ANNEXURE- 'A'

BOQ for the Work of "Design, Supply and Expert Supervision for installation works of Borosilicate Glass Block Lining including Wet Stack Flow Model Study for 150 mtrs. tall twin flue chimney at 2X490 MW Dadri Thermal Power Plant at Dadri, Gautam Buddha Nagar, U.P."

Project : 2X490 MW, NTPC, NCTPP, Dadri, Post - Vidyut Nagar, Distt.-Gautam Budh Nagar, Uttar Pradesh-201008

ANNEXURE-A

BOQ for the Work of "Design, Supply and Expert Supervision for installation works of Borosilicate Glass Block Lining including Wet Stack Flow Model Study for 150 m tall twin flue chimney at 2X490 MW Dadri Thermal Power Plant at Dadri, Gautam Buddha Nagar, U.P."

SL No.	Description of Item	Unit	Quantity	Rate (USD)	Rate (INR)	Total Amount in (USD)	Total Amount in (INR)	Remarks (If Any)
1	Supplying borosilicate glass blocks of minimum 38 mm thickness, conforming to physical & chemical properties mentioned in specification, offering chemical resistance to most acids, solvents & weak bases, should have proven resistant to thermal shock and also withstand occasional excursion of the flue gas temperature of more than 200 degree celcius. Contractor shall get thickness & size of borosilicate glass blocks approved by BHEL/NTPC before installation.Area of blocks for payment shall be calculated by multiplying the height of MS flue over which blocks are installed with inner perimeter of MS flue over that height. **Supply of required adhesives / membrance and primer for installation of Borosilicate Glass Blocks shall also be in the scope of vendor.** Nominal adhesive/ mebrane thickness shall be minimum 3 mm behind & between each block. A 1.5 mm thick layer should be troweled onto the liner as well as to the sides and back of each block before installation. The supplier shall also provide a ten (10) year full replacement guarantee and bear the cost of replacement if the lining system would fail to protect the chimney flue from internal deterioration, as per specifications.	SQM	5628					1. For Foreign Bidder: Rate up to CIF Mumbai. 2. For Indigenous Bidder: Rate up to NCTPP, Dadri site.
2	Expert supervision by borosilicate glass manufacturer during installation of borosilicate glass blocks, mixing of two components adhesive membrane by automated mixing machines etc. all complete.	MAN-DAYS	80					
3	**Wet Stack Flow Model Study :**			Rate / Unit (USD)	Rate / Unit (INR)	Total Amount in (USD)	Total Amount in (INR)	
3 (a)	Condensate Calculation							
3 (b)	Design of Condensate collection system							
3 (c)	Physical Wet Stack Model Study							
3 (d)	Design of Optimum Choke Geometry, if required							
3 (e)	CFD Plume Downwash Study							
3 (f)	Site Inspection and Supervision for 7 days							
3 (a) to 3 (f)	**Total**							
	Grand Total							

ANNEXURE- 'B'

"SPEC. NO.: PE-TS-436-142-N102"
(TECHNICAL SPECIFICATION FOR WET STACK FLOW MODEL STUDY FOR 2 x 490 MW NTPC-DADRI PROJECT)

CONTENTS

1.00.00 INTENT OF SPECIFICATION:

The intent of this enquiry/ specification is to carry out the Wet stack flow model study of 2x490 MW NTPC Dadri-FGD project for complete duct system from absorber outlet to the top of the stack, design and optimization of gas flow and liquid collection system to mitigate stack liquid discharge (SLD) and shell corrosion, Preparation of final report and recommendations, preparation of drawings/ documents for execution of collection system, obtaining approval on documents from BHEL/ Customer/ customer's consultant, Preparation of BOQ, preparation of bought out item specification, procurement assistance for specialized items, site visit as specified later in the specification & as necessary for completeness in all respects and for efficient & trouble free operation of chimney and liquid collection system for project.

Wet stack model study shall consist of the following:

- Condensation calculations & design of condensate collection system
- A scale physical flow model for liquid collector system (LCS) design.
- A computational flow model for plume downwash analysis.
- A physical or computational flow model for CEMS elevation flow performance.
- Design of optimum choke geometry if required.
- Review & Approval of liquid collector system construction drawings.
- Site inspection & supervision for 7 days to verify and evaluate LCS system performance prior to commissioning.

Wet stack study shall be performed for each unit with a wet stack installation where there does not exist an identical or mirror image installation. The objective of the wet stack study shall be to maximize liquid collection downstream of the mist eliminators and to preclude ground level rainout from the stack by recommending experimentally developed, tested, and optimized liquid collection devices and drainage systems to return collected liquid to the absorber with minimum re-entrainment.

The following codes and standard shall be followed for the conductance of this study:

- Revised wet stack design guidelines, 2012 by EPRI
- ACI 307 (American concrete institute code requirement for RC chimney
- EPRI report CS-2520 Entrainment in wet stack 1982
- EPRI report TR 107099 Wet stack deign guide 1996
- EPRI report TR-109380 guidelines for fluid dynamic design of power plant ducts, 1998
- EPRI report GS-6984 FGD mist eliminator system design and specification guide
- CICIND, ICAC, US EPA and other international and other latest codes and standards.

The study shall be carried out by design methods and tools:

- Preliminary design review based on experience
- Laboratory flow modeling -3-D
- Computer flow modelling -3-D
- Computer program calculations – 2-D

2.01.01 Preliminary design review based on experience

Based on the inputs furnished as per enclosed Annexure with this specification for the duct work and stack, preliminary design review need to be carried out to estimate the liquid collection requirements, predict the condensation rate in the duct & stack and perform the preliminary system design.

2.01.02 Condensation calculations using analytical / numerical tools

Gas flow study should include the calculation for the condensate formed and / or condensate carry over. The condensate flow study should include condensate quantity formed due to:

i) Thermal condensation on the liners
ii) Adiabatic condensation
iii) Turbulence of flue gas flow near entry of the stack
iv) At the outlet duct from absorber mist eliminator outlet
v) Contribution from mist eliminator carryover in case of normal wash cycle or mist eliminator become fouled with time.

Detailed calculations along with the design basis for condensation rate in the duct from absorber outlet to the top of the chimney for the worst operating case, minimum boiler load and design conditions shall be furnished as a function of ambient air temperature, wind velocity and liner design variables in the report with an accuracy of ±10%.

2.01.03 Design of Condensate collection & drainage system

(i) Size of gutter(s) along with inner surface of Chimney flue can and inlet duct from absorber outlet to inlet of chimney flue can, such that condensate is collected efficiently and drained off with a drainage system till its terminal point at ground outside the duct & Chimney shell.

(ii) As the gutter shall be made of Titanium/C-276 as compatible with inner surface, suitable shape, size and thickness is to be recommended so that gas flow occurs efficiently.

(iii) The size, thickness, location and material of condensate drainage pipe shall be included in recommendation. It is envisaged that pipe from gutter to outside of Chimney liner shall be of Titanium/C-276 and thereafter the drainage pipe shall be of FRP up to the collection pit. Routing of the drain pipes shall be provided.

After the flow-model study is performed, accordingly design of liquid-collection devices for the full scale Wet Stack is to be carried out and detailed drawings, design basis and calculations shall be submitted.

2.01.04 Computational 3-D fluid-dynamic-model study (CFD Analysis)

Performance of a computational 3-D fluid-dynamic-model study of the minimum upper one third of the stack liner and shell to evaluate downwash of the wet plume. CFD model shall include the surrounding structure which are significant to wind/ plume flow patterns preferably minishell, external handrails and floor at the stack outlet.

A computational model of the stack shell and liner(s) shall be constructed for the plume downwash study. The plume downwash study shall include analysis of the local wind/temperature data to identify the occurrence of critical wind and temperature conditions. The plume downwash study shall identify the stack velocity and ambient wind conditions that produce downwash and the maximum extent of expected downwash throughout the year for shell corrosion protection. For sites where ambient temperatures reach freezing, a "winter" period shall be simulated to evaluate icing potential on the stack.

Depending on the results of the downwash study, there may be a need to develop an optimum choke geometry, if required, to minimize the plume downwash & liquid impingement of the shell. This includes evaluation of liquid collectors and drains to prevent re-entrainment and discharge of large droplets from the top of the choke.

Bidder to use the latest software for the CFD modelling and shall submit the model along with results in form of contours and vector plots of velocity, pressure, concentration and temperature at various test locations and summarized in tabular format. The model shall be tested with various simulated operating, minimum and design flow conditions, maximum wind speed, wind orientations, to evaluate the potential of the downwash.

The Bidder shall review Minishell details (Liner extension above roof) enclosed as an Annexure and confirm the liner-extension design with their recommendation.

In case of the excessive downwash or reversed flow at stack exit or liquid exiting the stack liner and forming on the top of the concrete shell, bidder to provide the corrective actions, design modifications and evaluate the modified geometry.

2.02.00 Physical model of the system

An experimental gas-flow-model study to design and develop collectors for the duct and stack downstream of the mist eliminator that will collect and drain liquid from the walls to prevent re-entrainment.

