working at Height	-	SG	-	DLFBH	-	*FAS	* for vertical columns
Grinding & Chipping	CG	FS / SG	-	LA	-	-	--
Working in High Noise	-	-	EP / EM	-	-	-	--
Handling of Cement Concrete	RG	SG	-	-	DM	-	

Blasting	CG	SG	EP*	-	-	-	* at noise area
Excavation	CG	SG	-	-	DM	-	*Gum boot in place of Safety shoe for foot
Chemical Handling	PVCG	CSG	-	PVCA	-	-	*Full body rubber suit with hood
Electrical and C&I	ERG*	SG	-	-	-	-	*For high voltages
Sand/shot blasting	CG	-	EP/ EM	CA	SAMH	-	

ABBREVIATIONS: FS: Face Shield, CSG: Chemical splash goggles, HMWS: Helmet mounted welder's shield, GB: gum boot, DLFBH: Double lanyard full body harness, SG: Safety goggles, DM: Dust mask, SAMH L Supplied air mask/hood, EP/EM: Ear plug/Ear Muff, CG: Cotton hand gloves, LG: Leather hand gloves, LA: Leather apron, RG: Rubber gloves, PVCG: PVC Gloves, PVCA: PVC Apron, SCBA: Self-contained breathing apparatus, WG: Welding goggles, ERG: Electrical Rubber Gloves. OLBA: Online breathing apparatus

The list is not exhaustive. Additional PPEs to ensure Safe Work may need to be deployed as per the requirement of the task at no additional cost.

vii. The PPEs shall conform to the relevant standards as below (illustrative list) and bear ISI mark.

RELEVANT IS-CODES FOR PERSONAL PROTECTION

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

viii. Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public

ix. All the personnel and visitors shall mandatorily use safety helmet (with company logo), safety shoe and reflective vests, in addition to any other PPEs as deemed appropriate for the area of work/ visit.

x. Following Color scheme for Helmets shall be followed:
   a. Workmen: Yellow
   b. Safety staff: Green or white with green band
   c. Electrician: Red
   d. Others including visitors: White
   e. For height workers, special marking on helmets besides indication on Gate Pass/ ID Card

xi. The subcontractor shall maintain register for issue and receipt of PPEs.

xii. All the PPEs shall be checked for quality before issue and the same shall be periodically re-checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be replaced.

xiii. The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.

xiv. The body harnesses shall be serial numbered.

10. ARRANGEMENT OF INFRASTRUCTURE:

10.1 DRINKING WATER:

i. Drinking water shall be provided and maintained at suitable places at different elevations such that minimum quantity of 5 liters is available for each worker during the day.

ii. Drinking water tank shall be so installed so as to be available within 200 meters of each working area

iii. Container should be labeled as “Drinking Water” in languages understood by the workers

iv. Cleaning of the container shall be ensured at least once in a week. Mild cleaning detergents as used for cleaning vessels shall be applied and scrubbers (3M or equivalent) shall be used for removing scales and deposits on the inside surface. The tank shall be thoroughly cleaned with potable water only before it is refilled (also applicable to labor colony).

v. Suitability of water source for drinking to be tested as per IS10500 at least once in six months.

10.2 WASHING FACILITIES:

i. In every workplace, adequate and suitable facilities for washing shall be provided and maintained.

ii. Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.

iii. Water suitable for washing and not for drinking shall be clearly indicated as “Not for Drinking” in language understood by workers.

iv. Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

10.3 LATRINES AND URINALS:

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

10.4 PROVISION OF REST SHEDS FOR WORKERS DURING REST PERIOD:

Proper Rest Shed (s) with shelter shall be provided for rest during break so as to accommodate all workers as indicated in Section A

10.5 MEDICAL FACILITIES:

10.5.1 GENERAL

i. Provision of Medical Center, Ambulance etc. shall be as per Section A of this document
ii. Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste – Management and Handling Rules, 1998)
iii. Every injury shall be treated, recorded and reported.
iv. All First Aid injuries shall be recorded as per provided Format
v. List of qualified first aiders and their contact numbers to be displayed at conspicuous places.

10.5.2 FIRST AIDER/ FIRST AID BOX

i. The first aider along with facilities should be available at a point nearest to the work location wherein majority of the workers are working.
ii. The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
iii. The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
iv. The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
v. The first aid box shall be distinctly marked with a Green Cross on white background.
vi. Details of contents of first aid box is given in Annexure J
vii. A slip of contents shall be pasted on the First Aid Box with following details
viii. Monthly inspection of First Aid Box shall be carried out by the owner as per provided format
ix. The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

10.5.3 HEALTH CHECK UP

The persons engaged at the site shall undergo health check-up as per provided format before induction. In addition, the persons engaged in the following works shall undergo health check-up at least once in a year:

i. Height workers
ii. Drivers/crane operators/riggers
iii. Confined space workers
iv. Shot/sand blaster
v. Welding and NDE personnel

10.5.4 HEIGHT PHOBIA/ VERTIGO TEST:

i. The persons engaged in working at heights (above 2 meters) to be assessed for Vertigo and associated conditions and recorded as per provided format. Suggested Vertigo Test Procedure is given in Annexure K
ii. Such workers are to be allowed only on successful completion of test, otherwise shall be allocated ground-based jobs.
iii. IDs / Height passes shall be issued to such workers, besides special markings on helmets for easy identification.

10.5.5 PROVISION OF CANTEEN FACILITY:

i. Canteen facilities shall be provided for the workmen of the project inside the project site where worker strength is 250 or more.
ii. Proper cleaning and hygienic condition shall be maintained.
iii. Proper care should be taken to prevent biological contamination.
iv. Adequate drinking water should be available at canteen.
v. Fire extinguisher shall be provided inside canteen.
vi. Regular health check-up and medication to the canteen workers shall be ensured as per applicable regulations.
vii. Canteen waste to be disposed of in hygienic manner

10.6 PROVISION OF ACCOMMODATION/LABOR COLONY FOR WORKFORCE:

i. Proper accommodation for workforce to be provided in line with minimum requirements indicated in Section A
ii. Labor colony shall be inspected each week by HSE Officer and report submitted to BHEL as per provided format

10.7 PEST CONTROL:

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

10.8 SCRAPYARD:

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

10.9 ILLUMINATION:

i. The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
ii. Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
iii. Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
iv. Emergency lighting provision for night work shall be made to minimize danger in case of main supply failure.
v. Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II).

SUITABLE ILLUMINATION LEVELS FOR VARIOUS AREAS SHALL BE DECIDED BASED ON BROAD GUIDELINES INDICATED BELOW:

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

vi. Illuminations shall be inspected on weekly basis as per provided **format** using a calibrated lux meter.

11. HSE TRAINING & AWARENESS:

11.1 TRAINING PLAN:

i. All training programs to be carried out in a planned manner. Monthly/ Annual Training Calendar to be submitted to BHEL for approval and shall cover HSE Training requirements of all activities, workers, hazards applicable to the area(s) of work.
ii. Subcontractor shall nominate workers as per the schedule of specific training plan, failing which, penalty shall be imposed.
iii. Training records of all workers along with attendance, signatures, faculty details etc. shall be maintained in soft/ hard copy as per provided **formats**.
iv. Each labor should undergo at least 0.5% of total man-hours worked in HSE training.

11.2 HSE INDUCTION TRAINING

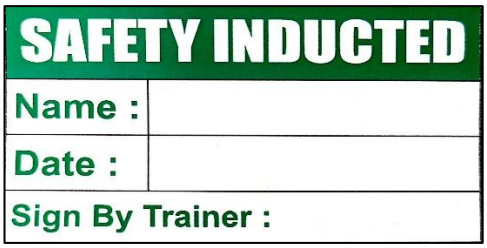
i. All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.
ii. The induction training shall be imparted through audio-visual medium (Classroom specialized training), and shall be minimum of 1 Complete Day.
iii. Evaluation to be carried out after training and training shall be repeated in case of failure.
iv. Safety Induction Card shall be printed by Subcontractor and provided to all trained workers. A Safety induction book shall also be printed and issued to each worker after induction training (Format for the same may be provided by BHEL).
v. Induction training subjects shall include but not limited to:

   a. Briefing of the Project details.
   b. Safety objectives and targets.
   c. Site HSE rules.
   d. Critical Safety Violations and consequences
   e. Site HSE hazards and aspects.
   f. First aid facility.
   g. Emergency Contact No.
   h. Incident & Near Miss reporting.
   i. Fire prevention and emergency response.
   j. Rules to be followed in the labor colony (if applicable)
   k. Accident case studies

vi. General:

   a. Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
   b. They must arrive fully dressed in safety wear & gear to attend the induction.
   c. Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.

d. On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form to declare that he had understood the content and shall abide to follow and comply with safe work practices.
e. They may only then be qualified to be issued with a personal I.D. card, for access to the work site subject to clearing the medical fitness test.



ABOVE STICKER SHALL BE PASTED ON HELMET OF WORKERS AFTER SAFETY INDUCTION TRAINING

11.3 JOB-SPECIFIC SKILL BASED HSE TRAINING

The contracting agency shall also impart job specific skill-based safety training to all its employees (Minimum one day) on various related safety topics using internal/external safety professionals/consultants as per the matrix given below. Record of such trainings and attendance particulars shall be maintained in a register for ready reference to statutory authorities/engineer-in charge as per provided format.

TRAINING MATRIX

Name of topic	Executives	Supervisors	Skilled Workmen	Other Workers
Safety Induction	Y	Y	Y	Y
Accident_ Causes, factors, cost	Y	Y	Y	-
Industrial hazards & Accident Prevention	Y	Y	Y	-
Investigating, reporting, records	Y	Y	-	-
Personal Protective Equipment	-	Y	Y	Y
Construction Safety & Role of Supervisory personnel	-	Y	-	-
Permit to Work (PTW)	-	Y	Y	y
Statutory Provisions (BOCW Act/Rules, Factories Act 1948 etc.)	Y	Y	y	y
Material handling	-	y	Y	Y
Emergency Management	Y	Y	Y	-
Electrical Safety	-	Y	Y	-
Fire safety	Y	Y	Y	Y
First Aid & CPR (cardio pulmonary resuscitation)	-	Y	Y	Y (Selected)
Safety in Welding & Cutting	-	-	Y	-
Safety Audit	Y	Y	-	-
Safety in Lifting Tools & Tackles	-	Y	Y	y

Safety in Working at height	-	Y	Y	Y
Safety in Confined space work	-	Y	Y	Y
Defensive Driving	-	Y*	Y*	Y*

*for construction vehicle operators, helpers & crane operators

Y=YES

Note:

i. Subcontractor shall prepare a training plan/ matrix covering all hazards and implement the same after approval of BHEL.
ii. It is to be ensured that every worker undergoes Job-Specific training once every 3 months.
iii. Records of training programmes along with attendance shall be maintained by the subcontractor
iv. Each worker to be issued a Card indicating the types of trainings undergone.

11.4 HSE TOOL-BOX TALK:

i. HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work and shall be randomly attended by subcontractor engineers/ officials. The agenda shall consist of the following:

   a. Details of the job being intended for immediate execution.
   b. The relevant hazards and risks involved in executing the job and their control and mitigating measures.
   c. Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
   d. Recent non-compliances observed.
   e. Appreciation of good work done by any person.
   f. Any doubt clearing session at the end.

ii. Tool box talk to be conducted before start of work in every shift.
iii. During toolbox talk, visual check-up of workers regarding health, any signs of fatigue, intoxication etc. shall be conducted and any suspected workers to be acted upon.
iv. Record of Tool box talk shall be maintained as per provided **format**

11.5 TRAINING ON HEIGHT WORK:

i. Training on height work shall be imparted to all workers working at height by in-house/external faculty at least once every 3 months.
ii. For Height Workers Separate pass shall be provided by the subcontractor.
iii. The training shall be of minimum 2-hour duration, through audio-visual medium and followed by evaluation. In case of poor scoring, training shall be repeated.
iv. The training shall include following topics:

   a. Proper use of PPEs – safety harness, lanyard, fall arrester, retractable fall arrester, life line, safety nets etc.
   b. Provision of secondary means of fall protection

c. Safe climbing through monkey ladders.
d. Inspection of PPEs.
e. Medical fitness requirements.
f. Mock drill on rescue at height.
g. Dos & Don'ts during height work.
h. Accident case Studies

11.6 Re-Induction Training

The induction training shall be repeated for every worker after at least 1 year and shall be a pre-requisite for renewal of Gate Pass/ ID card.

11.7 Penalty Training

The personnel involved in Safety Violations/ Incidents shall mandatorily undertake penalty training pertaining to the violation/ incident. Penalty training shall be at least half-day duration.

11.8 HSE Promotion-Signage, Posters, Competition, Awards etc.:

i. HSE Displays shall be installed as indicated in Section A
ii. Contracting agencies shall arrange for display of safety hoardings depicting suitable safety cartoons/messages/ cautionary notices at appropriate places of project site to remind the workers to perform their duties safely.
iii. Apart from safety hoardings, each agency should maintain a safety bulletin board at all their work locations. Such safety bulletin boards should depict the activities being planned for the day, good practices, permit details etc.
iv. Safety suggestion boxes shall be kept at each subcontractor's office at site for obtaining safety suggestions from the workers. Best suggestions should be implemented and may be rewarded suitably to encourage the workers for safety.
v. Safety awareness campaigns, competitions, plays, movie shows, songs etc. to be organized for workers at Site and Labor colony from time to time to enhance Safety Awareness

11.9 HSE Rewards & Incentive Scheme

Subcontractor shall implement a reward & incentive scheme for workers & supervisors displaying adherence to safety principles. Such workers shall be felicitated in a monthly function, attended by Subcontractor top management and BHEL representatives. Suitable gift shall be given to such workers for encouragement.

11.10 HSE Awareness Program for Officials:

Subcontractor shall arrange monthly HSE awareness program on different topics including medical awareness for all engineers/ supervisors / officials working at site. This program can be part of progress/ safety review meetings.

12. HSE COMMUNICATION AND PARTICIPATION:

12.1 HSE INCIDENT REPORTING, INVESTIGATION & CORRECTIVE ACTION:

i. All incidents (near misses, property damage, first-aid cases, minor, major and fatal incidents) shall be reported to BHEL as they happen immediately through SMS and Hard/Soft copy as per provided format

ii. All incidents including near miss, minor, major and fatal incidents shall be recorded

iii. All incidents shall be investigated for Root Causes and corrective actions ensured to prevent recurrence shall be implemented.

iv. Work shall be put on hold in the area till corrective actions are verified by BHEL

v. The Root Cause Analyses and Corrective actions taken shall be recorded

12.2 HSE EVENT REPORTING:

i. Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines

ii. Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

12.3 MONTHLY HSE REPORTING:

i. All routine and non-routine HSE activities shall be reported to BHEL on monthly basis by the subcontractor as per provided format. The reporting medium can be hard/soft as per BHEL requirement.

ii. The period of reporting shall be 25th of the preceding month to 24th of the present month and shall be submitted by the end of the calendar month.

iii. Report shall include good quality images of HSE Activities

12.4 DAILY HSE ACTIVITY REPORTING:

Daily HSE activities shall be reported by subcontractor to BHEL as per provided format

12.5 HSE SUGGESTIONS:

All workers and employees shall be encouraged to provide suggestions for improvement in Health, Safety & Environment performance at site. The suggestions shall be recorded in a “Suggestions Register” as per provided format. Suggestions found suitable for implementation shall be implemented and recognition / reward to be given to the submitter.

Suggestion Register to be placed at Site and Labor Colony and shall be reviewed on periodic basis

12.6 CLIENT COMMUNICATION:

All HSE related communication from BHEL, customer / external statutory and regulatory agencies to be handled on priority. Same to be recorded and issues to be resolved in expeditious manner

13. SAFETY DURING WORK EXECUTION:

Safety during work execution shall be ensured by following appropriate Safety Rules, providing adequate resources, deploying competent and trained manpower, regular training & inspection and non-conformity resolution. Main aspects are indicated as under:

13.1 OPERATIONAL CONTROL PROCEDURES:

In order to reduce the risk associated with hazardous activities, applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions, outcomes of Hazard Analysis & other requirements. This will be done as part of normal scope of work. Illustrative list of reference OCPs is given below.

TABLE 13.1 ILLUSTRATIVE LIST OF REFERENCE OCPS

No.	Topic	No.	Topic	No.	Topic
0	General Safety	**22**	Steam blowing	**44**	Material preservation
1	Handling of chemicals	**23**	Working in confined area	**45**	Electro-resistance heating
2	Electrical safety	**24**	Operation of passenger lift, material hoists & cages	**46**	Blasting
3	Energy conservation	**25**	Vehicle/ Crane maintenance	**47**	Transformer charging
4	Welding and gas cutting operation	**26**	Radiography	**48**	Handling of battery system
5	Fire safety	**27**	Waste disposal	**49**	DG set
6	Use of hand tools	**28**	Handling & storage of mineral wool	**50**	Sanitary maintenance
7	First aid	**29**	Working at night	**51**	Piling rig operation
8	Food safety at canteen	**30**	Computer operation	**52**	Passivation
9	Use of cranes	**31**	Storage in open yard	**53**	EDTA Cleaning
10	Storage and handling of gas cylinders	**32**	Drilling, reaming and grinding(machining)	**54**	Chemical cleaning of Pre boiler system
11	Manual arc welding	**33**	Stress relieving	**55**	Boiler Light up
12	Use of helmets	**34**	Hydraulic test	**56**	Rolling and Synchronization
13	Good house keeping	**35**	Trial run of rotary equipment	**57**	Loading of Unit

14	Safe excavation	**36**	Batching	**58**	Air compressor
15	Working at height	**37**	Cable laying/tray work	**59**	Hydra Operation
16	Filling of hydrogen in cylinder	**38**	Spray insulation	**60**	Duct Pre-assembly
17	Illumination	**39**	Compressor operation	**61**	Resumption of construction activities after lockdown and prevention of coronavirus infection during site operations
18	Handling and erection of heavy metals	**40**	Gas distribution test		
19	Acid cleaning	**41**	Cleaning of Hot well / Deaerator		
20	Oil flushing	**42**	Electrical maintenance	**61A**	Prevention of Covid-19 infection in labour colony
21	Alkali boil out	**43**	O&M of control of AC plant & system	**62**	Truss/ Structure fit-up and alignment

a. The reference OCPs shall be suitably modified by subcontractor as per specific requirements to control the hazards.

b. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will prepare and follow those as well.

13.2 Work Permit System:

i. The following activities shall be carried out by the subcontractor strictly after obtaining Permit to Work from BHEL
   a) Height working
   b) Hot working
   c) Confined space Work
   d) Excavation more than 2-meter depth
   e) Radiography
   f) Heavy / Complex / Critical Lifting Activity
   g) Night / Holiday Work
   h) Material Loading / Unloading
   i) Grating, Safety Net, Safety Facility Removal
   j) Live Electrical Maintenance etc. - Lockout / Tagout
   k) Beam / truss/ duct/ structure alignment

ii. The Work Permit Formats shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability

iii. The above list is not exhaustive. BHEL reserves right to introduce additional Permits or modify requirements for usage of existing Permits. The conditions for using the Permit are specified in the Format (General Requirements).

iv. Where customer is having separate Work Permit System the same shall be followed in conjunction / merged to ensure all activities and checks are covered in all systems.

v. Details of working Group to be attached along with work permit request.

vi. All the Permits along with JSA/HIRA must be initiated by Agency Execution Team
vii. Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
viii. All Permit signatories (including subcontractor's package in-charge and HSE Officer) shall physically visit the work area and check that all the safety control measures necessary for the activity are in place. Only then the permit shall be issued.
ix. Signatory shall physically visit the area of work and ensure all required safeguards before signing the Permit
x. Signatory shall periodically visit the area to confirm the availability of required safeguards throughout the currency of the permit
xi. In case any Permit requirement is not available, work will be stopped till it is made available
xii. Permit holder shall implement and maintain all control measures during the period of permit. The permit will be closed after completion of the work.
xiii. Online Work Permit System shall be used whenever provided by BHEL, otherwise hard copy shall be used

13.3 Activity-Specific Precautions/ Controls

Detailed HSE precautions for various activities undertaken at Site by the subcontractors are specified in **Annexure I**. Same are to be ensured by the Sub-subcontractor while carrying out respective activities at Site

Index of **Annexure I** is given as under

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3.1	Excavation	8
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14. ENVIRONMENTAL CONTROL & SOCIAL RESPONSIBILITY

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

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

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

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

v. Regular dust suppression using sprinklers shall be carried out in respective area

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

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

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

15. HOUSEKEEPING

i. Keeping the work area and access roads clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings have to be done by subcontractor within quoted rate, on daily basis.

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

iii. Dedicated Housekeeping gangs shall be deployed, who shall be provided all required PPEs and safety training

iv. Mass housekeeping shall be carried out for half a day in a week

v. Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.

vi. All surplus earth and debris are removed/disposed off from the working areas to identified locations.

vii. Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.

viii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations.

ix. Sufficient waste bins shall be provided at different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high locations.

x. Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.

xi. Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.

xii. Labor camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.

xiii. Fabricated steel structures, pipes & piping materials shall be stacked properly.

xiv. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.

xv. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

16. WASTE MANAGEMENT

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

ii. Details of E-Waste, Hazardous Waste, biomedical waste etc. and their disposal plan, shall be submitted to BHEL every 6 months as per provided **formats**.

16.1 Bins At Work Place

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

16.2 Storage And Collection

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

16.3 Segregation

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

16.4 Disposal

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

16.5 Warning And Signs

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

17. Traffic Management System

17.1 Safe Workplace Transport System

i. Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.

ii. Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.

iii. For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.

iv. Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.

v. Speed limits shall be clearly displayed for each kind of vehicle.

vi. Speed ramps preceded by a warning signs or marker are necessary.

vii. The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.

viii. Safest route shall be provided between places where vehicles have to call or deliver.

ix. Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse

x. Safe areas shall be provided for loading and unloading.

xi. Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.

xii. Ensure road crossings are minimum and clearly signed.

xiii. Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.

xiv. Set sensible speed limits which are clearly sign posted.

xv. Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.

xvi. Forklift trucks shall not pass over road hump unless of a type capable of doing so.

xvii. Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.

xviii. Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

17.2 Traffic Route For Pedestrians

i. Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.

ii. Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.

iii. Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.

iv. Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
v. Provide high visibility clothing for people permitted in delivery area.

17.3 WORK VEHICLE

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

i. A high level of stability.
ii. A safe means of access/egress.
iii. Suitable and effective service and parking brakes.
iv. Windscreens with wipers and external mirrors giving optimum all round visibility.
v. Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
vi. Provision of seat belts.
vii. Guards on dangerous parts.
viii. Driver protection - to prevent injury from overturning and from falling objects/materials.
ix. Driver protection from adverse weather.
x. No vehicle shall be parked below HT/LT power lines.
xi. Valid Pollution Under Control certification for all vehicles
xii. Wheel stopper shall be use during the parking of vehicle
xiii. Helper to be deployed in each vehicle as per site requirement.

17.4 DAILY CHECK BY DRIVER

1. There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.

Brakes	Mirrors	Warning signals
Tires	Windscreen waters	Specific safety systems i.e. controls & interlocks
Steering	Wipers	

2. Management should ensure that drivers carry out these checks.

17.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

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

vi. Warning signs shall be displayed during transportation of material.
vii. All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.
viii. Wheel stopper shall be use during the parking of vehicle
ix. Helper to be deployed in each vehicle as per site requirement.

