1 X 800 MW NTPC SIPAT STPP Stage-III

TECHNICAL SPECIFICATION
FOR
INDUCED DRAFT COOLING TOWER

BOOK 1 OF 2

(MECHANICAL, ELECTRICAL AND C&I SPECIFICATION)

SPECIFICATION No. PE-TS-520-165-W001
REV NO. 00

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA

INDEX

PROJECT INFORMATION

SL.NO	DESCRIPTION	DETAILS
1	**METEOROLOGICAL DATA**	
1.1	MAXIMUM TEMPERATURE	48.0 Deg C
1.2	MINIMUM TEMPERATURE	6.0 Deg C
1.3	MAXIMUM RELATIVE HUMIDITY	88%
1.4	MINIMUM RELATIVE HUMIDITY	19%
1.5	AVERAGE ANNUAL RAINFALL	1354.1
2	**ELECTRICAL DATA**	
2.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
2.2	RELATIVE HUMIDITY FOR DESIGN OF ELECTRICAL EQUIPMENT	95%
2.3	RATED FREQUENCY	50 Hz
2.4	FREQUENCY VARIATION	(+)3% to (-)5%
2.5	AC VOLTAGE	415V, 3 Phase
2.6	AC VOLTAGE VARIATION	+/-10%
2.7	DC VOLTAGE	220V
2.8	DC VOLTAGE VARIATION	(+)10% to (-)15%
2.9	FAULT LEVEL (KA/SEC)	50 at rated voltage
3	**SITE LOCATION:**	
3.1	Sipat STPP is located in Bilaspur district of Chhattisgarh, having latitude and longitude of 220 - 05’ to 220 - 09’ (N) and 820 -16’ to 820 - 18' (E) respectively. The site is approximately 20 Km from Bilaspur city and is approachable via Bilaspur - Baloda State Highway which passes through Sipat.	
3.2	The nearest rail head is Jairamnagar Railway Station (on Nagpur-Raipur-Kolkata mainline), is approximately 3 km from the project site.	
3.3	The nearest commercial airport, Raipur is about 150 Km from the project site.	
3.4	Sipat STPP has an installed capacity of 2980 MW under commercial operation with Stage-I (3x660 MW) and Stage-II (2x500 MW). The present proposal is for Sipat STPP Stage-III (1x800 MW) with Ultra-super critical technology.	
4	**GRADE LEVEL:** For IDCT Area, Finished Graded Level (FGL) shall be RL 282.0 M above mean sea level.	
5	**SOIL CONDITION AND GROUND WATER LEVEL & HFL**: Type of foundation, depth, safe bearing capacity, ground water table etc., shall be as per the Geotechnical Investigation report.	
6	**SEISMIC:** : All the structures shall be designed as per site specific seismic criteria as specified by customer in Technical specification and complying requirements specified in IS: 1893 (Part 1) - 2016 and (Part 4) – 2015.	
7	**WIND PRESSURE:**	
7.1	Wind force on structures has been considered as per the provisions of IS: 875 (Part 3) -2015. The basic wind speed of 47 m/sec at a height of 10m above the ground level and Category of Terrain – Category 2 shall be considered for all structures.	
7.2	Risk coefficient k1 is considered as 1.07 as per spec. Wind shall be assumed to blow in any direction and the most unfavourable condition shall be considered for design.	

Please also refer Climatological Table attached at page no 4 - 5 of this specification

Annexure-II

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : चम्पा STATION : Champa — अक्षांश LAT 22°02' N — देशांतर LONG 82°40' E — ऊंचाई HEIGHT ABOVE M.S.L. 245 METRES

1951 से 1980 तक के वर्षों पर आधारित
BASED ON OBSERVATIONS FROM 1951 TO 1980

MONTH	STATION LEVEL PRESSURE	MEAN DRY BULB	MEAN WET BULB	MEAN DAILY MAX	MEAN DAILY MIN	HIGHEST MEAN MONTH	LOWEST MEAN MONTH	EXTREMES HIGHEST	EXTREMES DATE AND YEAR	EXTREMES LOWEST	EXTREMES DATE AND YEAR	HUMIDITY RELATIVE HUMIDITY	HUMIDITY VAPOUR PRESSURE	CLOUD AMOUNT ALL CLOUDS	CLOUD AMOUNT LOW CLOUDS	RAINFALL MONTHLY TOTAL	RAINFALL NO. OF RAINY DAYS	RAINFALL TOTAL IN WETTEST MONTH OF YEAR	RAINFALL TOTAL IN DRIEST MONTH OF YEAR	RAINFALL HEAVIEST FALL IN 24 HOURS	RAINFALL DATE AND YEAR	WIND SPEED
	hPa	°C	°C	°C	°C	°C	°C	°C		°C		%	hPa	Okta	Okta	mm		mm	mm	mm		km/h
जनवरी JAN	988.7	15.8	12.7	27.2	13.0	30.3	9.0	32.8	28 1960	6.2	22 1963	67	12.1	1.9	0.5	14.9	1.1	78.2	0.0	64.0	06 1965	4.4
	985.1	25.3	18.9									39	12.6	2.1	0.6			1958				
फरवरी FEB	986.7	19.0	14.3	30.7	13.6	35.0	10.5	37.5	29 @ 1980	8.3	06 @ 1977	57	12.6	1.6	0.5	13.8	1.3	67.2	0.0	43.6	01 1961	5.2
	982.8	29.2	17.9									29	11.4	2.1	0.7			1961				
मार्च MAR	984.5	23.2	18.7	35.5	19.6	40.0	15.1	42.4	22 1972	11.5	04 1985	44	13.0	1.9	0.5	21.3	1.9	150.0	0.0	86.1	28 1951	5.8
	980.0	33.6	19.5									23	11.9	2.8	0.7			1951				
अप्रैल APR	981.1	28.5	23.0	40.2	24.4	43.9	20.0	46.9	28 1960	16.1	02 1985	38	15.3	2.2	0.4	9.2	1.1	37.3	0.0	34.6	19 1971	5.7
	979.1	33.6	25.5									19	12.1	3.4	1.0			1945				
मई MAY	976.7	33.0	22.5	42.7	27.9	45.9	23.2	48.0	23 1973	19.9	01 1963	38	18.8	2.5	0.3	15.0	1.4	60.0	0.0	37.6	28 1958	6.8
	971.8	40.7	25.1									20	14.0	3.6	1.5			1954				
जून JUN	973.5	30.1	24.4	38.2	27.0	44.3	22.8	47.2	03 @ 1979	20.4	09 1971	64	25.0	5.7	2.6	172.1	8.5	475.0	48.4	154.6	25 1988	8.0
	969.8	34.9	25.0									45	22.6	6.6	4.0			1946	1976			
जुलाई JUL	972.5	26.5	24.8	31.3	24.5	35.8	22.4	39.4	01 1964	20.4	16 1963	87	29.9	7.2	6.0	390.1	17.7	877.1	218.8	347.2	26 1947	7.8
	970.5	28.1	25.7									76	28.9	7.4	5.8			1947	1965			
अगस्त AUG	974.5	26.3	24.8	30.7	24.5	34.1	22.6	37.4	01 1972	21.5	17 1964	88	30.3	7.3	5.1	434.8	17.1	780.5	260.7	280.4	11 1963	7.2
	971.4	26.8	25.6									79	30.5	7.5	5.2			1944	1970			
सितम्बर SEP	976.1	26.7	24.7	31.6	24.3	34.3	22.3	34.0	11 1968	19.6	28 1972	85	29.8	5.8	2.2	222.7	11.4	535.4	55.3	198.0	23 1980	5.2
	974.8	29.1	25.4									74	29.4	6.4	2.2			1970	1979			
अक्टूबर OCT	973.7	24.4	21.9	31.7	21.4	34.1	17.3	34.2	12 1987	15.3	30 1974	79	24.4	3.0	1.3	48.1	3.3	238.1	0.0	100.2	03 1973	3.8
	970.2	29.0	25.2									61	23.9	3.6	1.5			1973				
नवम्बर NOV	980.7	28.7	19.2	29.7	16.4	32.0	12.8	35.1	22 1977	9.6	30 1980	71	18.5	2.1	0.6	4.5	0.4	47.5	0.0	41.1	29 1973	4.3
	984.7	28.6	19.2									58	18.1	2.4	0.8			1948				
दिसम्बर DEC	989.3	16.0	13.1	27.3	13.0	29.9	9.7	32.1	01 1963	4.9	30 1980	70	12.9	1.8	0.3	5.6	0.3	54.6	0.0	45.4	27 1967	4.1
	985.7	24.5	17.0									64	13.5	2.2	0.4			1978				
वार्षिक औसत ANNUAL MEAN	981.5	24.3	19.7	33.1	21.0	46.1	8.5	48.0		4.2		66	20.1	3.6	1.9	1354.1	65.8	2134.1	696.3	347.2		5.6
	977.7	30.8	21.7									47	19.1	4.2	2.2			1961	1979			
वर्षों की संख्या NUMBER OF YEARS	30	30	30	30	30	30	30	30		30		30	30	30	24	30	30	30	30	30		30
	30	30	30									30	30	30	24							

165

जलवायवी सारणी
CLIMATOLOGICAL TABLE

केन्द्र : चम्पा
STATION : Champa

MONTH	मौसम परिघटना WEATHER PHENOMENA: No. OF DAYS WITH: PPT 0.3mm or more	HAIL	THUN DER	FOG	DUST STORM	झंझावात सहित हिमी की संख्या No. OF DAYS WITH WIND SPEED (Km. p. h): SQU ALL	62 or more	20-61	1-19	0	पवन WIND: PERCENTAGE No. OF DAYS WIND FROM: N	NE	E	SE	S	SW	W	NW	CA LM	मेघ CLOUD: No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS: 0	T-2	3-5	6-7	8	No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS: 0	T-2	3-5	6-7	8	दृश्यता VISIBILITY: No. OF DAYS WITH VISIBILITY: FOGG Y	UP TO 1 Km	1-4 Kms	4-10 Kms	10-20 Kms	OVER 20 Kms
जनवरी JAN	1.6	0.0	0.8	0.1	0.0	0.0	0	0	23	8	52	5	5	2	0	0	11	25	16	5	4	4	2	25	1	2	0	1	0	0.1	0.1	0.0	0.2	24.6
फरवरी FEB	2.0	0.0	1.7	0.0	0.1	0.0	0	0	20	11	26	4	5	2	0	2	13	10	13	9	4	3	2	23	5	1	0	1	0	0.0	0.0	0.0	1.5	23.5
मार्च MAR	3.2	0.1	3.9	0.0	0.8	0.0	0	0	22	6	50	4	3	1	0	1	11	27	16	7	3	3	1	24	1	2	0	1	0	0.0	0.0	0.0	3.8	27.2
अप्रैल APR	2.4	0.0	3.6	0.0	0.9	0.0	0	0	25	10	38	6	4	3	1	2	9	31	17	7	4	4	2	26	1	3	0	1	0	0.0	0.0	0.1	10.6	19.8
मई MAY	2.0	0.0	4.8	0.0	1.3	0.0	0	1	24	9	18	4	3	1	0	1	7	13	14	6	6	5	1	16	2	8	1	1	0	0.0	0.0	0.1	9.3	19.9
जून JUN	12.0	0.0	10.7	0.0	1.2	0.0	0	3	24	5	11	4	6	2	0	4	18	35	7	2	1	5	6	15	2	5	2	6	0	0.0	0.1	0.2	4.1	24.2
जुलाई JUL	22.7	0.0	9.6	0.0	0.0	0.0	0	2	24	4	5	2	3	3	4	5	25	41	4	1	0	0	3	4	2	5	4	15	0	0.0	0.1	0.5	7.1	23.3
अगस्त AUG	22.1	0.0	10.5	0.0	0.0	0.0	0	0	25	6	5	1	6	2	3	4	18	40	5	2	0	0	2	2	3	9	3	14	0	0.0	0.1	0.5	6.8	23.7
सितम्बर SEP	15.0	0.0	8.3	0.0	0.0	0.0	0	0	22	8	16	3	10	4	5	3	8	21	8	2	0	0	2	2	3	10	4	8	0	0.0	0.0	0.3	3.0	24.9
अक्तूबर OCT	4.9	0.0	2.4	0.0	0.0	0.0	0	0	19	12	30	5	10	2	1	2	3	10	37	10	6	6	5	20	3	4	2	2	0	0.0	0.0	0.2	2.0	29.0
नवम्बर NOV	0.8	0.0	0.2	0.0	0.0	0.0	0	0	19	11	55	3	3	1	0	1	2	9	27	12	6	3	4	4	2	5	1	1	0	0.0	0.0	0.0	2.3	27.7
दिसम्बर DEC	0.8	0.0	0.3	0.0	0.0	0.0	0	0	17	7	65	3	2	1	0	1	3	10	21	16	6	4	3	2	1	2	1	1	0	0.0	0.0	0.0	1.5	25.0
वार्षिक योग TOTAL OR MEAN	89.5	0.1	57.0	0.1	4.3	0.0	0	3	270	92	29	4	5	3	2	7	14	8	24	121	51	52	73	68	239	20	33	19	54	0	0.1	0.3	3.4	67.4	293.6
कार्यवर्ष की संख्या NUMBER OF YEARS	28						0	9	266	90	20	3	5	2	3	10	20	14	23	79	66	65	82	93	169	66	83	14	53	0	0.0	0.4	3.3	42.7	316.6
							24				28									29								29					29			
							24				28									29								29					29			

166

SCOPE of Supply and Services

Each Cooling Tower shall be complete with following:

The scope of supply, services & civil works for cooling tower, complete with hot water distribution system, cold water basin and outlet channels, sludge pit, staircase from ground level to deck and all other equipment and accessories as mentioned herein after is in Bidder's scope. It is not the intent to list all details herein.

1	Complete packing / fill material and drift eliminators for cooling tower.
2	Complete Hot water Distribution System consisting of:-
2.1	Two (2) numbers motor operated inching type butterfly valves of size 2800 NB mm for Cooling tower for isolating the hot water riser/header to the cooling tower along-with valve supports.
2.2	Concrete encased CW pipes to carry hot water from BHEL's terminal point to cooling tower including its supporting arrangement.
2.3	Manually operated butterfly valve with open/close limit switch at inlet to each cell of cooling towers.
2.4	Hot water distribution systems along with water spray nozzles for cooling tower.
3	Design and fabrication of anchors, hangers and supports wherever required.
4	Drain sump and sludge disposal system for each cooling tower, including sludge sump, associated pipe work, Auto-coupling submersible type sludge pumps (2x100%, minimum capacity 150 cum/hr) valves, accessories and piping up to bidder's terminal point. Suitable portable type tripod arrangement for handling of sump pumps to be considered in bidder's scope.
5	Inlet air louvers (if applicable) for cooling tower.
6	Complete air moving equipment consisting of fans, reduction gear unit, transmission equipment, lubricating system and electrical motors with rain hood arrangement etc.
7	Screens and Stop log gates along with guides embedded in concrete shall be provided at the outlet of cold water basin. The minimum thickness of skin plate shall be 8 mm. The structural design of the stop log gate shall generally conform to relevant IS codes. The gate shall be painted with corrosion resistant paint.
8	Handling arrangement with monorail and a chain operated hoist with a travelling trolley and chain pulley blocks for stoplogs, screens and sludge pumps along with accessories.
9	Mechanical and electrical equipment Handling system and maintenance facilities for drive system gear reducers, fans, motor for each cooling tower.
10	Cross over facility, as required, over hot water pipes as per layout requirement.
11	Provision of three numbers of Isolation (Gate valve) Valves (in the stub connections) at the locations (in purchaser's scope of CW Piping) where flow measurement is to be carried out by means of pitot tubes.
12	All steel / cast iron inserts, plates, bolts, nuts, sleeves etc. to be grouted in concrete work and used to hold/ support the equipment/ system being supplied and erected under this specifications.
13	Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminal points.
14	Flushing lines with davit type valves in each branch at the end of hot water distribution pipes to enable removal of debris from the system at the start of commissioning.
15	Carrying out performance test of the Cooling Tower through CTI (Cooling Technology Institute-USA) / NTPC approved / listed testing agency.

16	The following are also included in bidder's scope:
16.1	One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers.
16.2	Various drawings, datasheets, calculation, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary.
16.3	Supply of first fill of lubricants for all equipment under this package including second fill/ replenishment as necessary after commissioning & handing over of the plant.
16.4	Supply of commissioning spares on as required basis.
17	The items/equipment though not specifically mentioned but are needed to make the system/ plant complete shall also be furnished, erected, and commissioned unless otherwise specifically excluded.
18	**Exclusions from bidder's scope:**
18.1	DCS Panels for Complete Cooling Tower. However, LCP for Sludge pumps and any other equipment's (as required) shall remain in bidder's scope.
18.2	Vibration Monitoring system along with its cabling is in BHEL scope (bidder to provide the vibration pad and key notch for mounting of BHEL supplied VMS sensors / probes in their scope). However, all other accessories like cable trays are in bidders scope as per scope demarcation mentioned in Electrical Scope Split.
19	Cooling Tower MCCs and MCC Building shall be provided by BHEL near IDCT.
20	**Equipment & Services to be provided by Purchaser:**
20.1	Supply and erection of incoming hot water piping up to bidder's terminal point.
20.2	Chlorine di-oxide dosing to control biological/ algae is envisaged in purchaser's scope.
20.3	Supply & erection of sludge discharge piping beyond the bidder's terminal point.
20.4	Cold-water outlet channel for cooling tower beyond the bidder's terminal point.
20.5	For Electrical, C&I and Civil works refer respective sub-sections.
20.6	Cement and Reinforcement Steel (Refer Terms and conditions for free issue items being given along with NIT)
21	**Terminal Points:**
21.1	Hot water header: 15M away from edge of CT Basin wall and at elevation as mentioned in the Technical Data Part- A.
21.2	Cold Water Outlet: 15M from edge of the CT basin wall and at elevation as mentioned in the Technical Data Part- A.
21.3	Power Cables, Control cables and Screened control Cables: As per Electrical scope split.
21.4	Cable Trench/cable Tray: As per Electrical scope split. (Refer page no 8-9)

PROJECT: SIPAT SUPER THERMAL POWER PROJECT (1X800 MW) EPC PACKAGE
PACKAGE : COOLING TOWER (INDUCED DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT :

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	a) 240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. b) Emergency supply feeder provided (if required) shall be 3 phase 3 wire only. Any other voltage level (AC/DC/Single ph emergency AC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Cabling material (Cable trays, accessories & cable tray supporting system)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation dwgs by vendor. 2. BHEL will provide cable trench/cable racks/cable padestals along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
6	Cable glands ,lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty Lugs. Aluminium lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.
7	Equipment grounding (including electronic earthing) & lightning	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval

PROJECT: SIPAT SUPER THERMAL POWER PROJECT (1X800 MW) EPC PACKAGE
PACKAGE : COOLING TOWER (INDUCED DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	protection			during detailed engineering stage. Refer note no. 4 for electronic earthing.
8	Below grade grounding	BHEL	Vendor	MS Rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.
9	LV Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
10	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider Lighting panels (LP) & timer control as per requirement. Further wires, any other material required for lighting system shall also be considered by vendor in their scope. **BHEL will provide the power supply alongwith LDB at one location near Cooling Tower for feeding coollng tower vendor LPs/other lighting loads. Further distribution including material is in vendor scope.**
11	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their civil assignment drawing.