Laboratory Physical model study shall include the following details for wet stack design:

i. Estimation of the total liquid load on the liner surface as a result of thermal and adiabatic condensation. This estimate shall be based on the liner and shell geometry, thickness, materials of construction and the flue gas–flow rate and properties over a range of expected plant-operating conditions and worst-case ambient weather conditions considering the mist eliminator fouling / wash cycles.

ii. Design and optimization of liquid collectors in the absorber-outlet hood, absorber-outlet ducts, stack-liner entrance region and stack liner outlet to prevent SLD. The collectors will collect liquid from surfaces, re-entrainment, and guide the liquid to locations where it can be drained out of the system. This development work shall be conducted on a scale model of the wet duct and stack system, from the outlet of each absorber's mist eliminator to four diameters of stack-liner above the top of the breech or inlet duct. Model scales shall be minimum 1:12 and to be selected to ensure accurate modeling results for all tested parameters. The same shall be finalized after the award of the contract. The design should be of integrated complete system of liquid collectors from absorber outlet to chimney top for each unit.

iii. The laboratory test includes details of liquid re-entrainment and drainage behavior over the expected range of unit operating conditions and confirm the stack-liner design velocity.

iv. Physical model shall include any internal devices larger than 3 inches in diameter/protrusion that may affect the flow, such as structural members, internal dampers, flow controls, and expansion joints. The model shall be mainly constructed from transparent acrylic or plastic, sheet metal, or coated rigid tubing such that it is suitable for wet testing. Modeled flow control and liquid collection devices may be constructed with sheet metal, or other suitable construction materials, so long as the scaled liquid flow performance is not adversely modified.

v. The physical model shall be tested for pressure and velocity profiles at selected cross sections through the ducts and liner. A velocity traverse shall be conducted within the modeled liner to ensure that the cyclonic flow levels are within the U.S. EPA Method 1 recommended limitations for CEMS operation. In the event testing indicates that cyclonic flow could be a concern at the continuous emissions monitoring system (CEMS) elevation, a simulation, either by extension to the physical model or using a computational fluid dynamic model, shall be performed to evaluate this flow at the CEMS level. If needed, corrective devices shall be designed and tested to reduce stack swirl at the CEMS elevation.

vi. The physical model shall be tested by introducing liquid in a size and quantity such that the model shall approximately match the two-phase flow modeling requirements for droplet trajectory and loading. This testing shall be used to locate and design the liquid collection devices and drains.

vii. Evaluation of re-entrainment at liner-expansion joints in the laboratory test rig and development of a unit-specific liquid-collector geometry to collect and drain the liquid from the liner-expansion joints.

viii. Using this model effective internal liquid collection devices shall be developed and optimized to improve the droplet deposition and liquid collection in the stack as well as to prevent the re-entrainment of droplets from liquid pools and films.

ix. Bidder shall submit the detailed standard procedure for carrying out the physical model study at vendor lab for customer information / approval before the conductance of physical model study at lab.

Site inspection & supervision

Bidder to perform an onsite inspection as per the EPRI Revised Wet Stack Design Guideline, 2012. Site visit should occur for 7 days time during the construction phase, when liquid collection system is nearing completion, to inspect the liquid collection system as installed to ensure that the designed flow controls, liquid collectors, drains, and drain protection are installed properly and shall perform as intended. Bidder to provide the site inspection report to validate the design and installation.

The onsite inspection should confirm that the liquid-collection system has been fabricated and installed correctly and to identify any deviations to the recommended design as a result of field modifications made to ease installation. The bidder shall also ensure the liquid collection system is installed properly.

The key deliverables from this study are:

a) Bidder to furnish the total quantity of condensate formed from absorber mist eliminator outlet to top of the stack.
b) Bidder to furnish the number, sizing and location of required various liquid collectors/ gutters, their shape, design of its evacuation piping from inside the chimney to outside and their Influence on the flow in the chimney liner.
c) Flow model study shall minimize system pressure losses and optimize collection and drainage and provide expected field wet stack system pressure loss across expected load range.
d) Bidder to achieve minimum stack liquid discharge. In case of excessive stack liquid discharge, possible means of modification to duct and stack geometry need to be proposed by bidder for improvement.
e) Bidder to ensure the design of effective liquid collection system for various plant load operating conditions and absorber combinations.
f) Bidder to furnish the comparison of the experimental and computer modelling.
g) Bidder to recommend modifications to prevent the chimney liquid discharge issues and to make the geometry more favorable for liquid collection.
h) Bidder to furnish the fabrication/installation drawings after the completion of model study for fabrication.
i) Bidder to identify appropriate liner system and gas inlet geometries (including flow control devices) to ensure homogeneous gas flow conditions and achieve cyclonic free flow distribution at the CEMS location.
j) Bidder to provide recommendations and design for sealing drain piping/ seal pots to inhibit backflow.

k) Bidder to recommend drain protection devices to minimize pluggage occurrences an flow and recommend method for monitoring liquid collection drainage flow in case of liquid collection system pluggage and SLD problems.

l) Bidder to provide stack outlet modifications, such as liner extensions or chokes, to minimize stack icing occurrences and to provide Stack shell coating requirements to protect concrete shells from corrosion due to plume downwash.

m) Bidder to evaluate the plume downwash and recommend modifications to minimize downwash using CFD model preferably at reduced unit load operation and high wind speed conditions.

n) Bidder to provide the drawings/documents for the necessary provisions in Chimney during the course of this study, if applicable, to carry out the performance test for wet stack at site in future.

Customer Specific Technical Requirements

2.00.00 **Chimney**

2.01.00 A "wet Chimney" shall be installed downstream of Wet Flue Gas Desulfurization (FGD) system by the Contractor. Clean gas from the absorber shall be taken to the Chimney through the mist eliminators. Treated flue gas from the absorber shall be discharged through a wet stack without reheating of the flue gas.

The wet stack shall be designed as per the guidelines of EPRI Revised Wet Stack Design Guide.

SN	Item	Design Condition
1	Boiler Load in MW (e)	VWO
2	Gas flow (M^3/sec)	Design Point
3	Gas temperature at Chimney inlet (deg. C)	To be worked out considering Design Point conditions
4	Flue Gas velocity (m/s)	< 18 at Design Point

2.02.00 A wet stack study shall be performed by the Contractor for each unit with a wet stack installation where there does not exist an identical or mirror image installation that has already had a wet stack study performed. A wet stack model study shall consist of the following:

(i) Condensation calculations

(ii) Minimum 1:12 scale physical flow model for liquid collector design

(iii) Computational flow model for plume downwash analysis

(iv) Physical or computational flow model for CEMS elevation flow performance

2.03.00 Liquid collectors shall be designed and developed experimentally using a physical model. The model shall begin at the outlet of the absorber mist eliminator(s), include the absorber outlet and ducting, the stack breaching duct and a minimum of three (3) diameters of the stack liner above the top of the stack breaching duct. Physical model shall include any internal devices that may affect the gas flow, such as structural members, flow controls, and expansion joints. Liquid collectors shall be located where needed in the absorber outlet, the ductwork between the absorber outlet and the chimney liner, in the chimney liner, and in the exit nozzle. These collectors shall collect liquid from surfaces, prevent re-entrainment, and guide the liquid to locations where it can be drained out of the system and prevent the discharge of droplets from the top of the stack that are large enough to rain out to the ground before evaporation.

3.02.05	In addition to the base offer as described above, the bidder may also submit an alternate offer for a different material / lining of duct from Absorber outlet to stack, if the bidder has previous experience of the same. The bidder should have supplied a similar design of duct in previous installations for similar application. Bidder shall indicate the applicable price implication for such an alternate offer in the relevant Bid Proposal sheet. The Bidder shall also furnish details of the previous installations of such system and bring out all the technical features of the system proposed. Bidder to note that application of lining material in the ducts shall be carried out under the supervision of designer/manufacturer. Bidder to note that application of lining material in the duct shall be carried out under supervision of Designer/Manufacturer.
3.02.06	Wherever required, expansion joints of proven design shall be provided in the ducts to take care of differential expansion in the system. The material chosen for expansion joints shall be suitable for the duty conditions and the corrosive atmosphere of the FGD system and shall be field proven for similar applications. The expansion joints shall be guaranteed for faultless material and workmanship, for a minimum guaranteed life of not less than 20000 hrs. of operation. During Guarantee period any defects noticed in the expansion-joints due to faulty material and workmanship shall be rectified by the Contractor free of cost.
3.02.07	The stack shall be designed as per the latest guidelines of EPRI Wet Stack Design Guide. The design of wet ducts and stacks system shall consider the Stack liquid discharge (SLD), Corrosion/chemical attack, Condensate collection system and its drainage etc. The Wet stack of proven design shall be provided either a separate chimney or chimney above absorber arrangement. The chimney shall be of 8 mm thick (minimum) Mild steel flue liner with lining of ~~Flake Glass or~~ Borosilicate brick lining ~~or cladding shall be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy.~~ Cladding shall be done to achieve the required quality as per ASTM B 898-11. External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium / C-276 sheet over insulation. ~~The height of wet stack shall be 115 meter incase separate single shell with single flue liner or chimney above absorber is provided, incase bidder offers~~ single shell with twin flue the height of chimney shall be 150 meter.
3.03.00	
3.03.01	