17.6 MAINTENANCE

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

18. EMERGENCY PREPAREDNESS AND RESPONSE

i. Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by BHEL
ii. Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
iii. All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
iv. Assembly point shall be earmarked and access to the same from different location shall be shown
v. Fire exit shall be identified and pathway shall be clear for emergency escape.
vi. Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
vii. Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
viii. First aid center shall be developed at site with trained medical personnel and ambulance
ix. Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
x. Tie up with fire brigade shall be done in case customer is not having fire station.
xi. Tie up with hospital shall be done in case customer is not having hospital.
xii. Disaster Management group shall be formed at site
xiii. Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL HSE Officer as per prescribed BHEL formats
xiv. Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

19. HSE INSPECTION

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

Online/ App-based HSE Inspection system shall be used for inspection whenever provided by BHEL otherwise Hard-copy based system shall continue

	OK	NOT OK
Contractor Name:		
Equipment Identification No :		
Inspection Date :		
Next Inspection Date :		
Inspected By :		

Every Inspected Equipment shall display above sticker

19.1 INSPECTION PLAN

Subcontractor shall prepare an inspection plan covering all areas/ activities/ equipment/ hazards and implement the same after getting approval of BHEL. Responsibility to ensure coverage of all areas/ activities rests with the subcontractor.

All Inspections shall be witnessed by BHEL – only then they shall be considered as valid

19.2 INSPECTION REPORTS

Monthly inspection reports as per plan shall be submitted to BHEL HSE Head

19.3 NON-CONFORMANCES

Any non-conformances identified during inspection observed shall be addressed on priority.

The responsibility of resolution shall rest with the Subcontractor Site In-charge

In case immediate closure of non-conformities is not possible:

a. work to be halted in the area
b. non-conformance to be generated and submitted to responsible person and BHEL
c. non-conformance to be resolved through responsible agency / person

Only after closure of non-conformances, work to be allowed to resume

19.4 DAILY HSE CHECKS

Both the Site Supervisors and HSE Officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites

are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

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

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

19.5 Indicative List of Inspections And Periodicities

Indicative list & periodicity of Inspections is given as under. It is the responsibility of the subcontractor to develop an inspection plan covering all areas & activities in the scope.

SL. No.	Format Name	Frequency of check (if applicable)
01	Inspection of First Aid Box	Weekly
02	Inspection of PPE	Weekly
03	Inspection of T&Ps	Monthly
04	Inspection of Cranes	Monthly
05	Inspection of Winches	Monthly
06	Inspection on Height Working	Weekly
07	Inspection on Welding & Gas Cutting	Monthly
08	Inspection on Electrical Installation	Monthly
09	Inspection on Elevator	Weekly
10	Inspection of Excavation	Weekly
11	Inspection of Labor Colony	Monthly
12	Inspection of Illumination Levels	Weekly

The checklists shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability before start of work

19.5.1 Inspection Of PPE

i. PPEs shall be inspected by HSE officer at random once in a week as per provided **format** for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
ii. The applicable PPEs for carrying out particular activities are listed below.

19.5.2 Inspection Of Tools & Plants (T&Ps)

i. A master list of T&Ps shall be maintained by each subcontractor in provided **format**.
ii. All T&Ps being used at site shall be inspected by HSE officer once in a month as per provided **format** for its healthiness and maintenance.
iii. The T&Ps which require third party inspection shall be checked for its validity during inspection. The third-party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.

iv. BHEL shall be given advance intimation of Third-Party Inspection. BHEL shall associate with Inspection as per discretion.
v. The validity of T&P shall be monitored as per provided **format**

19.5.3 Inspection Of Cranes And Winches

i. Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
ii. Cranes and Winches shall be inspected by HSE officer once in a month as per provided **format** for healthiness, maintenance and validity of third-party inspection.
iii. The date of third-party inspection and next due date shall be painted on cranes and winches.
iv. The operators/drivers shall be authorized by sub-subcontractor based on their competency and experience and shall carry the I-card.
v. The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

19.5.4 Inspection Of Height Working

i. Any activity carried out at more than 2 m height is classified as height work.
ii. Inspection of height working shall be conducted daily by Supervisors before start of work to ensure safe working condition including provision of
   a. Fall arrestor
   b. Lifelines – connected to rigid & independent structure
   c. Safety nets deployed below all height work activities
   d. Fencing and barricading
   e. Warning signage
   f. Covering of opening
   g. Proper scaffolding with access and egress.
   h. Illumination
iii. For full duration of height work, constant supervision to be maintained by dedicated HSE personnel
iv. Inspection on height working shall be conducted once in a week by HSE officer as per provided **format**.
v. Medical fitness of height worker shall be ensured.
vi. Height working shall not be allowed during adverse weather.

19.5.5 Inspection Of Welding And Gas Cutting Operation

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

iv. Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per provided **format**.
v. Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
vi. Availability of fire extinguisher at vicinity shall be ensured.

19.5.6 Inspection Of Electrical Installation / Appliances

i. Ensure proper earthing in electrical installation
ii. Use ELCB at electrical booth
iii. Electrical installation shall be properly covered at top where required
iv. Use appropriate PPEs while working
v. Use portable electrical light < 24 V in confined space and potentially wet area.
vi. Inspection shall be carried out as per provided **format**.

19.5.7 Inspection Of Elevator

i. Elevators shall be inspected by concerned supervisors once in a week as per provided **format**
ii. All elevators shall be inspected by competent person and validity shall be ensured.
iii. The date of third-party inspection and next due date shall be painted on elevator.

19.5.8 Inspection Of Excavation

Excavation activities shall be inspected as per provided **format**

19.5.9 Internal/ External HSE Audits/Inspections

i. All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed of by site in a time bound manner and reported back the implementation status.
ii. Corrective action and Preventive action on HSE issues raised by certification body issued by BHEL shall be implemented by site and reported to Site management.

20. Terms and Definitions:

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

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

3. **Man-Hours Worked:**
   The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labors. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the

period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

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

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

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

7. **Type of Incidents & Their Reporting:**
   The three categories of Incident are as follows:

8. **Non-Reportable Cases:**
   An incident, where the injured person is given medical help and discharged for work without counting any lost time.

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

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

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

    Number of Reportable LTI x 1,000,000/ Total Man Hours Worked

12. **Severity Rate:**
    Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:
    Days lost due to LTI x 1,000,000/ Total Man Hours Worked

13. **Incidence Rate:**
    Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:
    Number of LTIx1000/Average number of manpower deployed

14. HIRA:

Hazard Identification and Risk Assessment (HIRA) is a process of identifying Hazards in work area and then assessing them properly

15. Method Statement:

A method statement is prepared by the Execution/ Engineering Department detailing the steps, equipment, competencies and safety precautions required for carrying out any activity

16. Job Safety Analysis:

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. Other terms used to describe this procedure are job hazard analysis (JHA) and job hazard breakdown.

17. Safety Walk:

It's conducted periodically by an official - it's a walk through a portion or whole of a site as a HSE officer who notes down HSE observations, speak to concerned workmen and supervisor on observation, get the same corrected with personal follow up- this sends out a strong message on Management's commitment to safety.

18. Heavy & Complex Lifting:

A heavy and complex lifting activity includes:

1. Lifting above 20 Tons
2. Tandem Lifting using multiple cranes
   Total load exceeding 75% of capacity of crane. Depending up the condition of cranes, hydra cranes, winch machines & other lifting accessories
3. Lift of unusual difficulty or geometry or rigging
4. Lift over operating units
5. Any other lift as decided by site HSE / Erection

19. Safety Committee:

As per the BOCW, Safety Committee shall be constituted if there are more than five hundred or more construction workers are employed at any site. As per the Factories Act, 1948 it is for 250 workers. It shall be represented by equal number of representatives of employer and construction workers.

20. Night Work:

Work conducted after sunset when only a fraction of total manpower is available



ANNEXURES

ANNEXURE A

Medical Centre & Ambulance

A. Medical Centre

1. Paramedical staff
    a. When < 500 workers, 1 Trained Male Nurse (round the clock deployment)
    b. When >=500 workers*:
        i. Registered Medical Practitioner (Qualified MBBS) to be deployed for at least 8 hours in a day, 5 days per week
        ii. 2 Trained Male Nurses (round the clock deployment)
2. All articles as per Schedule IV of BOCW Central Rules, 1998 to be made available in the Medical Centre (given under for convenience)
3. Basic Facilities/ Requirements to be provided as per location eg. Refrigerator, Air Conditioner, Anti Venom Serums etc.
4. Tie-ups with speciality hospitals to be ensured for referring serious patients

* In case the number of workers is envisaged to exceed 500, a medical practitioner is to be engaged.

SCHEDULE IV (BOCW CENTRAL RULES, 1998) ARTICLES FOR AMBULANCE ROOM
[SEE RULE 226 (C)]

i. A glazed sink with hot and cold water always available.
ii. A table with a smooth top at least 180 cm x 105 cm.
iii. Means for sterilising instruments.
iv. A couch.
v. Two stretchers.
vi. Two buckets or containers with close fitting lids.
vii. Two rubber hot water bags
viii. A kettle and spirit stove or other suitable means of boiling water.
ix. Twelve plain wooden splints 900 cm x 100 cm x 6 cm.
x. Twelve plain wooden splints 350 cm x 75 cm x 6 cm.
xi. Six plain wooden splints 250 cm x 50 cm x 12 cm.
xii. Six woollen blankets.
xiii. Three pairs of artery forceps.
xiv. One bottle of spiritus annemia aremations (120 ml).
xv. Smelling salt (60 gm).
xvi. Two medium size sponges.
xvii. Six hand towels.
xviii. Four kidney trays.
xix. Four cakes of toilet, preferably antiseptic soap.
xx. Two glass tumblers and tow wine glasses.
xxi. Two clinical thermometers.
xxii. Two tea spoons.
xxiii. Two graduated (120 ml) measuring glasses.
xxiv. Two minimum measuring glasses.
xxv. One wash bottle (1000 cc) for washing eyes.
xxvi. one bottle (one litre) carbolic lotion 1 to 20.
xxvii. Three chairs.
xxviii. One screen.
xxix. One electric hand torch.
xxx. Four first-aid boxes or cupboards stocked to the standards prescribed in
xxxi. An adequate supply of tetanus toxide.
xxxii. Injections—morphia, pethidine, atrophine, adrenaline, coramine, novocaine (6 each).
xxxiii. Cramine liquid (60 ml).
xxxiv. Tablets—antihistaminic antispasmodic (25 each).
xxxv. Syringes with needles—2 cc, 5 cc, 10 cc and 500 cc.

xxxvi. Three surgical scissors.
xxxvii. Two needle holders, big and small.
xxxviii. Suturing needles and materials.
xxxix. Three dissecting forceps
xl. Three dressing forceps
xli. Three scalpels.
xlii. One stethoscope and a B. P. apparatus.
xliii. Rubber bandage—pressure bandage.
xliv. Oxygen cylinder with necessary attachments.
xlv. Atropine eye ointments.
xlvi. I. V. Fluids and sets 10 nos.
xlvii. Suitable, foot operated, covered, refuse containers.
xlviii. Adequate number of sterilised, paired, latex hand gloves.

B. Ambulance

1. When number of workers is <500:
   If the distance to a major hospital capable of handling critical injuries expected at Site is <= 50 KM from Site, then 1 BLS (Basic Life Support)/ Type B Ambulance otherwise ALS* (Advanced Life Support)/ Type D Ambulance
2. If no. of workers increases to >2000 workers one additional BLS Ambulance to be deployed
3. Minimum Articles as per Schedule V of BOCW Central Rules to be ensured in each Ambulance. (given under for convenience)

*Final call to be taken at Site in consultation with all the contractors

SCHEDULE V (BOCW CENTRAL RULES, 1998)
CONTENTS OF AMBULANCE VAN OR CARRIAGE
[SEE RULE 227]

The Ambulance Van shall have equipment prescribed as under:

a) General—a portable stretcher with folding and adjusting devices with the Head of the stretcher capable of being tilted upward. Fixed suction unit with equipment. Fixed oxygen supply with equipment. Pillow with case, sheets, blankets, towels, emergency bag, bed pan, urinal glass.
b) Safety Equipment-Flaros with life of three thousand minutes, floor lights, flash lights, fire extinguishers (dry power type), insulated guntlets.
c) Emergency Care Equipment—
   i. **Resuscitation**—Portable suction unit, portable oxygen unit, bag valve mask, hand operated artificial ventilation unit, airways, mouth gag tracheostomy adapters, short spine board, I.V. FLUIDS with administration unit, B. P. manometer cuff stethoscope.
   ii. **Immobilisation**—Long and short padded boards, wire ladder splints, triangular bandage—long and short spine boards.
   iii. **Dressing**-Gauze pads—100 m x 100 mm universal dressing 250 x 1000 mm, roll of aluminium foils—soft roller bandages 150 mm x 5 mm yards adhesive tape in 75 mm roll safety pins, bandage sheets, burn sheets.
   iv. **Poisoning**—Syrup of Ipecac, activated charcoal pre packeted dose, snake bit kit, drinking water.
   v. **Emergency Medicines**—As per requirement (under the advice of construction Medical Officer).

ANNEXURE A.1

Sample calculation for deduction of operational cost of facilities

Annexure A.1

Cost Calculation Methodology of Operation of Facilities (Data is indicative only)

(Period of 48 months is considered - shall be on actual basis)

A. Project Info:

Total time of Project	48 months
Project cost	1000 Crore
No. of packages	10 (A1-A10)

B. Item-wise Calculation:

Item	Nos.	Rate	Unit	Amount
Ambulance with Driver	2		Monthly/Unit	170000
Nurse/First aider	2 X 2 shifts	15000	Per month	30000
Training center one time cost	1	100000	Once	100000
Medical center one time cost	1	200000	Once	200000
Medicines at medical center	1	10000	Monthly	10000
Dust supression water tank	2	2000	Monthly	4000
Doctor	1	70000	Monthly	70000
Cleaning staff	1	12000	Monthly	12000
			Recurring monthly expenditure	296000
			Total one-time expenditure	300000

C. Package-wise Deduction Plan for a period of 48 months

Period (In Months)	6	36	6
	For 1-6 months	For 7-42 months	For 43-48 months
Cost to be incurred from contractors	7%	81%	12%
	1.17% per month	2.25% per month	2.00% per month

D. Calculation For One-Time Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10			
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000		
Share of common facilities one time running cost (in Thousands)	4	11	86	9	21	64	43	43	11	9	Individual Pkg value X Total one time running cost / All Pkg award values		
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48			
Month Count of work	6	8	47	31	9	39	43	34	9	8			
Deduction per month (in Thousands)	1	1	2	0	2	2	1	1	1	1	Total of One time Running cost (in thousands)	% deduction share of one time running cost per month	Nos. of active packages in month
Month No.													
1	1	1									2	1%	2
2	1	1	2								4	1%	3
3	1	1	2								4	1%	3
4	1	1	2								4	1%	3
5	1	1	2								4	1%	3
6	1	1	2	0			1				5	2%	5
7		1	2	0	2		1	1			8	3%	6
8		1	2	0	2		1	1			8	3%	6
9			2	0	2		1	1			7	2%	5
10			2	0	2	2	1	1			8	3%	6
11			2	0	2	2	1	1			8	3%	6
12			2	0	2	2	1	1			8	3%	6
13			2	0	2	2	1	1			8	3%	6
14			2	0	2	2	1	1			8	3%	6
15			2	0	2	2	1	1			8	3%	6
16			2	0		2	1	1			6	2%	5
17			2	0		2	1	1			6	2%	5
18			2	0		2	1	1			6	2%	5
19			2	0		2	1	1			6	2%	5
20			2	0		2	1	1			6	2%	5
21			2	0		2	1	1			6	2%	5
22			2	0		2	1	1			6	2%	5
23			2	0		2	1	1			6	2%	5
24			2	0		2	1	1			6	2%	5
25			2	0		2	1	1			6	2%	5
26			2	0		2	1	1			6	2%	5
27			2	0		2	1	1			6	2%	5
28			2	0		2	1	1			6	2%	5
29			2	0		2	1	1			6	2%	5
30			2	0		2	1	1			6	2%	5
31			2	0		2	1	1			6	2%	5
32			2	0		2	1	1			6	2%	5
33			2	0		2	1	1			6	2%	5
34			2	0		2	1	1			6	2%	5
35			2	0		2	1	1			6	2%	5
36			2	0		2	1	1			6	2%	5
37			2			2	1	1			6	2%	4
38			2			2	1	1			6	2%	4
39			2			2	1	1			6	2%	4
40			2			2	1	1	1		7	2%	5
41			2			2	1		1	1	7	2%	5
42			2			2	1		1	1	7	2%	5
43			2			2	1		1	1	7	2%	5
44			2			2	1		1	1	7	2%	5
45			2			2	1		1	1	7	2%	5
46			2			2	1		1	1	7	2%	5
47			2			2	1		1	1	7	2%	5
48			2			2	1		1	1	7	2%	5
Total	4	11	86	9	21	64	43	43	11	9	300	100%	

D. Calculation For Recurring Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10		
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000	
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48	Total of Recurring cost (in thousands)	Nos. of active packages in month
	6	8	47	31	9	39	43	34	9	8		
Month No.												
1	85	211									296	2
2	13	31	252								296	3
3	13	31	252								296	3
4	13	31	252								296	3
5	13	31	252								296	3
6	8	21	167	17			83				296	5
7		15	120	12	30		60	60			296	6
8		15	120	12	30		60	60			296	6
9			126	13	31		63	63			296	5
10			95	10	24	72	48	48			296	6
11			95	10	24	72	48	48			296	6
12			95	10	24	72	48	48			296	6
13			95	10	24	72	48	48			296	6
14			95	10	24	72	48	48			296	6
15			95	10	24	72	48	48			296	6
16			104	10		78	52	52			296	5
17			104	10		78	52	52			296	5
18			104	10		78	52	52			296	5
19			104	10		78	52	52			296	5
20			104	10		78	52	52			296	5
21			104	10		78	52	52			296	5
22			104	10		78	52	52			296	5
23			104	10		78	52	52			296	5
24			104	10		78	52	52			296	5
25			104	10		78	52	52			296	5
26			104	10		78	52	52			296	5
27			104	10		78	52	52			296	5
28			104	10		78	52	52			296	5
29			104	10		78	52	52			296	5
30			104	10		78	52	52			296	5
31			104	10		78	52	52			296	5
32			104	10		78	52	52			296	5
33			104	10		78	52	52			296	5
34			104	10		78	52	52			296	5
35			104	10		78	52	52			296	5
36			104	10		78	52	52			296	5
37			108			81	54	54			296	4
38			108			81	54	54			296	4
39			108			81	54	54			296	4
40			103			77	51	51	13		296	5
41			120			90	60		15	12	296	5
42			120			90	60		15	12	296	5
43			120			90	60		15	12	296	5
44			120			90	60		15	12	296	5
45			120			90	60		15	12	296	5
46			120			90	60		15	12	296	5
47			120			90	60		15	12	296	5
48			120			90	60		15	12	296	5
Total	143	388	5676	329	235	3102	2334	1772	132	96	14208	

ANNEXURE B

HSE Displays

A. Types of Displays

1. Based on Content

SN	Type
1.	**HSE Hazards & Precautions** Height Work, Housekeeping, Fire Safety, PPEs, Hot Work, Lifting & Rigging Activity, Site-specific Hazards – eg. for Refineries, Nuclear plants etc.; COVID Precautions; Environment Protection etc.
2.	**Other Displays, Signage etc.** HSE Policy, ISO Certificate, Safety Statistics, Assembly Area Location/ Route, Emergency Contact Numbers, Site Safety Rules & Regulations, Speed Limit, Work in Progress, Lock-Out Tag-Out (LOTO) Boards etc.

2. Based on Mounting

[Type 1]	[Type 2]	[Type 3]
Flex Sign Boards of Wooden Frame – directly mounted on Structures (walls, stairs, railings etc.)	Flex Sign Boards with Wooden Frame – mounted on metallic/ wooden legs – preferably double-sided	Coloured weather-proof Paintings on Walls (after due concurrence of BHEL/ Customer – Type 1 in case of no concurrence/ space)

B. General Requirements:

a. Displays should be weather-proof as per installation location, i.e. rain-proof, wind-proof and sun-proof.
b. Installation location and size to ensure visibility for the intended viewers (workers and moving personnel)
c. Displays to have at least 50% graphical elements preferably (as applicable). Language should be understandable by majority of the workers
d. Displays to be relevant to the hazards in the area
e. Proper installation to ensure boards don't obstruct activities and should not be prone to fall so as to pose danger
f. In case of multiple elevations (eg. Boiler, Power-house etc.), each elevation to have displays for applicable hazards including Height-Work, Housekeeping
g. For temporary work locations, posters/ boards may be erected and shifted after task is over
h. Minimum size of displays should be A1 unless otherwise specified
i. In case of damage, displays shall be reviewed and repaired/ replaced
j. In areas where night work is envisaged, fluorescent displays shall be installed and these should comprise of at least 20-30% of total displays
k. Total Number of displays to be not less than 1 per 10 workers and are to be dynamically updated based on number of workers

C. Area-wise Displays

Below is list of Area-wise displays that are to be installed at Sites (Numbers, locations may be adjusted for specific requirements)

SN	Area	Suggested Subjects	Minimum Size	Minimum Quantity	Locations
1	**Walls/ Foundations/ Cement Structures etc. belonging to the package area**	Safety Hazards Prevention and other HSE Awareness content	**[Type 3]**	As per BHEL assessment from time to time	
2	**Site Interior Roads belonging to the package area**	At least every 20 meters: 1. Speed Limit Indication, Safe Driving board 2. Boards for hazard awareness	1.As needed **[Type 2]** **2.** A1 or equivalent each [**Type 2]**	As indicated	Sides of Roads; Height to ensure good visibility
3	**Specific Package Areas**	**A. Common** At entry to respective Package/ Work Area, each contractor to put up daily updated board with following for each shift: 1. Scope of work and start date 2. Emergency Contact Numbers 3. Emergency Assembly Location, Escape Plan 4. Locations and supervisors of various gangs in the area, 5. Current Work permit Details 6. Safety Supervisor Location assignments - Names, Mobile Nos., Assigned Locations 7. Details (Name, Contact No. etc.) of Package In-charge - Contractor & BHEL 8. Details (Name, Contact No. etc.) of Safety In-charge - Contractor & BHEL 9. LTI Free Man-days & details of last LTI also to be indicated In addition, Area-Specific Displays as indicated in Table 1	**A0** **[Type 2]**	1 per Package Area	Entry/ Ground Level

Table 1

(Area/ Package-wise HSE Display Plan – As applicable)

Prepared By (Subcontractor)				
S. No.	**Area**	**Suggested Minimum No. of Displays & Types**	**Type**	**Numbers Installed**
1	Boiler	3 per working elevation	**[Type 1]**	
2	Powerhouse	5 per elevation	**[Type 1]**	
3	ESP	5 Per Pass	**[Type 1]**	
4	Buildings	5 per elevation	**[Type 1]**	
5	Cooling Tower (NDCT/ IDCT/ ACC)	20 per Structure	**[Type 1]**	
6	Chimney	20 per Structure	**[Type 1]**	
7	Fabrication Yard	10 per Yard	**[Type 2]**	
8	Batching Plant	5 per Plant	**[Type 1]**	
9	Material Storage Yard – Open	20 per Yard	**[Type 2]**	
10	Material Storage Shed – Semi-Closed/ Closed	10 per Shed	**[Type 1]**	
11	Electrical Booths	2 per booth + Line diagram, Emergency contact details	**[Type 1]**	
12	Medical & First Aid Centre	2 per Centre	**[Type 1]**	
13	Rest Shed	2 per Shed	**[Type 1]**	
14	Canteen	2 per Canteen	**[Type 1]**	
15	Drinking Water Area	1 Per Outlet	**[Type 1]**	
16	Washing Water Area	1 Per Outlet	**[Type 1]**	
17	Training Centre	10 per room	**[Type 1/2]**	
18	Assembly Area	5	**[Type 1/2]**	
19	Stairs	1 per landing elevation	**[Type 1]**	
20	Cylinder Storage Area	5 + Signage: Type of Gas, Empty, Filled etc.	**[Type 1/2]**	
21	Labor Colony	Electrical Safety with Distribution Plan/ Line Diagram - 1 COVID Precautions Posters – 5 Safety Awareness Posters – 10 Hygiene awareness posters - 2	**[Type 1]**	
22	Others	As per requirement	**[Type 1/2]**	

Date:

Sign (Contractor) **Sign (BHEL)**

ANNEXURE C

HSE Tools/ Equipment/ Devices

Following equipment conforming to relevant IS/ISO/BS Codes/ Standards in indicated quantities shall be ensured by subcontractor. This list is tentative, not exhaustive. Quantity and date/ period of deployment shall be as per site requirement.