	GENERAL TECHNICAL REQUIREMENT
1	The equipment shall comply with all applicable safety codes and statutory regulations of India where the equipment is to be installed.
2	The design, manufacture, inspection & testing and performance of Cooling Tower complete with all accessories, shall generally conform to the latest editions of the appropriate standards.
3	Latest codes and standards shall be applicable as on date of bid submission.
4	In the event of any conflict between the requirements of two clauses of this specification, documents or requirements of different codes and standards specified, stringent requirement as per the interpretation of the BHEL / owner shall apply.
5	Bidder to note that drawing/document submission shall be through web based Document Management System. Bidder would be provided access to the DMS for drg/doc submissions and adequate training for the same. Bidder to ensure proper net connectivity at their end.
6	The first revision drawings/ documents submitted by vendor shall be complete in all respects. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place as per the requirement for across the table submissions / discussions/ finalizations of drawings.
7	Drawing / documents to be submitted by bidder shall be as per "Documentation Requirement" given in this specification.
8	The scope of supply/ works including civil works as complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements except for items specifically mentioned in exclusion list of works.
9	Scope of works includes preparation of design and drawings, obtaining necessary approvals, materials, execution as per codes, specification, best engineering practices and to the satisfaction of BHEL/ Owner for all mechanical, architectural, civil structural, building electrification, etc. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder.
10	The omission of specific reference to any component / accessory which is necessary for completion of the system and for the proper performance of the equipment / Cooling Tower shall not relieve the bidder of the responsibility of providing such facilities to complete the supply / erection / commissioning etc. of Cooling Tower and its drives at quoted prices. In case this is not clear to bidder, the bidder may seek clarifications to same, failing which the specification intent shall be binding on bidder.
11	Cement and reinforcement steel for Cooling Towers are excluded from Bidder's scope and shall be free issue as per NIT. Terms and Conditions for free issue items being given along with NIT.
12	Bidder shall visit and apprise himself fully with existing site conditions including soil condition, rainfall data, availability of all construction materials including backfill, graded material etc. and other aspects for construction of plant, building structures etc. No extra claim whatsoever on any account shall be entertained by BHEL.
13	The materials of construction for various components specified are the minimum requirements. Superior materials suitable for fluid handled is also acceptable subject to Customer/BHEL approval. Materials of construction for other components not specified shall be similarly selected by the bidder for the intended duty and subject to Customer/BHEL approval.

14	Cost of Piling (if any) shall be included by bidder's in their quoted price.
15	The quality of water in CW system shall be Clarified water. The COC in CW System shall be '5'. Water analysis is enclosed in 'Compliance drgs' as Annexure-1. Chlorine di-oxide dosing to control biological/ algae growth is envisaged in purchaser's scope.
16	The location, orientation, wind rose, scope demarcation etc. for the cooling tower shall be as per the sketch enclosed in 'Compliance drgs' as Annexure-III.
17	Size of Branch & Cell isolation Butterfly Valves shall be same as that of pipe size.
18	The sizing of the hot water distribution system shall be done by limiting the velocity through the pipes to a maximum of 2.0 m/sec.
19	Piping upto 150 NB shall be carbon steel as per IS-1239 'HEAVY' Grade.
20	Piping 200 NB & above shall be Carbon steel rolled and Welded as per IS 3589 from CS plates as per IS:2062.
21	Minimum pipe thickness for overground piping shall be as follows: • 5.4 mm for pipe size upto 150 NB • 6.0 mm for pipe size from 200 NB and upto 600 NB • 7.0 mm for Pipe size 700 NB • 8.0 mm for pipe size 800 NB • 10 mm for Pipe size 900 NB to 1100 NB • 12 mm for pipe size 1200 NB • 12.5 mm for pipe size for 1400 NB • 14.2 mm for pipe sizes from 1600NB to 1800NB • 16 mm for pipe size for 2000 NB • 18 mm for pipe size for 2200 NB • 20 mm for pipe size from 2500 NB upto 2800 NB All pipes shall be adequately supported.
22	Burried CW pipe in Bidder's scope shall be concrete encased. Concrete encasement shall be of min 500 mm thick with square shape outside. M20 grade PCC encasement shall be provided other than locations of duct crossing road, rail or any other facility where RCC encasement of grade M25 shall be adopted. Minimum two layers of reinforcement (On both faces) of 12 mm diameter bars @ 200 mm c/c shall be provided for RCC encasement of CW Duct. Top of CW duct encasement shall be min. 1.5 m below FGL.
23	The minimum thickness of concrete encased steel pipes shall be as follows including corrosion tolerance of 2 mm: • Upto 1800 mm dia. - As per thickness of above ground piping indicated above. • For pipes above 1800 mm upto and including 2300 mm dia. - 12 mm • For pipes above 2300 mm upto and including 3200 mm dia. - 14 mm • For pipes above 3200 mm upto and including 3750 mm dia. - 16 mm • For pipes above 3750 mm upto and including 4000 mm dia. - 20 mm However, for concrete encased steel pipes running below road, minimum thickness of CW pipe shall be 20 mm.
24	Following shall be considered for design of C.W. concrete encased CW Pipes: (a) Maximum design water pressure (b) Surge or water hammer pressure of 5.0 Kg / Sq.cm. (c) Vacuum of 0.1 kg/cm² (abs). (d) Soil overburden (e) Surcharge Pressure of 2T/Sq.m (f) The effect of concrete encasement shall not be considered in the design of CW duct.

25	The completed CW pipe shall be tested for water tightness, for the pressure equal to twice the working pressure or 1.5 times the design pressure whichever is higher and shall be generally water tight to BHEL/NTPC's satisfaction. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld. Any in flow / leakage of water from the duct shall be sealed / repaired at Contractor's cost. However, tests in part of length of duct may be permitted with prior approval only.
26	Wherever required anchor / thrust blocks shall be provided with RCC M25 grade concrete.
27	Manholes of minimum 1000mm clear opening shall be provided in each CW pipe at a spacing of 200M (approx.) to facilitate maintenance / dewatering of CW pipes. At least one manhole shall be provided at the deepest point.
28	Under each valve, flange joint & such other items prone to gland/ joint leakage, suitable trays/ channels shall be provided so that any leakage water does not spread on the surroundings. This is also applicable for any air release valve that has to be mounted on hot water riser top. Erection of such air release valves is also to be done by the bidder.
29	The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Technical Data Part-A.
30	Manual operated B.F. valves with open/close limit switch shall be provided in hot water distribution piping such that each cell can be isolated without affecting the operation of other cells.
31	Special tools & tackles, if any, shall be included in scope of supply by the bidder. A list giving description of such tools & tackles shall be furnished by vendor.
32	The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature.
33	All the components shall be capable of safe, proper and continuous operation at all cooling water flows upto and including those specified under Technical Data Part-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.
34	No wood/ timberwork shall be used in any component of the cooling tower.
35	The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal / vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.
36	All parts subjected to periodical maintenance & inspection such as Inlet louvers (if applicable), fills, drift eliminators etc. shall be readily accessible.
37	For review/approval of drawings, bidder shall depute its concerned personnel for across the table finalization of drgs/docs at BHEL/owner’s office, as and when required. No price shall be admissible to bidder for same and bidder’s offer shall be considered inclusive of the same.
38	It is mandatory for the bidder to submit along with the bid, the deviations if any – whether major or minor in the schedule of deviations only. In the absence of deviations listed in the “Schedule of deviations, the offer shall be deemed to be full conformity with the specification, “not-withstanding” anything else stated elsewhere in bidder’s offer. The implied/indirect deviations shall not be binding on the purchaser.
39	Bidder may note the thermal calculations must be enclosed with the offer. In case these calculations are based on the collaborator’s design then these calculations should be duly vetted by his collaborator. The bidder shall show, explain and prove the validity of the basis, procedures and methods used in these calculations.
40	The spares provided shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during handling/storage at site till the time of erection/usage.

41	The Contractor shall guarantee the long term availability of spares to NTPC for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, he shall give the Employer atleast 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub contractors, Contractor will provide the Employers, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/ procurement of such items.
42.1	Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.
42.2	The interpretation of any technical specification clause, requirement, or provision within this document shall rest solely with BHEL. The decision and interpretation made by BHEL shall be deemed final and binding on bidder without exception.
43	**BUTTERFLY VALVES:**
43.1	All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.
43.2	Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required.
43.3	The actuator-operated valves shall be designed on the basis of the following:
43.3.1	The internal parts shall be suitable to support the pressure caused by the actuators.
43.3.2	The valve actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
43.3.3	All actuator-operated valves shall be provided with hand operated gearing mechanism also.
43.3.4	All actuators operated valves shall open/ close fully within time required by the process.
43.4	All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.
43.5	Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by NTPC/BHEL so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with NTPC/ BHEL site engineer.
43.6	The valves shall be designed for the design pressure/temperature as indicated in Technical data Part-A and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition.
43.7	The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However, for sizes 600 NB and below the valves of Wafer construction are also acceptable.
43.8	Valves-350Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.
43.9	Valves-200Nb and above shall also be provided with gear operator arrangement as a standard practice suitable for manual operation. Manual operation of valve shall be through gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

43.10	Limit and torque switches (if applicable) shall be enclosed in watertight enclosures along with suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.
43.11	**PROOF OF DESIGN TEST (TYPE TEST) FOR BUTTERFLY VALVES:**
43.11.1	Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder.
43.11.2	All valves that are designed and manufactured as per AWWA-C-504 / AWWA-C-516 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504/ AWWA-C-516. For Butterfly valves, designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWAC-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504/AWWA-C-516.
44	**RUBBER EXPANSION JOINTS**
44.1	All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
44.2	The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
44.3	The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
44.4	The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
44.5	Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
44.6	Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipe lines.
44.7	The expansion joints shall be of heavy duty construction made of high grade abrasion resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fiber having maximum flexibility and non-set characteristic.
44.8	The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
44.9	All expansion joints shall be provided with IS 2062 Gr E-250B galvanized steel retaining rings for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.
44.10	The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges. The flanges shall be as per ANSI B 16.5. For higher sizes, not covered under ANSI B 16.5, the same shall be as per AWWA.
44.11	All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.

44.12	Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.
44.13	Each joint shall have a permanently attached brass or stainless-steel metal tag indicating the tag numbers and other salient design features.
45	**CLEANING AND FLUSHING OF PIPES:**
45.1	All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
45.1	Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned.
45.1	After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.
46	**ELECTRICAL:**
46.1	BHEL will provide 240 V AC (supply feeder) /415 V AC (3 PHASE 4 WIRE) supply based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract.
46.2	Cable glands shall conform to BS:6121. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and Hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.
46.3	Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections
47	**CONTROL AND INSTRUMENTATION:**
47.1	ontrol of Induced Draft Cooling Tower(IDCT) package shall be through DCS (BHEL Scope) with CRT based OWS located in Control Room.
47.2	Complete Field Intrumentation for monitoring and operation of IDCT package be provided by bidder.
47.3	The quantity of instruments for the system indicated in "General Technical Requirement" shall be considered as minimum requirement by the bidder. Any other instrument/item required for completeness of the system shall be in bidder's scope of supply.
47.4	Following items are to be supplied for process as a minimum:
47.4.1	Temperature Elements with temperature transmitters and Temperature Gauges for each Gear box. Temperature sensors shall be on gear box while display (Gauge Meter & Transmitter display) shall be outside RCC Stack (near Fan Motor).
47.4.2	One no. Level Switch for each of the gear box for lube oil level.
47.4.3	1 no Pressure Gauge for each of the Hot Water Riser.
47.4.4	1 no Temperature Gauges for each of the Hot Water Riser.
47.5	Instruments required for conducting the PG Test shall be as per 'CT PG Test Procedure' attached in the specification.
47.6	Root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold, junction boxes and all other accessories required for erection of local / remote instruments shall be provided by bidder.

47.7	The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes.
47.8	Bidder shall provide mounting pads for vibration sensors for each fan motor.
47.9	Bidder to provide temperature transmitter along with junction box & other erection hardware.
47.10	All instruments shall be terminated on junction box in the field. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling and trunk cable.
47.11	For all profibus devices GSD/DD and DTM files are to be provided for configuration/ testing in the DCS for proper interfacing and diagnostics.
47.12	Number of pairs to be selected for Screen /Control cable 1. F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2) 2. G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
47.13	Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards.
48	All the first fill and one year's topping requirement of consumables such as greases, oils, lubricants, servo fluids / control fluids etc. which will be required to put the equipment covered under the scope of specifications into successful commissioning / initial operation and to establish completion of facilities shall be supplied by the contractor. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.
49	FRP tower shall be with proper sealing/isolation between cells to avoid short circuiting of air between adjacent cells of Cooling Tower and ensure that there is no reverse rotation of fan.
50	**3D MODEL REQUIREMENT:**
50.1	Bidder shall submit 3D Parametric model of the cooling tower area within terminal points compatible with E3D library.
50.2	Bidder to preferably use default library of E3D for creation to primitives/ model /layout so that it can be integrated with 3D model of the main plant
50.3	FOLLOWING REQUIREMENTS TO BE MET BY BIDDER
50.3.1	All the layouts shall be made using computerized 3D modelling system (E3D). The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check
50.3.2	Contractor shall prepare 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc), which is extracted from intelligent 3D model, for employer's review as & when desired by the employer.
50.3.3	The complete editable 3D model (complete 3D data) along with complete component catalogues for all the size range, configuration files, customization files, templates and all referenced databases pertaining to 3D model of the package etc. with any other document generated from 3D model and naming conventions with as-built updates shall be handed over to the employer after completion of Engineering.
50.3.4	The corresponding complete 3D review model shall also be handed over to the employer for reference after the completion of engineering of respective package.

50.4	**Handover Plan:** There shall be continuous handover of documents and data at various stages of the project including rules and trigger points for handover of data to employer shall be at 30%, 60% and 90 % of 3D model stage.
51	**BID EVALUATION CRITERIA:**
51.1	The bids shall be evaluated based on the Cooling Tower prices quoted by the bidder and quantity of Cement and reinforcement steel used in Cooling Tower.
51.2	Bidder shall furnish the quantity of Cement and reinforcement steel in the Price offer. The evaluation rate for Cement and reinforcement steel shall be as per the rates given in the Price Schedule/NIT.
51.3	During civil design while furnishing the drawing/ design for BHEL's review / approval, bidder shall also furnish the design quantities of Cement and reinforcement steel in the drawings.
51.4	If the total quantity of Cement and reinforcement steel during contract execution is found to be more than the quantities quoted at tender stage, the additional cost for excess quantity of Cement, reinforcement steel and Structural steel shall be deducted from the bidder's payments as per the rates specified in the NIT.
51.5	No benefit will be given to Bidder, in case of reduction in actual quantity of Cement and reinforcement steel with respect to the quantities considered in bid evaluation.

TECHNICAL DATA - PART - A (MECHANICAL)			
SL.NO	**DESCRIPTION**	**UOM**	**DETAIL**
1.0	**DESIGN CODES & STANDARDS**		
1.1	Acceptance Test Code for Industrial Water Cooling tower.		Cooling Tower Institution of USA, Bulletin ATP-105
1.2	Performance Test Code for Atmospheric Water Cooling equipment.		PTC-23:ASME
1.3	Specification for Water Cooling Towers.		BS-4485.
1.4	Design of FRP components of cooling tower		CTI STD- 131 and CTI ESG-152.
1.5	Fiberglass Pultruded Structural Products for use in Cooling Towers		CTI STD-137
1.6	Structural Design of FRP components		CTI STD-152
1.7	Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.		ASTM D-4385
1.8	Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition.		ASTM D-3647
1.9	Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Putlruded Shapes.		ASTM D-3917
1.10	Definitions of Terms Relating to Reinforced Plastic Pultruded Products.		ASTM D-3918
1.11	Property of PVC/PP fill		CTI 136: 2010
1.12	Thermo-Hydraulic Design of Induced Draught Counterflow Cooling Towers — Guidelines		IS 18758 : 2024
2.0	**DESIGN /SYSTEM PARAMETERS FOR EACH COOLING TOWER**		
2.1	No. of Cooling Towers required	Nos.	One (01) no. for station
2.2	Duty	-	Continuous
2.3	Type	-	RCC/FRP Induced draught Cooling tower
2.4	Air & Water Flow pattern	-	Counter Flow/ Cross Flow
2.5	Fill Type	-	Non-clogging type fills like modular splash/trickle grid/turbo splash or splash type fills like V-bar splash/splash grid
2.6	Design Cooling water flow	M3/hr	87000
2.7	Design Ambient Wet bulb temp	Deg C	27.5
2.8	Recirculation allowance	Deg C	0.8
2.9	Design Inlet wet bulb temp	Deg C	28.3
2.10	Design Cold water temperature	Deg C	32.5
2.11	Hot water inlet temperature	Deg C	42.84
2.12	Cooling Range	Deg C	10.34
2.13	Design Ambient Relative Humidity	%	50
2.14	Contribution of rain and spray zone to be considered in thermal design of tower		NIL
2.15	Liquid Handled	-	Clarified water with COC 5 (Annexure-1)

2.16	Maximum CW Pumping head permissible, viz. static head plus frictional losses as below: - Static head w.r.t. FGL - Frictional losses within bidder's T.P. with 10% margin	MWC	15.0
2.17	Minimum elevation of top of water level in hot water distribution duct with respect to Basin curv level	M	13.0
2.18	Maximum limit on total power consumption per cooling tower for the cooling tower fans at fan motor inlet terminals	KW	2800
2.19	No. of working Cells	Number	As per bidder's design
2.20	No. of spare Cells	Number	four (4)
2.21	Evaporation loss.	%	Bidder to inform
2.22	Maximum permissible drift loss	%	0.001
2.23	Design pressure for hot water distribution system	kg / cm2(g)	5.5
2.24	Maximum permissible Cooling Tower Plan dimensions at 'FGL' (Excluding staircase & pavement)	M x M	260 X 40
2.25	Minimum Fill Plan area (including standby cells)	SqM	As per bidder's design
2.26	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	%	120
2.27	Finished ground level (FGL)	M	EL (-) 0.5 M (RL 282.0 M)
2.28	Maximum water level	M	EL (-) 0.5 M (RL 282.0 M)
2.29	Normal Water Level	M	EL (-) 1.0 M (RL 281.5 M)
2.30	Min. Water level	M	EL (-) 1.5 M (RL 281.0 M)
2.31	Min. Free board above Maximum water level	M	0.3 M
2.32	Invert level of CT Basin	M	EL (-) 2.0 M (RL 280.5 M)
2.33	Invert level of CW channel near CT Outlet	M	EL (-) 4.5 M (RL 278.0 M)
2.34	Depth of Sludge pit	M	Suitable for complete dewatering of CT basin.
2.35	Submersible Type sludge pumps	No.	1 no. per Sludge Sump (of min cap 150 cub M/ Hr.)
2.36	Number of sludge pits	No.	Two
2.37	Number of cold water outlet channels		One no. CW Cold water outlet channel & shall match with Purchaser's channel at TP (Annexure-II)
2.38	Number of screens and gates in common outlet channel/Basin each) (Minimum)	No.	One (1)
2.39	Maximum allowable effective velocity through Cold water Outlet Channel	M/sec	1
2.40	Length of CW Header from edge of CW Basin in CT vendor's scope	M	15 (Annexure-III)
2.41	Length of CW Outlet/Channel from edge of CW Basin in CT vendor's scope	M	15 (Annexure-III)
3.0	**CONSTRUCTION FEATURES FOR EACH COOLING TOWER**		
3.1	Whether fan blades to have adjustable pitch		Yes
3.2	Whether fills are easily installable & removable		Yes
3.3	Fills supported by nailing acceptable		No