2.05.00 GENERAL

a) Bidder to furnish the detailed Master drawing list for wet stack flow model study for BHEL and customer approval.

b) Bidder to provide technical advice/ recommendations/ assistance & solutions regarding site related construction problems related to condensate collection and drainage system in the duct and chimney as and when required including site visits, participation in meetings through VC/WEB with BHEL/ customer/ customer's consultant.

c) The physical model study may be witnessed by BHEL / Plant Owner for approximately 3 days. Intimation for the witnessing shall be provided by the bidder 4 weeks prior to conductance of physical model test at vendor lab. Video streaming facility shall also be provided for witnessing the physical model test from India. In addition, complete physical model test including the flow patterns and droplets trajectory shall be recorded on video CD which shall be provided after the physical model study.

d) The physical model shall be stored at the vendor lab at no cost for a period of 1 year after the submission of final report and completion of the study. Thereafter its further disposal or storage shall be decided after the award of the contract on the cost basis. Optional prices may be quoted for the same and this shall not be considered for the evaluation of bid.

e) The bidder is advised to take care all information that may be necessary for preparing the bid and entering into the contract. Claims of any kind due to variation or ignorance of site conditions and environmental conditions after award of works will not be entertained.

f) All revisions/changes required as per BHEL/ Project owners, comments/ requirements, site requirement etc. shall be carried out by the bidder.

g) Three hard copies of approved reports/documents/drawings shall be submitted by the bidder. Electronic copies of the CFD model, analysis and report shall be submitted in primary original format as well as in printable non-proprietary formats (e.g. .pdf).

h) Change in recommendation / design after the analysis shall be taken care by bidder without any commercial implication in this contract value.

i) Bidder shall furnish detailed activity schedule, report generation schedule and list of inputs required for successful execution of Wet stack flow model study.

j) The Purchaser/ Customer however also reserve the rights to check the detailed calculations in the event of order and their interpretation shall be final in the event of any conflict.

k) Bidder shall furnish all the documents in English and SI units shall also be followed in the calculations and reports wherever used.

~~3.00.00 BID EVALUATION CRITERIA~~

~~Bidders should quote prices as per format (price schedule) enclosed in the tender document. Bids shall be evaluated based on the total price quoted for Wet stack flow model study work as per this specification.~~

~~4.00.00 DELIVERY SCHEDULE~~

~~Bidder has to carry out the complete activity including physical model, CFD, drawing /documents and final report approval by BHEL and plant owner within 15 weeks from the date of purchase order.~~

5.00.00 SUGGESTIVE DRAWINGS/ DOCUMENTS SUBMISSION:

Following Basic drawings/documents to be submitted within 2 weeks from LOI date.

1. MASTER DRAWING /DOCUMENT LIST. (to be finalized after order)
2. WET STACK STUDY SCHEDULE, PLANNING AND MILESTONES
3. LIST OF CODES AND STANDARDS TO BE FOLLOWED.
4. DETAILED STANDARD PROCEDURE FOR PHYSICAL MODEL & CFD STUDY, DRAWINGS & DOCUMENTS SUBMISSION.
5. DESIGN DRAWINGS OF CONDENSATE COLLECTION AND DRAINAGE SYSTEM
6. THERMAL AND ADIABATIC CONDENSATION CALULATIONS WITH DESIGN BASIS

Following Basic drawings/documents to be submitted and duly approved within 15 weeks from LOI date.

1. TECHNICAL DATASHEETS
2. BILL OF QUANTITIES
3. WET STACK STUDY REPORT WITH RECOMMENDATIONS
4. CFD MODEL, ANALYSIS AND RESULTS

This is not an exhaustive list of drawings/ documents for WET STACK STUDY.

Bidder shall furnish all applicable drawings /documents other than as mentioned above which is/are required for successful execution of condensate collection and drainage system after the absorber outlet to stack outlet.

NOTE:

1. Subsequent revisions of above drgs/docs to be submitted within 7 days of comments received from BHEL/ CUSTOMER.
2. Drawings submitted shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays to bidder's account.

~~6.00.0 OTHER TERMS OF CONTRACT~~

~~The contract will be awarded on Lump Sum Basis and no claims will be acceptable due to any reason whatsoever. The reports / design and drawings prepared by the bidder may be required to be revised / modified due to various reasons including site condition, engineering inputs, layout changes and CUSTOMER's requirement. The quoted rate shall be inclusive of additional effort to take care of such revisions.~~

7.00.00 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

a) Detailed procedure adopted for the conductance of the study.
b) Wet stack study planning and scheduling.
c) Computer program to be used for the 3D modelling and analysis.
d) Mathematical tools & codes / programs used for the analytical calculations.
e) Technical deviation schedule (if reqd.) (enclosed herein)

Apart from above no other drawings/documents/data sheets etc. are required to be submitted at bid stage and even if furnished shall not be taken cognizance of.

ANNEXURE-I : Project Information

CLAUSE NO.	PROJECT INFORMATION

NCTPP,DADRI STAGE-II (2X490MW)

1.00.00 BACKGROUND

Details of proposed Stage / Units

Project name	:	NATIONAL CAPITAL THERMAL POWER PROJECT(NCTPP)
Project stage	:	Stage-II
No. of Units x capacity	:	2 X 490 MW
Project setting up by	:	NTPC Ltd.

The SG with ESP package and TG package of the subject project was executed by M/s. BHEL.

1.01.00 LOCATION AND APPROACH

Project Location	:	(i)	Place	: Dadri
	:	(ii)	District	: Gautam Budh Nagar
	:	(iii)	State	: Uttar Pradesh
Latitude and Longitude of project location	:	North : 28 deg. 36' (N) East : 77 deg. 36' 25" (E)		
Nearest Railway station	:	Dadri		
Distance of project location from the Railway station	:	8.5 KM (Approx.)		
Nearest Major Town	:	Dadri		
Distance of the town from the Project site	:	6.75 KM		
Nearest Commercial Airport	:	Delhi		
Distance of airport from the project site	:	70 KM		
Nearest Highway	:	National Highway-3&24		
Vicinity plan	:	Vicinity plan of the project enclosed at Annexure-I.		

जलवायु सारणी
CLIMATOLOGICAL TABLE

स्टेशन : नई दिल्ली (सफदरजंग) अक्षांश दशांतर समुद्री तल माध्य से ऊंचाई मीटर
STATION: New Delhi (Safdarjang). LAT. 28° 35'N. LONG. 77° 12'E. HEIGHT ABOVE M. S. L. 216 METRES.