A. HSE Tools/ Equipment/ Devices

SN	Item
1	Lifelines
2	Retractable Fall Arrestors
3	Safety Nets (10m X 5m) fire proof double mesh
4	Sky Climbers
5	Fire Blanket
6	Honey Bee Removal Suit & Kit
7	Scaffolding Pipes
8	Flashback Arrestors
9	Barricading Tape
10	Binoculars
11	Walkie-Talkies
12	LOTO kit
13	24-Volt light
14	Sand Buckets
15	Hard barricading Pipes
16	Standby Fire kits
17	Hand-held Megaphone
18	Small Public Address System
19	Foldable Stretcher
20	Height Rescue Kit (Non-Motorized)
	(Others:)

B. Test & Measurement Devices

SN	Device
1	ELCB Tester
2	Multi meter (Light cables)
3	Earth Resistance Meter
4	Lux Meter
5	Sound Meter
6	Anemometer
7	Breath Analyzer (Alcohol)
8	Multi-gas dozi-meter/ detector
9	Gas leakage detector / alarm
10	Gas monitor (confined space)
11	Radiation meter & Badges
12	Blood Pressure Monitor
13	Fire detectors
14	Hand held signaling light
	(Others:)

ANNEXURE D

Rest Sheds

1. Determining the Number, Sizes and Locations of Rest Shelters

i. **Numbers:**

The number of rest shelters shall be determined based on maximum number of workers at any one time (across all shifts). Formula is:

Wmax = Maximum number of workers at any time in the Site

Space per worker = 1.1 sq meter

Total space required, Tspace = Wmax X 1.1

Based on total space requirement calculated above, the number of rest sheds can be decided according to availability of locations and concentration of workers – so as to ensure the required space.

ii. **Locations:**

The rest sheds should be so located so as to minimize the distance to be travelled by the workers from their locations of work considering all the practical constraints

iii. **Other:**

The Rest shelter should be fenced so that it cannot be used as parking area.

2. Design & Construction of Rest Sheds

a. Permanent/ Long duration Rest Sheds

i. For locations where, permanent rest sheds can be constructed without possibility of removal for relatively long period of time, a semi-closed shed can be constructed covered with tin roof and supported with well-grouted beams. The floor of the shed to be preferably cemented/ solidified.

ii. Adequate structural requirements suitable to the local weather (wind/ rain etc.) to be ensured.

iii. The design of the rest shed to be approved by Civil Engineering Department of BHEL Site before commencing work

b. Temporary/ Movable/ Portable Rest Sheds

i. For locations where, permanent rest sheds cannot be constructed either due to non-availability of permanent location or other reasons, temporary rest shed shall be constructed.

ii. Temporary rest sheds shall comprise of Tent arrangement carried out by professional agencies

3. Amenities in Rest Sheds

a. Essential Amenities

Following amenities shall be essentially ensured in a rest shed:

i. Hygienic environment with regular cleaning and housekeeping (with records)
ii. Adequate illumination
iii. Adequate ventilation/ heating as per weather conditions
iv. Clean Drinking water source
v. Hand Washing area
vi. Toilets & Urinals
vii. Benches/ mats for sitting/ lying
viii. Any other essential requirement deemed necessary by the Site
ix. Dust bins of sufficient quantity/ size that are vacated each day/ as per requirement

b. Additional/ Optional Amenities

Following amenities are optional but are recommended to enhance the level of satisfaction of work force:

i. Hot/ Cold drinks (Tea, Coffee, Glucose etc.) as per requirement
ii. Snacks
iii. Fans/ Coolers/ Heating arrangements as per requirement and weather conditions
iv. A nice, welcoming interior design, music etc.
v. Water cooler

4. Health & Safety Requirements of Rest Sheds

Use of asbestos in construction is banned and shall not be used.
In addition, following essential Safety features shall be ensured in Rest sheds:

i. Availability of Fire extinguishers (preferably CO2 type)
ii. Display of Safety Posters
iii. Pest/ reptile protection
iv. Mosquito prevention measures

5. Note:

Any suitable closed spaces/ newly constructed buildings etc. available at project may also be used for the purpose of rest shed with due concurrence of BHEL

ANNEXURE E

Labor Colony

1. These Guidelines suggest minimum requirements. However, additional requirements based on feasibility and circumstances, while adhering to directions of GOI/District Administration/Local Authority guidelines to be considered
2. Norms for social distancing, training/ awareness, face masks, disinfection, sanitization, gate entry, quarantine, medical, action in case of suspect cases of COVID and other communicable diseases etc. to be followed as per Govt. and BHEL guidelines issued from time to time
3. Labor colony to be developed as close to the Site as possible to avoid lengthy commute
4. A "Suggestion Register" shall be made available at the labor colony for residents. The feedback shall be reviewed on weekly basis and acted upon by concerned Contractor. Same shall be reviewed periodically by authorized BHEL Site Official.
5. **Canteens, Latrines & Urinals, Washing Facilities, Creches, Residential Accommodation and other infrastructure/ facilities:**
   Numbers/ Quantities and Features of these facilities shall be in line with the following as applicable:

   a. BOCW Act & State Rules
   b. The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act & State Rules
   c. Factories Act & State Rules
   d. Other Relevant Acts & Rules

6. **Cleanliness & Hygiene/ Housekeeping:**
   a. Regular cleaning of the labor colony to be ensured.
   b. Daily cleaning of Sanitary facilities.
   c. Proper drainage system to prevent water-logging
   d. Regular fogging to prevent spread of mosquitoes
   e. Prevention of foul smell through necessary interventions
   f. Dust suppression as per requirement
   g. Cutting of Grass at regular intervals and other necessary measures to prevent pests & reptiles
   h. Stray animals to be banned from labor colony.
   i. Outside every common facility, eg. Toilet, washroom, food hall/ canteen etc., provision of washbasin with flowing water and soap (preferably liquid soap) to be ensured
7. **Power Supply Layout:**
   Electrical supply Layout of Labor Colony shall have the provision of Safety devices like MCBs, ELCBs etc. and to be clearly displayed
8. **Washing & Drinking Water Availability**
   a. Adequate water to be provided in line with: "Estimation of Water Requirements for Drinking and Domestic Use (Source: National Building Code 2016, BIS)"
   b. Drinking water tank to be cleaned every week and sticker for the same pasted on the tank
   c. Drinking water source should be tested as per IS 10500
9. **Waste Disposal:** Separate bins for dry, wet and biomedical waste to be installed. These bins to be evacuated regularly
10. **Training & Awareness/ Displays**
    a. **HSE Awareness Displays**: Posters/ banners/ boards to be displayed in labor colony. Subjects of displays shall be precautions for applicable hazards at work site.
    b. **Emergency Contact Numbers** including that of Doctor, Hospital, Labor Colony Supervisor, HSE Officials to be displayed prominently

11. **Doctor Visits:**
    Regular and need-based visits by Doctors to be ensured through tie-ups etc.
12. **Inspection & Review:** Regular inspection of labor accommodation to be carried out by the Contractor as per prescribed format. Last inspection date, inspector and next due date to be prominently indicated near main gate
13. Provision of a Fair Price shop in the premises to be ensured as per requirement
14. Adequate arrangements to be ensured in case of children/ families

ANNEXURE F

Toilets

Toilets (Latrines and urinals shall be ensured at Site and Labor Colony in accordance with the Inter-State Migrant Workmen Act, 1979 as given below:

LATRINES	URINALS
1. Latrines shall be provided in every establishment on the following scale, namely: - a. Where females are employed, there shall be at least one latrine for every 25 females; b. Where males are employed, there shall be at least one latrine for every 25 males: Provided that where the number of males or females exceeds 190, it shall be sufficient if there is one latrine for 25 males or females, as the case may be, up to the first 100, and one for every 30 thereafter 2. Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.	1. There shall be at least one urinal for male workers up to fifty and one for female up to fifty employed at a time: Provided that where the number of male or female workmen, as the case may be, exceeds 500 it shall be sufficient if there is one urinal for every fifty females up to the first 500 and one for every 100 or part thereof thereafter. 2. The urinals shall be designed and located so as to ensure privacy.

Important:

1. Where workers of both sexes are employed there shall be displayed outside each block of latrine and urinal a notice in the language understood by the majority of the workers 'For Men Only', or For Women Ónly', as the case may be.
2. The notice shall also bear the figure of a man or of a woman, as the case may be.
3. The latrines and urinals shall be conveniently situated and accessible to workers at all times at the establishment.
4. The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
5. Latrines and urinals other than those connected with a flush sewage system shall comply with the requirements of the public health authorities.
6. Water shall be provided by the means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.
7. At Site, on ground, Modular Bio-toilets as per industry standard specifications and regular professional cleaning shall be ensured. The toilets should be sufficient in number and easily accessible to workers from every work area
8. At Site, in various elevations, suitable urinals with proper drainage to be ensured at each elevation in line with IS 2064 (1993). Same to be cleaned regularly

ANNEXURE G

Fire Extinguishers

SN	Type of Fire Risk (Class of Fire)	Extinguishing Medium & Relevant INDIAN STANDARD	Scale of Equipment (Minimum recommended)
1.	**CLASS 'A'** Fires involving ordinary combustible materials like wood, paper, textiles, rubber etc. (Ordinary hazard or low fire load)	WATER Soda acid type, water type (gas pressure) and water type (constant air pressure) IS: 934 -1976; IS: 940 -1976; IS: 6234 -1971	For every 600 square meter floor area or part, one 9-litre capacity. Minimum 4 numbers per floor or room; should not be required to travel more than 15 meter to reach any extinguisher.
2.	**CLASS 'A'** (Extra hazard &high fire load)	-do	-do – (Also, consult local fire authority).
3.	**CLASS 'A'** (Special hazards)	-do	-do – Extra provision For every 100 square meter floor area or part, one 4.5 Kg. CO2; minimum 2 numbers per room; should not be required to travel more than 10 meter to reach any extinguisher.
4.	**CLASS 'B'** (Fires in flammable liquids like oils, solvents, petroleum, products, varnishes, paints, etc. where blanketing effect is essential) (Storage and handling in small quantities)	FOAM / CARBON DIOXIDE / DRY CHEMICAL POWDER IS: 933 -1976; IS: 2878 1976; IS: 2171 1976; IS: 4308 -1982	For every 50 square meter floor area or part, 2 numbers 9 -liters foam or 5 kg dry powder; should not be required to travel more than 10 m in the area of storage to reach any extinguisher.
5.	**CLASS 'B'** (Bulk storage other than in tank form))	-do -	-do- (but minimum 3 numbers per room)
6.	**CLASS 'C'** (Fires involving gaseous substances under pressure where it is necessary to dilute the burning gas at a very fast rate with an inert gas or powder) (storage and handling of gas cylinders)	CARBON DIOXIDE / DRY CHEM. POWDER. The best way to extinguish such fire is by stopping the flow of fuel gas to the fire. Container is kept cool with water spray. IS: 2878 1976; IS: 2171 -1976; IS: 4308 -1982	For every 100 square meter floor area or part; 2 numbers, 10 kg powder extinguisher or 6 kg C02; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
7.	**CLASS'D'** Fires involving metals like magnesium, aluminum, zinc, potassium etc. where the burning metal is reactive to water and which require special extinguishing media or technique	SPECIAL DAY POWDER IS: 2171 -1976 IS: 4861 -1968	For every 50 square meter floor area or part, 2 nos. 5 kg special dry powder; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
8.	**MIXED OCCUPANCY** (electrical); Generators; Transformers; etc.	CARBON DIOXIDE DRY POWDER, IS: 2878 1976; IS: 2171 -1976	For every 100 square meter floor area or part one 10 kg C02. Minimum 2 numbers for every location should not be required to travel more than 10 meter to reach an extinguisher.
Note: Due to peculiarities of the power plant construction sites, there would be locations in the construction areas of Boiler, Turbine, Generator, Transformer, etc. where different types of fire risk (classes of fire) may co-exist. Special care shall be taken while selecting and installing portable fire extinguishers for such locations so that all types of fire risk that may co-exist, are adequately covered. Similar special care shall be taken for storage areas.			

a. All Electrical welding booths shall be equipped with appropriate Fire Extinguisher

b. Appropriate Fire Extinguishers shall be made within easy reach of all welding operations
c. Fire extinguishers shall be regularly tested and last checked date to be indicated on each. Master list shall be prepared with location and details
d. Providing appropriate fire-fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
e. Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labour colony etc. Such fire protection equipment shall be easy and kept open at all times.
f. The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
g. All other fire safety measures as laid down in the “codes for fire safety at construction site” issued by safety coordinator of BHEL shall be followed.
h. Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
i. Emergency contacts nos. must be displayed at prominent locations
j. Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.

ANNEXURE H

HSE Compliance Certificate

Bill Ref no:_____Date:_____

NAME OF THE AGENCY: _____ Work-Area/Package:_____

Sl. No.	Description	Remarks
1	**HOUSE KEEPING**:	
1.1	All working areas at site (specific to the agency) are free from garbage's, scraps & any other undesired non-plant materials. There is no encroachment in safe passage of man, material & T&P to carry out activities safely	
1.2	All the plant materials under the custody of the agency are stacked & stored properly.	
2	**GENERAL ILLUMINATION**:	
2.1	ALL the working areas at site & office of the agency including passages are having proper & sufficient illumination.	
3	**STATUTORY & REGULATORY REQUIREMENT**:	
3.1	Sufficient water for drinking & other purposes and sanitation in work area and labour colony are available.	
3.2	Periodical Medical check-up of workers & staff done regularly & report submitted to BHEL	
3.3	Regular EYE testing is done for Crane operators/Welders and data's are available with agency	
3.4	All the T&P, Cranes etc used by the agency are having proper T.Cs & Fitness certificate available from competent authority.	
4	**SAFETY COMPLIANCE:**	
4.1	Number of Tool box meetings between Safety officers, erection staff & workers of the agency held in this month with location mentioned	
4.2	All precautions & Safety measures including PPE compliances are taken before working at HEIGHT	
4.3	Permit for working at Height is taken & complied accordingly	
4.4	ELCB is used in Construction Power Supply source by the agency & Proper Distribution board and electrical cabling has been used by the agency and regularly checked by electrician & safety officer of the agency	
4.5	Unsafe areas barricaded properly &unsafe opening closed properly	
4.6	Proper Platforms & Hand-rails used In areas earmarked earlier	
4.7	Proper safety signage's, Slogans & Emergency contact phone numbers including FIRE contact nos. are made available by the agency in locations mentioned	
5	Whether any penalty imposed by BHEL towards non-compliance of above points.	

VENDOR'S SIGNATURE	
Erection Engineer	
HSE Officer	
Site-in-Charge	

BHEL'S SIGNATURE	
Erection Engineer	
HSE Officer	
Package-in-Charge	

ANNEXURE I

Activity-Specific Safety Precautions/ Controls

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General

The philosophy of hierarchy of controls as below shall be followed

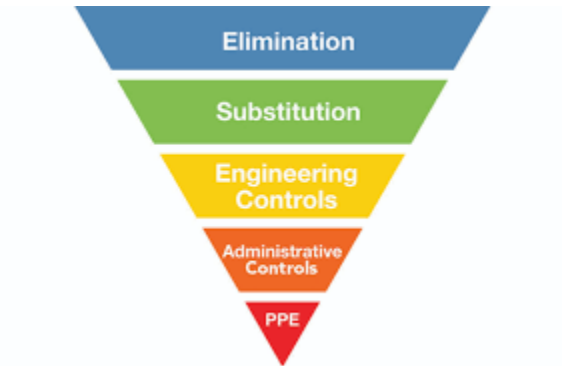


Fig. 1.1

It shall be ensured that there are multiple protections against any accident/ incident. For example, for height work there shall be safe platforms and walkways, Safety Nets and Lifelines for hooking double lanyard Safety harness by workers.

Monitoring and modifying worker behavior shall be part of ensuring safety. All personnel should be competent and trained for the job

Brief Safety guidelines for various hazardous activities are indicated below, besides the mandatory requirements based on Hazard Identification studies, HSE Procedures, Operational Control Procedures, Work Permits, applicable Indian Standard Codes and other provisions detailed in this document. Constant supervision at all times to be maintained by Execution & Safety Team to ensure implementation of these provisions.

1. WORK AT HEIGHT:

a. All work at height above 2 meter above ground level without complete platforms, handrails and other related fall protection shall require a work permit in the prescribed form. This shall require approval by the competent authority. The HSE officer of sub-contractors shall follow the checklist religiously by physically verifying the condition of the work area before recommending for approval.

b. Prior to the start of work at elevation, the HSE Officer involved with the work must meet the work supervisor to review the scope of work, and must review all the possible fall hazards and effective safety responses. The evaluation / analysis must be documented and kept on file and on site by the HSE Officer.

c. Whenever a fall hazard or other exposure exists for working at heights more than 2.0m/6ft, the nature and scope of work will be evaluated for conditions and environmental factors before selecting the appropriate fall protection system (active, passive or a combination of measures, as appropriate).

d. All Engineering and Administrative Controls including barricading, safe platform, Safety Nets etc. shall be made available at work location. Under no circumstances, there shall be total reliance on PPEs only

e. **Safety Nets**

   i. Contractor shall maintain sufficient stock of Safety Nets for deployment

   ii. Safety Nets as per IS: 11057:1984 should be used extensively for prevention / arrest men and materials falling from height.

   iii. The safety nets shall be fire resistant, duly tested and shall be of ISI marked.

iv. Safety Nets shall be deployed below all platforms where height work is envisaged. Duration of work, delay shall be no excuses for non-installation of Safety Net

f. Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.

g. Monkey Ladder shall be fitted with cages. Rope ladder should be discouraged.

h. In case of pipe-rack, persons should not walk on pipes and walk on platforms only.

i. In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.

j. For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor.

k. The procedures for the safety response to identified fall hazards developed and rescue plans must be reviewed with all individuals exposed to the hazards.

l. The HSE Officer must establish an inspection process of fall protection systems. Some equipment requires documented inspections by its manufacture on a regular schedule. Such equipment must have evidence of the inspection and re-certification process on it. This information must be reviewed before the equipment is actually used. Individuals must visually inspect the fall protection equipment before each use. Failure to complete this inspection process could result in serious injury or death.

m. Immediately remove from service any fall protection equipment that is identified as defective, damaged, or has been subjected to an impact. Damaged fall protective equipment must be destroyed to prevent re-use and not be discarded into trash containers, as the worn or damaged equipment could be unintentionally re-used.

n. Aerial lifting devices, excluding scissor lifts require the use of full body harnesses and lanyards in any elevated position.

o. Where Height related works are applicable then rescue team (consist of 5- 10 person) shall be identified and trained for potential rescue.

1.1 Personnel fall protection system must include:

a. Safety Harness

All height workers must use Full Body Safety harness with double lanyards with shock absorber (only). The primary lanyard is never unhooked until the secondary lanyard is secure. The design of the working platform should be such that under no circumstances, worker should have both lanyards unhooked while at height.

b. Lanyard

i. The type of work and the environment conditions determine lanyard and lifeline selection. If welding, chemical cleaning that may damage lanyards, connectors or lifelines, sandblasting, etc., either protect the components or use more appropriate type of system.

ii. Lanyards and lifelines must incorporate, or be used with, an appropriate deceleration (shock absorbing) device. Deceleration devices include rope grabs, rip-stitch lanyards, specially woven lanyards, tearing, or deforming lanyards, automatic self-retracting lifelines and lanyards which dissipate or limit the energy imposed on the employee during fall arrest.

iii. Once in use, the system's effectiveness is to be monitored. In some cases, a program for cleaning and maintaining the system may be necessary. Lanyard and lifelines must use locking snap hooks only and under

no circumstances must two lanyard snap hooks be connected.

c. Lifeline

All lifelines in general are to be made of min 12mm dia. steel rope (plastic coated) and tied to columns with 3 clamps at each end. Wherever columns are not available to tie the lifelines, the vertical posts as per the design below are to be provided after carrying out drop load test initially. A load of 240kg to be dropped off the mid-point of lifeline in this test.

d. Lifeline Post

DIAGRAM : LIFELINE POST

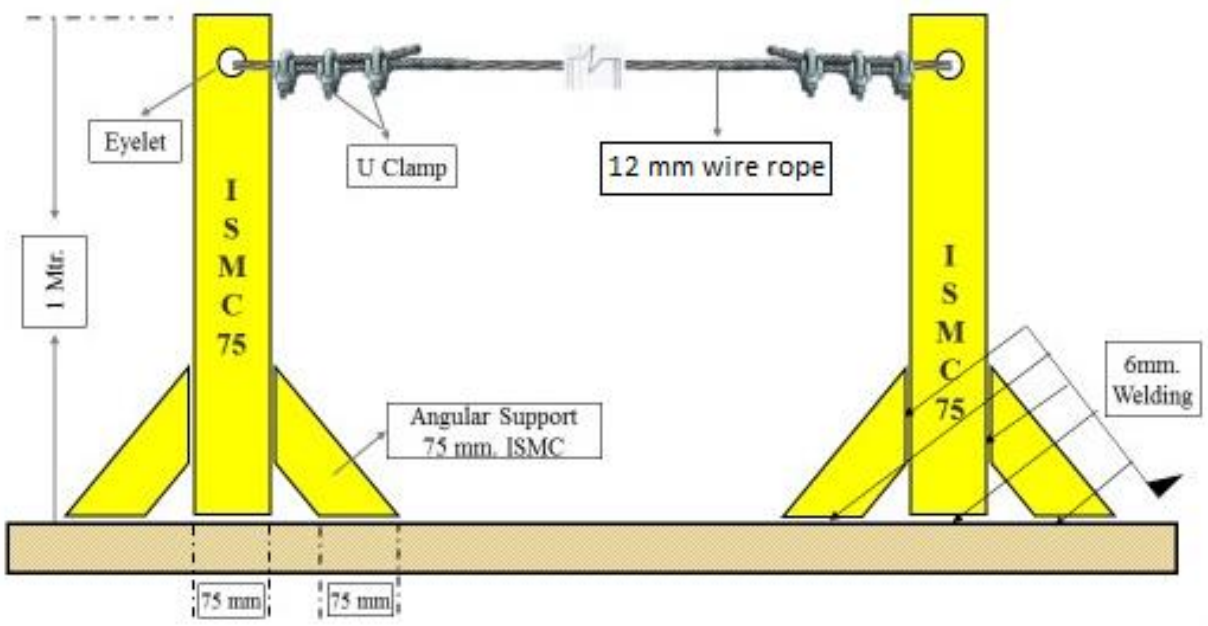


Fig. 2.1 Lifeline Post

i. The support at vertical post shall be fixed at end-to-end (welded/ bolted). The maximum length of one end to another end shall be 6 meters

ii. If the length of a lifeline is more than 6 meters, then intermediate vertical post(s) are to be used. Such intermediate post(s) will act as supports and the lifeline rope should simply pass through the eyelets (holes) of such supports without being anchored

iii. The lifeline need not be wrapped / clamped to any intermediate post

iv. Such intermediate posts must be used at an interval of every 6 meters

v. The post(s) in which the original lifeline is to be installed should be capable of sustaining a tensile stress of 2268 Kgs.

vi. In a horizontal lifeline installation, maximum allowable sagging is 500-600 mm

vii. For a single spun lifeline, no more than 3(Three Nos.) persons are allowed to work; for more than two workers, another lifeline should be installed

viii. Horizontal lifeline should be so installed that it does not impede safe movement of workers

ix. All the installation work must be carried out by competent person with adequate knowledge

1.2 Working Platform

a. Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or

floor level, they shall be closely boarded and shall have adequate width, which shall not be less than 750 mm and be suitably fenced.

b. <u>Precautions against the fall of Materials, Persons and Collapse of Structures:</u>

i. Every opening in the floor or a building or in a working platform shall be suitably barricaded to prevent the fall of persons by providing suitable fencing or railing whose minimum height shall be 90 cm.

ii. Adequate precautions should be taken such as the provision of fencing, or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered. Hard barricading shall be made at such places made of scaffolding pipe & clamps covered with reflective net. Cradle may be used for lifting materials - however this shall be made of MS angles and flats only and duly certified by the HSE officer. Operators may also use designed containers for lifting small tools.