3.4	Type of Gear box		Spiral bevel or Worm type.
3.5	Gear box service factor (minimum) on motor rating		3
3.6	Factor of Safety for drive Shaft over the torque to be transmitted at design duty (minimum)		2
3.7	Fan Motor rating Selection		Fan motor shall have atleast 10% margin over the maximum power requirement of fan when the fan is operating at its test block condition and at 50 deg. C ambient temperature as required at gear box input end.
3.8	Minimum clear space required between any two fan stacks on adjacent cells	M	2
3.9	Min. clear corridor width required all along the cooling tower roof for equipment handling	M	2
3.10	Required number of stair cases from ground level to cooling tower fan deck	Nos.	Two(2) viz. one at each end.
4.0	**Material of construction**		
4.1	**For RCC Induced Draught Cooling tower**		
4.1.1	Cold water basin, outlet channel/ sump & sludge pit.		R.C.C.
4.1.2	Casing & Superstructure		R.C.C
4.1.3	Cell partition walls		Precast solid concrete blocks with provision of pilasters for walls, if required
4.1.4	Cooling tower roof (top deck)		R.C.C
4.1.5	Fan Cylinder/ recovery stack		R.C.C
4.1.6	Staircase		R.C.C
4.1.7	Supporting structures		R.C.C.
4.1.8	Hot water basin for cross flow cooling tower		R.C.C.
4.2	**For FRP Induced Draught Cooling tower**		
4.2.1	Cold water basin, outlet channel/ sump & sludge pit.		R.C.C.
4.2.2	Casing & Superstructure		Pultruded FRP
4.2.3	Cell partition walls		Pultruded FRP
4.2.4	Cooling tower roof (top deck)		Pultruded FRP
4.2.5	Fan Cylinder/ recovery stack		Pultruded FRP / GRP
4.2.6	Staircase		Pultruded FRP
4.2.7	Hand rails at deck Level		Pultruded FRP
4.2.8	Supporting structures		Pultruded FRP
4.2.9	Hot water basin for cross flow cooling tower		Pultruded FRP
4.3	Hot water distribution nozzles		PVC/ Polypropylene / Gun metal as per IS:318 Gr. VI
4.4	Hot water distribution pipes for counter flow cooling tower		PVC (IS 4985 Class 3) / GRP / HDPE (IS 4984 PN6, Grade PE 80) / as per Bidder's proven practice
4.5	Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity		Heavily galvanized (610 gm/ sq.m) in accordance with IS: 2629 with corrosion resistant protective coating Surface preparation in accordance with IS:6129.
4.6	Hand rail		As per civil specification (Book 2 of 2)
4.7	Fills		PVC/ PP/ as per Bidder's proven practice

4.8	Fill support		SS:316 grid
4.9	Louvers		Bidder's proven practice
4.10	Drift eliminators		PVC (UV Stablised)
4.11	Fan blades		Fibre glass reinforced polyester/ Epoxy (hollow cast)
4.12	Fan hub		Heavily Galvanised M.Steel
4.13	Gears		Alloy Steel/ Equivalent
4.14	Gearbox and fan hub supporting structure		Hot dipped heavily Galvanised M. Steel
4.15	Fan drive shaft		Stainless conforming AISI-304 /Carbon fibre composite material with SS 304 couplings
4.16	Fan drive shaft coupling		Stainless conforming AISI-304
4.17	Bolts, buts etc. for fan blades		SS-316
4.18	BF Valves - Body & disc (Design as per AWWA-C-504)		ASTM A48, Gr. 40 with 2% Ni / IS: 210. Gr. FG-260, with 2% Ni/ SG iron BSEN 1563, Gr. EN GJS-400-15 with 2% Ni and epoxy coated. Fabricated steel (IS: 2062 GR. E-250B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm Nb diameter.
4.18	BF Valves - Shaft		BS 970 431 S: 291 / EN 57, or SS 410 Test pressure & duration shall comply with AWWA C504.
4.18	BF Valves - Seat ring		18-8 Stainless steel
4.18	BF Valves - Seal		Nitrile Rubber
4.19	Other Valves		Body & bonnet : ASTM A 216 Gr. WCB / ASTM A 105 Trim: ASTM A 182 Gr. F6 or Equivalent
4.20	Sludge pit isolation valves - Body		CI to IS-210 Gr. FG-260
4.21	Sludge pit isolation valves -Spindle & Trim		13% Cr. Steel.
4.22	Sludge outlet pipe		C.I.
4.23	Stop Log gate in Cold water Outlet Basin		As per civil specification (Book 2 of 2)
4.24	Guide for Stop Log gates		As per civil specification (Book 2 of 2)
4.25	Screen		As per civil specification (Book 2 of 2)
4.26	Guide for Screen		As per civil specification (Book 2 of 2)
4.27	Bolts, buts & other hardware		SS 316
4.28	Submesible Sludge Pumps - Casing		2.5 Ni% Ni-Ci to IS 210 Gr. FG-260
4.29	Submesible Sludge Pumps -Impeller		ASTM A351 CF8M
4.30	Submesible Sludge Pumps - Shaft/Sleeves		SS-316/SS-410
4.31	Material of construction for items not specified		As per purchaser's approval during detailed engineering.
5.0	**PERFORMANCE PARAMETERS**		
5.1	Cold-water temperature	DegC	32.5
5.2	Fan Auxiliary power consumption	kW	2800

(B) COOLING TOWERS - INDUCED DRAFT (MECHANICAL)

1.00.00 GENERAL

This specification covers the design, engineering, manufacture, shop fabrication, testing at works, transportation to site, unloading and storage at site, fabrication at site, Installation, testing and commissioning of induced draught RCC/ Pultruded FRP cooling towers for power plant cooling system.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture, inspection, and testing shall comply with all currently applicable standards. The equipment shall also conform to the latest applicable British/American standards. The equipment shall conform to the latest edition of the following standards: -

i) Cooling Tower Institute Publications.

ii) BS 4485-Specification for Water Cooling Towers.

2.02.00 CODES AND STANDARDS FOR FRP COMPONENTS

The design of FRP components of cooling tower shall comply with the requirements stipulated in CTI STD- 131, CTI STD -137, and CTI ESG-152. The cooling tower and its components shall be designed to withstand the most onerous loading case / combination resulting from the various loading cases / combinations stipulated in CTI ESG 152. All material properties, stresses and their reduction factors, deflection criteria, material service factors, connection details and their tolerances etc., as applicable as per CTI codes CTI STD- 131, CTI STD -137, CTI ESG-152, shall be so considered such that the cooling tower and its components withstand the severest temperatures in the place of installation and application and serve a reasonably long life not less than CTI indicated life expectancy.

3.00.00 DESIGN REQUIREMENTS / CRITERIA

3.01.00 Each cooling tower shall be complete with tower, basin, foundations and mechanical equipment as described below. The tower shall be of single inlet or double inlet, cross flow or counter flow type with type of fill as specified in technical data sheets. The tower shall be of induced draught type with the fan located on top of the tower.

3.02.00 The cooling tower shall be designed to meet the duty conditions as specified in this tender specification. Employer may get the verification and review of contractor's design done through third party (who can be employer's consultant/reputed designer/ National or International Technological Institute/National or International body on cooling tower & it's components), if required (during detailed engineering). All necessary data/ details/ drawings shall be provided by the contractor to get the same carried out.

3.03.00 Number of operating cells in the cooling tower shall not be less than eight (8). Bidder shall provide spare cells (Minimum four (4) per tower) in the cooling tower in case of one tower per Unit configuration and minimum two (02) numbers per tower in case of two tower per Unit configuration to facilitate maintenance without affecting the tower performance.

3.04.00 3The water distribution basin and piping system shall be so designed that when any two cells (other than standby cells) are out of operation for maintenance etc. the remaining cells shall be capable of handling the full quantity of water as indicated in technical data sheet.

3.05.00 3All cells of the tower shall be identical. Thermal design of the cooling towers shall be such that the guaranteed performance is met without operating spare cells.

3.07.00 For counter flow tower the area covered by the projected circle at 45 deg. angle from the fan cylinder opening on the drift eliminator plan area shall not be less than 80% of the drift eliminator plan area.

3.08.00 The layout of the cooling tower in the plant area and the wind rose is indicated in the drawings titled "General Layout Plan". The Bidder shall examine the proposed layout of the tower and accordingly determine the recirculation, which must be taken into consideration for the purpose of design of the tower to ensure that the design parameters of the tower are

maintained when all the cooling towers in the plant are operating simultaneously. Bidder must apply a correction factor to the design wet bulb ambient temperature to accommodate the recirculation effect. Minimum value of this recirculation correction factor shall be as given in technical data sheets.3.09.00 The length of the cooling tower shall be decided based on plant layout to be optimized by the bidder.

3.10.00 **Thermal Design Criteria**

The thermal design of cooling towers shall fulfil following design criteria.

Sensible heat of evaporated water shall be taken into consideration in the thermal design of the cooling tower. The air flow requirement shall not be less than that worked out by the formula given below:

GH = L(TI-T2) + EvT2

Where

L	=	Water flow rate in kg/hr.
TI	=	Water inlet temperature to the tower in deg C.
T2	=	Water outlet temperature to the tower in deg C.
EV	=	Evaporation loss in kg/hr at ambient RH
G	=	Air flow rate in kg/hr.
H	=	Change in enthalpy of air in kcal/kg.

3.11.00 Calculations justifying the selected airflow and evaporation loss shall be enclosed with the bid. International/National standard table of properties of air shall be used and a copy of the table clearly indicating the standard used shall be enclosed with the bid.

3.12.00 The bidder shall furnish in his bid the following:

i) Heat balance calculations and air requirements for cooling tower as per format given elsewhere.

ii) Available tower characteristics (KaV/L - as a function of air & water rates, fill geometry, hot water temperature, air velocity etc.) based on field performance tests. The relationship shall be of general form of equation given below and shall include values of the constants “C” and “n”. The equation shall cover range of L/G values from at least 20% above to at least 20% below design.

KaV/L = C(L/G)n

The bidder shall also submit an equation and / or curve defining the demand requirement at design approach, range and wet bulb temperature. The design L/G value shall be identified.

iii) Various pressures drop in the air circuit of the cooling tower to arrive at discharge pressure of fan.

iv) Calculations for arriving at the design power consumption.

v) Calculations for pumping head in the format given in elsewhere.

vi) Tower Performance curves (for both ambient and inlet WBT.)

Bidders may note that the calculations/curves specified above must be enclosed with the offer without which bids run the risk of rejection. In case, these calculations are based on the collaborator's design, then these calculations should be duly vetted by collaborator. The Bidder shall show/explain and prove the validity and the basis of procedures and methods used in the calculations.

3.13.00 The tower configuration shall be such that it shall offer minimum restriction to air flow.

3.14.00 To ensure uniform and stable distribution of entering air, the velocity pressure ratio shall not be less than 5 (Five). Velocity pressure ratio is defined as the ratio of system pressure drop

(i.e. from air inlet to the drift eliminator) to the velocity pressure at the inlet. For counter flow towers, the velocity at air inlet shall be calculated based on the clear air entry area available in vertical plane at the inner face of cooling tower wall. For purpose of calculating the velocity pressure ratio, the air velocity shall be computed considering the total airflow entering the individual cell and the total gross inlet air area of the individual cell. This will be calculated independently for each cell and the value calculated for each cell shall not be less than 5. For towers provided with over-dimensioned cold-water basin, the inlet air area shall be computed considering the water level in the cold-water basin at normal water level.

3.15.00 The exit air velocity of the fan recovery stack outlet shall not be less than 6m/s.

3.16.00 Maximum air Inlet velocity should be 5m/s.

3.17.00 ~~For design of Cooling tower, CT outlet temperature shall be considered as 32 deg. C.~~ Deleted

4.00.00 Constructional Features

Wood/timber shall not be used as construction material in any part of the cooling tower. Bidder may offer MOC of components different than that specified below based on his proven practices, however allowing of such MOC shall be under employer's discretion.

SN	Component Description	Material of Construction	
		RCC IDCT	FRP IDCT
1	Hot water header	MS to IS:2062 (around cooling tower)	
2	Hot water distribution pipes for counter-flow tower	PVC (IS 4985 Class 3) / GRP / HDPE (IS 4984 PN6, Grade PE 80)/ as per Bidder's proven practice	
3	Hot water basin for cross flow	RCC	Pultruded FRP
4	Cooling tower shell/ structure	RCC	Pultruded FRP
5	Cooling tower basin	RCC (Refer Civil specifications)	
6	Drift Eliminators	PVC	
7	Louvers	Bidder's proven practice	
8	Fill	PVC/ PP/ as per Bidder's proven practice	
9	Fill supports	SS:316 grid	
10	Fan blades	Fiber glass reinforced polyester/ Epoxy (hollow cast)	
11	Fan Hub	Heavily Galvanized M.S	
12	Fan Deck	RCC	Pultruded FRP

SN	Component Description	Material of Construction	
		RCC IDCT	FRP IDCT
13	Drive shaft and coupling	Stainless steel conforming to AISI 304 or Carbon fiber Composite material with SS 304 couplings.	
14	Base frame and base plate for gear box and motor/ Torque Tube Support	Heavily Galvanized MS	
15	Stair case	RCC	Pultruded FRP
16	Recovery Stack	RCC	Pultruded FRP/ GRP
17	Stop logs	Refer civil specifications.	
18	Any other hardware such as fasteners, clamps, supports etc. in direct contact with water	~~Stainless steel conforming to AISI: 304 or equivalent.~~ **SS 316**	
19	Any other mild steel parts used in cooling tower or its vicinity	Heavily galvanized (610 gm/m^2) in accordance with IS:2629 with corrosion resistant protective coating Surface preparation in accordance with IS:6129	
20	Hand Rails	Refer civil specifications.	Deck Level – Pultruded FRP Others – Refer civil specifications.
21	Misc. Structure(s)	Refer civil specifications.	
22	Nozzles/ Splash cups	PVC/ PP/ Gun metal as per IS:318 Gr. VI	
23	Cladding Sheets	RCC	FRP

4.02.00 **Pultruded FRP structural components**

The Pultruded FRP structural members shall be proven for use in Cooling Towers application. Documentary evidence about past experience of parties in respect of design, manufacture, supply, erection & satisfactory operation of Pultruded structure shall be submitted to the employer.

4.02.01 **Manufacturing Process**

a) **Pultrusion**: The process of pulling continuous forms of reinforcing materials, such as glass-fiber rovings, glass-fiber mats and various surfacing veils through a bath of liquid resin. The mass of fully wetted-out material then continues to a performer and directly into a healed forming and curing die where a chemical reaction is initiated which causes the thermosetting resin to harden and the composite structural shape is formed. An optional method of cure is to pass the wetted-out composite through a radio frequency (RF) preheated. The RF preheat initiates the cure process prior to entering the heated forming die. This process is particularly useful for heavy section processing. The hardened (or cured) shape is cooled in line by water or air and then enters a pulling device where continuous pulling is maintained. Both caterpillar type and reciprocating pullers are used in pultrusion. Upon exiting the puller, the composite structural shape is cut to the desired length.

b) Definition of terms relative to pultrusion can be found in ASTM D-883 and ASTM D- 3918.

c) Other forms or combinations of reinforcements such as carbon fiber, aramid fiber, etc. can also be utilized when different mechanical and physical properties are required. Specific mechanical and physical properties should be negotiated between the pultrusion supplier and cooling tower.

4.02.02 **Design Temperature**

For members in cooling towers which are subjected to extended periods of operation in temperatures greater than 77°F, the pultrusion suppliers published allowable design values for flexural and compressive loads shall be reduced to account for reduced properties at the higher temperatures. These correction factors are published in Table II of CTI STD-137. For Type IV products, pultrusion suppliers are to supply the cooling tower manufacturer with temperature-moisture correction factors. All structural components for the tower should be selected to account for maximum expected hot water temperature including any upset conditions as a minimum (i.e., maximum hot water temperature +10°). This will account for the possible the effects of fan off operation, tower idle in hot weather and load excursions. A statement indicating the design temperature should be included as part of the cooling tower manufacturer's proposal.

4.02.03 **Materials**

a) Glass fiber-reinforcements may be either continuous roving's, continuous strand mats, woven or non-woven fabrics, uni-directional fabrics or combinations of these. Glass fibers shall be made for A, C, E or S-type glass. Other reinforcements may be specified for custom applications.

b) The resin grade shall either be a Grade I isophthalic polyester resin or Grade 3 vinyl ester resin as per Section 4.2 of CTI Std. 137. The resin may contain additives for various purposes such as flame retardancy. UV stabilization, pigmentation or smoke reduction. These additives should be selected so as to add to the overall performance of the product without affecting the structural properties, chemical resistance an/or longevity of the part.

c) Surfacing veils shall be used to improve surface appearance, assistance in chemical resistance, improved weatherability and to prevent glass fibres from coming to the surface as a result of wear or UV attack. Surfacing veils are thin tissue-type products incorporated during the pultrusion manufacturing operation as the outermost surface layer of non-resinous material. All exterior surfaces of Pultruded members shall have a minimum surface veil of 10mil and shall have UV inhibitors to protect against UV degradation. Heavier surface veils may be provided on supplier's discretion. The final degree of UV protection is a function of the total manufactured thickness of the surfacing veils and/or surface coatings. Glass fibres exposed during fabrication process and/ or installation shall be gel coated and sealed to prevent wicking.

4.02.04 **Physical Properties**

Physical properties should be in line with CTI specifications, CTI-STD-137. Moreover, the pultruded FRP structural components shall be fire retardant with the resin composite having a flame spread rating less than 25 as per ASTM E 84 standards.

4.02.05 **Mechanical Properties from Coupons**

Minimum mechanical properties (taken from coupons) shall be as per CTI specifications CTI-STD-137.

4.02.06 **Applicable Documents**

a) CTI STD-137: Fiberglass Pultruded Structural Products for use in Cooling Towers

b) CTI STD-152: Structural Design of FRP components

c) ASTM D-4385 Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.

d) ASTM D-3647 Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition.

e) ASTM D-3917 Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Putlruded Shapes.

f) ASTM D-3918 Definitions of Terms Relating to Reinforced Plastic Pultruded Products.