1931 से 1960 तक के प्रेक्षणों पर आधा
BASED ON OBSERVATIONS FROM 1931 TO 1

माह / MONTH	स्टेशन की सतह दाब / STATION LEVEL PRESSURE	वायु तापमान (—के) माध्य / AIR TEMPERATURE MEAN (OF)						चरम / EXTREMES				आर्द्रता / HUMIDITY		मेघ की मात्रा / CLOUD AMOUNT		वर्षा / RAINFALL						माध्य पवन गति / MEAN WIND SPEED
		शुष्क बल्ब / DRY BULB	नम बल्ब / WET BULB	दैनिक अधिकतम / DAILY MAX.	दैनिक न्यूनतम / DAILY MIN.	माह में उच्चतम / HIGHEST IN THE MONTH	माह में निम्नतम / LOWEST IN THE MONTH	उच्चतम / HIGHEST	दिनांक और वर्ष / DATE AND YEAR	निम्नतम / LOWEST	दिनांक और वर्ष / DATE AND YEAR	सापेक्ष आर्द्रता / RELATIVE HUMIDITY	वाष्प दाब / VAPOUR PRESSURE	समस्त मेघ / ALL CLOUDS	निम्न मेघ / LOW CLOUDS	मासिक योग / MONTHLY TOTAL	वर्षा के दिनों की संख्या / No. OF RAINY DAYS	वर्ष सहित सबसे नम महिने का योग / TOTAL IN WETTEST MONTH WITH YEAR	वर्ष सहित शुष्कतम महिने का योग / TOTAL IN DRIEST MONTH WITH YEAR	24 घंटों की सबसे भारी वर्षा / HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष / DATE AND YEAR	
	मि०बा० mb.	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C	डि.सें. °C		डि.सें. °C		प्रतिशत	मि०बा० mb.	आकाश के अष्ठमांश Oktas of sky		मि०मी० mm.		मि०मी० mm.	मि०मी० mm.	मि०मी० mm.		कि०मी० प्र० घ० Km.p.h.
जनवरी I	992·2	10·0	7·6	21·3	7·3	27·0	3·0	29·4	24 1946	—0·6	16 1935	72	8·8	3·0	0·9	24·9	1·6	173·2 1885	0	116·8	28 1885	8
JANUARY II	989·9	19·2	12·8									41	9·5	2·7	0·9							
फरवरी I	989·7	13·5	9·8	23·6	10·1	29·6	5·6	33·3	26 1934	1·7	11 1950	59	9·4	2·5	0·5	21·8	1·5	153·4 1915	0	104·1	21 1942	10
FEBRUARY II	987·3	23·5	14·1									28	8·7	2·6	0·6							
मार्च I	986·9	19·8	13·7	30·2	15·1	35·8	9·9	40·6	31 1945	4·4	6 1945	47	10·9	2·2	0·4	16·5	1·4	78·2 1915	0	62·2	11 1915	10
MARCH II	983·9	29·2	16·6									21	9·1	2·7	0·7							
अप्रैल I	983·2	27·0	17·0	36·2	21·0	41·2	14·3	45·6	29 1941	11·7	1940	32	11·4	1·5	0·3	6·8	0·8	105·2 1909	0	40·9	22 1909	10
APRIL II	979·7	35·2	18·9									16	9·1	2·3	0·7							
मई I	978·3	31·5	20·5	40·5	26·6	44·3	21·3	47·2	29 1944	18·3	11 1952	31	14·8	1·2	0·4	7·9	1·2	63·3 1885	0	30·5	10 1885	12
MAY II	974·6	39·3	22·0									18	12·2	1·8	1·1							
जून I	974·5	32·5	24·1	39·9	28·7	44·1	23·3	46·7	17 1945	18·9	23 1932	48	22·9	2·6	0·9	65·0	3·4	414·8 1936	0	235·5	28 1936	14
JUNE II	970·6	38·0	24·6									32	19·4	2·8	1·6							
जुलाई I	974·3	30·1	25·9	35·3	27·2	40·3	23·6	45·0	1 1931	21·7	6 1948	73	30·2	5·2	2·7	211·1	9·7	464·3 1949	4·1 1941	266·2	21 1958	10
JULY II	971·1	33·2	26·6									60	29·3	5·3	2·9							
अगस्त I	976·3	28·9	25·4	33·7	26·1	37·2	23·8	40·0	12 1945	22·2	7 1939	77	29·8	5·4	2·9	172·9	9·3	582·9 1908	0	181·6	6 1891	9
AUGUST II	973·3	31·7	26·4									65	29·7	5·5	3·0							
सितम्बर I	980·3	27·9	21·3	34·1	24·6	37·0	21·3	40·6	16 1938	17·8	30 1944	70	25·9	3·1	1·8	149·7	6·0	492·3 1900	0	176·5	16 1904	9
SEPTEMBER II	977·3	32·1	24·8									54	24·9	3·1	1·9							
अक्तूबर I	986·6	23·8	18·0	33·1	18·7	36·3	14·1	39·4	17 1951	9·4	31 1937	54	15·8	0·9	0·5	31·2	1·3	238·3 1954	0	172·7	1 1954	6
OCTOBER II	983·6	30·4	20·3									35	15·3	1·0	0·6							
नवम्बर I	990·5	16·6	11·1	28·7	11·8	32·4	7·8	35·0	5 1943	3·9	28 1938	48	8·9	0·8	0·1	1·2	0·1	31·2 1911	0	20·8	6 1925	6
NOVEMBER II	987·8	25·5	16·0									31	10·2	1·0	0·1							
दिसम्बर I	992·3	11·0	7·8	23·4	8·0	26·0	4·0	28·9	15 1959	1·1	26 1945	63	8·4	2·1	0·3	5·2	0·5	134·4 1884	0	53·3	15 1894	7
DECEMBER II	989·8	20·8	13·5									38	9·5	2·3	0·3							
वार्षिक योग माध्य I	983·8	22·7	16·9	31·7	18·8	44·9	2·7	47·2		—0·6		56	16·4	2·5	1·0	714·2	36·8	1533·1	262·9	266·2		
ANNUAL TOTAL OR MEAN II	980·7	29·8	19·7									37	15·6	2·8	1·2			1933	1929			
वर्षों की सं० I	30	23	23	23	23	23	23	30		30		23	23	30	20	30	30	80	80	80		
NUMBER OF YEARS II	23	23	23									23	23	23	20							

352 - 286 A

ANNEXURE-II : Flue gas process parameters

GENERAL DATA					
Project Name		NTPC-Dadri			
Boiler Application		Utility	**No. of Chimneys**		Single shell, twin flue
Boiler Capacity		490 MW	**Type of Chimney**		Twin flue with Borosilicate liner
No. of Boilers		Two (02)			
Fuels Fired		Coal	**Height of Chimney**		150 m
OPERATING CONDITIONS (Per Boiler)					
Boiler Load			**Design Point**		**Guarantee Point**
			VWO		**500 MW**
Type of Coal			**Worst Coal**		**Worst Coal**
Flue Gas Flow	:	**TPH**	2942.61		2715.662
Flue Gas Volume	:	**m^3 / s (wet)**	809.227		726.3639
Flue Gas Temperature	:	**°C**	61.3		57.2
Flue Gas Density	:	**kg /m^3**	1.01009		1.03853
FGD OUTLET-FLUE GAS COMPOSITION % BY VOLUME – (WET BASIS)					
CO_2	:	%	9.5122		9.9347
N_2	:	%	64.1764		67.0584
O_2	:	%	5.6741		5.9355
SO_2	:	%	0.0032		0.0033
H_2O	:	%	20.6339		17.0679

*DUST SIZE DISTRIBUTION AT CHIMNEY INLET - % MICRONS			
Below 3	94.3	Between 10 - 15	22.19
Between 3 - 5	45.79	Between 15 - 20	15.0
Between 5 - 10	28.8	> 20	10.69

OTHER DATA		
Elevation of Breeching Line of the Duct	32.70 m (Approx.)	
Duct Opening Size	5.3 (W)x10.2 (H) mxm	
Chimney Shell Opening Dimensions	6.3 (W)x11.2 (H) mxm	
Flue Gas Pressure at Chimney Entry Level	+20 mm WC	