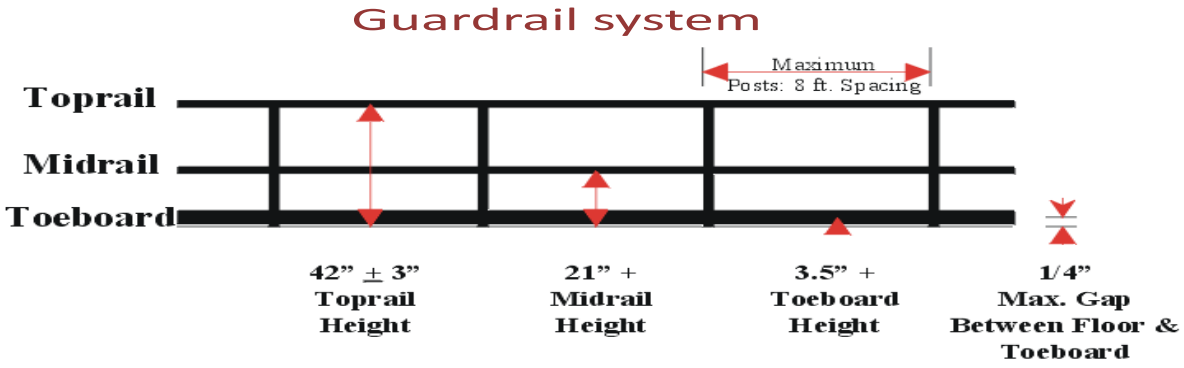
iii. Guardrails (including scaffolding) erected over/adjacent working areas must have the guardrails screened (opening < 0.5), to prevent material from falling outside the platform/decking.

iv. Guardrails must be able to withstand a 200-pound force exerted in any one direction.

v. Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.

vi. All openings through which workers are liable to fall should be kept effectively covered or fenced and indicated in the most appropriate manner.

vii. Guardrails and toe-board/barricades and sound platform conforming to IS: 4912-1978 and other Indian laws and regulations as depicted below should be provided.



<u>Fig. 2.2 Guard Rail System</u>

viii. Guardrails shall be provided to protect workers from falling from elevated work places. The rails are generally made of MS pipes of suitable dia. Rebar shall not be used for any handrails, ladder or cover purpose. Wherever the guard-rails and toe-boards cannot be provided:

a. adequate safety nets or safety sheets shall be erected and maintained; or
b. adequate safety harnesses shall be provided and used and / or
c. adequate fall arrestor shall be provided and used.

As mentioned under PPE clause, all these PPEs shall be defect free and regularly inspected for any defect. The full body safety harness shall have double lanyard only with max 1.8m length.

ix. The monkey ladders shall have sufficient fall arrestors. Adequate lifelines of 8mm steel wire rope shall be provided across the work area.

x. The HSE officer shall recommend appropriate PPEs after analyzing hazards and risks involved.

1.3 Scaffolding

All scaffolds shall be conformant to the relevant standards including IS 3696 and IS 4014 as applicable. A sketch of the scaffolds proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use. Only cup lock type scaffoldings will be allowed in site. Where cup lock type scaffolding arrangement is not feasible by the virtue of the location, in that case only pipe and clamp type scaffolding will be allowed.

a. The scaffolding work must be carried out by a competent person, who shall train the scaffold users on safety aspects
b. All scaffolds shall be erected / dismantled by scaffolding crew under direct supervision of competent scaffolding supervisors.
c. All scaffolds shall be capable of supporting 4 times maximum intended load and erected on sound, rigid footing, capable of carrying the maximum intended load without settling or displacement. Bamboo scaffolding is not permitted for use on site.
d. Each employee on the scaffold shall use an approved safety harness attached to an independent lifeline. The lifeline is to be securely attached to substantial members of the structure (not the scaffold itself) or to securely rigged lines, which shall safely suspend a worker in event of a fall.
e. Guard rails and toe boards shall be installed on all open sides and ends of platforms more than (2) meters above ground or floor
f. Scaffold planks must be at least 5 cm x 25 cm (2" x 10") full thickness lumber scaffold grade or better.
g. Scaffold planks shall not span distances greater than 2.5 meters (8 feet).
h. Scaffold planks shall extend over end supports not less than 6 inches nor more than 12 inches and be secured to the scaffold. Scaffolding and accessories with defective parts shall be immediately repaired or replaced.
i. All scaffolding must be a minimum of two planks wide. No one may work from a single plank.
j. Scaffold planks must be inspected before use. Planks that have been damaged must be removed from the site.
k. Access ladders must be provided for each scaffold. Climbing the end frames is prohibited unless the design incorporates an approved ladder.
l. Adequate mudsills or other rigid footing capable of withstanding the maximum intended load must be provided.
m. Scaffolds more the 6 meters (20 feet) in height must be tied to the building or structure at intervals which do not exceed 4 meters (13 feet) vertically and 6 meters (20 feet) horizontally.
n. Do not overload scaffolds. Material should be brought up as needed. Scaffolding must not be loaded in excess of its rated capacity.
o. Barrels, boxes, kegs, blocks or similar unstable object must never be used as work platforms or to support scaffold.
p. Where persons must work under or pass under a scaffold then a 18 gauge wire mesh screen must be installed between the toe board and guard rail.
q. Employees exposed to overhead hazards while working on a scaffold will be protected by 5 cm (2") thick planks.
r. Wooden/bamboo ladders shall not be allowed at any cost. Ladder's rungs shall be fitted /welded

properly. Before every use the rungs should be checked for safe use.

s. Wooden scaffolds shall not be used in areas where fire / fire products are expected

t. Ropes made of jute / Plastic and other fire prone material shall not be used to tie up scaffolding components together

u. The platform should have permanent hand rail and mid rail with Toe board without fail.

v. All platforms are to be tightly planked for the full width of the scaffold, except as may be necessary for entrance openings. Platforms shall be secured in place.

w. On suspension scaffolds designed for a working load of 500 pounds, no more than two workers are permitted to work on the scaffold simultaneously. On suspension scaffolds with a working load of 750 pounds, no more than three workers are permitted on the scaffold simultaneously.

x. Requirements for different types of Scaffolds:

A. Suspended Scaffold

i. Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.

ii. Requirements for use are to be preapproved by HSE Head, under a specific Permit to Work.

B. Rolling Scaffolds

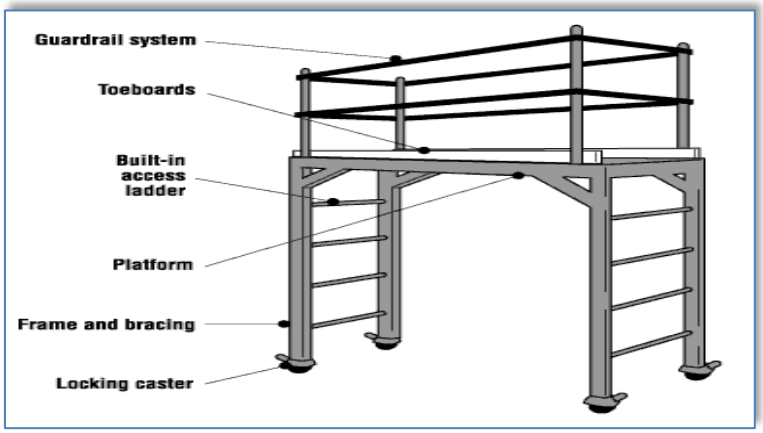
i. The height of rolling scaffolds shall not exceed three times the minimum base dimension.

ii. The minimum base dimension of rolling scaffold will be 1.25 meters (4 feet).

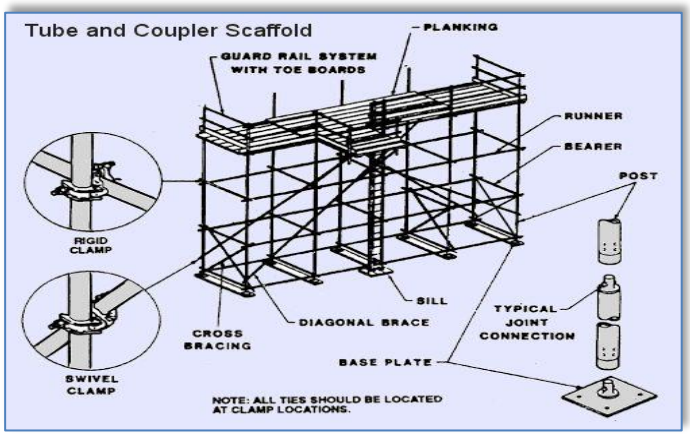
iii. Adequate help must be provided when moving a rolling scaffold.

iv. Secure or remove all loose materials, equipment and tools before moving a rolling scaffold.

v. No one is permitted to ride a rolling scaffold when it is being moved. Castor brakes must be locked-on when the scaffold is not being moved.



Rolling Scaffold



Tube & Coupler Scaffold

Fig. 2.3 Types of Scaffolds

1.4 Ladder Safety

A sketch of the ladders proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use

a. Safe Use of Ladders:

i. Fall protection is required when working on a ladder above 2 meters and when climbing above nearby guardrails.

ii. Ladders must be inspected prior to use and by a competent person quarterly, with documentation.
iii. Use portable ladders for height up to 4 M only
iv. Provide fixed ladders for height above 4 M
v. Place the ladder at an angle of 75 degrees (approx.) from the horizontal (1:4)
vi. Extend ladder at least 1 M above the top landing
vii. Secure top and bottom of the ladder firmly to prevent displacement- anti skid lining at the bottom
viii. Ensure that the width of the ladder is not less than 300 mm and distance between rungs is not more than 300 mm
ix. Provide landings of minimum size 600 x 600 mm at intervals not more than 6 M for fixed ladders. Check the ladders daily for any defects
x. Ensure that the areas around base and top of the ladder are clear. Getting on and off the ladder is more hazardous than using it. Use a mudsill if the ladder is to rest on soft, lose or rough soil
xi. Do not use ladders of conducting material near power lines, and only use ladders near power line or other energize system with exposed parts if they are confirmed locked-out and de-energized.
xii. Stand no higher than the fourth rung from the top for carrying out any job standing on a ladder.
xiii. Never reach out from a ladder to perform work where your belt buckle protrudes past the ladder rung.
xiv. Always face the ladder while climbing up or down
xv. Maintain three-point contact while climbing up or down a ladder i.e. two hands and one foot or two feet and one hand on the ladder at all the times.
xvi. Avoid climbing up or down a ladder while carrying anything in hands. Lift tools, equipment and materials with a rope.
xvii. Work from portable and extension ladders near guardrail where fall expose exists over the guardrail regardless of height, and above 2.0 mtr. heights from the working/walking surface will require the use of personal fall arrest equipment

2. EXCAVATION & CIVIL WORKS

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

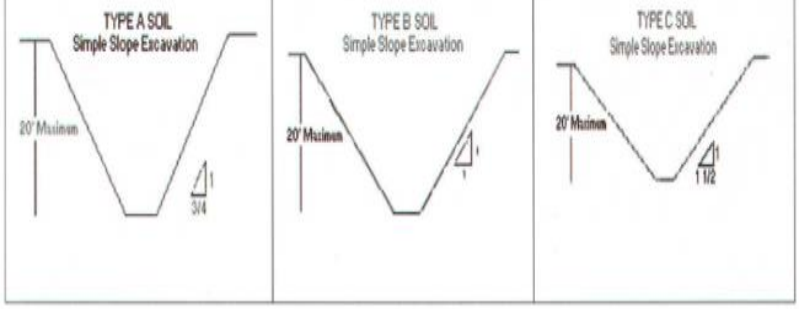
2.1 Excavation

The following safety measures are to be ensured before and during excavation:

a. All Excavation activities more than with depth of 1.22 meter or more shall require and Excavation Work Permit
b. Check for underground utilities like electrical / telephone cables, sewage, water lines and proper care has to be exercised to protect and prevent damage to it.
c. Electrical cables and service lines to be identified using cable detector/locator device before carrying out the excavation work
d. Proper and adequate slope is maintained while excavating
e. Adequate shoring or sheeting is done wherever require to prevent soil sliding
f. Safe access through ladder or steps for exit & entry to excavation
g. No material /excavated soil is kept within one meter from the edge
h. Safe way is planned and provided for movement of HEM /transport equipment near excavation
i. Safety helmet and shoes/gum boots are provided and worn by the workmen at excavation works

j. Dewatering arrangement is made where water seepage is prevailed.
k. Stop blocks are provided to avoid vehicles reversing into the excavated trenches
l. Danger signs /Caution boards are displayed at work spot
m. Hard Barricading is provided at excavated pits. It should be made of scaffolding pipe and clamp with reflective nets.
n. All Excavated area of depth 3mtr or more is to be hard barricaded with pipe.

Soil Type	Height/Depth ratio	Slope Angle
Stable Rock	Vertical	90 deg.
Type A	¾ : 1	53 deg.
Type B	1 : 1	45 deg.
Type C	1½ : 1	34 deg.



Determining Soil Type

Type	Description	Examples
A	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater.	Clay, silty clay, sandy clay, clay loam and in some cases: silty clay loam and sandy clay loam.
B	Cohesive soils with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	Angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases silty clay loam and sandy clay loam.
C	Cohesive soils with unconfined compressive strength greater than 0.5 tsf or less.	Granular soils such as gravel, sand and loamy sand; submerged soil or soil from which water is freely seeping; submerged rock that is not stable.

Fig. 3.1 Excavation Reference

2.2 Piling

Ensure the following precautionary measures before starting piling works:

a. Inspection of piling equipment by responsible person for its condition before initiating piling operation.
b. Checklist and OCP for piling to be prepared using manufacturer's instructions and used
c. Testing and its certification wire rope, slings, D-shackles, chain pulley blocks using in the process of piling work by competent person
d. Adequate support and secured foundation of the piling equipment to avoid toppling
e. Hoses should be lashed and adequately secured
f. Proper work platform is to be provided on piling frame
g. Safe work procedures and close supervision to prevent unsafe acts of operators/any unsafe conditions that may arise
h. Only experienced and trained operators are engaged for the piling operation
i. Provision of Personal Protective Equipment (PPE) like safety shoes/gumshoes/safety helmet/safety belt etc. and its use by their workmen.
j. Special care and precautions If work is near electrical live cables/ electrical equipment
k. Cordoning of work area to prevent un authorized entry
l. Guarding of revolving parts
m. Specific measures to prevent over turning of pile driver/missing of hammer/ hammer movement out of range

2.3 Batching Plant Operation

Following Safety considerations for batching plant are to be ensured:

1. Modern type batching plant should be used in which all the moving parts are protected and emergency

and safety features are incorporated.

2. Installation of external Electric moto-vibrators in the feeding hopper of all batching plants to reduce human intervention.
3. Installation of safety devices like pull-chord on both the sides of conveyor for stopping the conveyor in emergency
4. Workers carrying cement / sand to be given appropriate PPEs like respiratory masks & gloves.
5. Conveyor belt/rotating parts must be guarded properly.
6. Safety awareness shall be inculcated in workmen about the risk involved in rotating parts.
7. The agency shall ensure to erect the batching plant as per drawing including installation of all safety devices as provided by manufacturer and witnessed by BHEL Engineer in charge before starting of machine in future.
8. Safety audit to also focus on Batching plant.
9. The site shall impose penalty on the agency who has violated the safety norms as per contract.

2.4 Mobile Plant

Mobile plant includes tractors, trailers, dumpers, excavators, bulldozers, road rollers etc. for earthmoving purpose and concrete mixers, concrete transit mixtures, concrete pumps etc for concreting purpose. Due to the very nature of their function and movement in difficult terrains, congested areas, working in tandem with manual work and other operations the danger is inherent.

Automatic reverse camera with reverse horn connected with reverse gear is compulsory for all moving machineries.

Following Safety measures to be ensured for Mobile Plant:

a. Where movement around site is involved, routes should be planned, obstruction free and well maintained
b. Observe specified speed limits
c. Operating personnel should be aware of associated risks and its preventive measures
d. Only experienced, trained and authorized persons with valid license (wherever applicable) should operate the mobile equipment/vehicles
e. Provide and use Warning lights and reverse horn for cautioning the people around
f. Operation should be on level and stable ground with adequate working clearance.
g. Loading of out riggers/stabilizers should be well within safe ground bearing capacity
h. No person should be on equipment or vehicle during loading and unloading of material
i. Operators should be protected by warning barriers or switching off power when working in close proximity of overhead power lines
j. The equipment /vehicles should be well maintained and provided with effective brake system and other safety devices (wherever require)
k. Rotating parts of equipment should be adequately guarded
l. Provide necessary personal protective appliances and ensure its use by the operating personnel Ensure effective measures at source to control harmful emissions, dust, fumes contaminating atmosphere and cause health hazards to the operators and people in the vicinity.
m. No overloading/over stressing of vehicles/plant is allowed
n. Hoses, pipes, receivers, gauges and valves involved in carrying out hydraulic fluid/ compressed air should be checked for leaks and tested prior to operation.

o. Adequate safe clearance for swing and movement is to be judged during operation of Concrete mixer
p. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
q. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket
r. Operator leaving work spot should ensure that the equipment/vehicle is kept in neutral position and place on firm and level ground.
s. The hand brake should be kept in position and block road wheels as additional safety measure
t. Blades/buckets should be kept low while moving
u. The dozer blades should not be used as brakes except in emergency
v. The ground should be examined for its bearing capacity and general safety especially when operating road roller at the edges of slopes, embankments.
w. The roller should not be moved downhill with the engine out of gear
x. If operating near excavations the following precautionary measures are to be ensured
y. Barricading, edge protection to prevent fall of persons/vehicles over running while reversing etc.
z. Suitable support system and adequate allowance to avoid the danger of side collapsing
aa. Experienced signaler /attendant should be always accompanied with operator/driver for proper direction /signal and also to caution others in the working Zone during operation of mobile plant

2.5 Concrete Vibrators

a. Revolving parts/belt drives should be adequately guarded and Vibrating unit shall be completely enclosed and have suitable overload relays and effectively earthed
b. Ensure sufficient length of cable to the Vibrator.
c. Ensure electric starters and other accessories are firmly fixed adequately supported
d. Ensure locking of needle load while inserting needle in to the vibrator,
e. Ensure periodical lubrication and maintenance

2.6 Concrete Mixers

a. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
b. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket

3. WELDING & GAS CUTTING SAFETY (HOT WORK)

a. All Hot Work shall require a Hot Work Permit
b. Inbuilt Voltage Reduction Device (VRD) equipped arc welding machine will only be allowed for work.
c. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced.
d. All safety precautions shall be taken for welding and cutting operations as per IS-818.
e. When possible, items to be welded, cut, heated, etc. shall be moved to a safe location free of combustible or flammable material. If this is not possible, then all combustibles/ flammables that can be removed from the area shall be removed within a 35-foot circumference and a positive means of confining arcs and sparks generated by the process shall be ensured and additional person(s) shall be stationed as fire-watch for the area(s) still exposed, along with obtaining the Hot Work Permit as applicable.
f. Appropriate fire-fighting equipment is to be available in close proximity of any welding and gas cutting operations at all times suitable for the type of Fire.

g. Drums, tanks, and similar containers that have contained flammable or toxic material shall not be welded, cut, or heated until they have been made safe by water filling, thorough cleansing or similar accepted practices. The container shall also be ventilated during the welding, cutting, or heating process.
h. Proper ventilation is required for any welding or torch operations performed in a confined space.
i. Any welding or gas cutting operations performed on metals of toxic compounds or coating such as zinc, stainless steel, lead, cadmium, chromium, and beryllium shall be properly ventilated and/or proper respiratory protection shall be worn by any person that could be exposed to fumes, vapors, and gasses created by the welding and gas cutting processes.
j. Wherever it is practical, all arc welding operations shall be shielded to prevent direct light rays or sparks from contacting persons in the vicinity or from reaching areas normally used to travel through or into the vicinity. Where this is not practical, persons who shall be in the area are to use proper eye and skin protection. Other persons who are not participating in the welding or gas cutting operations are not to be allowed into the hazard zone.
k. Welders and other employees who are exposed to arc welding radiation shall wear suitable clothing and protective apparel to prevent burns and other types of ultraviolet radiation damage to the skin.
l. Arc welding machines shall be shut down when being moved or when they are not in continuous use. Electrode holders left unattended shall have electrodes removed and shall not be left where they might contact employees or conducting objects.
m. Arc welding power supply cable shall be of proper rating and material, e.g. copper.
n. Welders shall guard against allowing materials adjacent to or behind them to reflect radiation back toward them or towards others in the area. Reflected radiation can cause skin burns and eye flash burns.
o. Valve caps shall be in place when cylinders are not in use. Valve caps shall never be used for lifting the cylinder vertically.
p. Torches shall only be lit by approved strikers; never with matches, cigarette lighters, or hot-work.
q. Splatter / Slag Collector:

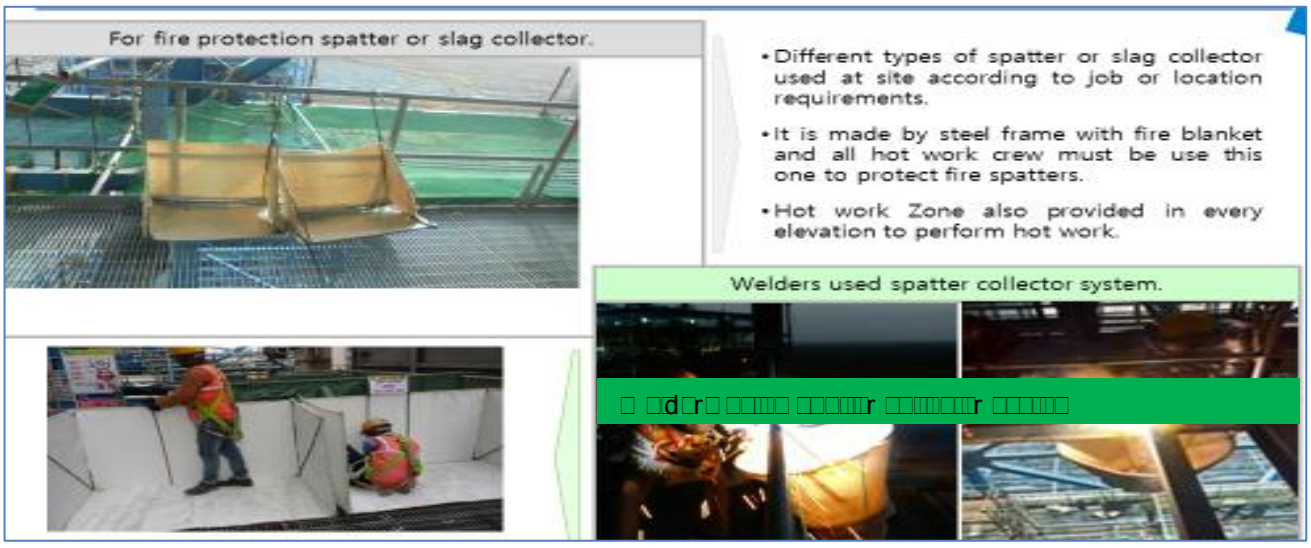


Fig. 4.1 Splatter / Slag Collector

While carrying out job at height, the sparks or molten slag shall be prevented from falling down by putting a fire-resistant (non-asbestos) sheet or patter/ slag collector or even MS Sheet. The passage of falling sparks

or molten slag shall be barricaded till ground floor and any cable/ tubes/ any other objects interfering in the passages hall either be removed or covered with Fire-resistant sheet or MS Sheet.

r. COMPRESSED GAS

i. All cylinder valves shall be closed when any work is finished and when any Cylinders are empty or being moved. Valve protection caps shall be placed and secured properly before gas cylinders are transported, moved or stored.

ii. Compressed gas cylinders shall be secured in an upright position with chain or appropriate means during storage & use. However, a trolley shall be used for transportation.

iii. Compressed gas cylinders shall always be secured from tipping or falling, whether in use, in storage or in transit. The cylinders shall always be secured upright, except during times when actually being hoisted or carried.