4.02.07 Ultraviolet exposure test for 300 hours to be carried out at reputed third party laboratory once as per ASTM G-154 and Impact resistance test before & after UV exposure shall be conducted as per ASTM D-256. This will be applicable to Pultruded as well as moulded FRP components.

4.02.08 FRP tower shall be with proper sealing/isolation between cells to avoid short circuiting of air between adjacent cells of Cooling Tower and ensure that there is no reverse rotation of fan.

4.03.00 Cooling Tower Basin and Shell Structure

The material of cooling tower basin and super structure shall be as mentioned above. The depth of basin shall be at least 1.0 m from normal water level with free board of at least 0.3 m above maximum water level unless otherwise indicated in relevant tender drawing. The Velocity of water at the outlet of the cooling tower should not exceed 1 (one) m/sec. If required, the basin may be suitably depressed to meet this requirement.

4.04.00 Cold Water Basin **Drainage Arrangement**

4.04.01 Cold water from the basin shall flow by gravity to cooling water channel through the outlet channel.

4.04.02 Provision shall be made to completely drain the basin. For this purpose, the basin floor shall slope towards the drain sump in the Cooling Tower as shown in the relevant tender drawing. Water shall flow from the drain sump into an external sludge sump through a 300 mm NB GRP pipe 12mm thick and a gate valve of size 300mm NB with extended spindle. Two sludge sumps shall be provided for each tower. The sludge sump shall be at least 2m x 2m plan area and minimum 2.5m deep. One number sludge disposal pump of capacity 150 cum/hr and suitable head shall be supplied for each sludge sump. Sludge Pumps can be of fixed type or submersible type with proper handling arrangement.

4.05.00 Inlet Louvers

The water loss in the inlet air openings shall be prevented with provision of adequate number of louvers of proper slope, width and spacing or alternatively by over dimensioning the cold-water basin by minimum 1.0 meter all-around. Louvers, if provided, must be properly designed to give uniform distribution of air with minimum pressure drop and must be able to withstand the corrosive atmosphere.

4.06.00 Cooling Tower **Fill and Fill Supports**

1) The fill shall be of non-clogging type fills like modular splash/trickle grid/turbo splash or splash type fills like V-bar splash/splash grid and easily installable. The fills shall be adequately supported to prevent sagging and damage. The tower shall be levelled so that water will be uniformly distributed over the fills and does not cause channeling. The splash type fills shall be placed horizontally.

2) The non-clogging type fills shall be in modular form. These fills are to be mechanically assembled without any use of adhesives. Assembling by other proven method is also acceptable. The fill shall be freely rested, and bottom supported to prevent any sagging and damage.

3) The fill material shall promote a high rate of heat transfer, provide low resistance to air flow and maintain uniform water and air distribution throughout the fill volume. The fill material shall be highly resistant to deterioration and shall be fire retardant. PVC/PP fill, shall be of proven quality. The make and its properties shall be subject to Employer's approval. Bidder shall furnish details of PVC/PP fill regarding fire-retarding properties, ageing effect, vibration caused by water and wind effects. The property of PVC/PP fill shall be in line with CTI 136: 2010.

4) In case of PVC/PP fill, the material should be ultra violet ray stabilized and only virgin PVC/PP material should be used.

5) The type of fill to be supplied for this package shall be of proven design. Necessary supporting data for this shall be enclosed along with the bid.

6) Preferably, the fill shall not be extended into the air inlet area. In case the bidder's standard design calls for such an arrangement, then field performance test results of towers with comparable fill arrangement supplied by the bidder duly certified by the user shall be furnished along with the bid to establish the design.

7) Type Test of PVC/PP Material

In addition to the routine tests specified in this Technical specifications, ultra-violet exposure for 500 hours on the PVC/PP material shall be carried out for this contract once as per ASTM-G155, Test Method 3 and Impact resistance test before and after UV exposure shall be conducted as per ASTM D-256. The above type test shall be carried out by the Contractor at reputed third-party laboratory.

Offered fills shall be tested by an independent reputed laboratory approved by NTPC to validate thermal characteristic and pressure drop correlation of the offered fill. In case the bidder has their own established test facility where such tests have been conducted for other reputed clients in the past, the same is also acceptable subject to owner's approval.

Test bed shall have fill height same as the offered fill height. During testing water and air loading as well as the air velocities shall be maintained same as the duty conditions and in the range of performance guarantee conditions for which tower is designed.

4.07.00 **Inlet Water Distribution System**

1) General Requirements:

The hot water distribution system of the tower shall be designed to ensure uniform distribution to all operating cells and also to all areas in a cell. For cross flow type of towers a minimum free board of 50 mm shall be provided with the standby cell not in service. Each

cell shall be able to operate independently. Suitable valves for isolation of any cell for any maintenance or repair work and to regulate the flow of water to individual cells shall be provided. The water shall be discharged throughout the plan area of the packing. For counter flow towers sufficient headroom (minimum 1.8M) shall be provided between the water distribution system and drift eliminator for inspection and maintenance. Fill cone down spray/up spray water distribution system should be provided so that there is no interference between the nozzle exit and top of fill.

2) Special requirements of distribution Nozzles:

i. The Nozzles shall be arranged in a uniform pattern with proper distance to produce 15% overlapping of the individual sprays.

ii. Selected nozzle characteristics like 'Head vs Flow' and 'Head vs Spread area' at three or four distances from nozzle bottom to fill top shall be furnished based on the 'Single nozzle test' and 'Four nozzle test'. Previous test reports are to be furnished covering all tests along with the offer. In case the test was not conducted in the past, the above tests shall be carried out in presence of the Employer.

iii. Single Nozzle Test: The nozzle shall be placed at the bottom of the overhead tank. The head in the tank can be maintained at different head of 0.1 m, 0.2 m and 0.3 m by adjusting the inlet flow. The water spread area for different heads and flow can be measured with the help of spread measuring instrument (scale) in LHS and RHS.

iv. Four Nozzle Test: The nozzle shall be placed at the bottom of tank. The water-collecting compartment shall be placed at the bottom and center of spray nozzles. For different head, the quantity of water collected in the collecting compartments for 30 seconds/ 60 seconds shall be measured and this shall be verified with the design prediction/ assumption.

v. Nozzle connection with internal hot water distribution pipes shall be preferably by fasteners. Fasteners shall be of stainless steel. Push on fit type connection is not acceptable.

3) Specific Requirements for cross flow towers:

The hot water distribution basin shall be provided with a suitable cover to avoid direct sun rays falling on the distribution trough/basin to minimize algae growth and to prevent choking of distribution nozzles. The covers provided shall be easily openable for inspection and maintenance of the distribution system.

4) Specific Requirements for counter flow towers:

All distribution pipe work shall be adequately supported. The pipe supports shall accommodate thermal movement while ensuring the pipe joints do not fail when subjected to pressure surges. The Bidder shall submit the details of the proposed method of supporting distribution system. The design calculations for sizing of the system shall be furnished by the Bidder for Employer's approval during detailed engineering stage.

5) Specific Requirements for Pultruded FRP Cooling Towers:

Each riser pipe in case of Pultruded FRP Cooling Towers shall be connected to the Cooling Tower shell through a rubber expansion joint of the diameter same as that of the riser pipe and meeting the requirement of REJ as specified elsewhere in this specification.

4.08.00 Drift Eliminators

The drift eliminators shall be designed to keep the drift loss to a maximum of 0.001% of total water in circulation. The drift eliminators shall be of profile type and gluing is not allowed. The air pressure drop across the eliminators shall be kept to a minimum by providing proper

number of airflow direction changes across the eliminators. The water collected in the eliminators shall be returned to the tower basin and shall not mix with the discharge air system.

HOT WATER PIPING, VALVES, ACCESSORIES

Main header shall be branched into two (02) nos for feeding to each section of cooling tower. Two (02) **nos motor operated inching type butterfly valves** of suitable size shall be provided in branch pipe of each cooling tower. These valves shall be in the **horizontal** section of hot water piping and shall be overground. **After branch header isolation valves, the hot water pipe running along the air inlet side of CT shall be underground with suitable wrapping & coating.**

4.09.00 Recovery stack

Recovery stack shall be of proper shape to improve the fan performance. The height of the stack shall be sufficient to recover the velocity and discharge the humid air to a sufficiently high level to minimize recirculation. The maximum efficiency of the stack for velocity recovery to be considered for calculation of fan power consumption shall be 75%. No credit shall be given during bid evaluation for efficiency of the stack for velocity recovery beyond the specified efficiency. In case, Fan power consumption figure (quoted by the bidder) is derived considering higher velocity recovery, the same shall be corrected for evaluation purpose. A minimum clearance between the stack and fan blades shall be maintained along the entire periphery of the stack to prevent the rubbing of fan blades while rotating.

4.10.00 Fan Deck

4.10.01 Fan deck shall act as an access platform for the mechanical equipment.

4.10.02 Adequate access for roof deck, fan deck, distribution level, and drift eliminators shall be provided. For counter flow towers there shall be provision for access to water distribution level of each cell from tower roof deck or through stair case provided at each cased face of the tower. Walkways with platforms and suitable hand and knee rails and toe guards shall be provided inside towers.

4.10.03 Handrails shall be provided all around the periphery of the cooling tower fan deck. Pipes shall be of 32 NB (Medium class). Handrails provided elsewhere should also conform to the above specification.

4.11.00 Internal Walkways

For Cross Flow Towers: Walkways with permanents and suitable hand rails shall be provided inside the towers. The drift eliminators shall be easily accessible from these walkways. One door at each cased face of the tower shall be provided.

4.12.00 Staircase

For access up to the top (roof) of the cooling tower, two numbers of staircases one at each face of the tower shall be provided for cooling tower. The staircases shall be constructed adequately away from the face of cooling tower in order to prevent splashing of water on the stairs.

4.13.00 **Gearbox**

The fans shall be motor driven through suitable reduction gear. Flexible coupling shall be provided both at motor and reducer to minimize the effect of misalignment on account of any setting and/or warping. Flexible couplings should be pin and bush type. The support structure of the reduction gear shall be rigid. The reduction gear shall be heavy-duty type suitable for installation in outdoor and humid environment. The gear drive shall be of spiral bevel or worm type and the reduction may be accomplished in either single stage or multi stages.

4.13.01 The gearbox shall be of proven design. Design rating of the gear box shall be arrived at after considering a suitable service factor (min. 3.0) on motor rating. In selecting the gear box design rating the thermal derating effects at 50 degree C shall also be considered. Gearbox thermal rating shall be calculated considering max. Operating Gearbox Oil temperature which should be at least 5 deg C lower than the Permissible Gearbox Oil temperature. Detailed gear box

	sizing calculation shall be furnished for Employer's approval during detailed engineering. In no case, the design thermal rating of the gear box shall be less than 125% of the name plate kW rating of the selected drive motor. Also, the mechanical rating shall be checked so that minimum 25% margin is available at Pull Out Torque of the motor.
4.13.02	The piping for oil level gauge/dipstick and thermometer shall be arranged in such a way that oil can be drained and refilled from outside the stack. This pipe shall have proper supports at frequent intervals and shall be insulated. Further, a breather connection shall be provided in the gear box. The breather provided shall be such that it prevents moisture from entering the gear box. The breather arrangement and details of oil seals shall be to Employer's approval. Oil temperature gauge should be located outside the cell through a capillary tube, which is connected to gear box stub.
4.13.03	The gear box design should be such that the temperature of oil shall be within the manufacturer's recommended limits during all operating conditions.
4.13.04	The gear boxes shall utilize non-hygroscopic oil for lubrication so that its lubricating properties are not lost if contaminated with water vapor.
4.13.05	Each gear box shall be provided with a base plate. The vibration measurement sensors shall be mounted on the gear box. Vibration probe should not be mentioned on the inspection cover of the gearbox.
4.13.06	Bidder shall furnish the maximum temperature that the lube oil can withstand and shall guarantee the maximum value of lube oil temperature when the gear reducer is in operation.
4.13.06	Offered gearbox (minimum one no.) shall be tested at full load at manufacturer's own or any third party testing facility to demonstrate its thermal performance.
4.14.00	**Drive shaft**
	The drive shaft shall be of tubular construction. The design of the shaft shall take into consideration a factor of safety of 2 (minimum) over the torque to be transmitted at design duty conditions. The fan shaft shall be designed in such a way that the first critical speed shall be at least 120% of the operating speed of the shaft. Shaft design requiring intermediate bearings are not acceptable. The beams at fan deck level should be designed based on dynamic analysis. The bearings shall be of proven design and shall be suitable for operation in the humid condition prevalent in the fan stack. The minimum life of bearing shall not be less than 30,000 working hours. The drive shaft design shall be such that the fan blades should not be damaged in case of shaft failure.
	In case of Carbon fiber composite material, drive shaft shall have the following additional requirements.
	1) Shaft flanges shall be preferably of Carbon fiber composite material.
	2) Bonding between shaft and shaft flange shall be done by a proven method.
	3) The Carbon fiber composite material should be ultra violet ray stabilized.
4.15.00	**Fans**
4.15.01	Induced draught fans of suitable capacity shall be provided. Fans shall be axial/propeller type with blades, which can be adjusted so that pitch can be altered +/- 5 deg. from the normal setting. For adjusting the fan blades, graduated stop marks with suitable locking arrangements shall be provided on the hub so that all the blades can be set to the same angle accurately. The fan blades shall be easily removable. These shall be of aerofoil section and shall provide uniform air velocity from hub to tip with low noise and vibration. Fan shall be manufactured as per the processes listed below:
	i) Hand Moulded Seamless FRP fan blades using ballooning method. The method of hand moulding with parting plane is not acceptable.
	ii) Hand moulded FRP fan blades with PU foam core and hot forming.
	iii) Pultruded FRP fan blades.

4.15.02	Stack shall be provided to eliminate air turbulence in the throat area. Blades, shanks and hubs shall be suitably insulated to prevent electrolytic corrosion.
4.15.03	The number of blades shall not exceed twelve (12) and the blade tip velocity shall not exceed 65 m/Sec. Each fan shall be driven by an electric motor.
4.15.04	Fans to be supplied for this package shall be of proven design and make and shall be subject to approval of Employer.
4.15.05	Fan for each cooling tower cell shall be sized (fan design point at test block) to have at least 5% margin on flow and min 10% margin on total head over and above the maximum cooling tower fan air flow and total head required (cooling tower fan duty point), to meet the specified / guaranteed cooling tower performance. Bidder shall submit detailed cooling tower fan calculation, characteristic curves etc. for the fan sizing as per the above.
4.15.06	A scaled down model test of the fan offered shall be carried out by the contractor at the fan supplier test facility or at any other identified/recognized fan test facility to establish the rated parameters such as efficiency, power consumption etc. of the fan. Scale of model shall be minimum 1:10. The test should be carried out prior to start of manufacturing of the fan and shall be conforming to requirement of ANSI/AMCA A 210 or equivalent code.
4.16.00	**FAN MAINTENANCE FACILITIES**
4.16.01	For maintenance of drive equipment (Fan, motor, gear reducer, etc.) following arrangements shall be furnished.
4.16.02	Each cell of cooling tower shall be provided with a monorail. In addition 3 numbers of manually operated chain pulley blocks along with travelling trolley for each of the cooling towers shall be provided. The capacity of the hoist shall be such as to be able to lift the heaviest portion of the fan motor assembly, but in no case less than 2.0 MT. Out of these specified numbers of monorail hoists, one will be used to lift equipment from ground level to tower top and accordingly the lift shall be provided. Balance two numbers of hoists shall be used for handling equipment for two (2) numbers of cells simultaneously during maintenance. The lift of these two (2) hoists shall be selected accordingly. In addition to the above a hand trolley which is sized to carry the heaviest and largest single piece of equipment shall also be provided for the cooling tower. This trolley will be used on the fan deck to transport equipment from each cell to and from the end of tower where the monorail hoist is located to lift equipment from ground level to tower top. For cross flow type of tower care shall be taken so that the equipment to be lifted does not need to be carried over the distribution basin. Suitable platforms/ scaffoldings (for at least 2 fans) for doing maintenance work in situ for gear reducer, fan and motor shall also be provided in addition to permanent walkways as specified elsewhere in the specification.
4.16.03	Alternative arrangements are also acceptable, if the arrangement provided is adequate to carry out maintenance on at least two cells of the tower simultaneously. In such a case, the complete equipment for easy removal of equipment from fan flume and bringing it down to ground level shall be furnished. The arrangement proposed shall be clearly brought out in the offer by the bidder.
4.17.00	**FAN MOTOR** Each electric motor shall be provided with a base plate and a base frame. Fan motor shall have at least 10% margin over the maximum power requirement of the fan when the fan is operating at its test block condition and at 50 deg. C ambient temperature as required at gear box input end.
4.18.00	**STOPLOG GATE AND HANDLING FACILITY** For isolation of the cold-water basin of the tower, groove for steel stop log gate shall be provided in the cold-water outlet channel of each tower. Number of stop logs to be supplied by bidder shall be as mentioned in the civil section. The minimum thickness of skin

	plate shall be 8 mm. The structural design of the stop log gate shall generally conform to relevant IS codes. The gate shall be painted with corrosion resistant paint.
	To handle the stop log gate a monorail beam at sufficient height shall be provided across each cold-water channel. A hand operated chain pulley block with travelling trolley of adequate capacity to handle the stop log gate shall be provided for each tower. The capacity of the hoist however shall in no case be less than 125% the weight of the stoplog gate.
4.19.00	**Torque Tube Support (in case of Pultruded FRP Tower)**
	The torque tube support shall be designed to stabilize the fan within the fan cylinder and maintain constant alignment between the motor and gear reducer. The pipe, heavy angles and plates shall be hot dip galvanized after assembly. It shall be properly fastened to the structure.
5.00.00	**MISCELLANEOUS**
5.01.00	Necessary stub connections for pitot tube shall be provided in the hot water header of cooling tower for measurement of flow.
	Any special equipment tools and tackles required for the successful completion of the Performance & Guarantee Test shall be included by the bidder in his scope.
6.00.00	**TESTS AT SITE**
	After Installation at site, the complete systems/equipment will be operated at site to show satisfactory performance as required by the applicable clauses of the specification. Further, all piping shall be hydraulically tested at site.
7.00.00	**PG Test**
7.01.00	Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.
7.02.00	The cold water temperature as specified in technical data sheets shall be guaranteed for the design conditions of CW flow, range, ambient WBT specified in technical data sheet and design power consumption indicated by the bidder.7.03.00 COOLING TOWERS
	The test circulating water flow shall be corrected for change in test fan power consumption as compared to the design fan power consumption using the cube root formula. “Predicted cold water temperature” shall then be arrived at from the guaranteed cold water temperature by correcting the same for the test conditions of range, ambient conditions and corrected circulating water flow using the performance curves furnished by the contractor. In case the “Test cold water temperature is higher than the “Predicted cold water temperature”, Employer reserves the right to reject/accept the tower after assessing the liquidated damages. The liquidated damages for not meeting the guarantee(s) have been specified elsewhere.
7.04.00	The performance test of one of the Cooling Tower shall be carried out by the Contractor through CTI approved/listed testing agency in presence of Employer. The testing agency proposed by the Contractor shall be approved by the Employer. The tower to be tested through CTI testing agency shall be decided / chosen by Employer. For the balance cooling towers, the demonstration performance test shall be conducted as per the same approved PG Test procedure by the contractor himself or by experienced reputed third party. In no case, the thermal performance of these towers should be less than that of the tower tested by CTI agency. In case it is found to be less, the contractor shall take appropriate measures and correct the tower to improve its performance at least up to the level of performance of tower tested by CTI agency, failing which the contractual obligation will not be completed.
	The data logged in the data logger shall be given to EMPLOYER in soft form for reference immediately after the test, which should be readable in EMPLOYER computer. In case, any software is required, the same shall be supplied to employer without any extra cost to employer. The CTI agency shall simultaneously submit their final report to both Contractor as well as the client (EMPLOYER).