REMARKS: NIL

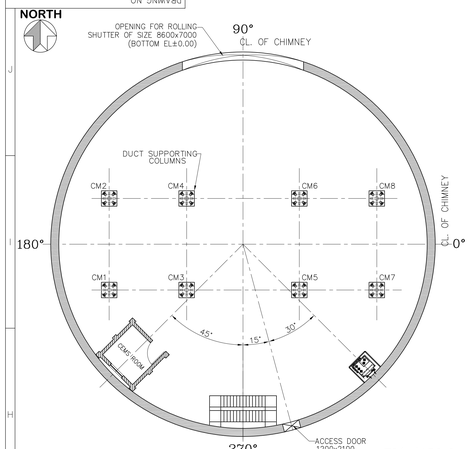
Customer / Plant: NTPC-Dadri

ANNEXURE-II : GA of Chimney

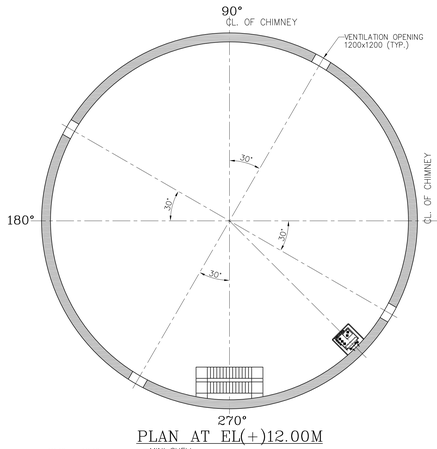
DRAWING NO. PE-DG-436-620-C001

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

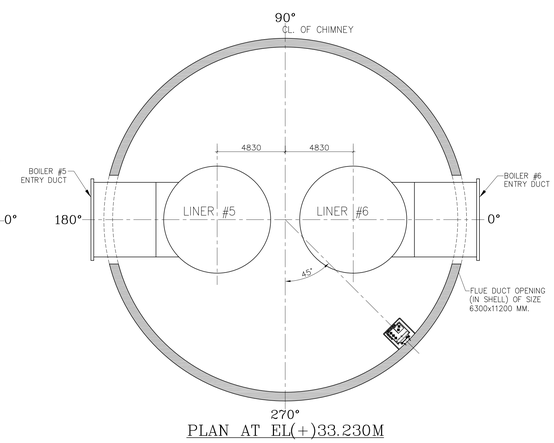
NORTH



PLAN AT EL(±)0.00M



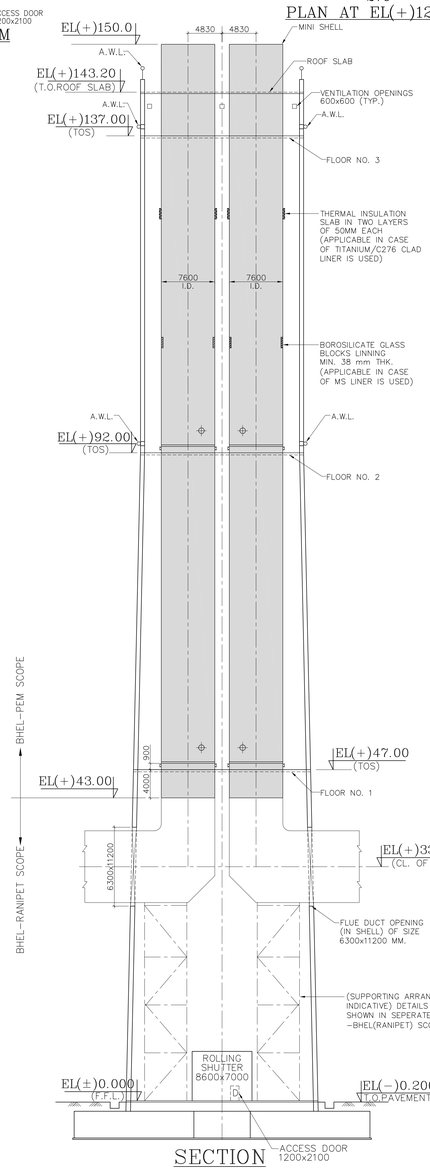
PLAN AT EL(+)12.00M



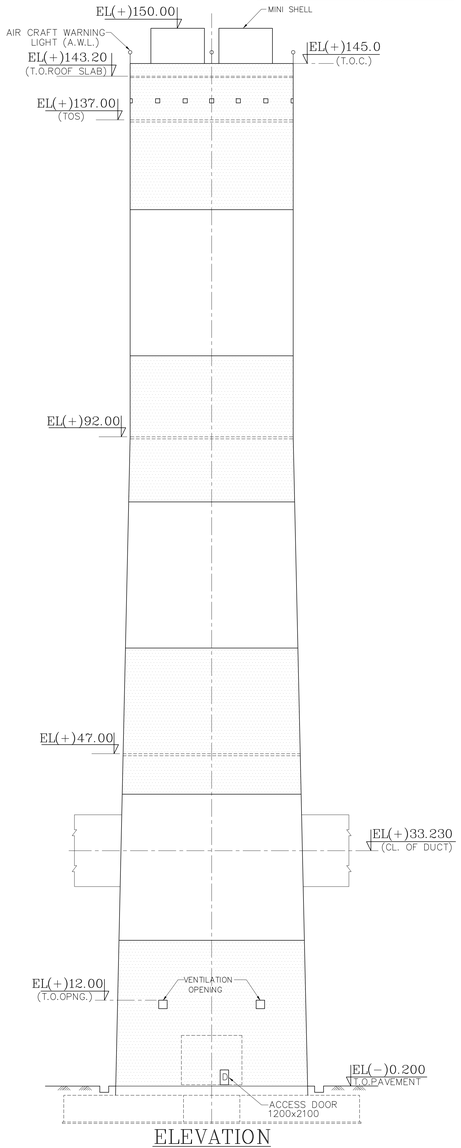
PLAN AT EL(+)33.230M

145.00	23150	575	CYLINDRICAL
145.00	23150	575	
137.00	23150	575	
128.00	23150	575	
119.00	23150	575	
110.00	23150	575	
101.00	23150	575	
92.00	23150	575	
83.00	23549	582	
74.00	23949	589	
65.00	24348	597	
56.00	24748	604	2075 91500
47.00	25147	611	
38.830	25510	618	
33.230	25759	622	UNIFORM LINEAR TAPER
27.630	26007	627	
20.000	26346	633	
12.000	26701	639	
7.000	26923	643	
+2.100	27140	647	
±0.000	27232	648	
−1.500	27300	650	

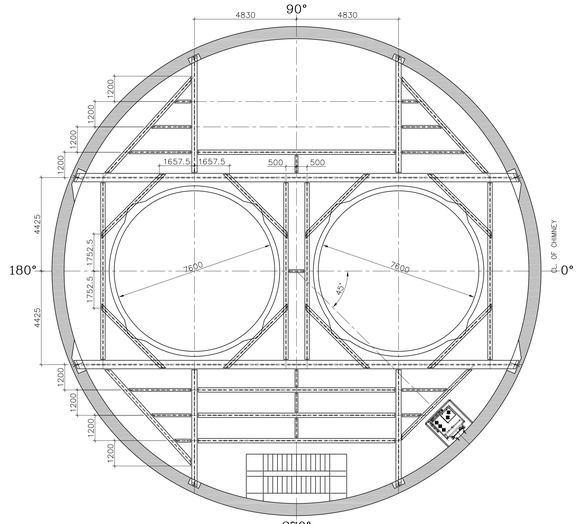
ELEVATION (M)	OUTSIDE DIAMETER OF SHELL (mm)	SHELL THK (mm)	OUTSIDE PROFILE OF SHELL (mm)



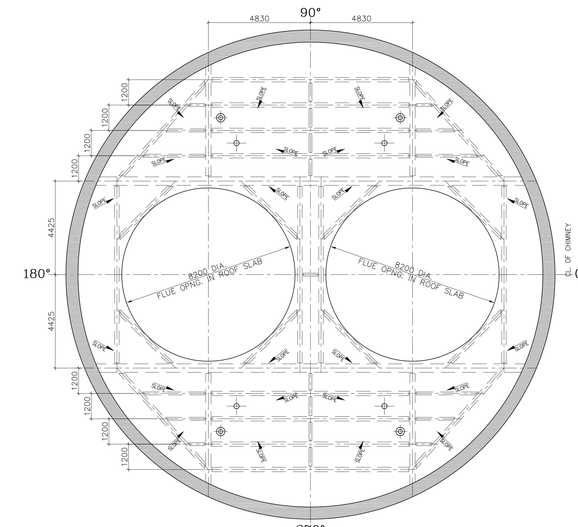
SECTION



ELEVATION



TYP. PLAN FOR PLATFORMS



PLAN AT ROOF SLAB
(T.O.C. = EL+143.200 M.)

TENDER PURPOSE ONLY

NOTES: −

1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
2. COMPLIANCE WITH STANDARDS SHALL RELATE TO LATEST PUBLISHED EDITIONS.
3. ALL ELEVATIONS ARE REFERRED TO THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING AS EL(±)0.00 M WHICH CORRESPONDS TO RL(+)209.75 M. ABOVE MEAN SEA LEVEL.
4. THE OTHER COMPONENTS OF THE CHIMNEY INCLUDE ROLL UP DOORS, PERSONNEL ACCESS DOORS, HAND RAILS, HOOD HATCH, LINER TEST PORTS, NON METALLIC EXPANSION JOINTS, RAIN WATER DRAINAGE SYSTEM, VENTILATION OPENINGS, ELECTRICAL POWER SUPPLY DISTRIBUTION BOARDS, LIGHTING PANELS, SOCKET OUTLETS, POWER AND CONTROL CABLING, RACEWAY SYSTEM, STAIR AND PLATFORM LIGHTING, LIGHTNING PROTECTION & GROUNDING SYSTEM, COMMUNICATIONS SYSTEM ETC. AND SHALL BE PROVIDED AS PER TECHNICAL SPECIFICATIONS.
5. FOR STANDARD NOTES & DETAILS FOR RCC WORKS REFER APPROVED DRG. NO. PE-DG-436-600-C001.
6. FOR STRUCTURAL DETAILS, WELDING, HANDRAILING ETC. REFER APPROVED DRG. NO. PE-DG-436-600-C002.
7. AIRCRAFT WARNING LIGHT (A.W.L.) SHALL BE PROVIDED TO MEET THE REQUIREMENT OF RELEVANT STANDARD STATUTORY BODY.

REV.	DATE	ALTD	CHD	APPD

JOB NO. 436

STATUS: CONTRACT

DISTRIBUTION

PRINT SCALE IN METRE 0 2 4 6 8 10 20 30 40 50

NTPC DRG. NO.

OWNER: NTPC

NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)

PROJECT
2x490 MW NTPC NCTPP, DADRI STAGE-II
(FGD PACKAGE)

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA (U.P.)