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

v. Regulators shall be removed when cylinders are not in use or are in transit, unless the cylinder is firmly secured on a special carrier designed for this purpose.

vi. Gas cylinders are not allowed to be used in man-basket when occupied.

vii. Cylinders containing oxygen or fuel gasses shall not be taken into confined spaces.

viii. Oxygen cylinders shall be stored a minimum of 6 meters from fuel gas cylinders or shall have an approved firewall between them.

ix. All cylinders shall be kept at a safe distance from welding or cutting operations or shielded from arc/ sparks / slag.

x. All cylinders shall be placed where they cannot become part of the electrical circuit.

xi. Oxygen and acetylene shall not be stored together. Oxygen must be separated from acetylene (or ANY fuel gas) or combustible material by at least 20ft or a barrier with a 30-minute fire resistance rating.

xii. All Cylinders should be stored upright in a designated area with labels for the type of gas. All applicable precautions to be ensured during storage

xiii. Oxygen and fuel gas regulators, hoses and associated equipment shall not be altered and shall be in proper working order while in use.

xiv. Compressed air can be extremely dangerous if allowed to penetrate the skin. As such, the use of compressed air to clean off yourself or other workers shall be strictly prohibited.

xv. All gas cylinders shall be stored in upright position. Suitable trolley shall be used for cylinder movement, the design of which shall be submitted to BHEL Engineer for approval.

xvi. No of cylinders shall not exceed the specified quantity as per OCP

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

xviii. All cylinder should be kept only in cylinder trolley.

xix. Cylinder shall be transported in upright vertical position by suitable mean.

4. LIFTING & RIGGING SAFETY

a. All Heavy / Complex Lifting operations as defined in Clause 6.12 shall require a Lifting Work Permit. A written rigging procedure and plan must be prepared for all individual heavy/ complex lifting operations.

b. All the cranes and lifting tools & tackles shall be inspected on daily / weekly basis as well as monthly by expert as per applicable formats.
c. In addition, inspection / certification as mandated by law shall be carried out wherein these shall be tested and certificates of fitness shall be obtained from 3rd party State Govt. approved competent agency before deploying at site and later periodically. BHEL shall be given advance intimation of any such inspections
d. The last date of Third-Party Inspection and the next Due date shall be conspicuously displayed on all cranes. A copy of certificate shall be pasted on operator's cabin of all the lifting equipment.
e. Specifically designed heavy steel plates lifting clamps shall be used for lifting heavy metal sheets. Manmade lifting clamp chapa shall not be used for lifting/shifting of plates.
f. Following requirements shall be mandatorily followed, wherever applicable:
    i. The manufacturer's instruction for maintenance shall also be followed. All safety measures shall be followed.
    ii. All tools tackles, lifting appliances; material-handling equipment etc. used by the subcontractor shall be of safe design and construction.
    iii. The operators, slingers and signalers shall be qualified as per IS 13367 (part-1):2003 "Safe use of cranes- code of practices".
    iv. There shall be a person responsible for co-ordination among cranes where multiple cranes are used, and lifting over load chart of the crane to be avoided.
    v. Mobile phone should be banned for crane operator and lifting operation. Only walkie talkie shall be allowed in rigging/Lifting purpose.
g. Lifts/Movements between 5 Tons and 20 Tons:
    i. Shall include a rigging plan, detailing schematic representation of the handling/lifting operations that must be included on the Method Statement.
    ii. When performing similar lifts of identical items, only one rigging plan need be prepared, provided each of the lifts can be performed in accordance with the rigging plan.
h. Lifts/Movements Less Than 5 Tons:
    i. An equipment rigging plan is not required for lifts less than 5 tons, safety measures are covered in the JSA. This could change as per BHEL requirement

i. Personnel Lifts (Man-Basket / Jhoola):

The design of personnel man basket shall be submitted to BHEL Engineer for approval before use. Relevant permit (Height work & others as applicable) shall be completed prior to lifting any people, along with a rigging plan.

i. A separate Lifeline / fall arrestor anchored to a fixed structure outside of Jhoola shall be provided for the workers inside the basket. All occupants of the basket shall have Safety Harnesses equipped with rope grabs, which are to be hooked to the vertical lifeline.
ii. Man-basket shall be used where access through ladders or scaffolding is not feasible.
iii. Man-baskets shall be designed and engineered by a manufacturer (job made man-baskets are not allowed, unless designed and tested by a certified engineer), and built robust with MS Angles and flats or plates or channels only.
iv. Guard rails top and mid, must be in place and screened-in to avoid material from falling out of

basket. The factor of safety shall be 200%.

v. It shall have a door with double latches and shall open inside. Anchor points shall be identified within the man-basket.

vi. The man-basket shall be thoroughly inspected and load tested and a trial run performed without personnel before being put to job.

vii. It shall be treated as a lifting tool (T&P Item) and shall undergo same certification cycle and inspection as other lifting equipment.

viii. An additional sling of required lifting capacity shall be fixed the man-basket main lifting point and attached to the crane above the ball or block.

ix. While lifting man-basket, the crane shall maintain a uniform speed of lift without any swing.

x. Once man-basket reaches the destination, the lift brakes shall be locked as long as the basket
   a. remains at that point. The same care shall be taken in its descent.

xi. As for hanging man-basket, the same shall be hung off a rigid structure with help U-shaped handle welded to man-basket. This shall be tested once in a year by a competent person.

xii. Use of Rebar steel for making and monkey-ladder must be avoided.

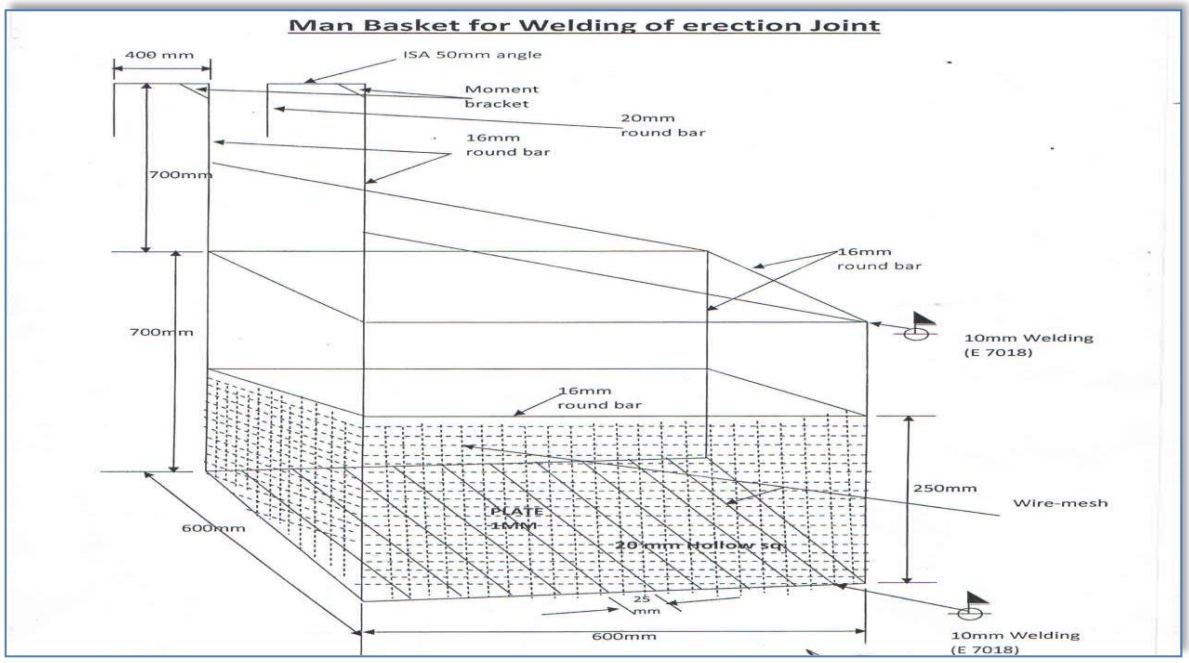


Fig. 5.1 Man Basket for Welding Erection Joint

4.1 Cranes & Hoisting Equipment:

This section provides the guidelines to ensure proper rigging and lifting activities are accomplished safely and in accordance with applicable specifications, codes, and regulations.

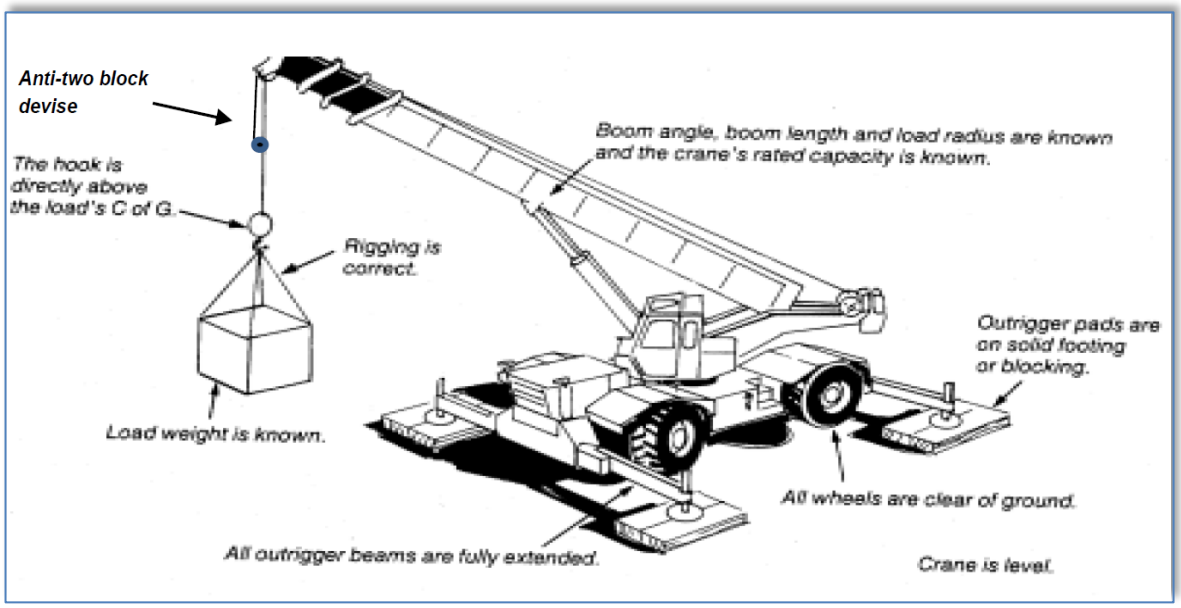


Fig. 5.2 Proper Crane Setup

a. On every crane or piece of hoisting equipment notices of all rated load capacities, recommended operating speeds, and any hazard warnings or special instructions shall be conspicuously posted. All instructions and warning shall be visible from the equipment operator 's station.
b. Cranes shall have an Anti-Two-block safety device installed
c. All mobile cranes shall have overload and backup alarms, load angle indicators and limit switches
d. All areas within swing radius of cranes that are potentially accessible by pedestrian, vehicular, or equipment movement shall be barricaded to prevent anyone or any vehicle or equipment from being struck by the crane or hoisting equipment, or its load(s).
e. No part of the lifting equipment or its load shall be within the distance as specified in the Indian Electricity Act from an energized power line
f. Cranes shall have annual certified third-party inspection and be inspected before use by the operator. Any defects shall be corrected before use. Logs of crane inspection shall be kept with the crane.
g. Make certain that the rigging personnel, material, and equipment have the necessary capabilities for the job and are in safe condition.
h. Communicate with person(s) directly responsible for accomplishing the work and / or work area to establish requirements/responsibilities and make certain that all preparatory work is complete.
i. Mats/Pads must be used on all lifting equipment, equipped with out riggers.
j. Pick and carry must have the load secured to the rig in front.
k. Only BHEL Approved Plate Lifting Spreader Beam configuration shall be used (Sample in Fig. 11.3.5.3)
l. <u>Crane operators must follow the following:</u>
    i. Pass an annual Operator's Physical examination
    ii. Carry a valid training certification card at all time while operating issued by the Govt. or other recognized institute.

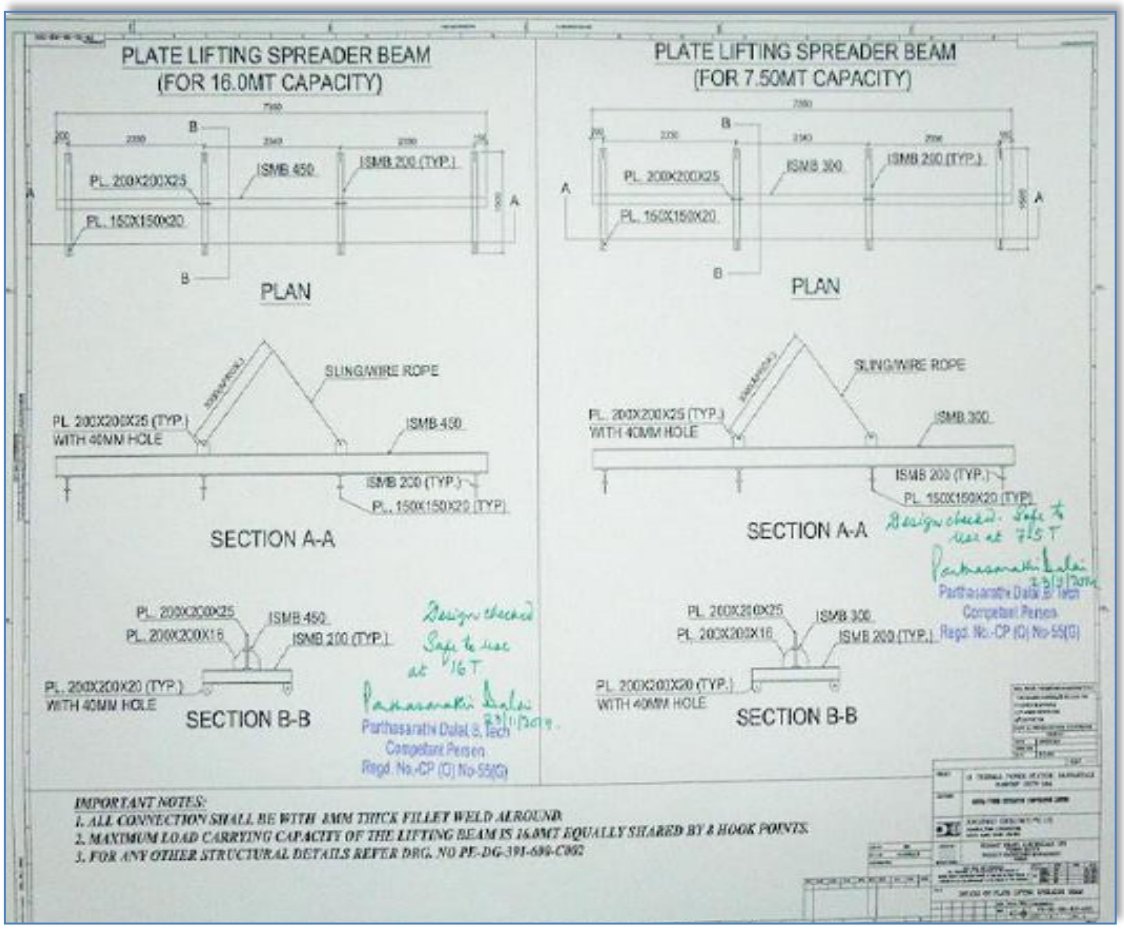


Fig. 5.3 Typical Plate Lifting Spreader Beam Configuration for 7.5 MT and 15 MT Loads

m. Safe Rigging Practices

i. Review the planned operation and requirements with the operator and rigging crew.
ii. Ensure a pre-lift meeting is conducted with crane operator, tagline operator, signal personnel, and Safety Manager.
iii. Designate a qualified person from the rigging crew to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desire clearance by visual means.
iv. Clear the lift area of all unnecessary personnel.
v. Hydras shall only be allowed for loading & unloading works & shall not be allowed to move with load

n. Rules for Safe Rigging

i. Use loops, thimbles and corner pads to prevent damage to slings when used around corners or on cutting edges.
ii. Never allow wire rope to lie on the ground for any length of time or on rusty steel or near solvents, chemicals or corrosive substances.
iii. Slings must not be pulled from between or under loads with load resting on the sling.
iv. Keep all rope away from flame cutting or welding operations.
v. Never use rope as sling material.
vi. Never wrap a wire rope completely around a hook.

vii. Do not bend wire rope near any attached fitting.

viii. The sling must be selected to suite the most heavily loaded leg rather than the total weight when using multi-legged sling to lift loads in which one end is heavier than the other.

ix. When using 3 and 4-legged sling configurations, any two legs must be capable of supporting the entire load.

x. Where possible, wire rope choker hitches must include a shackle with the eye around the shackle pin to prevent breaking wires of the choke. The choker hitch must be “snugged down” prior to lifting, not after tension is applied.

xi. Unless authorized by the hook manufacturer when more than two rope eyes are placed over a hook, install a shackle, pin resting in the hook, and place the rope eyes in the bowl of the shackle.

xii. Properly rig all loads to prevent dislodgment of any part.

xiii. Use guide ropes or tag lines to prevent the rotation or uncontrolled motion of the load when necessary.

xiv. Loads must be safely landed and properly blocked before being unhooked and unslung. Tag lines must not be used in situations that jeopardize the safety of the lift.

xv. Lifting beams must be plainly marked with their weight and designed working load and must only be used in the manner for which they were designed.

xvi. The hoist rope or chain must never be wrapped around the load. The load must be attached to the hook by slings or other rigging devices that are adequate for the load being lifted.

xvii. Multiple part lines must not be twisted around each other.

xviii. The hook must be brought over the center of gravity of load before the lift is started.

xix. If there has been a slack rope condition, determine that the rope is properly seated on the drum and in the sheaves prior to lifting.

xx. Keep hands away from pinch points as the slack is being taken up.

xxi. Leather gloves are recommended when handling wire rope.

xxii. Avoid impact loading caused by sudden jerking when lifting or lowering. Lift the load gradually until the slack is eliminated.

xxiii. Never ride on a load that is suspended.

xxiv. Avoid allowing the load to be carried over the heads of any personnel.

xxv. Never work under a suspended load until the load has been adequately supported from the floor and all conditions have been approved by the supervisor in charge of the operation.

xxvi. Never leave a load suspended unless emergency evacuation is required.

xxvii. Never make temporary repairs to sling.

xxviii. The capacity of a sling is determined by its angle, construction, type of hitch and size.

xxix. Never lift loads with one leg of a multi-leg sling until the unused legs are made secure.

xxx. Never point load a hook unless it is especially designed and rated for such use.

xxxi. Make certain that the load is broken free before lifting and that all legs are taking the load.

xxxii. When using two or more slings on a load make certain all slings are made from the same materials.

xxxiii. Lower the loads on to adequate blocking to prevent damage to the slings.

xxxiv. Materials and equipment being hoisted must be loaded and secured to prevent any movement which could create a hazard in transit.

xxxv. The weight of the hook, load block and any material handling devices must be included when determining crane capacity.

xxxvi. Calculated weights cannot exceed load chart without written approval.

xxxvii. Personnel must be completely clear of loads being picked up or set down by crane. Tag lines will be used to control the loads. Loads must not be touched by hand while placing/ moving.

o. Slings

The following are rules for safe use of synthetic slings:

i. Synthetic slings must be marked to show the rated capacity for each type of hitch and type of web material.

ii. Nylon web slings must not be used where fumes, vapors, sprays or mists or liquids of acids or phenolic are present. Web slings with aluminum fittings must apply in this category.

iii. Synthetic web slings must be removed from service and destroyed if any of the following conditions are present:

a. Acid or caustic burns
b. Melting or charring of any part of the sling surface
c. Snags, punctures, tears or cuts
d. Broken stitches
e. Distortion of fittings
f. Synthetic web slings of polyester or nylon must not be used at or come in contact with temperatures in excess of 82°C
g. Polypropylene web slings must not be used at or come in contact with temperatures in excess of 93°C
h. Insulated hooks must be tested yearly to ensure insulation integrity to at least manufacturer's specifications.

p. Wire Rope Slings must be removed from service and destroyed if any of the following conditions are present:

i. In (10) randomly distributed wires broken in one (1) rope lay, or five (5) broken wires in one (1) strand in one (1) rope lay.
ii. Wear or scraping of one-third the original diameter of outside wires.
iii. Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope structure such as:
iv. Evidence of heat damage.
v. End attachments that are cracked, deformed worn.
vi. Corrosion of the rope or end attachments.

q. Metal mesh slings must be immediately removed from service if any of the following conditions are present:

i. A broken weld or broken brazed joint along the sling edge.
ii. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.
iii. Lack of flexibility due to distortion or corrosion.