7.05.00	To ascertain the fulfillment of Guarantees of the Cooling Towers, the test results of the tower tested through CTI approved testing agency shall be considered for PG test evaluation and based on the test result, the liquidated damage if applicable shall be levied for all the Cooling Towers.
7.06.00	The indicative PG test procedure to be followed as per PG test procedure chapter.
8.00.00	**CONTROL & OPERATION PHILOSOPHY**
8.01.00	This control write-up/ operation philosophy details the control / operation requirements of cooling tower fans as a general guideline only and the contractor shall furnish his proposed philosophy during detailed engineering for approval of the Employer.
8.02.00	Modes of Operation: The fans can be started in SOLO mode or in GROUP mode. The selection for individual and Group operation shall be made from OWS. Further, any of the fan can be put either in STANDBY mode or NOT IN STANDBY mode. (i) Group Mode START In Group Mode: On receipt of the GROUP START command from OWS, all pre-selected fans (except for the fans selected as "STANDBY") would start sequentially one after another after pre-defined time gap between start of the fans. STOP in GROUP Mode: On receipt of the GROUP STOP command from OWS, all the running fans will be tripped simultaneously. GROUP STOP command will have priority over and already executing GROUP START command. (ii) SOLO Mode: In the OWS, for each individual FAN, a separate START/STOP Button will be provided. The START button will be enabled only when the SOLO mode is selected. A fan can be started in SOLO mode immediately by pressing the START button. The fan can be stopped either by pressing the STOP push-button (of the corresponding Fan) or GROUP STOP button.
8.03.00	Interlock and Protection Following are the Start-up permissive for the fans: 1. MCC Healthy 2. Oil Level Not Very Low 3. Emergency PB not pressed 4. Gear box oil Temperature not high Following are the protections for Fan tripping: 1. Oil Level Very Low 2. Emergency PB Pressed 3. Vibration Very High 4. Motor Overload 5. Gear box Temperature very high Control System shall issue OPEN/CLOSE command for Electrical Breaker operation and monitor status. Necessary interlocks finalized during detailed engineering shall be implemented.

The close status of butterfly valves and the ON/ OFF /TRIP status of fans shall be indicated in OWS. Operator shall be alerted through audio visual indication during the condition when the fan of any cell is ON and the corresponding cell isolation valve is closed or vice-versa.

BHEL	TECHNICAL SPECIFICATION IDCT SIPAT SUPER THERMAL POWER PROJECT STAGE-III (1X800 MW)	PE-TS-520-YYY-HZZZ Issue No: 01 Rev. No. 00 Date :24.10.2024

TECHNICAL DATA - PART - A (ELECTRICAL)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Three phase induction motors :		IS15999, IEC:60034, IS: 12615, IS: 325
1.2	Single phase AC motors		IS:996, IEC:60034
1.3	Energy Efficient motors		IS 12615, IEC:60034-30
1.4	Crane duty motors		IS:3177, IS/IEC:60034
1.5	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity		IS 12075/IEC 60034-14
1.6	Designation of Methods of Cooling of Rotating Electrical Machines		IS 6362
1.7	Designation for types of construction and mounting arrangement of rotating electrical machines		IS 2253
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	Rated voltage	V	415
2.2	Frequency	Hz	50
2.3	Permissible variations for		
a)	Voltage	%	+/-10
b)	Frequency	%	(+)3 to (-)5
c)	Combined	%	10 (absolute sum)
2.40	System fault level at rated voltage for 1 sec	kA	50
2.4	Short time rating for terminal boxes for 0.25 sec	kA	50
2.5	Type of motors		a) Squirrel cage induction motor suitable for direct-on-line starting (for non- VFD motors). b) Motor operating through VFD shall be suitable for inverter duty with VPI insulation.
2.6	Efficiency class		*Continuous duty LT motors upto 50 KW Output rating (at 50 deg.C ambient temperature), shall be super Premium Efficiency class-IE4, 50-200 KW shall be of Premium Efficiency class – IE3,conforming toIS 12615, or IEC:60034-30.*
2.8	Rating		
a)	Motor duty		Continously rated-S1
b)	Design margin over continous max. demand of the driven equipment (min)		10%
3.0	**CONSTRUCTION FEATURES**		
3.1	Winding		Electrolytic grade Copper conductor
3.2	Enclosure Details		
a)	Degree of protection		
	i) Indoor motors		IP 55
	ii) Outdoor motors		IP 55

b)	Method of ventilation		Totally enclosed fan cooled (TEFC) or totally enclosed tube or ventilated (TETV) or Closed air circuit air cooled (CACA) type.
3.3	Insulation		Class 'F' with temperature rise limited to class 'B'. Non-hygroscopic, oil resistant, flame resistant Insulation.
3.4	Bearings		Grease lubricated ball or roller bearings for Horizontal motors Grease lubricated ball or roller bearings or combined thrust and guide beaing for Vertical motors.
3.5	Main terminal box		
a)	Type		-Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation. -Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame. - The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
b)	DOP		Same as motor
c)	Position when veiwed from the non driving end		Left hand side
d)	Rotation		90 Deg.
e)	Space heater		Motors rated 30KW and above shall have space heater suitable for 240V, 50 Hz single phase AC supply. Separate terminal box for space heaters & RTDs shall be provided.
f)	Cable glands and lugs		-Motor terminal box shall be furnished with Solder less crimping type heavy duty Lugs (aluminium lugs for aluminium cables and copper lugs for copper cables) and double compression Ni-Cr plated brass glands to match with cable used. -Gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
3.6	Earthing points suitable for conenction		Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
3.7	Paint shade (Corrosion proof paints of colour shade)		RAL 5012 (Blue) The thickness of finish coat shall be minimum 50 microns (minimum total DFT shall be 100 microns). However, in case electrostatic process of painting is offered. minimum paint thickness of 50 microns shall be acceptable for finish coat.Epoxy based paint with suitable additives shall be used.

3.8	The spacing between gland plate & centre of bottom terminal stud		UP to 3 KW As per manufacturer's practice. Above 3 KW - upto 7 KW 85 Above 7 KW - upto 13 KW 115 Above 13 KW - upto 24 KW 167 Above 24 KW - upto 37 KW 196 Above 37 KW - upto 55 KW 249 Above 55 KW - upto 90 KW 277 Above 90 KW - upto 125 KW 331 Above 125 KW-upto 200 KW 385/203 (For Single core cables only)
3.9	Minimum inter-phase and phase-earth air clearances with lugs installed		UP to 110 KW 10mm Above 110 KW and upto 150 KW 12.5mm Above 150 KW 19mm
4.0	**PERFORMANCE PARAMETERS**		
4.1	Starting requirement		
a)	Minimum permissible voltage as a percentage of rated voltage, at start to bring the driven equipment upto the driven equipment upto rated speed		a) Up to 85% of rated voltage for ratings below 110 KW b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW
b)	Maximum locked rotor current		as per IS 12615
c)	Starting duty		Two hot starts in succession, with motor initially at normal running temperature.
d)	The locked rotor withstand time under hot condition at highest voltage limit		a) atleast 2.5 secs. more than starting time(for motors with starting time upto 20 secs. at minimum permissible voltage during starting) b)atleast 5 secs. more than starting time(for motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting) c) more than starting time by at least 10% of the starting time(For motors with starting time more than 45 secs.at minimum permissible voltage during starting) Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
e)	The ratio of locked rotor KVA at rated voltage to rated KW		(a) Below 110KW : 11.0 (b) From 110 KW & upto 200 KW : 9.0
4.2	Torque (percent of full load torque)		1] Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. 2]Pull out torque at rated voltage shall not be less than 205% of full load torque.
4.3	Noise level (max.)		85 dB(A)
4.4	Vibration shall be limited within the limits		as per IS:12075/IEC 60034
5.0	**INSPECTION/TESTING**		

5.1	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed 3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip 5. Temperature rise test 6. Momentary excess torque test. 7. High voltage test 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Overspeed test.		
5.2	The type test listed above should have been conducted within 10 yrs prior to supply under this contract. In absence of type tests reports or in case reports are not found to be meeting the specification/standards requirements, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval.		
5.3	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.		
5.4	All acceptance and routine tests as per the specification and relevant standards shall be carried out.Charges for these shall be deemed to be included in the equipment price.		
5.5	For motor rating upto 50 KW, BHEL QP No. PE-QP-999-Q-006 Rev 02 is to be followed. For motor ratings above 50 kW NTPC Quality assurance plan will be followed.		

ANNEXURE- IV

1.0 LIGHTING SYSTEM DESIGN:

1.1 The illumination system shall be designed to ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period.

1.2 All fixtures shall be of a proven design for applications in power plant environment.

1.3 **LED LUMINAIRES**

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas. LED luminaires shall be surface mounting type.

The individual lamp wattage for LED shall be min 3 watt. Fractional wattage LEDs can also be provided. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 100 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be " cool day light" (min 5700K) type for indoor areas.For outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. LED shall conform to the LM 80 requirements.

The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaire.

Care shall be taken in the design that there is no water stagnation anywhere in the housing of the luminaire. The entire housing shall be dust and water proof protection as per IS 12063.

1.4 **DRIVER CIRCUIT-**

LED driver shall be integral type. LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer.
LED drivers shall have following control & protection:

(i) Suitable precision current control of LED
(ii) Open circuit protection
(iii) Short circuit protection
(iv) Over temperature protection
(v) Overload protection
(vi) Surge Protection

1.5 The lighting fixtures in the plant area shall be group controlled from lighting panel. Lighting panel (LP) shall be provided with synchronous timer with additional provision to bypass the timer.

1.6 All outdoor fixtures shall be weather proof and of min. IP65 degree of protection.

1.7 Junction box for lighting shall be made of fire-retardant material. Material of JB shall be thermoplastic or thermosetting or FRP type. Degree of protection shall be IP55.

1.8 **LIGHTING PANELS-**

Lighting panels shall be constructed out of 2 mm thick CRCA sheet steel. The door shall be hinged and the panel shall be gasketted to achieve specified degree of protection. Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have min. IP55 degree of protection.

All MCBs/Isolators/Switches/Contactors etc. shall be mounted inside the panel and a fibre glass sheet shall be provided inside the main door such that the operating knobs of MCBs etc., shall project out of it for safe operation against accidental contact.

Terminal bocks shall be 1100 V grade, clip-on stud type, made up of polymide 6.6 or better suitable for terminating multicore stranded aluminium conductor incoming cable and 10 Sq. mm. stranded aluminium conductor for each outgoing circuits voltage. All terminals shall be shrouded, numbered and provided with identification strip for the feeders.

MCB's shall be current limiting type with magnetic and thermal release suitable for manual closing and automatic tripping under fault condition. MCB's shall have short circuit interrupting capacity of 9 KA rms. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping on fault even if the knob is held in ON position. MCB terminal shall be shrouded to avoid accidental contact.

Contactors of AC lighting panels shall be 3 no's,63 A, single pole continuous duty MCB, with neutral link,load make-break type suitable for 415 V, 3 phase 4 wire system.

Programmable Digital Timer shall be Electronic Astronomical Almanac Time switch with battery backup of min. TEN years, 4 Digit LED display, 24 hours range, manual override facility, 10 Amp 3 relay output, with NO/NC Contacts suitable for operation on 240V single phase AC supply.

Lighting Panels shall have 20% spare outgoing feeders.

2.0 ILLUMINATION DESIGN CALCULATION:

The following average illumination levels shall be achieved and guaranteed by the contractor after considering maintenance factor of not more than 0.6.

AVERAGE LUX LEVEL & TYPE OF FIXTURES			
S. NO.	LOCATION	AVERAGE LUX LEVEL	TYPE OF LIGHTING FIXTURES
1	AC Normal LIGHTING		
(i)	On equipment	150	LED Luminaire
(ii)	General area on fandeck	50	LED Luminaire
(ii)	Stairways and landings	100 Lux [minimum one (1) light fixture at each landing]	LED luminaire
(iii)	Building Periphery Lighting	10	LED Street Light fixture/ LED Luminaire

3.0 LIGHTING SYSTEM DESCRIPTION

Lighting system for IDCT will be provided with normal supply from lighting distribution boards / switchboard MCCs.AC Normal lighting will provide 100% illumination level and normally all AC lighting fixture shall remain 'ON' as long as normal AC supply is available.
AC Normal lighting fixtures are fed through a number of conveniently located AC Lighting panel (ACLP) which are fed from Lighting Distribution Board (LDB).

Each Lighting DB shall have 2x100% transformers. LDBs shall consist of dry type isolation transformer housed in LDB with proper separation from distribution panels.

AC normal lighting panel as per details given below is envisaged:

Incomer type: TPN MCB
Incomer rating: 63A
Outgoing feeder type: SP MCB
Outgoing feeder rating: 20A
Short circuit rating: 9kA
No. of outgoing feeders: 6/12/18 (as per loading requirement of the area where LP is installed)
On/off control: With synchronous timer (for outdoor LP)
20% spare outgoing feeders will be provided for lighting panels.

4.0 LOW VOLTAGE POWER SERVICES

4.1 Industrial receptacle: At least 01 no. 20A, 3-Pin, 240V AC industrial type receptacle with switch will be provided at suitable location for each IDCT. These receptacles will be controlled with a switch. Industrial receptacle will be fed from LP.

4.2 Welding receptacle: 63A, 3-phase, 415V AC welding receptacles with isolating switch will be provided at specific points near all major equipment and at an average distance of 50m (location will be decided during detailed engineering). Maximum 04 nos. receptacles will be fed through one feeder.

4.3 Receptacles boxes shall be fabricated out of 2 mm thick MS steel hot dip galvanized or of not less than 2.5 mm thick die-cast aluminium alloy or fabricated out of 2 mm thick CRCA sheet with electro static powder coating.

4.4.Welding receptacles shall be fed directly from nearest BHEL ACDB/MCC. (Feeder for same is to be specified in load data in format attached with this specification).

5.0 WIRING / CONDUITS

5.1 LDB to LP, cables shall be used. LP to downstream lighting system, wires shall be used. Wiring of lighting system will be done as follows:

(i) Wiring installation will be done by multi-stranded, PVC insulated, unsheathed, copper, colour coded wires laid in GI conduits conforming to IS-9537. Colour of the PVC insulation of wires shall be Red, Yellow, Blue, black for R, Y, and B phases & neutral respectively and white & grey for DC positive & DC negative circuits respectively.
(ii) Following sizes of 1100 V grade, PVC insulated, single core, stranded copper conductor wires will be used-
Lighting Panel to JBs: 2.5 sq. mm (Cu) wire
JBs to LED light fixtures: 1.5 sq. mm (Cu) wire
5.2 Welding receptacles shall be connected to BHEL ACDB/MCC by cable.

5.3 **Conduits-**

(i) Conduits will be heavy-duty type hot dip galvanised steel conforming to IS-9537 with 20 mm dia size (minimum). The thickness of conduits up to & including 25 mm dia will be 1.6 mm and conduits above 25 mm will be 2.0 mm.
Conduit accessories will be hot dip galvanised. In corrosive area, conduits will have suitable epoxy coating additionally.
(ii) Flexible conduits shall be water proof and rust proof made of heat resistant TERNE coated steel.
(iii) Conduits shall be threaded on both sides and thread length shall be protected by zinc rich paint.
(iv) Pull out boxes shall be provided at suitable interval in a conduit run. Boxes shall be suitable for mounting on Walls, columns, structures etc. Pull-out boxes shall have cover with screws and shall be provided with good quality gasket lining. Pull-out boxes used outdoors shall be weather proof type suitable for IP-55 degree of protection and those used indoor shall be suitable for IP-52 degree of protection. Pull-out boxes and its cover shall be hot dip galvanised.
(v) Filling area of wires in conduit shall not exceed 40% of the conduit area.
(vi) Lighting and receptacles will be fed from separate circuits. No two different phase circuits will be run in the same conduit. However, different circuits of same phase may be laid in the same conduit.

6.0 EARTHING

Earthing of lighting system will be done by using of following sizes of wire / flat:

Lighting Distribution Board	GS Flat 50X6 mm (two earthing leads)
Lighting panels	GS Flat 25X3 mm (two earthing leads)
Lighting fixtures,receptacles,conduits, junction boxes & switch boxes	14 SWG GI Wire (one earthing lead)
Welding receptacles	GS Flat 50X6 mm (two earthing leads)
Lighting pole	GS Flat 25X3 mm (one earthing leads)
Electrode for pole	1 no. 40 mm dia MS Rod, 3 mtr long

7.0 STATUTORY & REGULATORY REQUIREMENT

Statutory and regulatory regulation shall be applicable as per Indian Electricity Rule, 1956 with amendment-3 Rule no. 35, 48, 49, 50, 61 & 64 for illumination & low voltage power services.

8.0 TYPE TEST REPORTS

Type test reports of Lighting fixtures/Lighting panel/Junction boxes/LED/LED chip as per relevant Indian standards shall be submitted for approval if required by the ultimate customer.