DEPT CODE C

	NAME	SIGN	DATE
DRN	SANJAY		23.02.2018
DESN	TABREZ		23.02.2018
CHD	MKP		23.02.2018
APPD	GPK		23.02.2018

TITLE
CHIMNEY
GENERAL ARRANGEMENT

MPL	ELEC	C&I	MSE	MAX

DEPT. SCALE 1:150

SIGN

DATE

DRAWING NO. PE-DG-436-620-C001

SHEET 1 OF 1 REV. 0

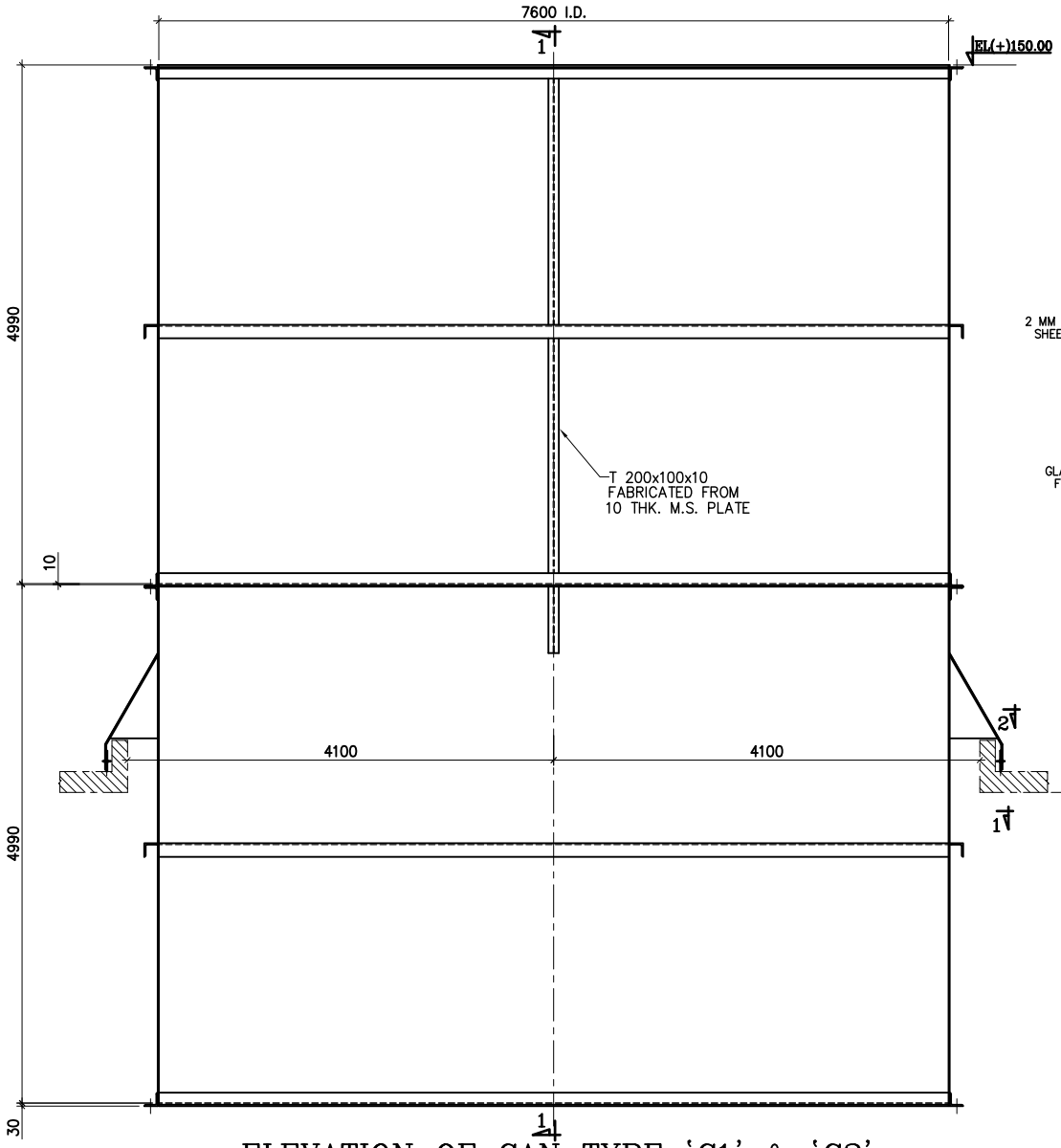
Feb 27, 2018 — 4:56pm

FORMAT SIZE A0

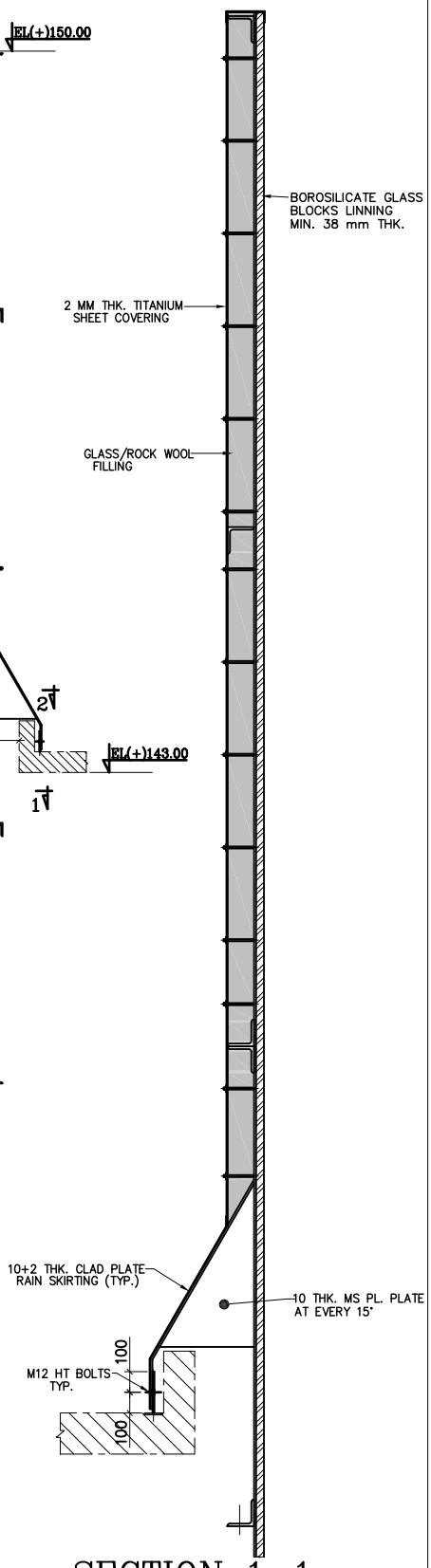
CAD FILE NAME: D:\PROJECTS\DADRI\436-620-C001 TENDER.dwg

COPY RIGHT AND CONFIDENTIAL
This drawing is the property of BHARAT HEAVY ELECTRICALS LIMITED
The information on this document is confidential and proprietary and shall not be used, published or disclosed directly or indirectly in any way detrimental to the interest of the company.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

ANNEXURE 2



ELEVATION OF CAN TYPE 'C1' & 'C2'



SECTION 1-1

Annexure-V : FGD Layout

DRAWING NO.

ASH SILOS-I

HYDROBI

N

REFER 6130-109-PVM-F-001
SH-2 OF 2 FOR KEY PLAN

LSSST-A
77.000 S
85.000 W

LSSST-B
95.000 S
85.000 W

118.000 S
120.000 W

℄ OF EXISTING ROAD 120.000 W

EXISTING RAILWAY LINE

170.065 S
160.850 W

OXIDATION BLOWER AREA

RC PUMP AREA

MAINTENANCE SPACE

ABSORBER AREA SUMP&PUMP

ABSORBER AREA SUMP&PUMP

ABSORBER (SINGLE TOWER)

ABSORBER INNER CORNER
180.465 S
184.150 W

AAT SUMP&MOTOR

AAT
229.404 S
64.682 W

Duct length from Absorber outlet to Chimney inlet = 105 m (approx)

℄ OF BUF-B 179.800 W

4000 X 4000

7250

12000

3500

BUF MAINTENANCE SPACE

BUF SUCTION 249.061

111.309 S
186.550 W

38500 (TYP)

5000

OXIDATION BLOWER AREA

RC PUMP AREA

MAINTENANCE SPACE

12000

4M WIDE ACCESS ROAD

℄ OF NEW WET STACK 85.15 S

℄ OF NEW WET STACK 196.517 W

℄ OF BUF-A 199.800 W

4000 X 4000

7250

3500

ABSORBER (SINGLE TOWER)

ABSORBER INNER CORNER
121.709 S
217.950 W

℄ OF BUF-B 205.500 W

5500 X 6000

7250

12000

3500

BUF MAINTENANCE SPACE

SUCTION 190.305

5500 X 12000

7200

21200 (TYP)

5500 X 6000

7250

℄ OF BUF-A 225.500 W

25250 (TYP)

Duct length from Absorber outlet to Chimney inlet = 50 m (approx)

Note : Layout is non-identical hence study to be carried for both the units.

ACW/DMCW P/H
(20M x 16M)

16000

12000

COMPRESSOR HOUSE

20000

233.072 S
230.800 W

254.559 S
230.800 W

30000

FGD CONTROL ROOM

20000

289.600 S
223.000 W

℄ OF EXISTING ROAD 240.000 W

℄ OF EXISTING DRY ASH PIPE TRESTLE 257.000 W

EXISTING PIPE TRESTLE

EXISTING PIPE TRESTLE

EXISTING CONVEYER

26628

26628

5500 X 12000 (TAP-OFF: NLET)

5500 X 12000 (TAP-OFF: NLET)

℄ OF EXISTING CHIMNEY 232.115 S

℄ OF EXISTING CHIMNEY 290.386 W

UNIT#5

UNIT#6

FROM ID FAN

FROM ID FAN

FROM ID FAN

FROM ID FAN

BYE-PASS DAMPER

BYE-PASS GATE

BYE-PASS DAMPER

BYE-PASS GATE

LEGEND:-

FGL	– FINISHED GROUND LEVEL
FFL	– FINISHED FLOOR LEVEL
BMB	– BALL MILL BUILDING
GDW	– GYPSUM DEWATERING BUILDING
FWT	– FILTER WATER TANK
LSSST	– LIMESTONE SLURRY STORAGE TANK (REAGENT TANK)
AAT	– AUXILIARY ABSORBENT TANK
BUF	– BOOST UP FAN
WWT	– WASTE WATER TANK
SHFT	– SECONDARY HYDRO CYCLONE FEED TANK
PWT	– PROCESS WATER TANK
CLWT	– CLARIFIED WATER TANK

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES
2. EL(±)0.000 IS THE GROUND FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)209.750
3. FGL (FINISHED GRADED LEVEL) OF ABSORBER, BUF & DUCTING AREA IS EL(-)0.500 AND RL(+)209.25 M
4. THE BUILDING AND EQUIPMENT SIZES SHOWN IN THIS DRAWING IS INDICATIVE ONLY AND WILL BE FINALIZED DURING DETAIL ENGINEERING

REF. DWGS

1. 6130-999-POC-F-001-REV 000 : NCTPP GENERAL LAYOUT PLAN
2. 6130-109-PVM-F-001-SH2 : FGD SYSTEM LAYOUT-SH2

FGD SYSTEM LAYOUT (PART-1)
(ABSORBER, BUF, DUCT AND CHIMNEY AREA)

REV.	DATE	ALTD.	CKD.	APPD.	REV.	DATE	ALTD.	CKD.	APPD.
--	--	---	---	---	--	---	---	---	---

CAUTION : THE DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LTD. AND IS NOT TO BE REPRODUCED OR DISCLOSED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED WITHOUT THE EXPRESSED WRITTEN PERMISSION OF BHEL

CUSTOMER NOS: G501 & G502

NTPC DRG NO: 6130-109-PVM-F-001

CUSTOMER: NTPC LIMITED.