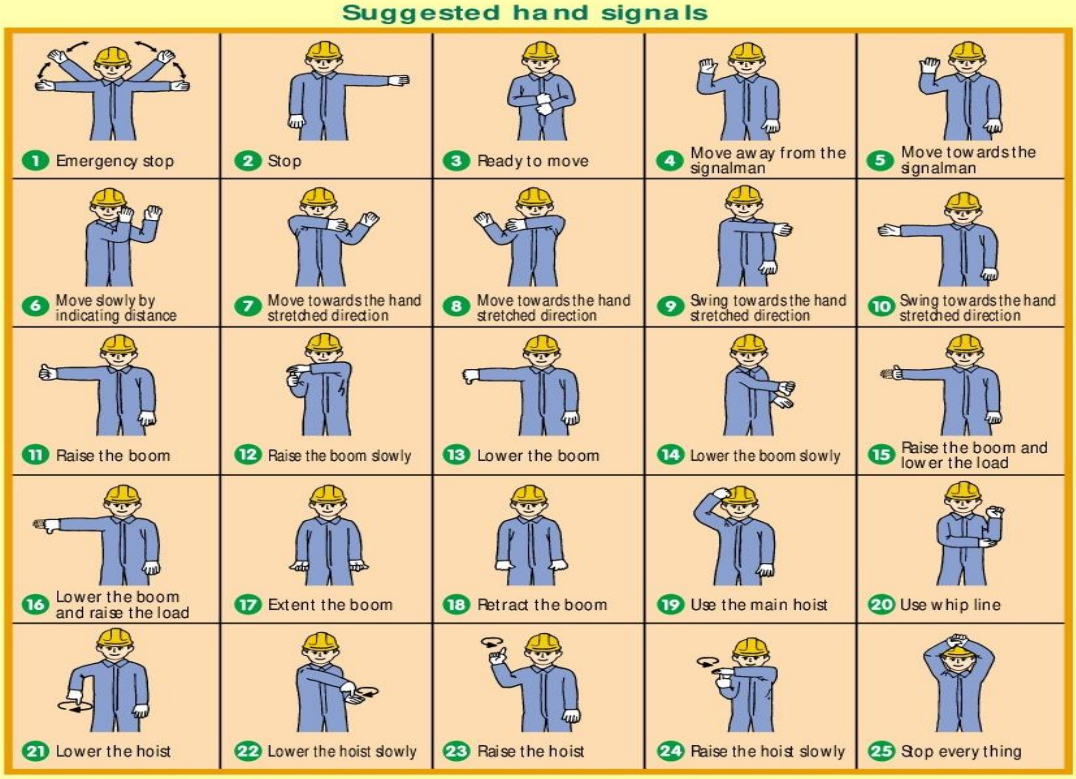
r. Requirements of Plate Clamps:

i. The rated load of the plate clamp must be marked on the main structure.

ii. Care must be taken to make certain the load is correctly distributed for the plate clamp being used.
iii. Do not allow load or plate clamp to come into contact with any obstruction.
iv. The plate clamp must not be used for side pulls or sliding the load.
v. When lifting stainless steel or special alloys, ensure plate clamp is designed for use on the specific metal.

s. Signaling Practices:

- The "slinger" is responsible for attaching and detaching the load to and from the crane. He shall:
  – have received appropriate training on general safe lifting operations;
  – be capable of selectings lifting gears suitable for the loads;
  – liaise with the operator and direct the movement of the crane safely.
- The "signaller" is responsible for relaying the signal from the slinger to the crane operator. He shall:
  – have received appropriate training on general safe lifting operations;
  – be able to direct the movement of the crane and loads.



Note: During the lifting operation, either the slinger or signaller shall communicate with the operator. Other communication methods (e.g., wireless walkie-talkies, telephones, etc.) may also be used.

Fig. 5.4 Recommended Signaling Practices

5. DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured, besides using the Work Permit:

a. All roads and open areas adjacent to the work site shall either be closed, suitably protected or restricted for movement
b. No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.

c. All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

6. T&PS GENERAL

a. All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test /calibration certificates bearing endorsement from competent authority of BHEL.

b. Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

c. Tagging and punching in all lifting tool is compulsory with SWL, sr. no. and due date.

d. All T&Ps shall be inspected by authorized Third Party agency as per applicable frequency. BHEL shall be kept informed of any such scheduled inspection

e. All T&Ps shall be internally inspected in each quarter and colour coded.

7. CHEMICAL HANDLING

a. Displaying safe handling procedures & MSDS for all chemicals such as lube oil, acid, alkali, sealing compounds etc. at work place.

b. Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

c. The used containers of chemicals shall be segregated and disposed of suitably

d. In case the used containers need to be re-used, all traces of the chemical to be removed by thorough cleaning with detergents etc. under trained supervision

8. ELECTRICAL SAFETY

a. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.

b. No PDB or any other distribution board shall be more than 03 (three) years of purchase. Only modern PDB with industrial sockets as shown in layout below to be allowed to use at site.

c. Power supply to all equipment at site to be routed through MCBs of appropriate rating. A 'Power Supply Distribution Plan' shall be prepared and submitted to BHEL Engineer for approval

d. All power supplies through cables shall be underground or overhead with height > 3mtrs.

e. All power distribution boxes shall be locked and the key controlled by site management of concerned subcontractor.

f. All individual equipment & tools at site shall be powered through Earth Leakage Circuit Breakers of 30 mA sensitivity.

g. These MCBs and ELCBs shall be regularly tested as per Clause 14

h. All fuses and fuse wires shall be of standard size and rating.

i. All electrical appliances used in the work shall be in good working condition and shall be properly double earthed other that armour earthling.

j. All extension boards shall have separate switches for all sockets / connections.

k. All portable electric tools used by the subcontractor shall have safe plugging system (industrial top & socket) to source of power and be appropriately earthed.

l. Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts especially in confined spaces like inside water boxes, turbine casings, condensers etc.

m. Electrical appliance shall have proper earthing and for appliances equal to & more than 415V shall have two separate earthing (as per IS-3043-1987)

n. Portable Electric Lights

i. Portable electric lights used in wet or potentially wet locations must be either low voltage type (24 volts or less) or protected by a GFI (ground fault interrupter).

ii. They must be visually checked before each use and periodically while in use to assure their original integrity is maintained.

iii. Cords with cuts, breaks, deep abrasions, etc. shall be taken out of service immediately.

iv. Repairs to extension cords shall only be performed by qualified/ licensed electricians.

v. Must not be allowed to lie in wet or potentially wet areas.

o. Underground Cables:

i. Every electric line or cable of unknown origin that is discovered or exposed during a digging, drilling, probing, or similar operation is to be considered as energized and life threatening.

ii. The senior company employee on the site will ensure that all necessary safety precautions are taken in order to isolate the line from all workers and the public.

iii. Such precautions may include halting the operation if appropriate.

iv. The senior company employee on the site is to then contact the proper authorities to have the line identified and either confirmed to be abandoned and/or made safe for continuing the work.

v. Any and all underground lines that are discovered or become severed must be considered energized on both sides, and be treated accordingly.

p. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL

q. The subcontractor shall use only properly insulated and armoured cables and conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.

r. BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the risk & cost of the subcontractor.

s. No maintenance work shall be carried out on live equipment

t. Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public

u. The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

v. Wiring and Branch Circuits Must be protected by a proper amperage over-current device such as a HRC fuse or circuit breaker. Such installations must be located so as to prevent physical damage to the wire conductors & panels.

w. The sub-contractor shall supply modern power distribution board of different combination (1-phase & 3-phase). All the distribution of power should be through modern PDB. Equipment drawing is mentioned below.

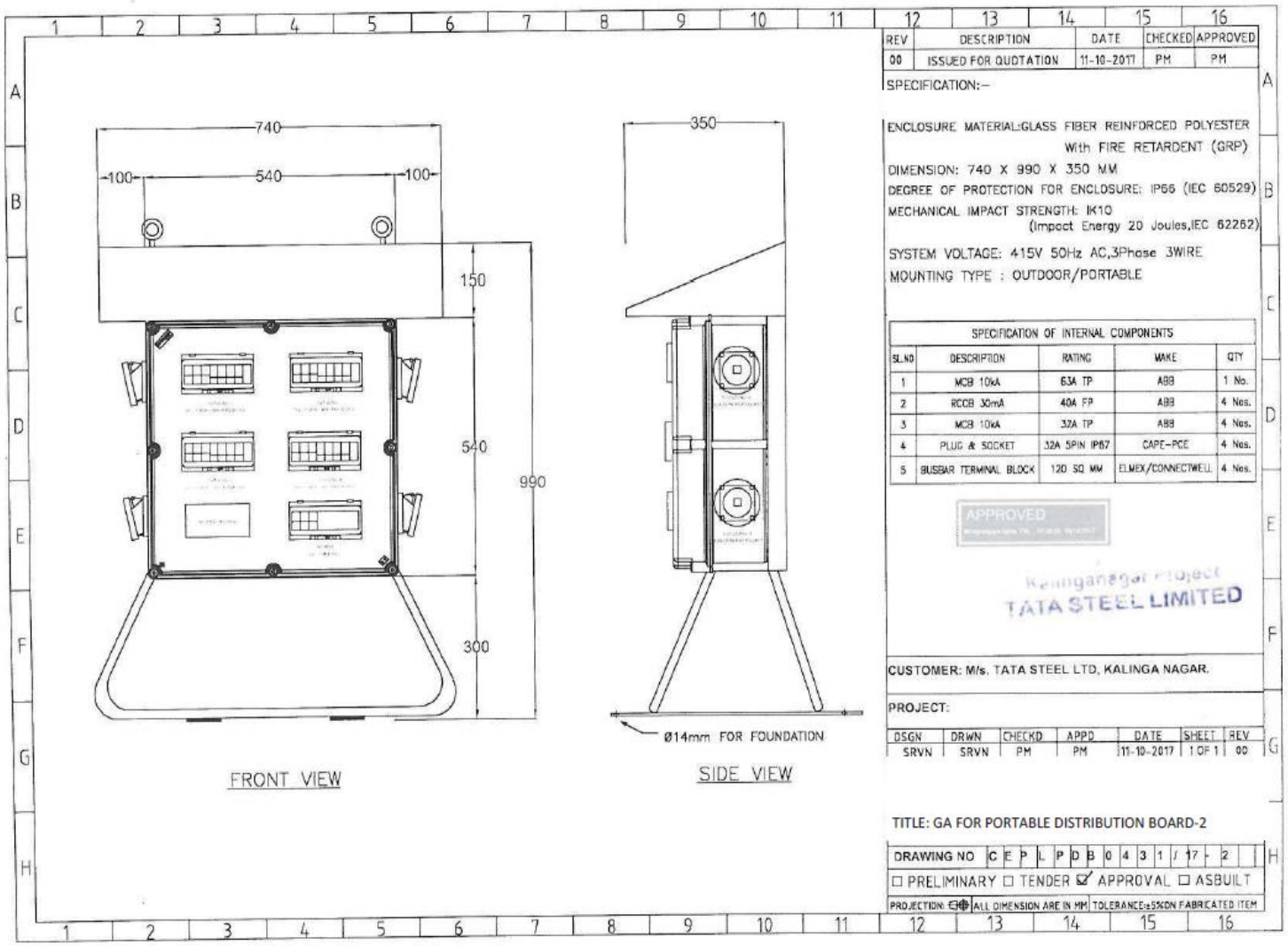


Fig. 9.1 Layout of a modern Power Distribution Board

x. General Electrical Safety

i. In general, equipment or machinery being moved or transported must maintain minimum clearances of 25 ft. to all power lines.

ii. TAG IN/ TAG OUT must be in force in Switch Room and all Distribution Boxes for live power line. The authorized person's name and contact no shall be displayed

iii. Ensure "double insulated" three - core cables and three pin connectors are used and are properly ground "all insulated" types, all electrical tools and appliances must be manufactured for industrial use.

iv. All connections shall be electrically and mechanically sound and properly insulated. Taped joints are not permitted. Connections to socket outlets must be made with proper plugs (industrial top and socket).

v. Splices in electrical cords are not permitted. Repairs must be made at the socket connection and retain the same mechanical and dielectric condition of the original connection.

vi. Damaged or defective electric tools, equipment and extension cords, etc. must not be used and shall be tagged out of service, removed from the work area and taken back to stores.

vii. Only licensed electricians are authorized to repair and work on electrical equipment. Tampering with electric tools or equipment by others could result in termination.

viii. Temporary electric cabling should be elevated 2.2 meters above the floor/ground or covered for protection. It must be kept clear of walkways and other locations where it may be exposed to damage or create a tripping hazard.

ix. Energized wiring in junction boxes, circuit breaker panels and similar places must be covered and locked at all times.

x. Areas with live high voltage wires or terminals must be barricaded against entry and warning signs posted Danger – High Voltage and Authorized Personnel Only.

xi. Personnel should never work on energized equipment, de-energizing (lockout/tag out) the equipment is always the first requirement.

xii. The lockout and tag out procedure will be used when testing or working on, or around, energized installation.

xiii. Working around energized equipment should never be done alone. A second electrician must always be available for assistance.

xiv. If lockout/tag out of the work is infeasible (must be demonstrated), work on energized electrical circuits must be approved by the Site In-charge. All safety precautions necessary must be taken, PPE use must be evaluated per the exposure and used, i.e high/low voltage gloves, insulated shoes, overcoats/aprons, face shields, and other protective equipment like insulated tools, blankets, mats, etc. must be used.

xv. The welding machines earth leads shall be properly fixed without loose contacts. The earth cable only has to be used. No steel members shall be used as earth leads.

xvi. Electrical crews must be qualified for the equipment and tools they work on, including being trained in Cardio-Pulmonary Resuscitation (CPR) methods and First Aid for rendering help in the event of electric shock.

y. Qualified Persons for Electrical Works

(One who is trained and wiremen licensed to Govt. of Respective State and familiar with the construction, operation and safety hazards of the equipment upon which they are permitted to work.)

i. Qualified persons are intended to be only those who are well acquainted/experienced with and thoroughly conversant in the electric equipment and electrical hazards involved with work being performed.

ii. Only qualified persons may be permitted to work on or near exposed energized parts. Such persons are required to have been trained in three specific areas:

iii. Qualified persons must be capable of working safely on energized circuits;

iv. Must be familiar with the proper use of special precautionary techniques and procedures bases on equipment and exposure; and

v. Must be familiar with required personal protective equipment, insulating and shielding materials, and insulated tools.

vi. Qualified persons are expected to be able to evaluate unknown situations and adjust their activities in such a way that only safe work practices are used. Such behavior is the responsibility of the qualified person.

vii. It is possible and likely for an individual to be 'qualified' with regard to certain equipment in the work place, and unqualified on other equipment they must know their limitation and stop work if not qualified on what equipment they were to work on.

viii. An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. The process must be documented as proof.

z. Mandatory PPEs of electrical work on LV & HV

i. HV arc flash suit with protective hood (for protection of face and head) as specified for hazard risk category-4 in NFPA-70E or similar IS specification for working on HT switch gear (for all voltage >690 V) to the concerned licensed electrician or competent person.

ii. LV arc flash jacket/FR as specified for hazard risk category-4 in NFPA-70E or similar IS specification having ATPV rating of 8.5 to 9 cal/cm2 for working on LV (>260V and <=690V) to the concerned licensed electrician or competent person.





iii. The LV arc flash jacket as shown above shall be worn continuously while working on LV (>260V and <=690V). The color specification of LV arc flash jacket should be blue.

iv. Electrical hand gloves should have following specification: Flame resistance, arc flash and cut protection of voltage rating (>260V and <=690V).

v. Electrical safety over shoe of relevant IS make for foot protection of licensed electrician or competent person while working in HV & LV line or equipment.

9. USE OF HAND TOOLS AND POWER-OPERATED TOOLS

a. General Provisions

i. All hands and power tools and similar equipment, shall be maintained in safe condition.

ii. When power operated tools are designed to accommodate guards, they shall be equipped

iii. with such guards, when in use;

iv. Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains and other reciprocating, rotating or moving parts of the equipment shall be similarly guarded;

v. Personnel using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazards;

vi. All hand-held powered platen sanders, grinders, grinders with wheels of 5 cm or less, routers, planers, laminate trimmers, nibblers, shears, scroll saws and jigsaws with blade shanks of 0.5 cm wide or less shall be equipped with only a positive on-off control.

vii. All hand-held powered drills, tappers, fastener drivers, horizontal, vertical or angle grinders with wheels greater than 5 cm in diameter, disc sanders, belt sanders, reciprocating saws, saber saws and other operating powered tools shall be equipped with a momentary contact on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

b. Hand Tools

i. The subcontractor shall not issue or permit the use of unsafe hand tools;

ii. Wrenches including adjustable pipe end and socket wrenches shall not be used when saws are sprung to the point that slippage occurs;

iii. Impact tools such as drift pins, wedges and chisels shall be kept free of mushroomed heads;

iv. The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight on the tools.

c. Power Operated Tools

i. Electric power operated tools shall be either of the approved double-insulated type or shall be grounded;

ii. The use of electric cords for hoisting or lowering loads shall not be permitted;

iii. Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming incidentally disconnected;

iv. Safety clips or retainers shall be securely installed or maintained on pneumatic impact (percussion) tools to prevent attachments from being incidentally expelled;

v. All pneumatically riveting machine staplers and other similar equipment provided with automatic fastener feed, which operate at more than 7 kg/cm2 pressure at the tool a safety device on the muzzle to prevent the tool from ejecting the fasteners unless the muzzle is in contact with the work surface;

vi. Compressed air shall not be used for cleaning purposes except when the pressure is reduced to less than 2 kg/cm2 and that too with effective chip guarding. The 2 kg/cm2 pressure requirement does not apply to concrete form, mill scale and similar cleaning purposes;

vii. The manufacturer's safe operating for hoses, pipes, valves, filters and other fittings shall not be exceeded;

viii. Only personnel who has been trained in the operation of the particular tool shall be allowed to operate power-actuated tools;

ix. The tool shall be tested each day before loading to see that the safety devices are in proper working condition. The method of testing shall be accordance with the manufacturer's recommended procedure;

x. Any tool found not in proper working order, or that which develops a defect during use, shall be immediately removed from service and not used until properly repaired;

xi. Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any other person. Hands shall be kept clear of the open barrel end;

xii. Loaded tools shall not be left unattended;

xiii. Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tiles, surface hardened steel, glass block, live rock, face brick or hollow tiles;

xiv. Driving into materials that can be easily penetrated shall be avoided unless backed by a

xv. substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side;

xvi. No fastener shall be driven into a palled area caused by an unsatisfactory fastening;

xvii. Only non-sparking tools shall be used in an explosive or flammable atmosphere;

xviii. All tools shall be used with the correct shield, guard or attachment as recommended by the manufacturer.

d. Abrasive Wheels and Tools

i. All grinding wheel must be ISO certified only.

ii. All grinding machines shall be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operation;

iii. Grinding machines shall be equipped with suitable safety guards;

iv. The maximum angular exposure of the grinding wheel periphery and sides shall not be more than 900, except that when the work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 1200. In either case, the exposure shall begin not more than 8.650 above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the bursting of the wheel;

v. Floor and bench-mounted grinders shall be work-rests, which shall be rigidly supported and readily adjustable. Such work-rests shall be kept at a distance not to exceed 5 mm from the surface of the wheel;

vi. Cup type wheels used for external grinding shall be protected by either revolving cup guard or a band type guard;

vii. When safety guards are required, they shall be mounted as to maintain proper alignment with the wheel and the guard and the guard and its fastening shall be adequate strength to retain the fragments of the wheel in case of incidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 1800;

viii. Portable abrasive wheel used for internal grinding shall be provided with suitable safety flanges;

ix. When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of incidental breakage, shall be used;

x. All abrasive wheels shall be closely inspected and ring tested before mounting to ensure that they are free from cracks or defects;

xi. Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place;

xii. All employees using abrasive wheels shall be protected by suitable eye protection equipment.

e. Wood Working Tools

i. All fixed power-driven woodworking tools shall be provided with a disconnect switch that can either be locked or tagged in the off-position;

ii. The operating speed shall be attached or otherwise permanently marked on all circular saws over 0.5 m in diameter or operating at over 3000 peripheral rpm. Any saw so marked shall not be operated at a speed other than that marked on the blade. When a marked saw is re-tensioned for a different speed,

the marking shall be corrected to show the new speed;

iii. Automatic feeding devices shall be installed on machines wherever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points;

iv. All portable power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position.

10. START UP, COMMISSIONING AND TESTING:

There are various activities involved prior to commissioning- the major ones are -Hydraulic Test, Steam Blowing, Transformers Charging, Boiler Light Up, Rolling and Synchronisation and Full loading of unit.

a. These activities shall be personally supervised by the site executive along with the commissioning engineer.
b. Appropriate Work Permits shall be taken as applicable
c. The readiness of upstream and downstream system shall be ensured before taking up.
d. These shall be handled strictly by the authorized persons only and the team shall be suitably briefed about the activity including hazards & risks involved and control plan by the concerned executive-in-charge before start.
e. Entry of persons to the area of activity shall be suitably restricted and the emergency functions like Ambulance, first aid center and Fire station shall be intimated about the plan well in advance.
f. Tag-in/ Tag-out shall be in place while charging transformer and whenever necessary.
g. Electricians with valid wiremen license only shall be permitted to work on power lines.
h. The area and the passage shall be adequately illuminated.

11. FIRE SAFETY

a. The Fire Prevention, Protection and Preparedness Program is an integral part of the overall HSE Program. Effort and consideration must be given to safety, life and potential for delays in construction schedules and plant startup, as well as protection of property on a given project. The purpose of which is to prevent
    i. Inception of fire
    ii. Loss of life or personal injury
    iii. Loss of Property
    iv. Interruption of operations
b. Site-in-charge / Safety Officer will make periodical review of the site Fire Protection, Prevention Preparedness Programme, Site conditions and available fire protection equipment. It is very imperative that the Sub-contractors along with BHEL to establish good contact with Local fire station for availability of Fire tender in case of emergencies, in additional to their own fire equipment.
c. Fire Protection, Prevention and Preparedness Inspections - The Contractor /Sub-Contractor will be required to make frequent fire prevention inspections of his work site and operating facilities.
   Deficiencies will be corrected at once.
d. Area where Hot work activities are carried out (Gas cutting / Welding/ any other spark producing work)

above a working spot, a GI / fire-resistant non-asbestos sheet or suitable material shall be placed to prevent the fall of hot sparks. A bucket of water shall be kept nearby while doing hot work

e. Hot work shall be preferably carried out in a designated area with a standing Hot Work Permit, to be renewed monthly. The designated area shall have fire extinguishers.

f. Any hot work outside designated area shall require a Hot Work permit and fire watch. No flammable material shall be stored within 35 feet from any fire load.

12. PAINTING:

a. Requirements provide a detailed procedure to be implemented by all concerned employees and sub-contractors involved in painting activities.

b. Significant Environmental Hazards:

i. Chemical hazard due to inhalation of lead fumes (lead containing paint)

ii. Chemical hazard due to inhalation of VOC's from paining operations

iii. VOC's from painting and coating operation

iv. Disposal of paints and coats drums

c. Control Procedure for Paining:

i. Chemical products used in painting and coating operation shall have proper MSDS sheet in place. Whenever any doubt arises with respect to handling and safety point of view it should be accessed to all concerned.

ii. Toxic substances and hazards relate the toxic chemicals shall be identified.

iii. Proper PPE shall be used including plastic gloves appropriate overall etc.,

iv. Arrangement for cleaning of spillage shall be ensured

d. Only trained workers shall be allowed and proper training should be imparted to the works.

e. Exposure limits of the toxic substances shall be checked before starting the work and nobody shall be allowed to carry the work beyond the permissible limit.

f. Ventilation or exhaust facility shall be provided at place where painting and coating operations are carried out.

g. Overalls shall be supplied by the contractors/subcontractors to the workmen and adequate facilities shall be provided to enable the painters to wash at the cessation of work.

h. Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored.

i. A caution board in national /regional language "**smoking strictly prohibited**" shall be displayed in the vicinity.

j. Suitable fire extinguishers/sand buckets shall be kept available at places where flammable paints are stored, handled or used.

k. In case of indoor painting or painting in confined spaces, exhaust ventilating shall be provided. If adequate ventilation is not provided a proper respirator shall be provided and used by persons who are trained and fit tested.

l. The VOC's from painting and coating operations shall not exceed the permissible level of CPCB/ SPCB norms. The paints and coats must be selected as per the guidelines.

m. Workers shall thoroughly wash their hands and feet before leaving the work.