	TECHNICAL SPECIFICATION INDUCED DRAFT COOLING TOWER 1 X 800 MW NTPC SIPAT STPP Stage-III	PE-TS-520-165-W001 Rev. No. 00 Date : 05/11/2024

TECHNICAL DATA - PART - A (CONTROL & INSTRUMENTATION)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Impulse pipes, tubes (material, rating)		ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
1.2	Valves (material, pr. Class, size)		ASTM A182/ASTM A105 as per ASME 16.34
1.3	Fittings (size, rating, material)		ANSI B31.1, ANSI B31.1a, ASME B16.11
1.4	Installation schemes		BS 6739-2009, ANSI/ISA 77.70
1.5	Fieldbus concepts		IEC 61158
1.6	Instruments and apparatus for pressure measurement		ASME PTC19.2 (1964)
1.7	Bourdon tube pressure and vacuum gauges		IS-3624
1.8	Instrument and apparatus for temperature measurement		ASME PTC 19.3(1974)
1.9	Temperature measurement by electrical Resistance thermometers		IS:2806
1.10	RTD Sensor		IEC-751/ DIN-43760
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	**SPECIFICATIONS - PRESSURE GAUGE**		
	Sensing element		Bourdon for high pressure, diaphragm/bellow for low pressure
	Sensing element material		SS316
	Movement material		SS316
	Body material		SS316
	Dial size	mm	150mm
	End connection	inch	1/2 inch NPT (m)
	Accuracy	%	±1% of span
	Scale		Linear, 270° arc graduated in metric units
	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
	Range selection	%	Cover 125% of max. of scale
	Diaphragm seal material		Suitable for process fluid
	Diaphragm fill fluid		Inert liquid
	Wetted parts		All wetted parts upto diaphragm seal shall be suitable for process application
	Housing		IP-55
	Zero/span adjustment		External
	Accessories		Blow out disc, siphon, snubber, pulsation, dampener, chemical seal, gauge isolation valve
2.3	**SPECIFICATIONS - LEVEL SWITCH**		

	Repeatability	%	+/-0.5% of full range
	No. of contacts		2 No.+2NC. SPDT snap action dry contact
	Rating of contacts	V, VA	60 V DC, 6 VA
	Elect. Connection		Plug in socket.
	Set point adjustment		Provided over full range.
	Dead band adjustment		Adjustable/ fixed as per requirement of application.
	Enclosure		IP-55, metallic housing.
	Power Supply	V	24V DC
	Sensing Element		Float type, conductivity type, Ultrasonic type as per suitability to the application
	Material		316 SS
	End connection		Manufacturer standard
	Over range/ proof pressure	%	150% of maximum operating pr.
	Accessories		All mounting accessories
2.4	**SPECIFICATIONS - TEMPERATURE GAUGE**		
	Body Material		Die-cast aluminium
	End connection		3/4" NPT (M)
	Accuracy	%	± 1% of span
	Dial Size	mm	150 mm
	Scale		Linear, 270° arc graduated in °C
	Range selection	%	Cover 125% of max. of scale
	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
	Housing		IP-55
	Zero/span adjustment		Required
	Accessories		SS Thermowell
2.5	**SPECIFICATIONS - TEMPERATURE TRANSMITTER**		
	Transmitter Type		Profibus PA complying to IEC 61158 with EMC compatibility as per EN 61326, Dual input (Trip/Protection), Single Input (other application)
	Compatibility		fully compatible with RTDs
	Protection Class		IP-67
	Display		Integral digital display
	Diagonstic feature		self-indicating diagnostics
	Operating ambient temperature (with display)	DegC	70 deg C
	Operating ambient temperature (without display)	DegC	85 deg C
	Electrical Connection	inch	1/2” NPT(F)
	Composite Accuracy	%	RTD =<0.25% of 0-250 deg C span
	Changeover facility		Bump less changeover to second sensor in case first sensor fails with alarm facility.

	Composite accuracy Calculation		Accuracies of temperature transmitter for converting sensor input to output + temperature effect on these accuracies at ambient temperature of 50 deg C (based on the figure/ formula given in the standard product catalogue for span as specified for RTD).
	Emergency/failure Measures		In case of failure (open or burn-out) of RTD, transmitter shall provide low temperature output.
2.6	**SPECIFICATIONS - RESISTANCE TEMPERATURE DETECTOR (RTD)**		
	Type		Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
	No. of element		Duplex
	Housing		Diecast Aluminium
	Protection Class		IP-65
	Head		Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter
	Plug in connectors		Required
	Terminal head		Spring loaded for positive contacts with the thermo well
	Insulation and sheathing		Mineral (magnesium oxide) insulation and SS316 sheath
	Calibration and accuracy		As per IEC-751/ DIN-43760 Class-A for RTD
	Accessories		Thermo well and associated fittings
2.7	**SPECIFICATIONS - THERMOWELL**		
	Design		One piece solid bored type of step-less tapered design
	Material		SS316
2.8	**SPECIFICATIONS - WIND SPEED SENSOR**		
	Principle		Frequency proportional to wind speed
	Range	m/sec	0-60 m/ sec
	Accuracy	%	2 % of full scale
	Threshold	m/sec	0.3 m/ sec
	Operating Temperature	DegC	0 to 50 deg C
2.9	**SPECIFICATIONS - WIND DIRECTION SENSOR**		
	Principle		Potentiometric type Sensor proportional to Wind direction
	Range	Degree	0-360 degree
	Accuracy	%	2 % of full scale
	Threshold	m/sec	0.3 m/ sec

	Operating Temperature	DegC	0 to 50 deg C
2.11	**SPECIFICATIONS - LIMIT SWITCH**		
	Operating voltage Range		10-40 V DC
	Sensing system		Inductive Proximity type , 2 Wire
	Sensor Contact Type		NO
	Reverse polarity and short circuit protection		Yes
	IP Class-Sensor		IP67
	IP Class-Enclosure(Switch box)		IP67
	Cable entry-Enclosure(Switch box)		2 no-1/2" NPT
	Casing material-Sensor		Brass /SS
	Enclosure(Switch box) Housing material		FRP or SS
	Operating Ambient temp(sensors)	DegC	-5 to 70 deg C
	Max allowed Voltage Drop across sensor	V	5 V
	Standard applicable		EN 60947-5-2 or equivalent.
	Applicable for		Manual valves and solenoid operated on-off valves
	Corrosion resistance		Silver plated with high conductivity and non corrosive
	Protection class		IP 55
	Contact rating		shall be sufficient to meet the requirement of DCS subject to a minimum of 60 V, 6 VA rating
2.12	**SPECIFICATIONS - JUNCTION BOX**		
	No. of ways		12/24/36/48/64/72/96/128
	Material and Thickness		4mm thick Fiberglass Reinforced Polyester (FRP)
	Type of terminal blocks		Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm2. A M6 earthing stud shall be provided.
	Protection Class		IP- 55 min. for indoor & IP-65 min for outdoor applications.
	Grounding		To be provided
	Color		RAL 7035
	Spare Terminals		At least 20% unused terminals
2.13	**Impulse piping for water area/equipment**		
	Painting color scheme		Grey RAL 9002
	Identification Tag/band color scheme		Sea green, ISC no. 217
2.14	**Impulse piping for Oil area**		
	Painting color scheme		Grey RAL 9002
	Identification Tag/band color scheme		Light Brown, ISC no. 410
2.14	**Temperature Switch**		

		Sensing Element		Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (5 m minimum, to suit application) 61158, digital output
		Material		Bulb 316 SS/ capillary 304 SS
		End connection		½ inch NPT (F)
		Repeatability		+/- 0.5% of full range
		No. of contacts		2 No.+2NC. SPDT snap action dry contact
		Rating of contacts		60 V DC, 6 VA (or more if required by DDCMIS)
		Elect. Connection		Plug in socket.
		Set point adjustment		Provided over full range.
		Dead band adjustment		Adjustable/ fixed as per requirement of application.
		Enclosure		Weather and dust proof as per IP-55, metallic housing
		Accessories		Thermo well of 316 SS and packing glands
		Mounting		Suitable for rack mounting or direct mounting
	Notes:	1) Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.		
		2) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.		
	2.15	**DATASHEET - MOTORISED VALVE ACTUATOR**		
	2.15.1	**General**		
		Duty		☐ On / Off ☐ Inching
		Valve type		☐ Globe ☐ Gate ☐ Reg. Globe ☐ Butterfly
		Ambient condition		Shall be suitable for continuous operation under an ambient temp. Of 0-60 deg c and relative humidity of 0-95%
	2.15.2	**Construction and sizing**		
		Construction		Totally enclosed weather proof, minimum IP:68
		Mechanical position indicator		To be provided for 0-100% travel
		Bearings		Double shielded, grease lubricated anti-friction.
		Gear train for limit switch/torque switch operation		Metal (not fibre gears). Self-locking to prevent drift under torque switch spring pressure when motor is de-energized.
		Sizing		Open/close at rated speed against designed differential pressure at 90% of rated voltage. For isolating service three successive open-close operations or 15 mins. Whichever is higher. **For inching service - 150 starts/hr or required cycles whichever is higher.**

	2.15.3	**Handwheel**		
		Required		■ Yes ☐ No
		Orientation		☐ Top Mounted ☐ Side Mounted
		Additional requirement		To disengage automatically during motor operation.
	2.15.4	**Electric actuator**		
		Motor type		Squirrel cage induction motor suitable for Direct On-Line (DOL) Starting
		Power supply to motor / starter		415V +/- 10%, 3 Ph, 3W & 50Hz +/- 5%
		Control voltage requirement		To be derived from the Power Supply to the Starter ☐ 230 V ■ 110 V AC / 24 V DC
		Enclosure class of motor		IP 68
		Insulation class		Class F. Temperature Rise 70 Deg C. Over 50 Deg C Ambient
		Winding temp protection		Thermostat (3 Nos.,1 In Each Phase)
		Single phasing protection & wrong phase sequence protection		Required, suitable means shall be provided to diagnose the type of fault locally.
	2.15.5	**Integral starter**		
		Integral starter		Required with built in SPP (Single Phasing Preventer)
		Type of switching device		■ Contactors ☐ Thyristors
		Type		Non-Intrusive Profibus Actuator
		Feature		All actuator settings including torque, limit shall be possible without opening the actuator cover.
		If smart		
		A) Serial link protocol		☐ Foundation Field-Bus ■ Profibus DP
		B) Redunadant profibus DP port		Required
		C) Hand held programmer		Required
		D) Profibus DP cable connection		Suitable connector integral to the actuator, or external devices/ accessories (mounted inside minimum IP65 protection class enclosure) shall be provided so that the actuator can be isolated online from the profibus network without disturbing the profibus communication of other actuators of the segment.
		E) Open/Close command termination logic		Shall be suitably built inside actuator
		F) GSD and DTM files		To be provided which shall be configured/ tested with DCS for proper interfacing and diagnostics
		G) Available signals to DCS (through profibus network)		Open/ close commands, open/ close feedback status, disturbance signal etc. along with diagnostics. The detailed diagnostics including the actuator operating data shall be available to the DCS
		Step down cont. Transformer		Required

		Open / close PB		Required
		Stop PB		Required
		Indicating lamps		Required
		Local remote s/s		Required (Lockable)
		Status contacts for monitoring		Required
	2.15.6	**Position/ torque transmitter**		
		Position/torque transmitter		i. Position/limit measurement shall be done using absolute encoders which will give information of position/limit in both the directions.
				ii. Electronic measurement of torque shall be provided.
		Supply		24V DC
		Accuracy		+ 1% FS
	2.15.7	**Space heater**		
		Space heater		Required
		Power supply (non integral)		230V AC,1 Ph.,50 Hz
		Power supply (integral)		Power supply derived from main power supply available at actuator end
	2.15.8	**Terminal block**		
		Actuator/motor terminal block		Required. For power cables, the grade of TBs shall be minimum 650V
		Terminals / connectors		Suitable terminals/ connectors, integral to actuator, for terminating fieldbus cables and power cables shall be provided
		Earthing terminal		Required (2nos.)
	2.15.9	**Cable glands**		
		Type		Double Compression
		Material		Brass Material
		Armored fieldbus cable glands		Required
		Power cable glands		Required
	2.15.10	**Wiring**		Suitable voltage grade copper wire
	2.15.11	**LCD Display**		
		LCD Indication		Integral to actuator body
		Local display information		Regarding actuator alarms, status and valve position indications as a minimum.
	2.15.12	**Motor considerations**		
		Power Supply		shall operate satisfactorily under the +/- 10% supply voltage variation at rated frequency, -6% to +4% variation in frequency at rated supply voltage, simultaneous variation in voltage & frequency the sum of absolute percentage not exceeding 10%.
	2.15.13	**SIL certification**		SIL2

	2.15.14	**Accessories**		
		Accessories for calibration / settings / configuration of various parameters of actuator		Required
	2.16	**DATASHEET - LOCAL CONTROL PANEL**		
	2.16.1	**Construction**		
		Type		Skid mounted
		Construction		Folded
		Devices & equipments		Panel enclosure, secondary instruments, annuniciation system, selector switch, push buttons, indicating lamps/ led cluster, relays, MCBs, clamp on terminals, plug socket, panel light, space heater, nameplate, earth bus
		Enclosure sheet material		Cold rolled sheet steel
		Enclosure sheet thickness		Minimum 3.0 mm for load bearing sections (mounted with instruments)
				2.0 mm for doors
				Minimum 2.0 mm for other sections
		Height		Minimum 1100 mm
		Frame thickness		Minimum 3.0 mm
		Internal plate thickness		2.5 mm
		Gland plate thickness		3.0 mm
		Cable gland		Double compression
		Base channel		ISMC 100 with anti-vibration mounting & foundation bolts
		Class of protection		IP-55
	2.16.2	**Doors**		
		Rear doors		Required with integral lockable handle
		Door locking		Door when locked shall be held at minimum three places.
		Type		Removable type with concealed hinges to facilitate maintenance work
		Suitable pocket inside the door		Required for keeping the drawings / documents
		Double door		Required with suitable glass windows as per the requirement.
	2.16.3	**Power & control supply**		
		Input power supply		415V 3 phase AC
		No. Of feeders		Two
		Control supply		230v ac
		Additonal requirement for control supply		MCBs
				Supervisory relay along with a pilot lamp to indicate control supply 'on'
				Auto changeover unit mounted on panel
	2.16.4	**Internal wiring**		
		Voltage	V	1100 V

		Material & size		PVC insulated copper multi strand wire /flexible of 1.5mm2, power cable 2.5sqmm
		Routing and runs		Through PVC troughs, AC & DC wires shall be kept separately
		Colour		Separate colours for AC & DC wires
		Ferruling		Cross ferruling
	2.16.5	**Painting details***		
		Painting shade & thickness - exterior / interior (these details shall be finalised during		RAL 5012 & minimum 85 microns / glossy white & minimum 70 microns
	2.16.6	**Gasket**		
		At door & removable cover		Neoprene
	2.16.7	**Ventilation system along with louvers**		
		Cooling fan		2 x 100%, covered with removable wire mesh
	2.16.8	**Terminal block**		
		Type		Clip on, separate for AC & DC circuits
		Voltage		1100 V
		Tb points		Cage clamp
		Mounting height from finished floor		>=250 mm
		Spare		20%
		Identification strip		To be provided
	2.16.9	**Illumination**		
		Light		Led tubelight
		Shrouded cover	W	15W minimum
		Operating power supply		240V 50 Hz AC
		Operable through		Panel door switch
		Power receptacle		15 Amp, 3-pin
	2.16.10	**Earthing studs**		
		Termination to main station earth		Internally with 10 mm bolts at extreme ends for connection
	2.16.11	**Alarm annunciator system**		
		No. Of windows	Nos.	Minimum 20
		Facia		Solid state discrete
		Hooter		10W
		Annunciator spare (with electronics)		10% spare window or minimum 2nos. Whichever is more
		Lamp test provision		Required
	2.16.12	**Mounting devices on panel**		
		On front side		All operable and indicating devices
		Inside panel		Aux. Relays, terminal, PVC trough, MCBs etc.
		Easy access for operation / maintenance.		Required

TECHNICAL DATA - PART - B (MECHANICAL)
(SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	Type Model No. (Single air inlet, Double air inlet)		
2.0	Quantity	Nos/ Unit	
3.0	Rated Capacity	M^3/Hr	
4.0	No. of Cells	Nos./ CT	
4.1	Working		
4.2	Standby		
5.0	Ambient Design Wet Bulb Temperature	°C	
6.0	Recirculation Allowance	°C	
7.0	Design Inlet Wet Bulb Temp (including recirculation allowance)	°C	
8.0	Cold Water Temperature	°C	
9.0	Cooling Tower Approach	°C	
10.0	Cooling Tower Range	°C	
11.0	Cooling Tower Loss		
11.1	Evaporation Loss		
11.2	Drift Loss		
11.3	Blow Down Loss (Concentration Factor to be indicated)		
12.0	Basin Storage capacity	M3/hr	
13.0	Cell size (Length x Width x Height)	M x M x M	
14.0	Overall Size of Cooling Tower (Length x Width x Height)	M x M x M	
15.0	Required Pumping Head including all losses measured	M	
16.0	Dia of fan stack	M	
17.0	Cooling Tower Levels		
17.1	Graded Level	M	
17.2	Maximum Water Level	M	
17.3	Basin Curb Level	M	
17.4	Minimum Water Level	M	
17.5	Basin Bottom Level	M	
18.0	Overall Tower Height from Basin Floor	M	
19.0	Basin Dimensions		
19.1	Length	M	
19.2	Width	M	
19.3	Depth (from basin curb)	M	
20.0	Free Board (Above Max. Water Level)	mm	
21.0	Heat Transfer Data		
21.1	Heat Transfer Coefficient (K)		
21.2	Tower Coefficient © Ka V/L	M	
21.3	Average Fill Height	M	
21.4	Total Fill Volume	Cub M	
21.5	Total Water wetted surface	Sq M	

21.6	Total Tower Wetted Surface	Sq M	
22.0	Hot Water Distribution Piping		
22.1	Size (OD X Thk)	mm x mm	
22.2	Elevation of Center Line of Hot Water distribution Header	M	
22.3	Design pressure for Hot Water Distribution System	Kg/cm2(g)	
23.0	Isolation Valves in Hot Water Risers		
23.1	Size	mm	
23.2	Quantity	Nos./ cell	
23.3	Type/Code & Standard		
23.4	Make		
23.5	Pressure drop across the valve in fully open position	MWC	
23.6	Materials of Construction		
23.6.1	Body		
23.6.2	Disc		
23.6.3	Drive Shaft/Stub Shaft		
23.6.4	Bearings		
23.7	Test Pressure / duration	Kg/cm2(g) / Min	
24.0	Flow Control Valves (If Applicable)		
24.1	Make		
24.2	Size	mm	
24.3	No. of Cell	Nos	
24.4	Materials of Construction		
24.4.1	Body		
24.4.2	Spindle		
24.4.3	Trim		
25.0	**Isolating Valve in Sludge Pit**		
25.1	Size	mm	
25.2	Quantity	Nos / CT	
25.3	Type		
25.4	Make		
25.5	Conform to which code in respect of design/testing		
25.6	Materials of Construction		
25.6.1	Body		
25.6.2	Stem		
25.6.3	Trim		
26.0	**Stationary Screen**		
26.1	Quantity	Nos / CT	
26.2	Size & Material of Bar		
26.3	Clear Space between the bar		
26.4	Lifting Arrangement		
27.0	**Fill & Fill Supports**		
27.1	Type of fill		
27.2	Material		