PROJECT: NCTPP (2X490MW) DADRI STAGE-II

FGD SYSTEM PACKAGE

BHARAT HEAVY ELECTRICALS LIMITED.
UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.

DEPT CODE		NAME	SIGN	DATE
M	DRN	TA	-sd-	15.02.18
	CHD	SKD/KBP	-sd-	15.02.18
	APPD	RL	-sd-	15.02.18

TITLE: PLANT LAYOUT OF FGD SYSTEM SH-1 OF 2

SCALE : NTS

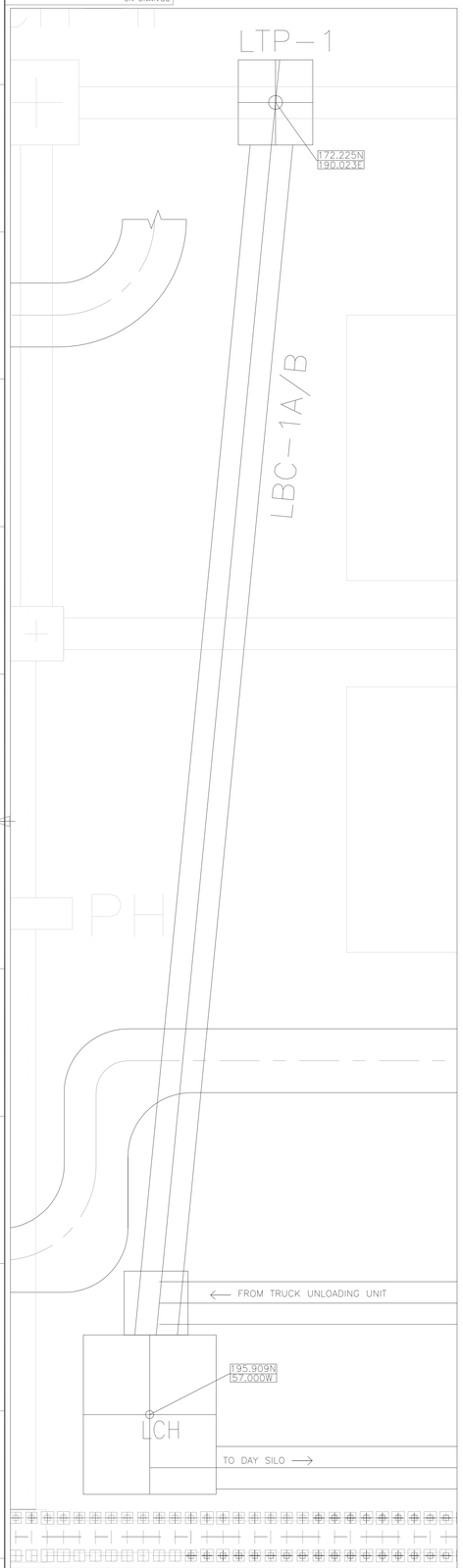
DRAWING NO. 0-FW-000-00143

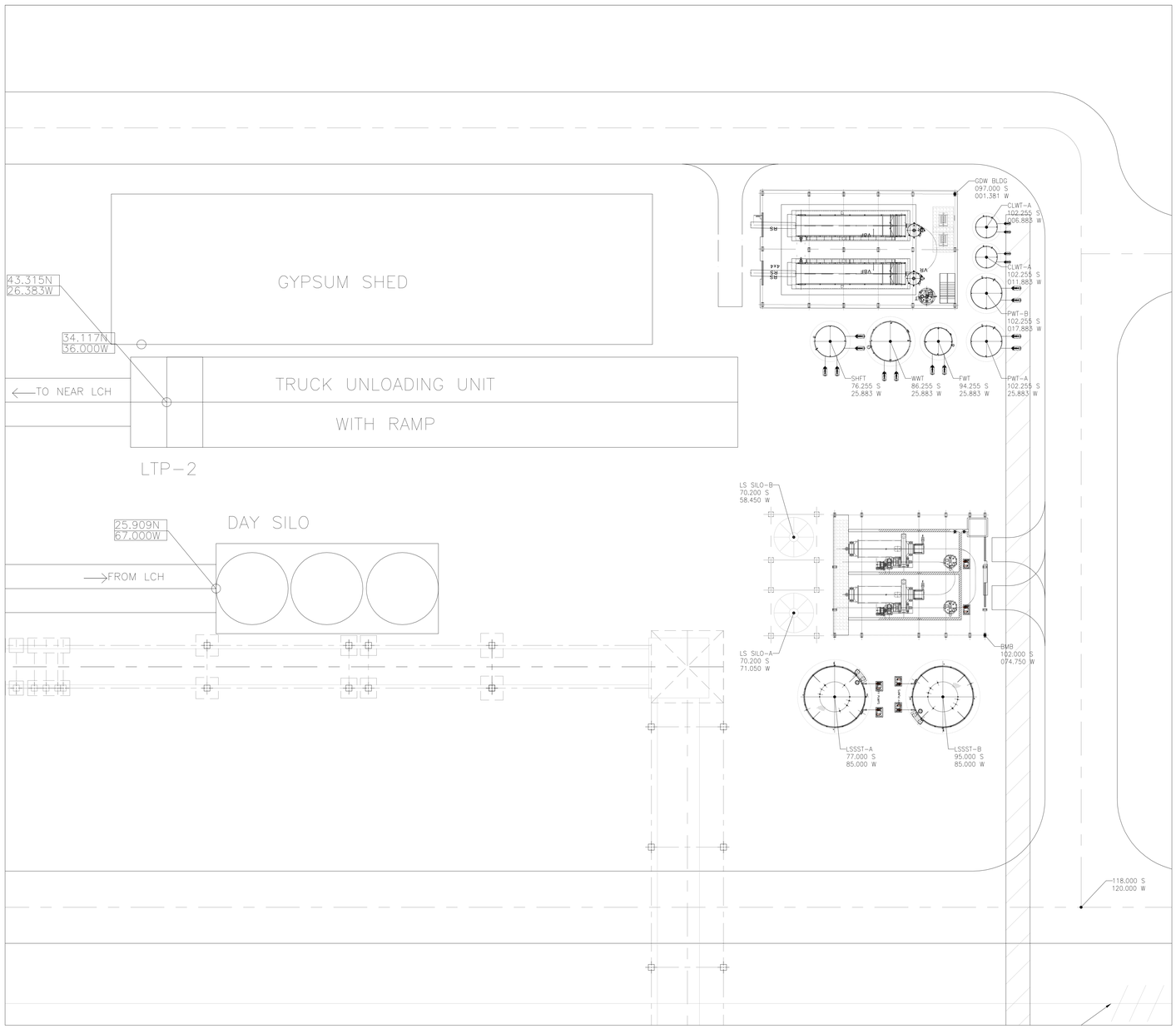
SH 01 OF 02

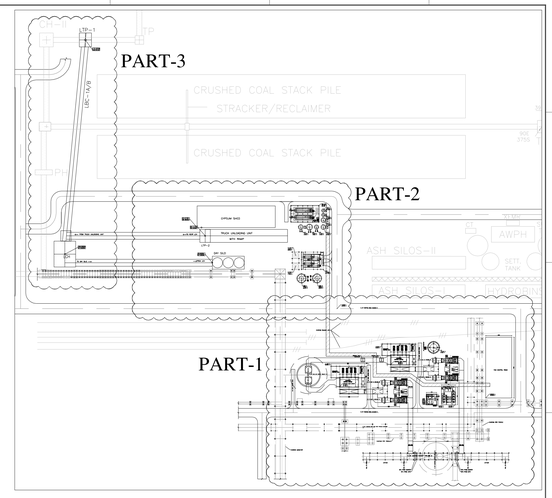
REV. 00

Size A0

DRAWING NO.