13. "HAZARDOUS ENERGY" CONTROL PROCEDURE/ LOCKOUT/TAGOUT (LOTO)

Hazardous Energy Control Procedures, known as "Lockout/Tagout (LOTO)" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

Contractors must develop and submit a written LOTO program This requires that a designated qualified individual turns off and disconnects the machinery or equipment from its energy source(s) before performing service or maintenance and that the authorized employee(s) either lock and tag the energy- isolating device(s) to prevent the release of hazardous energy and test the machine or equipment to verify that the energy has been isolated effectively.

a. Minimum Requirements:

The following are minimum requirements that must be included in the Contractor's LOTO program:

i. Inspection of equipment by a trained individual who is thoroughly familiar with the equipment operation and associated hazards.

ii. Identification and labeling of lockout devices. Purchase of locks, tags, and blocks Development of a standard written operating procedure, permitted through a controlling authority that is followed by all workers.

b. General Requirements

The following steps must be taken to protect workers that install or service equipment and systems:

Follow the hazardous energy procedures and statutory regulations. Follow the manufacturer's service/repair instructions. Identify and label all sources of hazardous energy. Before beginning work, accomplish the following:

i. De-energize all sources of hazardous energy:

ii. Disconnect or shut down engines or motors.

iii. De-energize electrical circuits.

iv. Block fluid (gas or liquid) flow in hydraulic or pneumatic systems.

v. Block or secure machine parts against motion.

vi. Block or dissipate stored energy.

vii. Discharge capacitors.

viii. Release or block springs that are under compression or tension.

ix. Vent fluids from pressure vessels, tanks, or accumulators—but never vent toxic, flammable, or explosive substances directly into the atmosphere

c. Lockout and tag out all forms of hazardous energy including electrical breaker panels, control valves, etc. Make sure that only one key exists for each of your assigned locks and that access to the key is controlled. Verify by test and/or observation that all energy sources are de- energized.

d. After completion of the work, accomplish the following:

i. Inspect repair work before removing the lock and activating the equipment.

ii. Make sure that only the worker that installed the lock removes his/her assigned lock.

iii. Make sure that all workers are clear of danger points before re-energizing the system.

e. LOTO Procedure

PURPOSE AND SUMMARY

This procedure provides the requirements and responsibilities of Hazardous Energy Control and the process for Lockout / Tag out (LOTO) of energy isolating devices (valves, circuit breakers, disconnect, etc.). Its use

shall ensure that machinery, equipment, or systems are isolated from all potentially hazardous energy to prevent unexpected energization, startup, or release of stored energy which may cause personnel injury or property damage.

This procedure applies to all BHEL personnel and subcontractors working on the WBPDCL (1X660MW) STAGE-III projects where equipment must be taken out of service for the performance of work activities such as installation, maintenance, repair, construction, or equipment removal. The procedure may also be used to isolate equipment of which the energization or operation may present danger to personnel or property.

Lockout / tag out are not required for electrical equipment that can be unplugged from the source and the person performing the work has control of the plug.

This procedure shall be applied to prevent injury or damage caused by the unexpected release of active or stored energy. Hazardous energy sources could be in the form of the following:

- Electrical
- Hydraulic
- Chemical
- Thermal
- Mechanical
- Pneumatic

Preplanning of work activities includes the identification of all potential hazardous energy sources so that they may be properly controlled and isolated, locked, and tagged out.

Prior to initiating work activities on or around locked out / tagged out equipment, the equipment must be tested and tried by or in the presence of the person(s) performing the work activities.

RESPONSIBILITIES

- The Engineers in Charge is responsible for implementing and enforcing this procedure and approving lockouts /tag outs that impact the operation of the project.
- The Engineer in Charges responsible for authorizing Lockout /Tag out Requests.
- The Lockout / Tag out Coordinator is responsible for maintaining the Lockout / Tag out Log. Each shift should have a designated Lockout / Tag out Coordinator.
- The Isolator is responsible for determining the proper isolation devices and device positions required to isolate all potential energy sources so that the work stated on the Lockout /Tag out Request Permit may be safely performed. The Isolator must be familiar with the equipment and energy type(s) that require isolation. For this reason, in some cases the Isolator may be more than one person (i.e. Engineer, System Operator and/or Electrician). The Isolator shall position the specified device points, and apply locks and tags, and sign the tags and the LOTO Permit isolation point blocks.
- The Safety Manager is responsible for conducting an annual audit that is documented to ensure all procedures and requirements are current and being followed as written.

DEFINITIONS

Affected Employee: -

An employee whose job requires him/her to operate or use machinery or equipment on which servicing or maintenance is being performed under a lock out/tag out procedure or whose job requires him/her to work in an area in which servicing or maintenance is being performed under a lockout/tag out procedure

Authorized Employee: -

An employee who implements a lockout/tag out procedure on machinery, equipment, or systems in order that servicing or maintenance may be performed. Often an authorized employee and an affected employee may be the same person.

Danger "Do Not Operate" Tag

A tag used to identify energy isolation devices and specify the required position of the device. The tag should be affixed to the isolation device such that it is in plain view of anyone attempting to operate the device. The tags shall be sequentially numbered and shall specify the lockout/ tag out request number. The tag shall also state the purpose, and the expected duration of the lockout /tag out

Isolation Device

A device that is designed and intended to prevent the passage of energy. These devices, usually located at the energy source, are typically valves, circuit breakers, etc. Isolation devices should have a means of being locked in position

Lockout Device

A device that uses a positive physical means such as a lock, either key or combination type to maintain an energy isolation device in the safe position and prevent the in advertent energization of machinery, equipment, or systems. Device locks should serve no other purpose other than hazardous energy control isolation

Lockout Tag out Request Permit

A pre-numbered form used to request that machinery, equipment or systems be taken out of service. A Lockout/Tagout Request Permit may be initiated by any one requiring energy isolation for work activities or for taking faulty equipment out of service

Lockout / Tag out Request Log

A record of all Lockout /Tag out Request Permits shall be maintained by the Lockout /Tag out Coordinator.

PROCEDURE

1. REQUESTING A LOCKOUT / TAGOUT PERMIT

When machinery, equipment, or systems are partially or completely taken out of service for work activities or equipment protection, a lockout / tag out shall be requested. The requestor shall be familiar with scope of work required and shall provide a brief description of the work on the Lockout / Tag out Request Permit. The requestor shall also provide the proposed start time and estimated duration of lockout / tag out. If familiar with the machinery, equipment, or system to be taken out of service, the requestor may identify the devices that are required to be isolated. The LOTO Request Permit shall be forwarded to the Authorized Lockout / Tag out Coordinator for reviewed and signature, along with Permit to Work number to be entered on the LOTO Request Permit.

a. The Lockout / Tag out Coordinator shall record the necessary information on the Lockout / Tag out Request Log and forward the request to the Engineer in Charge for approval.
b. The Safety Manager or Engineer in Charge shall review the Lockout / Tagout Request Permit for impact on project operations. Project operations could be impacted by the equipment being taken out of service or by the required isolation to take the equipment out of service. If project operations are impacted by the Lockout / Tagout, the request shall be forwarded to the Engineer in Charge for approval.
c. The Engineer in Charge shall provide the lockout / tag out isolation points necessary to perform the task stated on the request. The device identification, device location, device position, and locking mechanism

shall be entered into the appropriate blocks on the Lockout / Tag out Request Permit.

d. The Engineer in Charge indicates approval of the Lockout / Tagout Request Permit by signing in the appropriate space on the request. If the Lockout /Tag out Request Permit is rejected, the Engineer in Charge shall return it to the requestor, via the Lockout / Tagout Coordinator with a written explanation of the rejection.
e. Once approved, the Lockout / Tag out Request Permit shall be forwarded to the Lockout / Tag out Coordinator to assign tags and locks.
f. The log shall show current status of all Lockout / Tag out Request Permits from submittal to approval, through lifting of locks and tags to final closeout. The log shall be maintained by the Lockout / Tag out Coordinator in their office.

2. PLACEMENT OF LOCKS AND TAGS

a. The tags shall be filled out to match the information on the LOTO Request Permit. Appropriate locks for the types of isolation devices specified shall be collected and placed with the tags and the Lockout / Tag out Request Permit.
b. The isolator(s) shall take the device locks, tags, and the Lockout / Tagout Request Permit to position the specified isolation devices, sign and hang the tags, and place the locks. If the isolator does not agree with or understand the Lockout / Tagout Request Permit, or has a problem performing the isolation, the problem should be brought to the attention of the Safety Representative or Area Supervisor immediately and the lockout / tag out should be postponed until the situation is resolved.
c. Once the Isolator has placed all “locks” on isolation points, they will “test ”and “try” the machinery, equipment, or system to ensure all hazardous energy has been completely removed and the isolation is one totally accomplished, and has initialed and signed the Lockout /Tag out Request Permit indicating all isolation points have been confirmed. Examples of “lock”, “test” and “try”:
    - by checking that all locks on the LOTO Request Permit have been applied and are in the specified position open/closed, on/off, etc.; metering test of electrical circuits, opening of drain valves, checking pressure gauges or indicators; and try by pushing start buttons and on/off switches, etc.
    - Testing shall be performed by person(s) knowledgeable of the energy source(s) being isolated (e.g., an electrician should meter electrical circuits).
d. A copy of the completed Lockout /Tag out Request Permit shall remain with the Work Package and used as part of the daily Pre-Job Briefings

3. WORKING UNDER A LOCKOUT / TAGOUT REQUEST

a. Prior to starting the work activity, the person(s) performing the work shall review the Lockout / Tag out Request Permit and place the necessary tags and personal locks on the identified isolation devices. Personal locks may be placed only on devices that have already been locked and tagged in accordance with the Lockout / Tag out Request Permit.
- All personal locks shall be accompanied by a tag that is signed and dated by the worker(s) and specifies the work activity being performed.
- Personal locks should be of a different color than device locks for ready identification.

b. Verification of the effectiveness of the isolation by the Isolator shall be performed for Worker’s working under the lockout / tag out, by demonstrating the checks on “lock”, “test” and “try”,
c. When the work activity is finished, personal locks and tags shall be removed and the Safety Representative

shall be notified that the Lockout / Tagout is no longer required. If work under a lockout / tag out is to be delayed or interrupted for a period in excess of 24 hours, personal locks shall be removed until the work restarts. Personal locks shall be removed prior to the worker(s) leaving the project at the end of shift unless the key(s) are maintained at the project.

4. REMOVAL OF LOCKS AND TAGS

a. When the lockout / tag out is no longer required, the Safety Representative or Area Supervisor shall obtain the Lockout / Tagout Request Permit from the work package for LOTO removal. Prior to removing locks or tags that may allow equipment to be energized, a check shall be made to verify that the equipment is free to safely operate (i.e., will not cause damage or injury). The locks and tags shall be removed and returned to the Lockout / Tagout Coordinator. Isolation devices may be repositioned at the discretion of the Engineer in Charge according to operational requirements. The Isolator shall complete the Lockout / Tagout Request Permit indicating each lock and tag has been removed and the Safety Representative or Area Supervisor forward to the Lockout / Tagout Coordinator.

b. The Lockout / Tagout Coordinator shall discard the tags and maintain the completed Lockout / Tagout Request Permit for future reference.

c. In the event that an employee leaves the job site without removing the personal lock I tag, the following measures shall be taken and documented. The measures listed below are a minimum set of guidelines and under all circumstances, refer to the site-specific safe work plan for detailed procedures:

- Attempt calling / contacting the employee to return to the site for removal.
- In the event an employee cannot be contacted, the Site Manager and Safety Manager shall sign an Emergency Lockout/Tagout Removal Form, which has been completed by the Area Supervisor.
- Employee shall be notified upon returning to the site, prior to beginning any work.

5. INTERRUPTION OF A LOCKOUT / TAGOUT

Operational Emergency

The Engineer in Charge / Safety Manager /Area Supervisor may deem it necessary to temporarily remove the locks and tags from isolation devices, prior to the end of the work activity. The standard procedure for removal of locks and tags shall be followed. Extreme caution shall be taken by the Isolator removing the locks and tags to prevent personnel injury.

Testing

When the performance of a work activity requires the functional testing of a machine, component, or system, the locks and tags may be temporarily removed in accordance with the tag removal, to perform the test. As a result of the testing, if it is determined that the equipment needs further work, the locks and tags shall be positioned back on to the device. If it is not necessary to replace all the locks and tags, then the unnecessary locks and tags may be returned to the Lockout / Tagout Coordinator. The Engineer in Charge shall initial the Lockout / Tag out Request Permit in the removal block to indicate that these locks and tags have been removed. When testing has been satisfactorily completed, the locks and tags shall be removed.

ISOLATION DEVICES

- In most industrial applications, there are isolation devices that were not designed to accommodate a locking device. In these instances, an acceptable alternative that physically obstructs or prevents the use of the isolation device shall be found. Chains shall be placed on valves or electrical panels. Wires shall be determinate, pulled back, taped, and secured.

- If an isolation device does not accept a lock, a tag only is acceptable; however, all possible precautions shall be undertaken to provide a level of safety for the workers. The tag shall be readily visible to anyone attempting to operate the device.
- If more than one Lockout / Tagout Request Permit requires that a single isolation device be locked and tagged, a lock and tag for each request shall be placed. Each lock in itself prevents the inadvertent operation of the device.

GROUP / COMPLEX LOCKOUT

In a multiple lockout / tag out procedure, each person working on the machinery or equipment must place a lock or tag on the energy isolating device. If the energy isolating device will not accept multiple locks or tags, a hasp (a multiple lockout device, may be used. The locks or tags must be placed in such a way that energy cannot be restored to the machinery or equipment until every lock or tag is removed. As each employee involved no longer needs to maintain lockout / tag out protection that employee removes his - her lock and/or tag. The employee attaching the lock or tag is the only person authorized to remove the lock or tag.

6. TRAINING

The training must include recognition of hazardous energy source, type and magnitude of energy available, methods and means necessary for energy isolation and control. Each authorized employee shall receive adequate training. The training should address that all affected employees are instructed in the purpose and use of the energy control procedure. There should be training provisions included for any other employee whose work operations are or may be in an area where energy control procedures may be utilized. The employee training should also address when tag out systems are used including the limitations of a tag (tags are warning devices and do not provide physical restraint). The training should also include that a tag is not to be removed without authorization. The tag is never to be ignored or defeated in any way. Retraining is required when there is a change in job assignments, in machines, a change in the energy control procedures, or a new hazard is introduced. All training and I or retraining must be documented with employee's name and dates of training.

7. PROGRAM REVIEW

The lockout / tag out program must be reviewed at least annually. The review must ensure that procedures are being followed and that they are effective. A documented review of the inspection must include the date, the equipment, employees involved & the inspector. The inspector must be someone other than those actually using the lockout / tag out in progress.

ATTACHMENTS

#1. Danger (DO NOT OPERATE) Tags



#2. Device & Personal Locks and Multi Lock Hasp:



#3. Lockout / Tagout Request Permit

BHEL	**LOCKOUT / TAGOUT REQUEST PERMIT**	□OTO R□□□□□□P□r□ □N□.□
		□ □r□P□r□ □N□.□
E□□□□. O□□□□ S□r□□□□□	□OTO D□□□ R□□□□d □□□ □□□□□□□□□□□□□□□□□□□□	E□□□ □□d D□r□□□□□	**LOTO Requested** D□□□□
S□□□□ □□□ □r□□		**LOTO Authorization** S□□□d □□□
		D□□□□
		LOTO Removal Authorization S□□□d □□□
		D□□□□ T□□ □□

T□□ N□.	D□□□□□ □□ □□ T□□□□d □□□□□d I.D. N□.	D□□□□ □□□□□□	D□□□□ P□□□□□ *OPEN / CLOSED -*	□□□ N□.	T□□/□□□□ P□□□d □□Pr□□S□□ □ D□□□T□□ □		T□□/□□□□ R□□ □□d □□Pr□□S□□ □ D□□□T□□ □	

C□□ □ □□□□ I□□r□□□□□□□ **Attachment 3.Lockout / Tag out Request Permit:**

#4. Lockout / Tag out Request Log

LOTO Permit No.	Requestor Name	Equipment & Location	Est. Work Completed Date	Approval Date	LOTO Placed Date	LOTO Removed Date	Comments

14. RISK ASSESSMENT

Risk and Hazard Analysis

In order to produce an overall Project EHS Plan, a project must be assessed for its risks. There are two components to the risk and hazard analysis. The procedure used to examine and plan for the identified risks and hazards is called a General Hazard and Risk Assessment.

JSA/HIRA review

Prior to commence the following activities Method statement and JSA/HIRA to be prepared by the concern engineer in coordination with EHS officer and submit to the client for review and approval. After getting approval the work will be started under PTW after clearance. For HIRA and criteria for the defining the high, medium & low risk the relevant annexure be referred. In case any deviations required in the approved method statement the concerned engineer/supervisor has to prepare additional HIRA/JSA to cover the new activities and associated risk. Following activities to be covered,

- Deep excavation (more than 5 feet)
- Significant concrete pouring (like heavy foundation, TG deck, Slab casting etc.)
- Confined entry
- Blasting
- Working on electrical/ energized equipment's
- Steel erection more than 5-Ton weight
- Working at height prior to completion of stairs/ladders/hand railing etc.

Definition:

HAZARD - Any potential or present danger to persons or property within the project site, e.g., oil on the floor is a hazard.

INCIDENT - An unintended happening that may result in injury, loss or damage, e.g., Slipping on the oil is an Incident.

INJURY – Physical harm, the result of an Incident, e.g., a sprained wrist from the fall would be an injury.

Hazard Analysis Document

- For high risk and dangerous work identified, the Applicant shall complete and submit a Hazard Analysis Document together with the PTW request. It will be a JSA (Job Safety Analysis) or Preliminary Hazard Analysis Checklist. And it shall be reviewed and approved by respective Construction and HSE Representatives.
- Issues such as work interface, coordination, drawings, toolbox meetings and work type/duration shall be detailed and included with supporting documentation for the Applicant's request for PTW.
- If applicable, Hazard Analysis Document shall be used as the foundation for development of Safe Work Method Statement. Each hazard identified shall be addressed in the Safe Work Method Statement and be submitted as part of the Applicant's submittal package.

Evaluation of Sub-contractor Risk Assessments includes

- Experience and expertise in performing similar type work.
- Duration of work performed
- Location of the work to be performed.

- Nature of the work to be performed.
- Potential for a subcontractor performing the work to expose themselves, other persons or employees, to hazards.
- Potential for exposure to work site hazards.

Review of Subcontractor specific issues

Preventive and protective measures must be introduced according to the following order of priority

- Eliminating the hazard by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc.
- Controlling the hazard at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc.
- Minimizing the hazard through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- Providing appropriate personal protective equipment (PPE) in conjunction with training, use, and maintenance of the PPE.

15. HSE PREPAREDNESS FOR ADVERSE CLIMATES AND WEATHER

All Preventive and Precautionary measures to ensure Health & Safety of workers in all possible adverse weather conditions based on the analysis of the local area conditions to be taken by the subcontractor

15.1 SUMMER

1. The Working Time and Lunch Hour will be as per instruction of Statutory Authorities (no work between 11am to 3:30pm). However, in case temp comes down due to rain/cloudy weather work will continue as per normal routine.
2. During long lunch break, worker will be allowed to go back home for rest. Those who will like to stay back will avail at the facility of rest shed or other designed area.
3. They will be allowed to take small break during work as per their need.
4. Water sprinkling will be done on roads to reduce dust concentration.
5. Workers will be provided with adequate cool drinking water and Butter milk/Lemon water etc.
6. Adequate ORS stock will be made available at the work location in the First-Aid Box for use as needed and at First-aid Centre for emergency need.
7. Fire prevention shall be on high alert, with removal of dry grass and bushes, etc, inside and outside the surrounding work areas. No smoking, and control of open flame/sparks shall be maintained and monitored.
8. Worker will be informed about the Do's and Don'ts to be followed during summer in the Pre Job Brief.

Dos & Don'ts

1. Drink plenty of cool water and other non-alcoholic fluid and keep body well hydrated.
2. Eat salt in food to replenish loss of salt through sweating.
3. Avoid over physical exercise.
4. Have adequate sleep at night.
5. Eat light and less spicy food
6. Avoid eating food which was cooked long time ago.

7. Nobody should use small water bodies such as pits, running rain water through crevices etc. for drinking and cleaning purpose as it may be unhygienic.

Emergency Handling

In case of emergency due to heat disorder:

1. Rescue the victim from workplace and place under shed.
2. If to be rescued from height, use stoke basket or rescue kit.
3. Inform Ambulance immediately.
4. If nearby any air conditioned room/shed is available, place him inside the room/shed.
5. Administer First aid by trained First aider for Heat Disorder
6. If conscious, give him ORS solution to drink.
7. If required send the victim hospital immediately.

15.2 MONSOON

A. Height Work & Structural Safety:

1. Ensure that all height work platforms are barricaded and avoid any highly hazardous
2. Height work.
3. Ensure that all personnel have good quality and intact safety shoes
4. Stop all dangerous height work during rain
5. Explain Do's and Don'ts to workers during Tool Box Meetings
6. Ensure that there are no weak structures, boards etc. that can fall during high winds
7. Do not allow any loose material (e.g. GI sheet, Ply board, empty cement bag, aluminium foil, foam sheets etc.) on roof sheds or top of structures.
8. Do not permit any one to ride up or come down scaffolds frame work during heavy wind or rain.
9. Provide "anchor" of adequate strength to scaffolds and other high-rise structures.
10. All rest sheds and GI sheds will be anchored into the round and wall and roof panels will be secured with J hook to prevent shed from blowing over or parts/pieces becoming airborne. Proper earthing per IS standard is also to be installed.
11. Do not go alone nor permit anyone to stay at tower-tops, roof-tops, high structures or on electrical poles during the course of stormy weather or heavy rain.

B. Electrical:

1. All electrical connections / loads have to be routed through ELCB / RCCB (residual current circuit breaker) whose rating should be 30mA.
2. RCCB operational checks need to be done DAILY / WEEKLY during monsoon season.
3. Avoid joints on power cables which need to be laid over-head or under-ground, better not to have any joint at all. In case joints become essential, such cables must be housed rigidly and insulation must be provided as per approved standard. The joint shall be suitable for outdoor use.
4. All electrical distribution board shall be properly covered at top and sides to protect from rain water. Extension boards shall be protected from rain water.
5. Ensure proper "earthing" for each and every electrical appliance.
6. Double earthing need to be provided for 3-phase power supply and for voltage more than 220V.

7. Provide lightening arrestors at the top of Boiler 3 and boiler 4 and rest sheds which are not covered by existing lightening arrestor of other installation.

C. Others:

1. Maintain smooth flow on open drains. i.e. no obstruction or blockade shall be made on storm water drains. If required, make temporary drains.
2. Arrange back-filling of excavated pits on war-footing basis.
3. Arrange bringing down booms of all cranes, hydra machines during stormy weather (wind speed 40-50 km/hr)
4. Confirm that all gantry cranes are effectively choked to prevent rolling and toppling.
5. Do not forget to deep ready a dew battery operated lights at site-offices during rainy season.
6. Avoid using wet damp clothes.
7. Hard Barricade excavated zone filled with water with scaffolding pipe & clamp with reflective net
8. Engage diesel operated water pump to dewater work area. For electrically operated water pump, the starter shall be protected from rain water. All rotating parts shall be guarded. Ensure availability of sufficient water pumps.

D. Health and hygiene:

1. Monsoon reduces the immunity of our body and makes us vulnerable to many diseases which are commonly associated with this season. It is time for us to keep our body challenging against disease by boosting our immunity and taking safety measures against these diseases.
2. The diseases associated with monsoon are Malaria, Jaundice, Gastro-intestinal infections, like typhoid, cholera etc. apart from these viral infections like cold and cough also make their presence felt. Majority of above said diseases are on account of:
3. Puddle of water formed due to rain become breeding grounds for mosquitoes which spread disease like, malaria and dengue fever. As a precautionary measure against mosquito-bite disease one can use mosquito net around the end which is better choice to mosquito repellents like mats and coils.
4. Pollution of drinking water during monsoon is very common. It is very necessary to drink clean and pure water when water-borne monsoon diseases like diarrhoea and gastro-intestinal infections threaten us.
5. Walking in dirty water during rainy season leads of numerous fungal infection which affect toes and nails. Diabetic patients have to take a special care about their feet. Keeping feet always dry and clean is very necessary. Avoid walking in dirty water. Keep shoes socks and raincoats dry and clean.