27.3	Type of treatment (in case of timber fill)		
27.4	Expected Life	Years	
27.5	Arrangement of Fill/splash bars (horizontal etc.)		
27.6	Method to prevent dislocation of Fills		
27.7	Type/Material/Size of fixing arrangement to supporting grid		
27.8	Fill Support Grids		
27.8.1	Type		
27.8.2	Material (give full specification)		
27.8.3	Size		
27.8.4	Colour of Fill		
27.9	Grid Supporting Frames		
27.9.1	Type		
27.9.2	Material (give full specification)		
27.9.3	Size		
27.10	Fasteners		
27.10.1	Type		
27.10.2	Fill		
27.10.3	Fill Support Grids		
27.10.4	Frames for Supporting the Grids		
28.0	Drift Eliminators		
28.1	Number of Passes		
28.2	Gross Face Area per pass	Sq M	
28.3	Type		
28.4	Eliminator Blades		
28.4.1	Material		
28.4.2	Maximum Length of blade	mm	
28.4.3	Size and shape of blades		
28.4.4	Type and material of drain boards		
28.5	Blade Support Spacers		
28.5.1	Type		
28.5.2	Material		
29.0	**FANS**		
29.1	Manufacturer		
29.2	Type		
29.3	Model Number		
29.4	Number furnished	Nos./CT	
29.5	Diameter	M	
29.6	Number of Blades/fan		
29.7	Fan speed	RPM	
29.8	Tip speed	M/Sec	
29.9	Blade tip clearance	mm	
29.10	BHP per fan		
29.11	Air delivery per fan	Cubm/hr	
29.12	Fan static efficiency	%	

29.13	Blade material		
29.14	Hub material		
29.15	Fasteners & Hardware material		
29.16	Entire fan assembly statically balanced		
29.17	Total differential pressure drop (considering receovery)		
29.17.1	Drop through louvers	MWC	
29.17.2	Drop through fills	MWC	
29.17.3	Drop though eliminators	MWC	
29.17.4	Velocity pressure	MWC	
29.18	Drop through plenum	MWC	
29.19	Noise level of fan at rated pitch and speed	dB	
29.20	Total guaranteed power consumption at motor inlet (to be supported by calculations)	KW/Fan	
29.21	Fan motor rating	KW	
30.0	**GEAR REDUCER**		
30.1	Manufacturer		
30.2	Model Number		
30.3	Reduction Ratio		
30.4	Service factor at rated HP of drive		
30.5	Bearing and material		
30.6	Material of gear tooth and hardness.		
31.0	**DRIVE SHAFT**		
31.1	Manufacturer		
31.2	Number		
31.3	Rated HP		
31.4	Drive and shaft material		
31.5	Coupling material		
31.6	Number of couplings furnished per driving unit		
31.7	Type of couplings and whether coupling guard provided.		
31.8	Drive shaft statically dynamically balanced.		
32.0	**Gate in Cold Water Outlet Channel**		
32.1	Number per cold water outlet channel		
32.2	Gate Type		
32.3	Name of Manufacturer		
32.4	Gate Size		
32.5	Weight of each gate	Kg	
32.6	Are elements of gate dismantling type?		
32.7	Weight of each Element	Kg	
32.8	Frame Type		
32.9	Fixing arrangement of frame with RCC channel		
33.0	**Lifting Arrangement of Gate**		
33.1	Type of treatment for the wood (in case of wooden gates)		
33.2	Expected Life	Years	

34.0	**VERTICAL SLUDGE PUMP & MOTOR (Optional Item)**		
	Vertical sludge pumps complete with electric motors, valves, piping and fittings at their discharge offered.	Yes / No	
34.1	Make & Model No.		
34.2	Rated capacity	M3/Hr	
34.3	TDH	MWC	
34.4	Pump speed	RPM	
34.5	Pump efficiency	%	
34.6	Power consumption at rated flow	KW	
34.7	Motor HP provided	HP / KW	
34.8	Material of Construction		
34.8.1	Impeller		
34.8.2	Casing		
34.8.3	Pump & Line Shaft		
34.8.4	Bearings		
34.8.5	Impeller/Casing Wearing Rings		
35.0	Oil Level Indication in Gear Box provided	Yes/No	
35.1	Type & Model No.		
35.2	Manufacturer		
35.3	Contact rating		
36.0	Cooling Tower Materials of Construction		
36.1	Casing		
36.2	Louvers		
36.3	Cell Partition Walls		
36.4	Basin Partition Walls		
36.5	Stack		
36.6	Stair Case		
36.7	Hot Water piping		
36.8	Hot Water distribution basin		
36.9	Internal Walkways		
36.10	Supporting Structure		
36.11	Hand Rails		
36.12	Structure Connector		
36.13	Bolts, nuts, washers and other hardware		
36.14	Nails		
36.15	Anchor Bolts		
36.16	Hot Water Distribution Nozzle		
36.17	Hot Water distribution Plates		
36.18	Spacers		
36.19	Mechanical Equipment Support		
37.0	Weight of Equipments		
37.1	Weight of Heaviest part to be handled	Kg	
37.2	Size of largest part to be handled		
37.3	Weight of gear box	Kg	

37.4	Weight of fan drive motor	Kg	
38.0	Inspection & Testing		
38.1	Hydro Test Pressure for Hot water piping		
38.1.1	Test Pressure	Kg/cm2(g)	
38.1.2	Duration	Minutes	
38.2	Balancing test for the fan and the drive shafts shall be conducted.	Yes / No	
38.3	Field performance test for the tower shall be conducted.	Yes / No	
39.0	Flow per cell at design condition	M^3/Hr	
40.0	Maximum Water Handling capacity (per cell)	M^3/Hr	
41.0	Cooling Water Flow Rate (L)	Kg/m^2/Hr	
42.0	Dry Air Flow Rate (G)	Kg/m^2/Hr	
43.0	Ratio of Water to Air	(L/G)	
44.0	Dry Air Flow	Kg/Hr	
45.0	Temperature of air leaving the Stack	°C	
46.0	Inlet air Enthalpy	KCal/Kg	
47.0	Exit air Enthalpy	KCal/Kg	
48.0	Total Heat Exchange/Kg of Inlet Dry air	KCal/Kg	
49.0	Losses in hot water piping	MWC	
50.0	Type of air inlet	MWC	
51.0	Pressure recovery from fan stack	mm	
52.0	Air inlet are per cell	Max.	
53.0	Splash surface of fill per cell	M^2	
54.0	Whether fan blades are adjustable degree of pitch adjustment	°C	
55.0	Max. possible discharge through fan (indicate angle of pitch)	M^3/Hr	
56.0	Design value of discharge through fan (indicate angle pitch)	M^3/Hr	
57.0	Weight of complete fan assembly	kg	

TECHNICAL DATA - PART - B (SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO		UOM	DETAIL
1.0	**GENERAL**		
i)	Manufacturer & Country of origin.		
ii)	Equipment driven by motor)		
iii)	Motor type		
iv)	Country of origin		
v)	Quantity	nos.	
2.0	**DESIGN AND PERFORMANCE DATA**		
i)	Frame size		
ii)	Type of duty		
iii)	Type of enclosure and method of cooling		
vi)	Type of mounting		
vii)	Direction of rotation as viewed from DE END		
viii)	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard	(KW)	
ix)	(A) Derated rating for specified normal condition i.e. 50 deg. C ambient temperature	(KW)	
	(B) Rating as specified in load list	(KW)	
xi)	Rated speed at rated voltage and frequency	rpm	
xii)	At rated Voltage and frequency		
	a) Full load current	A	
	b) No load current	A	
xiii)	Power Factor at		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
	e) NO load		
	f) Starting.		
xiv)	Efficiency at rated voltage and frequrecy		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
xv)	Starting current *(inclusive of IS tolerance)* at		
	a. 100 % voltage	A	
	b. Minimum starting voltage	A	
xvi)	Starting time with minimum permissible voltage		
	a. Without driven equipment coupled	sec	
	b. With driven equipment coupled	sec	
xvii)	Safe stall time with 110% of rated voltage		
	a. From hot condition	sec	

	b. From cold condition	sec	
xviii)	**Torques :**		
	a. Starting torque at min. permissible voltage	(kg-mtr.)	
	b. Pull up torque at rated voltage.	(kg-mtr.)	
	c. Pull out torque	(kg-mtr.)	
	d. Min accelerating torque available	(kg-mtr.)	
	e. Rated torque	(kg-mtr.)	
xix)	Stator winding resistance per phase (at 20 Deg.C.)	Ohm	
xx)	GD^2 value of motors		
xxi)	Locked rotor KVA input (at rated voltage)		
xxii)	Locked rotor KVA/KW.		
xxiii)	**Bearings**		
	a. Type		
	b. Manufacturer		
	c. Self Lubricated or forced Lubricated		
	d. Recommended Lubricants		
	e. Guaranteed Life in Hours		
	f. Whether Dial Type thermometer provided		
	g. Oil pressure Gauge/switch		
	i. Range		
	ii. Contact Nos. & ratings		
	iii. Accuracy		
xxiv)	**Vibration**		
	a) Velocity	mm/s	
	b) Displacement	microns	
xxv)	Noise level	db	
3	**CONSTRUCTIONAL FEATURES**		
i	Stator winding insulation		
	a. Class & Type		
	b. Tropicalised (Yes/No)		
	c. Temperature rise over specified max.		
	i. Cold water temperature of 38 DEG. C.		
	ii. Ambient Air 50 DEG. C.		
	d. Method of temperature measurement		
	e. Stator winding connection		
	f. Number of terminals brought out		
ii	Type of terminal box for		
	a. stator leads		
	b. space heater		
	c. Temperature detectors		
	d. Instrument switch etc.		
iii)	For main terminal box		
	a. Location		
	b. Entry of cables		
	c. Recommended cable size		
	d. Fault level	MVA	
iv)	Temperature detector for stator winding		
	a Type		
	b. Nos. provided		
	c . Location		
	d. Make		
	e. Resistance value at 0 deg. C	ohms	

vi)	Paint shade		
vii).	Weight of(approx)		
	a. Motor stator (KG)		
	b. Motor Rotor (KG)		
	c. Total weight (KG)		
4	Relevant motor curves		

TECHNICAL DATA - PART - B (SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO	DESCRIPTION	UOM	DETAIL
	FOLLOWING DATA SHALL BE FILLED UP BY VENDOR FOR EACH INSTRUMENT(LS/LT, RTD, THERMOWELL, TT, TG, PG, LIMIT SWITCH ETC.)		
1.0	MAKE		
1.1	MODEL		
1.2	TAG NO. / KKS NO.		
1.3	SERVICE		
1.4	QUANTITY		
1.5	OPERATING PRESSURE		
1.6	OPERATING TEMPERATURE		
1.7	DESIGN PRESSURE		
1.8	DESIGN TEMPERATURE		
1.9	RANGE		

ANNEXURE-VIII

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.		ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE		NAME	DATA FILLED UP ON
		SYSTEM / S	IDCT	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION		SHEET 1 OF 1 REV. 00	DE'S SIGN. & DATE

CABLE SCHEDULE FORMAT

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:
(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.

2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.

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    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.

4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).

5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

A	NN	A	NNN
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

please refer below examples:

i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)
B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS
B = Armoured Non-FRLS
C = unarmoured FRLS
D = Unarmoured Non-FRLS

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

7. For any assistance or clarifications, please contact mailto:praveendutta@bhelpem.co.in

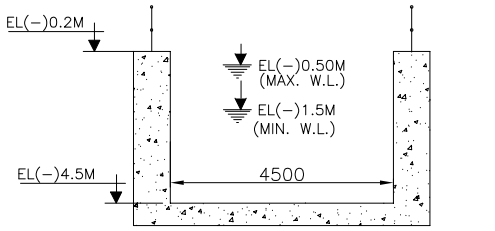
COMPLIANCE DRAWING

A) WATER ANALYSIS (ANNEXURE-I)
B) DETAILS OF CT OUTLET (ANNEXURE-II)
C) COORDINATES AND BATTERY LIMIT OF IDCT (ANNEXURE-III)
D) ELECTRICAL DRAWINGS (ANNEXURE-IV)

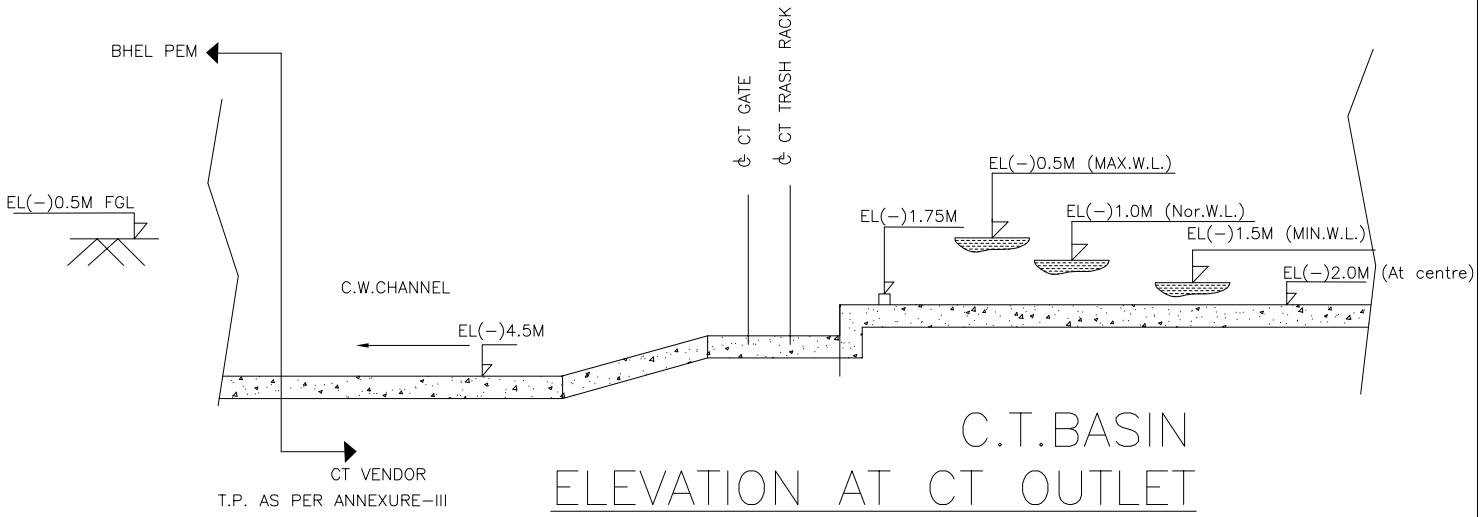
				Annexure-I
S.No.	**Constituent**	**Unit**	**Expected Clarified Water Analysis**	**Expected Circulating Water Analysis**
1.0	Calcium	mg/l as CaCO3	111	556
2.0	Magnesium	mg/l as CaCO3	35	175
3.0	Sodium	mg/l as CaCO3	25	125
4.0	Potassium	mg/l as CaCO3	8	40
5.0	Total Cations	mg/l as CaCO3	179	896
6.0	Bicarbonates	mg/l as CaCO3	68	340
7.0	Carbonates	mg/l as CaCO3	7.0	35
8.0	Chloride	mg/l as CaCO3	63	317
9.0	Sulphate	mg/l as CaCO3	48	238
10.0	Total Anions	mg/l as CaCO3	186	930
11.0	Silica-Total	mg/l as SiO2	20.5	102.5
12.0	Silica-Colloidal	mg/l as SiO2	6.5	32.5
13.0	Silica- Reactive	mg/l as SiO2	14	70
16.0	Iron (Total)	mg/l as Fe	0.3	2
18.0	pH Value	-	7.2-8.7	7.2-8.7
19.0	Turbidity	NTU	10	50
20.0	Total Suspended Solids	NTU	10	50
21.0	Total Dissolved Solids	mg/l	244	1222
22.0	Organics(As per KMnO4 method)	mg/l	0.05	0.250
23.0	TOC	mg/l	8.00	40.000

EL(+)0.0M CORRESPONDS TO RL 282.5M

ANNEXURE–II



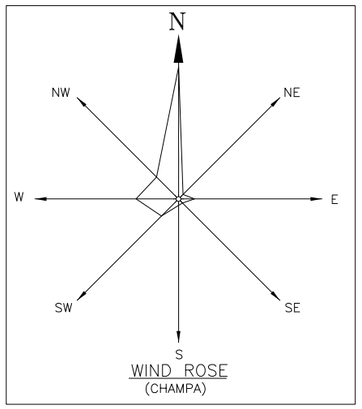
COOLING WATER CHANNEL



C.T.BASIN

ELEVATION AT CT OUTLET

ANNEXURE–III



1200N

R/W WATER PIPELINE

CW TREATMENT PLANT

20

EFFLUENT TREATMENT PLANT

CLO2

904.25W
1259.3N

22

867.25W
1259.3N

23

6

MAINTENANCE BAY

816.00W
1259.3N

7

PIPE RACK

803.00W
1192.5N

TP

934.50W
1186.0N

RL(+)282M

1173.0N

397.0W

1170.0N

IDCT

8

PIPE RACK

1018.0W
1101.0N

56

IDCT MCC

822.00W
1112.0N

PIPE RACK

1081.000N

PIPE RACK

921.000W

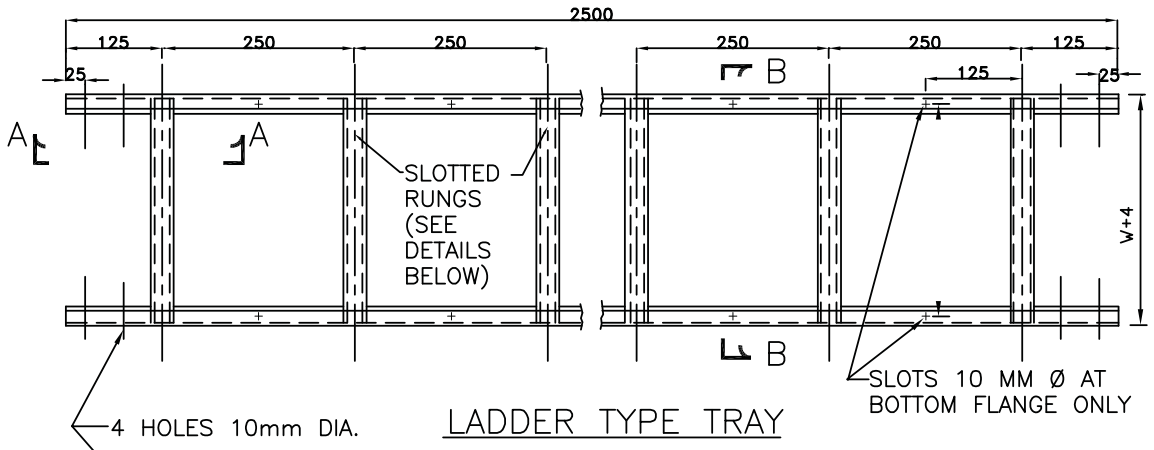
1081.264N

1000N

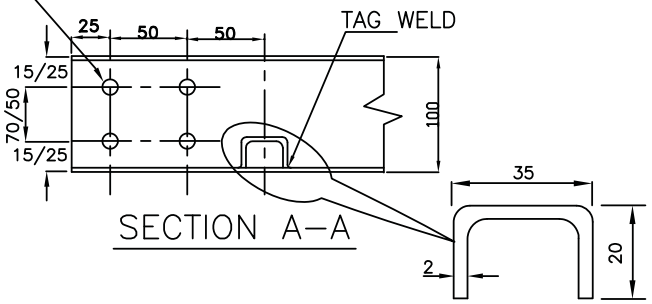
600W

400W

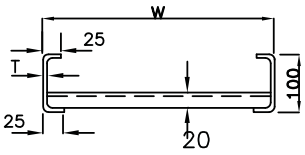
ANNEXURE-IV



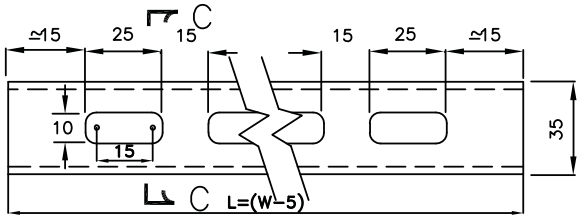
LADDER TYPE TRAY



SECTION A–A

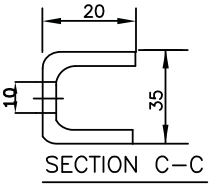


SECTION B–B

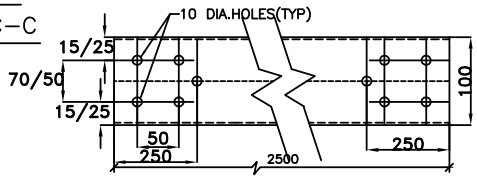


SLOTTED RUNGS

(TO SUIT TRAY WIDTH)