KEY PLAN

LEGEND:-

FGL	–	FINISHED GROUND LEVEL
FFL	–	FINISHED FLOOR LEVEL
BMB	–	BALL MILL BUILDING
GDW	–	GYPSUM DEWATERING BUILDING
FWT	–	FILTER WATER TANK
LSSST	–	LIMESTONE SLURRY STORAGE TANK (REAGENT TANK)
AAT	–	AUXILIARY ABSORBENT TANK
BUF	–	BOOST UP FAN
WWT	–	WASTE WATER TANK
SHFT	–	SECONDARY HYDRO CYCLONE FEED TANK
PWT	–	PROCESS WATER TANK
CLWT	–	CLARIFIED WATER TANK

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES
2. EL(±)0.000 IS THE GROUND FLOOR LEVEL OF POWER HOUSE BUILDING WHICH CORRESPONDS TO RL(+)209.750
3. FGL (FINISHED GRADED LEVEL) OF ABSORBER, BUF & DUCTING AREA IS EL(–)0.500 AND RL(+)209.25 M
4. THE BUILDING AND EQUIPMENT SIZES SHOWN IN THIS DRAWING IS INDICATIVE ONLY AND WILL BE FINALIZED DURING DETAIL ENGINEERING

REF. DWGS

1. 6130-999-POC-F-001-REV 000 : NCTPP GENERAL LAYOUT PLAN
2. 6130-109-PVM-F-001-SH21 : FGD SYSTEM LAYOUT-SH1

FGD SYSTEM LAYOUT (PART-3)
(LCH AREA AND CONVEYER LAYOUT)

FGD SYSTEM LAYOUT (PART-2)
(BALL MILL AREA, GDW AREA, TRUCK UNLOADER AREA AND SILO AREA)

REV.	DATE	ALTD.	CKD.	APPD.	REV.	DATE	ALTD.	CKD.	APPD.
--	--	---	---	---	--	---	---	---	---

CUSTOMER NOS: G501 & G502

NTPC DRG NO: 6130-109-PVM-F-001

CUSTOMER: NTPC LIMITED.

PROJECT: NCTPP (2X490MW) DADRI STAGE-II

FGD SYSTEM PACKAGE

BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.

DEPT CODE		NAME	SIGN	DATE
M	DRN	FA	–sd–	15.02.18
	CHD	SKD/KBP	–sd–	15.02.18
	APPD	RL	–sd–	15.02.18

TITLE: PLANT LAYOUT OF FGD SYSTEM SH-2 OF 2

SCALE : NTS

DRAWING NO. 0-FW-000-00143

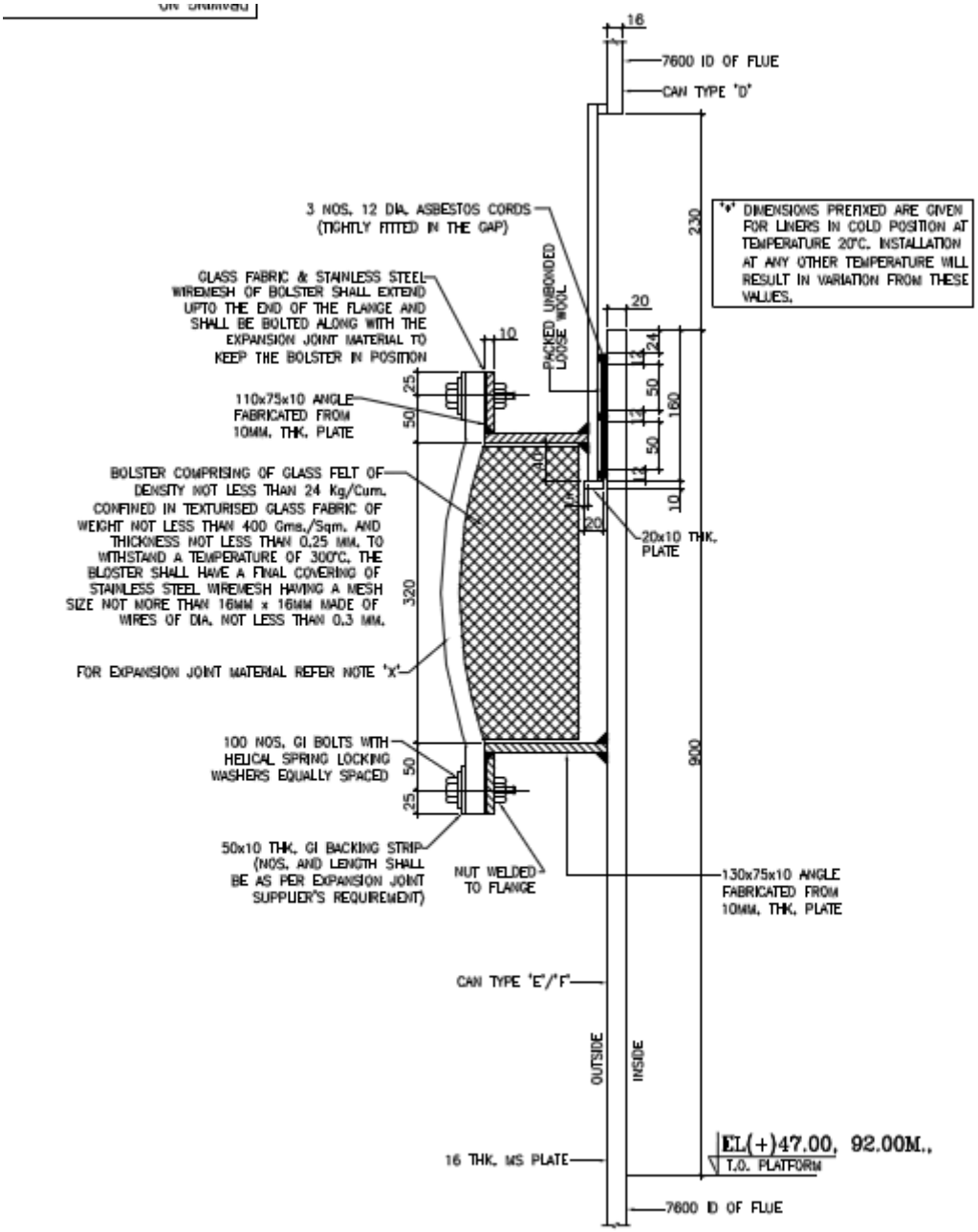
SH 02 OF 02

REV. 00

Size A0

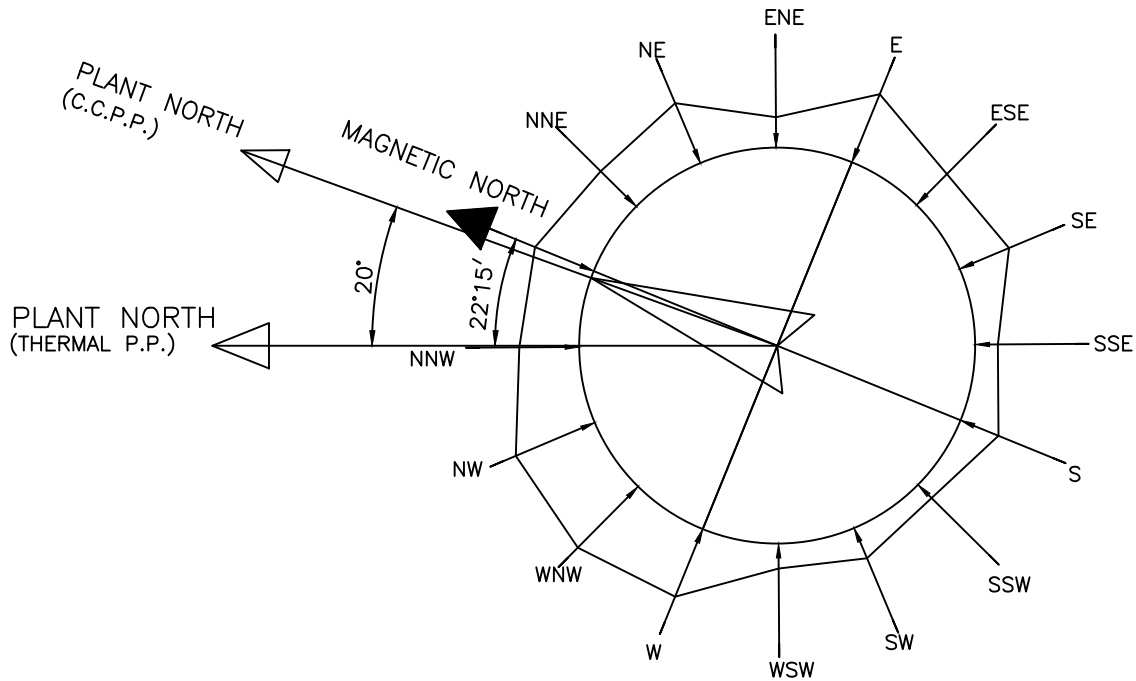
CAUTION: THIS DRAWING IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LTD. AND IS NOT TO BE REPRODUCED OR COPIED OR USED FOR ANY PURPOSE EXCEPT WITH THE WRITTEN PERMISSION OF BHARAT HEAVY ELECTRICALS LTD.

Annexure-VI: Expansion Joint



EXPANSION JOINT DETAILS

Annexure-VII: Wind Rose Diagram



WIND ROSE