E. Workmen will be made aware of following Do's and Don'ts:

1. Do not sleep in daytime.
2. Avoid over physical exertion.
3. During lightning and thunder storm, do not take shelter under tree. Take shelter inside rest shed or store room.
4. Wash vegetables with clean water and steam them well to kill germs.
5. Avoid eating un-cooked foods and salads should be washed properly before consumption.
6. Drink plenty of water and keep body well-hydrated.
7. Always keep the surrounding area dry and clean. Don't allow to get water accumulated around.
8. Keep body warm as viruses attack immediately when body temperature goes down.

9. Do not enter air conditioned room with wet hair and damp cloths.
10. Dry your feet and webs with soft dry cloth whenever they are wet.
11. Eat light and less spicy food.
12. Avoid eating food which was cooked long time ago.
13. Eat salt in food to replenish loss of salt through sweating.

15.3 EMERGENCY WEATHER CONDITIONS

Cyclone/Severe thunder storm

In the event of Cyclone/Severe thunder storm, alert will be issued by subcontractor on notification received by Govt. authorities/Metrological departments Customer or BHEL.

The actions required during cyclone/rough weather:

1. Check and advice subcontractors to clean-up work area. Pick up all loose and unused material of respective supervisor's area.
2. Tie to secure all gas cylinders to avoid displacement and unsafe conditions which could be due to wind pressure.
3. Secure portable electricity generating sets and other equipment, pumps, hoses etc.
4. Make preparation for removal of water logging.
5. Take review of work activity and make preparation for removal of equipment and material from vulnerable areas.
6. Isolate/turn off all electrical power form the main panel/switches. Secure and anchor panels properly.
7. Recheck anchorage/tie of all temporary structures/sheds, tall objects, cranes, rigs, scaffolds etc. to avoid toppling due to wind force.
8. Cranes boom shall be secured, either locked or lowered the booms as reasonably and practicably possible and rigs to safe position for the safety point of view.
9. Group up all trash barrels, wooden pallets, forms; wooden decks etc. and anchor properly.
10. Welding machines, air compressors and such equipment are to be grouped together and secured to the stable objects. Welding leads, electrical cables, hoses are to be rolled up and secured properly.
11. Set on site vehicles on high ground in the site area with brakes set firmly.
12. Anchor all tanks, vessels, gas cylinders that may be moved by high wind and water.
13. Evacuate job site.

Personnel Evacuation:

1. Personnel Evacuation will be required if predicted wind speed and storm surge heights are beyond acceptable limits as per the instructions from Govt. Authorities/ Metrological departments or Customer.
2. Once the warning is received for personnel evacuation, an emergency response team shall be formed. The team will work with local authorities and other agencies formed/deployed to evacuate and transport all personnel involved in the project to the cyclone shelter.
3. Cyclone may be followed by the calm "EYE", be aware of it. If the wind suddenly drops, don't assume the cyclone is over. Violent wind may resume from the opposite side direction. Wait for the official "All clear Signal".

4. After the cyclone, do not go outside until officially communicated about safe situation outside. Use recommended routes for returning. Do not panic or rush while returning.
5. Checking of gas leaks and well-being of electrical appliances is essential before leaving the site.
6. Follow local communications for official warning and advice. The construction Manager shall also obtain updates from customer/metrological departments and communicate to the personnel on project site.

15.4 PREVENTION OF COVID-19 (COVID-19 HERE TO BE READ AS COVID-19 AND OTHER PANDEMICS/ COMMUNICABLE DISEASES) AT PROJECT SITE & LABOUR COLONY:

Resumption of Construction Activities after Lock Down and Prevention of Coronavirus Infection during Site Operations and OCP 61A: Prevention of COVID-19 Infection in Labor Colony will be strictly followed.

A. <u>Preventive measures at project site:</u>

- BHEL and Agencies shall nominate COVID Marshalls, who will be responsible for monitoring the COVID prevention measures and apprising management on the same.
- Mandatory health check-up for every worker/ official joining the site
- All activities to be carried out using least amount of paperwork and physical proximity as far as possible.
- ***HSE Observer App*** to be used to monitor HSE Activities and follow up with agencies for closure of non-conformities.

<u>a. Strict Control at the Gate/ Banning Entry to Anyone Not Wearing Masks</u>

i. Security personnel at the gate may erect a barricade preferably approx. 10 meters from the gate and only allow personnel who are wearing proper masks inside.

ii. Public address system may be used to warn any non-compliant visitors

iii. Near entry gate, round markers at minimum 1-meter distance to be ensured so that distancing is ensured

iv. A hand-wash or hand sanitiser facility is preferable at the gate to allow entry after hand wash or hand sanitisation. These are also to be provided at key locations to enable hand wash / hand sanitisation before starting work, before eating, etc.

v. Gutkha, Paan, tobacco etc. to be banned from the site. Spitting to be strictly prohibited.

<u>b. Screening at Gate with Contactless Thermometer & Action on Suspected Cases</u>

i. Security Personnel at the Gate to screen each person entering the premises using a non-contact infrared thermometer, which is duly serial numbered and calibrated.

ii. In case any site worker/ official is found to have fever more than 99 Degrees Fahrenheit or found coughing/ sneezing, he/she may be advised rest till recovery and entry to be permitted after obtaining clearance from medical officer/assistance/attendants.

- Parcel to be collected from gate by concerned person preferably with provision of Special Box
- Any construction material received at site, unless properly sanitized, to be kept undisturbed for at least 3 days and to be used only after that period.
- During Toolbox Talks, minimum 1-meter distance between any two workers to be ensured

<u>c. During site execution activities:</u>

For all site execution activities, social distancing is to be maintained. In case this is not possible due to nature of work, speciality of work, etc, ensure sensitisation of the labour/staff involved and use of appropriate PPEs, especially mandatory face mask. In any case, close working to be allowed only in special

circumstances and ensuring these activities are preferably time staggered to the extent possible

d. In office premises:

i. Sharing of items like pens, water bottles etc. in office premises to be avoided

ii. Doors preferably to be in open condition to avoid contact

iii. All common touch points to be frequently disinfected in a day.

e. Regular disinfection of all Areas, Equipment and facilities

i. A dedicated disinfectant gang to be identified for the task by each agency. The disinfectant gang to be provided full body suits for the task.

ii. All areas (including office premises, site areas, chairs, tables, furniture etc.), tools & equipment to preferably be disinfected by dedicated gang every day before resumption of work.

iv. Common touch points like handrails, lift buttons, door/window knobs or handles, vehicle door handles, taps, conference room & dining hall tables/chairs, common sofas/chairs, visitor sofa/chairs, files & folders, etc to preferably be disinfected regularly at frequent intervals every day.

v. Pool vehicles, to be disinfected after every use. Social distancing to be maintained inside the common pool vehicles as per Govt./ statutory body guidelines.

f. Disinfecting the operator/driver touch points of Vehicles/cranes, T&Ps etc.

Disinfection to also be carried out for all Cranes, Vehicles, Equipment, consoles, T&Ps etc. which come into contact with operating personnel.

g. Posters on COVID-19

Sufficient Posters on COVID-19 to be ensured across the site in languages understood by most workers.

h. Brief guidelines for hand washing are as below:

i. Soap to be provided at each wash basin and replenished regularly.

ii. Washing with soap for at least 20 seconds is recommended.

iii. As a general guideline, for every 100 workers, 1 wash-basin may be provided at site areas.

iv. Close queue to be avoided near wash-basins and 1-meter distance to be maintained. Round markers at 1-meter distance can be ensured as guidance

Composition of Disinfectant:

i. Readily available 1% hypochlorite solution or 4%

ii. Liquid chlorine-1% solution

Iii. Surgical spirit-95% alcohol content

iv. Hand sanitizer should have: Isopropyl alcohol-75%, Gycerol-1.45%, Hydrogen Peroxide-0.125%

B. Prevention of COVID-19 Infection in Labor Colony:

- Spacing of minimum 2 meters between living areas of workers inside a room may be maintained. Preferably, the living area of each worker may be partitioned using sheet of cloth, plastic etc.
- Rooms to be properly ventilated as far as possible
- Sanitation to be given prime importance and personal hygiene to be promoted
- Face masks shall be worn by everyone inside the colony premises
- Spitting of Pan. Gutkha etc. inside the colony and urinating etc. outside the toilets to be strictly avoided
- Regular visits by Doctors to the labor colony can be arranged on non-working day for check-up of all workers
- **Identification of "COVID Wardens" (CWs) by each agency for maintaining the following:**

i. Keeping an eye on the health of workers and report any suspected cases of fever, coughing etc. to the

management

ii. Keeping an eye on the social distancing measures in the labor colony and report any non-conformances to the management.

iii. Educate the workers about social distancing and COVID prevention measures.

- Training/ Awareness regarding COVID-19 to be provided to workers regularly.
- Workers to be instructed to maintain social distancing of minimum 1 m at all time
- **Posters on COVID-19:** Sufficient Posters on COVID-19 to be ensured across the labor colony in languages understood by most workers.
- All workers to be instructed to inform any suspected cases of illness (individual or others) to an emergency contact number of CW, the emergency contact numbers and CW contact numbers to be displayed at prominent locations
- **Inspection & Review**

  i. Daily Inspection by concerned COVID Wardens and reporting to Agency

  ii. Regular inspection by Agency & BHEL

15.5 Noise Mitigation

High noise is harmful to the human health and it can cause impairment if exposed for long duration at regular intervals, and also cause disruption in nearby communities.

- Noise monitoring shall be carried out in all construction locations periodically.
- Use of silent DG is allowed at site during construction.
- Low noise generation equipment's to be preferred.
- Work areas where noise levels exceed the 85db shall be posted as hearing protection required.
- Use of PPEs / ear plug/ear muff for personnel entering into high noise area.
- Activities generation High noise will be planned in day shift.

Noise Level Chart

Parameter	Night Noise level dBA	Daytime Noise Level dBA
At 1-meter from each piece of equipment	85	85
At Property boundary	70	70

ANNEXURE J

First-Aid Box

Details & Contents of First Aid Box as per Contract Labor (Regulation & Abolition Act), Central Rules, 1971

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

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

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ANNEXURE K

Vertigo Test

Vertigo Test Procedure/ Guidelines

This document specifies minimum requirements for vertigo test. These may be supplemented by any additional requirements deemed fit by the medical examiner/ HSE department)

Fear of height may be physiological or psychological. Therefore, to rule out any possibility of physiological factor, detailed medical check-up of workers is carried out before vertigo test. Medical check-up of workers includes the following:

history of past illnesses (like epilepsy, drug allergy, diabetics/ hypertension, unconsciousness etc.), general physical examination (like height, weight, BMI, build and nourishment etc.), measurement of pulse rate, Blood Pressure, respiratory rate.

After this check-up, those who are found suitable for height work by examining doctor, are allowed to undergo vertigo test.

During this health check-up, psychology of workers is also studied. If any worker finds it extremely difficult/ frightening to climb the monkey ladder & walk on the beam, during/after performing vertigo test or even before performing, then he is treated as disqualified.

As per standard, during vertigo test, worker is allowed to climb on a foundation through monkey ladder, walk on a beam, then steps down at the other end of beam, through monkey ladder. Height of the beam should be at least six feet from ground level. All necessary safety precautions are taken during this test. Worker has to wear full body harness with double lanyard. A horizontal lifeline is run parallel to the beam and worker has to put his lanyards into the lifeline. Additionally, a safety net is also put below the beam for rescue of the victim in case of a fall from beam.

Following activities are suggested to be carried out during testing:

1. **Walking Bench Training:**
   a. Person should walk over the channel. He should maintain balance & walk without much problem.
   b. If the person has problem to balances himself on repeated chances, he may be having flat foot or some other problem. So, he may not be fit for height work.
2. **Rope Climb Training:**
   Person should be able to climb the rope up to the top channel for ensuring that in case of fall, a person hanging on the safety harness, will be able to safely climb back to the platform within minimum time period before the safety harness start breaking down under the load.
3. **Height Work Training:**
   Person should walk freely on the middle channel while holding the top channel with the help of safety harness.
4. **Ladder for Vertical fall arrestor Training:**
   Vertical fall arrestor rope is fixed from top to bottom of the ladder. It will ensure:
   - Usage of vertical fall arrestor.
   - Usage of two lanyards of a safety harness.
   - Ensure 3-point contact on the ladder while climb.
5. **Chair for work at height Training:**
   - Climb though vertical ladder with two lanyard ropes.
   - Hooking of two lanyard ropes to life line. With this safe arrangement, he can walk to chair.
   - Sits in the chair safely, comes out & walks back to the vertical ladder & come down from vertical ladder. After completion of vertigo test, blood pressure of worker is again measured. If it is not within acceptable limits for any worker, concerned worker is denied height pass.

Only those who pass the above training are to be considered as fit for height work.

CUSTOMER CONTRACT SPECIFIC SAFETY CLAUSES

3.72 SAFETY

3.72.01 SAFETY CODE FOR CONTRACTORS

3.72.01.01 Safety is the responsibility of every employee individually and collectively.

3.72.01.02 Head of the dept. should ensure that a copy of this Contractor's Safety Code is handed over to every Contractor working under his control and he should in turn display all rules on the office notice board for the benefit of all the men working under him.

3.72.01.03 The Contractor shall in connection with provide adequate guards, illumination, fencing and watching wherever necessary at the construction site & working area, for the safety & convenience of public or others.

3.72.01.04 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard, especially near the site stores.

3.72.01.05 Adequate washing facilities with proper drainage shall be provided properly maintained near the place of work but at a safe distance from railway tracks and busy roads.

3.72.01.06 When work is to be done near any place, where there is risks of drowning, arrangements to be made for safe barricading of such areas. All necessary equipment shall be provided and kept ready for use and necessary steps taken for prompt rescue of any person in danger and adequate provision shall be made for prompt first-aid treatment of all injuries likely to be sustained during the course of the work in case of mishap.

3.72.01.07 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Safety Engineer, the Labour Officer, Engineer-in-charge of the department or their representatives.

3.72.01.08 Notwithstanding the above clauses, there is nothing in those to exempt the Contractor from the operation of any other Act or Rule in Republic of India for the safety of men and materials.

3.72.01.09 An injury sustained in the plant, must be reported to the First-Aid Station no matter how slight it is, the injured person will inform Supervisor/Officer in-charge.

3.72.01.10 In case of a fatal accident, the Contractor must inform the Engineer in-charge of the department for which he is working. and report in writing should be made in the form.

3.72.01.11 Smoking or keeping of naked light is strictly prohibited near gas lines, valves and any other equipment connected with the gas distribution.

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3.72.01.12 Smoking and carrying of matches, lighters and other spark producing devices is strictly prohibited within the area where inflammable liquids are stored, handled or used or where loading or unloading operations are performed. Any tank or container containing flammable liquid should be properly grounded for preventing ignition due to static electricity spark. Contractor should ear-mark such areas and provide necessary warning signals.

3.72.01.13 Contractors should ensure that employees do not come to work while still under the influence of intoxicants. Any employee found on duty under the influence of liquor or of intoxicating drugs, will be liable to severe disciplinary action.

3.72.01.14 Work surrounds should be kept clean, free from oil, grease and other obstructions or fallen objects like nuts bolts etc.

3.72.01.15 After a job or work is completed, all left-over junk and other scrap materials should be cleared from the area immediately.

3.72.01.16 Drums or other make-shift arrangement must not be used in place of ladders or as work benches or supports for any job.

3.72.01.17 Employees must not walk through or across any operating units unless their duties require them to do so or they are authorised to do so.

3.72.01.18 Compressed air should not be used for removing dust from one's clothes. Compressed air should not be blown against anyone as it may injure or even kill him.

3.72.01.19 If an employee, in the course of his work, encounters condition of unusual hazard with which he is not familiar, he should contact the supervisor for advice before proceeding further. He should also inform the Contractor as well as the Engineer in-charge.

3.72.01.20 Contractors should particularly ensure that they or their employees do not meddle with any equipment and see that they keep away from such equipment.

3.72.01.21 It should be ensured that no one takes rest/shelter below any under cut pit/excavation or near any stock of materials.

3.72.01.22

i) For any work involving repair & maintenance underground work the Contractor shall follow the safety procedural orders/instructions issued by TANGEDCO.

ii) The Contractor shall exercise supervision of such jobs by competent persons within the meaning of factories act & rules.

iii) All persons engage on such jobs shall have to have beforehand proper training instructions as required under Factories Act & Rules.

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3.72.02 SAFETY MEASURES IN CONTRACTUAL WORK

Whereas, it is necessary to take steps to ensure safety at work site by the executing contractual agency, it is incumbent of TANGEDCO to introduce all measures to guide, induce, train and bind the agencies concerned to adopt remedial steps to prevent accidents. Problem gets aggravated in contractual zones due to lack of training, in-adequate supply of personal protective equipment, shortage of skilled labour changing deployment of works etc. Accordingly, the following measures are intended to be introduced and the salient clauses will be included in the contract documents.

3.72.02.01 The Contractor shall take all safety precautions and provide adequate supervision in order to carryout the job safely and without damage to equipment.

3.72.02.02 Any special safety precautions, if required to be followed by the Contractor, has to be taken care-of by the contractor. While removing the equipment, necessary dummy/isolation shall be provided by the contractor without any extra cost.

3.72.02.03 The executing department would take necessary shut-downs wherever there are hazards of gases, electricity, moving machinery etc. The Contractor shall ensure that the shut-down/clearance are taken before sending workers to such locations.

3.72.02.04 The Contractor shall supply safety appliance like shoes, safety belts, ladies chappals, helmets, gloves etc. to his workers depending on working conditions and Life-saving jackets shall be kept in readiness always at the site. The Contractor shall not deploy any workmen without safety boot and safety helmet and the safety applicable to the specific work conditions.

3.72.02.05 Before starting the day's job, the TANGEDCO's Supervisor/representatives will ensure that safety briefing has been done to the Contractor's supervisor who has been imparted safety induction earlier.

3.72.02.06 HOD/Zonal in-charge will nominate Engineer in-charge of the contractual work under reference who will be fully responsible for the safe execution of the work at site.

3.72.02.07 In case of injury to persons, the Contractors shall first take the injured person to Doctor /Hospital authorised by TANGEDCO with the necessary forms. In no case the Contractors are allowed to take injured persons directly to their own Doctors.

3.72.02.08 The Contractor shall abide by the provisions of Factories Act, State Factory Rules, Workmen's Compensation Act, Payment of Wages Act, Contract Labour (Regulation) Act etc. and keep TANGEDCO indemnified of provision the above Acts and Rules.

Power Sector Hydro Bus

3.72.02.09 The Head of Dept. executing the contract upon the satisfaction that the Contractor is not conforming to the Safety requirements may direct stoppage of work and require the Contractor to remedy the defects. The Contractor shall not proceed with the work until he has complied with each directions to the satisfaction of such Head of the Department.

3.72.02.10 The Contractor shall be fully responsible for accidents caused due to him or his agents or workmen's negligence or carelessness in regard to the observance of the safety requirements and shall be liable to pay compensation for injuries.

3.72.02.11 Without prejudice to the right conferred for stoppage of work for violations of safety requirements the Contractor shall be liable for penalty as deemed fit for violation of safety rules & regulations upto first two instances. For the third violation he shall be liable to be debarred from further contracts upto a period of one year from the date of issue of debarring notice.

3.72.02.12 The Head of the Safety Engineering Department or the Head of the Department executing the contract will assess the penalty amount having regard to the circumstances, in particular, the nature and gravity of the violation. After issuing a notice to the Contractor to show cause why the amount specified therein shall not be imposed as a penalty and considering the cause shown by the Contractors, if any, he shall pass final orders which shall then be final and binding on the Contractor. The penalty amount will be recoverable from any bill and/or EMD/SD of the Contractor without any further reference to him.

3.72.02.13 Whenever work, at height is involved, Contractor must obtain height passes from Safety Engineering Department for those persons required to do work at height.

3.72.02.14 Contractor must insure all the workmen against "Workmen Compensation Act."

3.73 LIMITATION OF LIABILITY:

The contractor will not be liable for consequential losses. The total liability will not exceed 100% of contract value. This is apart from Workmen Compensation, if any.

Power Sector Hydro Business Group Sector 62, Noida U.P.

Annexure
C1

DATE:31/08/2021

T&P HIRE CHARGES

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

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	24500.00	24500.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	10940.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	53560.00
4	PORTAL CRANE, 360T	15	14070.00	13390.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	52770.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	65280.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	31880.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	19920.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	28690.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	30130.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	25110.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	34580.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	14390.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18050.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	15940.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	20720.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10360.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	12750.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10420.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10200.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8440.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9560.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9560.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5210.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	5880.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5150.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4230.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	2910.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2180.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2180.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	680.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	370.00

Annexure

C1

DATE:31/08/2021

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

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	650.00	640.00
31	FORK LIFT 3T	5	540.00	530.00

Annexure C2 DATE:31/08/202

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

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	27230.00	27230.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12160.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	59520.00
4	PORTAL CRANE, 360T	15	15630.00	14880.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	58630.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	72540.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	35420.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	22140.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	31880.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	33480.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	27900.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	38420.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	15990.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20060.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	17710.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	23020.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	11510.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14170.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11580.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11330.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9380.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	10620.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	10620.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5790.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6540.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5720.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4700.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3240.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2430.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2430.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	760.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	410.00

Annexure C2 DATE:31/08/202

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

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

Annexure I

RATES FOR INTER REGIONAL HIRE CHARGES FOR CRANES OF CAPACITY 75 TON OR MORE FOR PERIOD 01-09-2021 TO 31-08-2023

Dt : 31/08/2021

SL NO.	ITEM DESCRIPTION	Rates (Rs./MONTH) valid from 01/09/2021 to 31/8/2023
I.	CRANES : -	
1	Portal Gantry Crane 500T	1243192
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	631183
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	2717358
4	PORTAL CRANE, 360T	679333
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	2676917
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	3311783
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	1617475
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	1010917
9	MANITOWOC M-250T TRUCK CRANE	1455725
10	270 MT Class Crawler Crane- Manitowoc Model 2250	1528508
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	1273758
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	1754150
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	730283
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	915892
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	808733
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	1051358
15	CRAWLER CRANE SUMITOMO, 150T	525675
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	646983
17	CRAWLER CRANE, 120 T Fushun Model QUY120	601125
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	517592
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	428625
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	485242
20	CRAWLER CRANE 100 T (KH 500)	485242
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	300558
22	ROUGH TERRAIN CRANE 75T (RT880)	321758
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	281533

ANNEXURE-T I
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELCTRIC WINCH 5T	1270
6	ELCTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500

ANNEXURE-T I
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1160
22	Air Blower (Flow: 20000 m^3/Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910

ANNEXURE-T I
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGONISTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	430

ANNEXURE-T I
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360
96	Plasma Cutting Machine (With complete accessories)	310
97	JCB make DG Set 80 KVA	670
98	Diesel Generating Set 82.5 KVA	610
99	Portable Jacking Oil Pump	1080
100	Alloy Analyser	1770

ANNEXURE-T II
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELCTRIC WINCH 5T	1410
6	ELCTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010

ANNEXURE-T II
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1290
22	Air Blower (Flow: 20000 m^3/Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220

ANNEXURE-T II
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGONISTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast - 9 metres (4X400 W)	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	510
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500

ANNEXURE-T II
DT: 31/08/2021

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

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400
96	Plasma Cutting Machine (With complete accessories)	340
97	JCB make DG Set 80 KVA	740
98	Diesel Generating Set 82.5 KVA	680
99	Portable Jacking Oil Pump	1200
100	Alloy Analyser	1970