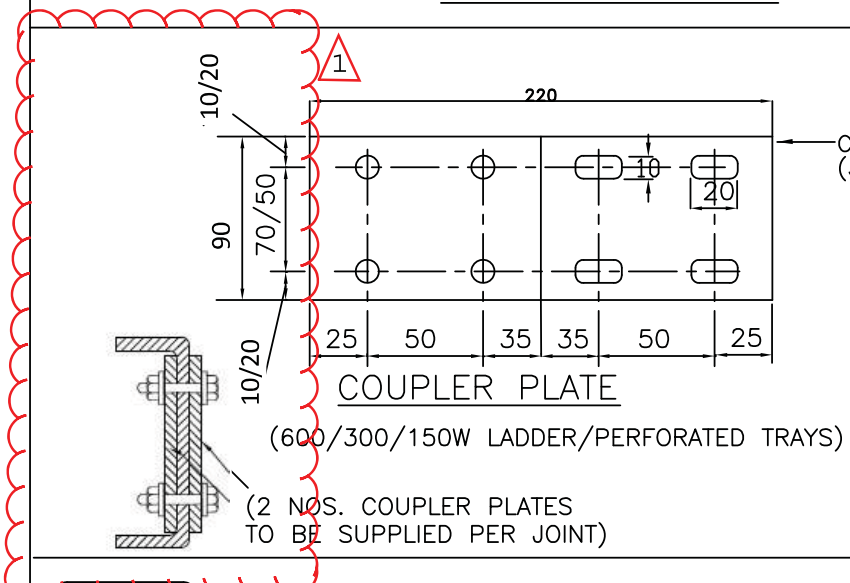


SECTION C–C



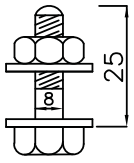
SIDE RUNNER

LADDER TYPE TRAY



COUPLER PLATE

(600/300/150W LADDER/PERFORATED TRAYS)



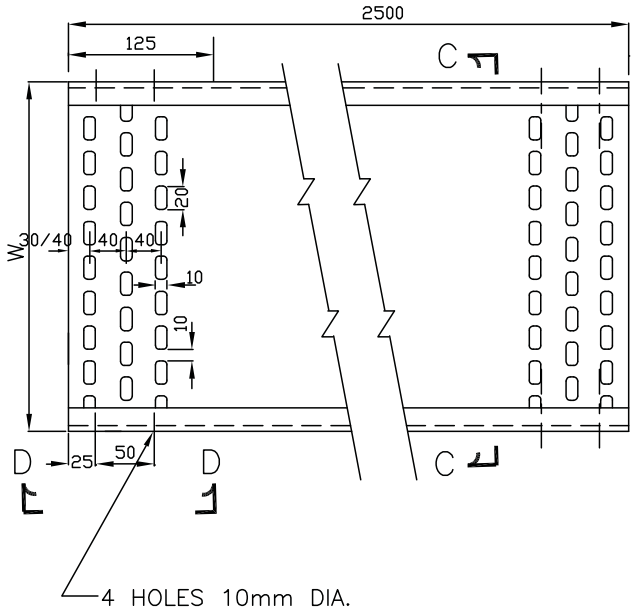
8 NUMBERS BOLTS 8mm DIA 25mm LONG WITH NUTS AND WASHERS ARE TO BE SUPPLIED WITH EACH COUPLER PLATE

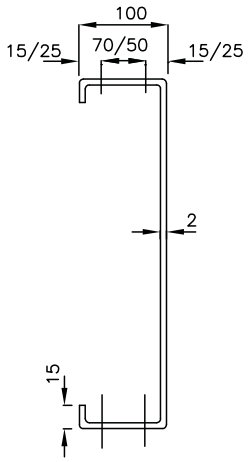
BHEL

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

DRAWING NO.

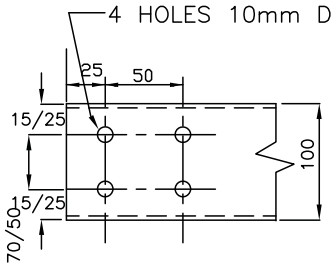
SH 2 OF 12 | REV 00





SECTION–CC

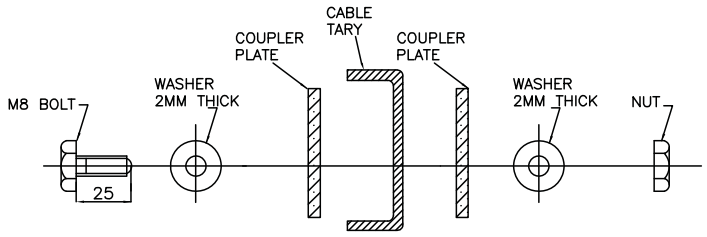
600/300/150 TRAYS



SECTION–DD

600/300/150 TRAYS

PERFORATED TYPE TRAY

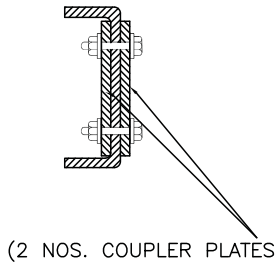


SEQUENCE OF M8 BOLT, WASHER, NUT, COUPLER PLATE & CABLE TRAY

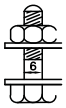
FOR TYPICAL CABLE TRAY JOINT

SEE GENERAL NOTES IN SHEET 12.

BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DRAWING NO.
		SH 3 OF 12 / REV 00

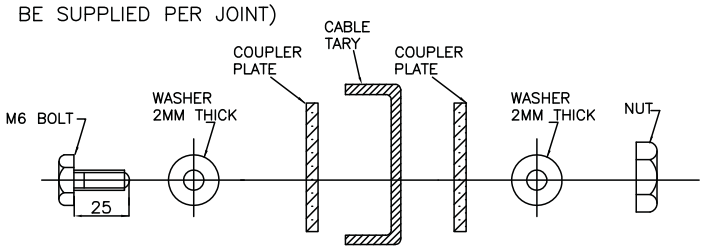


(2 NOS. COUPLER PLATES
OF 3 MM THICKNESS TO
BE SUPPLIED PER JOINT)



QTY. REQD/TRAY SECTION

A) 16 NOS. M6 BOLTS
B) 16 NOS. NUTS
C) 32 NOS. WASHERS

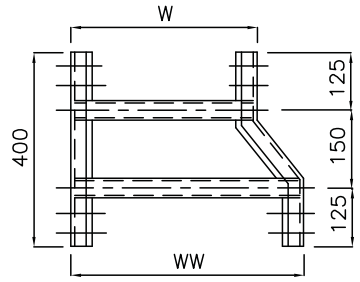


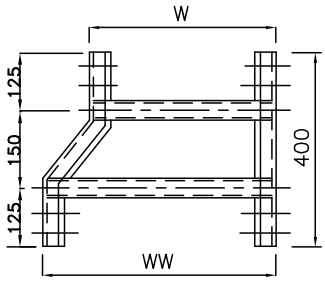
SEQUENCE OF M6 BOLT, WASHER, NUT, COUPLER PLATE & CABLE TRAY

FOR TYPICAL CABLE TRAY JOINT

SEE GENERAL NOTES IN SHEET 12.

भेल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DRAWING NO.
		SH 4 OF 12 / REV 00



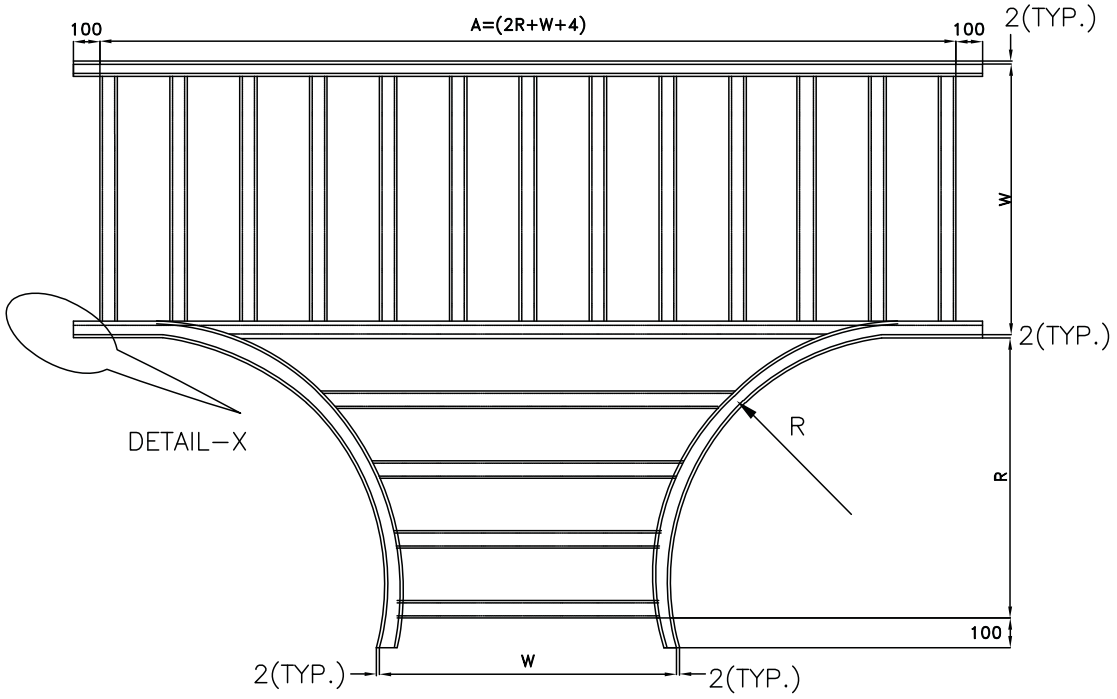


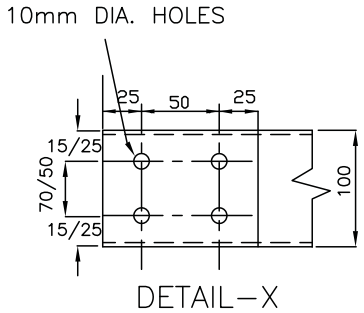
WW	W	DEPTH
600	300	100
600	150	100
300	150	100

LEFT HAND REDUCER

RIGHT HAND REDUCER

LADDER TYPE





WIDTH W	BENDING RADIUS R	DEPTH	A		
			W		
			150	300	600
150, 300 & 600	600	100	1354	1504	1804

SEE GENERAL NOTES IN SHEET 12.

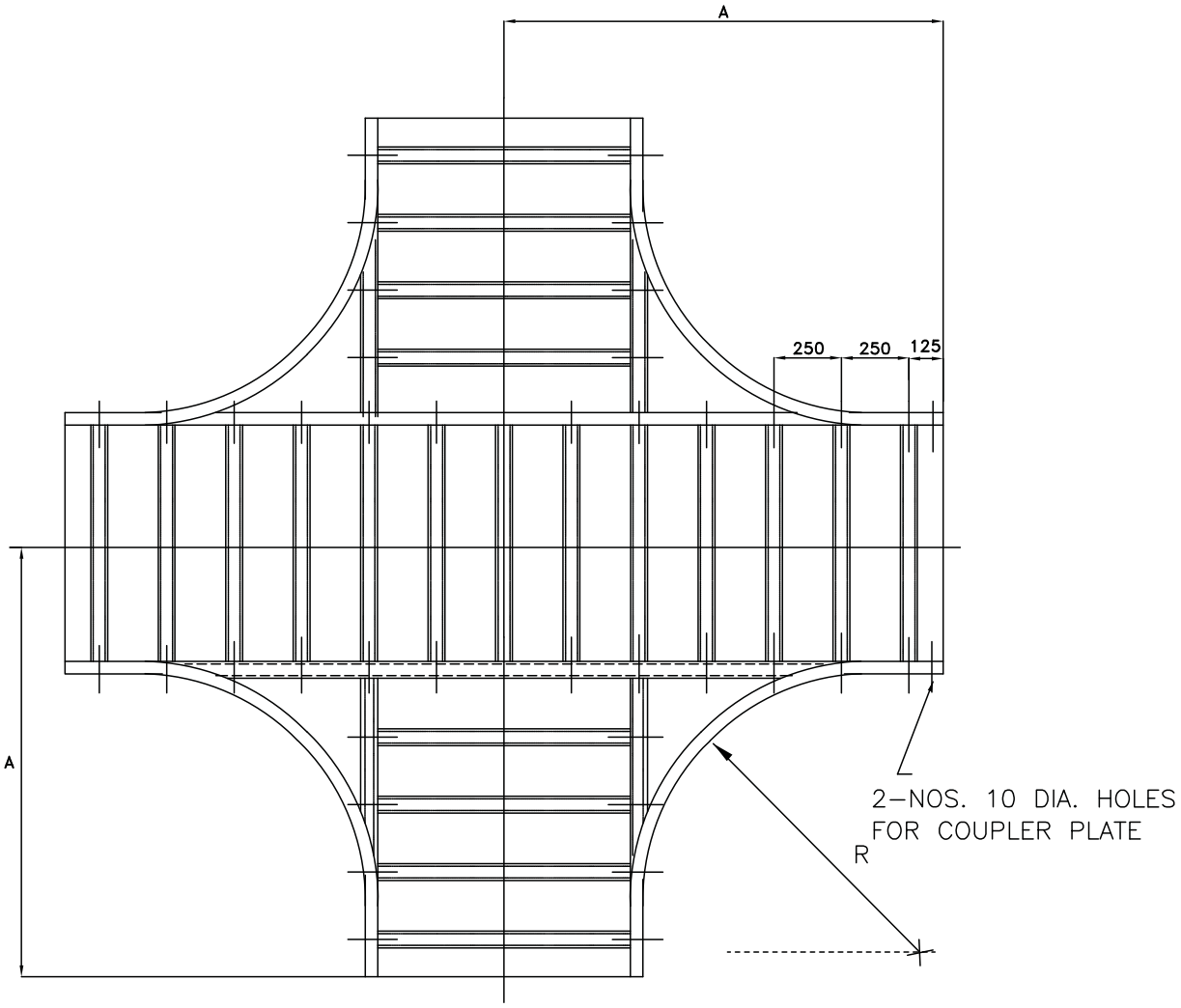
LADDER TYPE

बी एच ई एल
BHEL

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

DRAWING NO.

SH 5 OF 12 | REV 00



HORIZONTAL CROSS–PLAN

WIDTH W	BENDING RADIUS R	A=R+W/2+100
600	600	1000
300	600	850

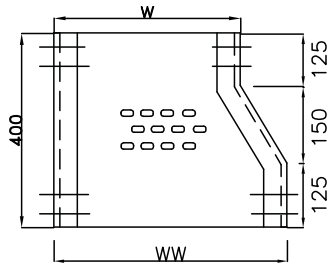
SEE GENERAL NOTES IN SHEET 12.

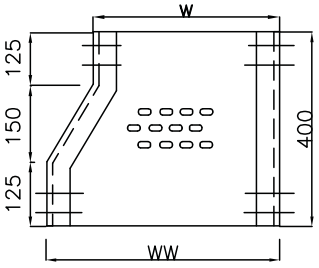
भेल BHEL

TYPICAL DETAILS OF
CABLE TRAYS AND ACCESSORIES

DRAWING NO.

SH 6 OF 12 | REV 00

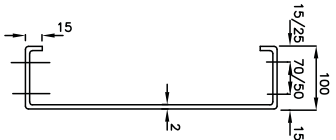




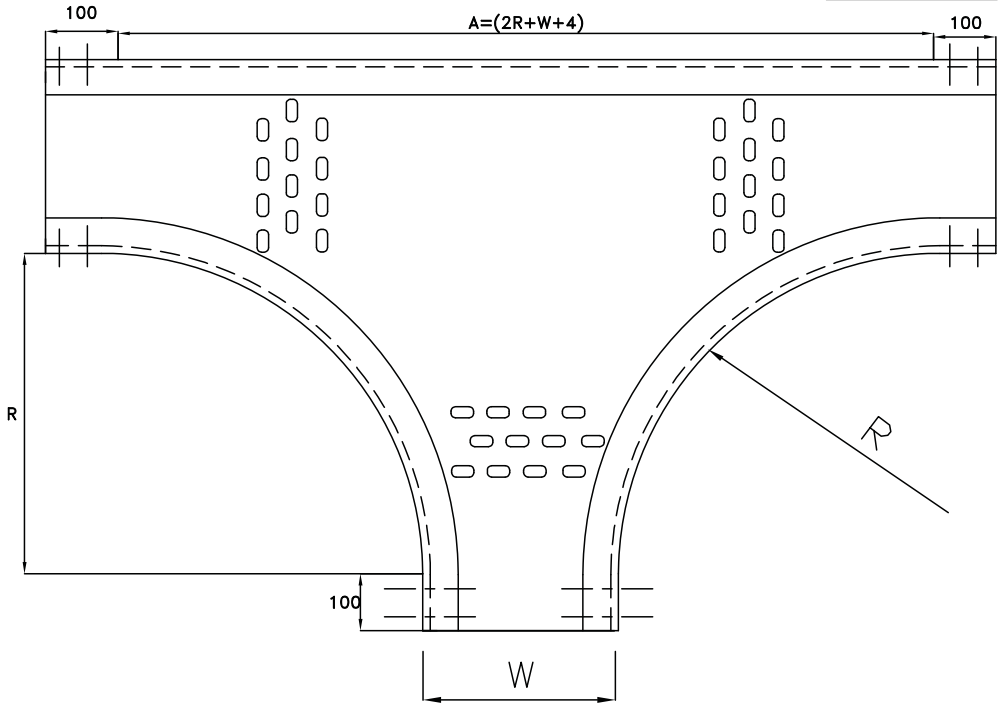
WW	W	DEPTH
600	300	100
600	150	100
300	150	100

LEFT HAND REDUCER RIGHT HAND REDUCER

PERFORATED TYPE



SECTION–EE



TEE

WIDTH W	BENDING RADIUS R	DEPTH	A		
			W		
			150	300	600
150, 300 & 600	600	100	1354	1504	1804

SEE GENERAL NOTES IN SHEET 12.

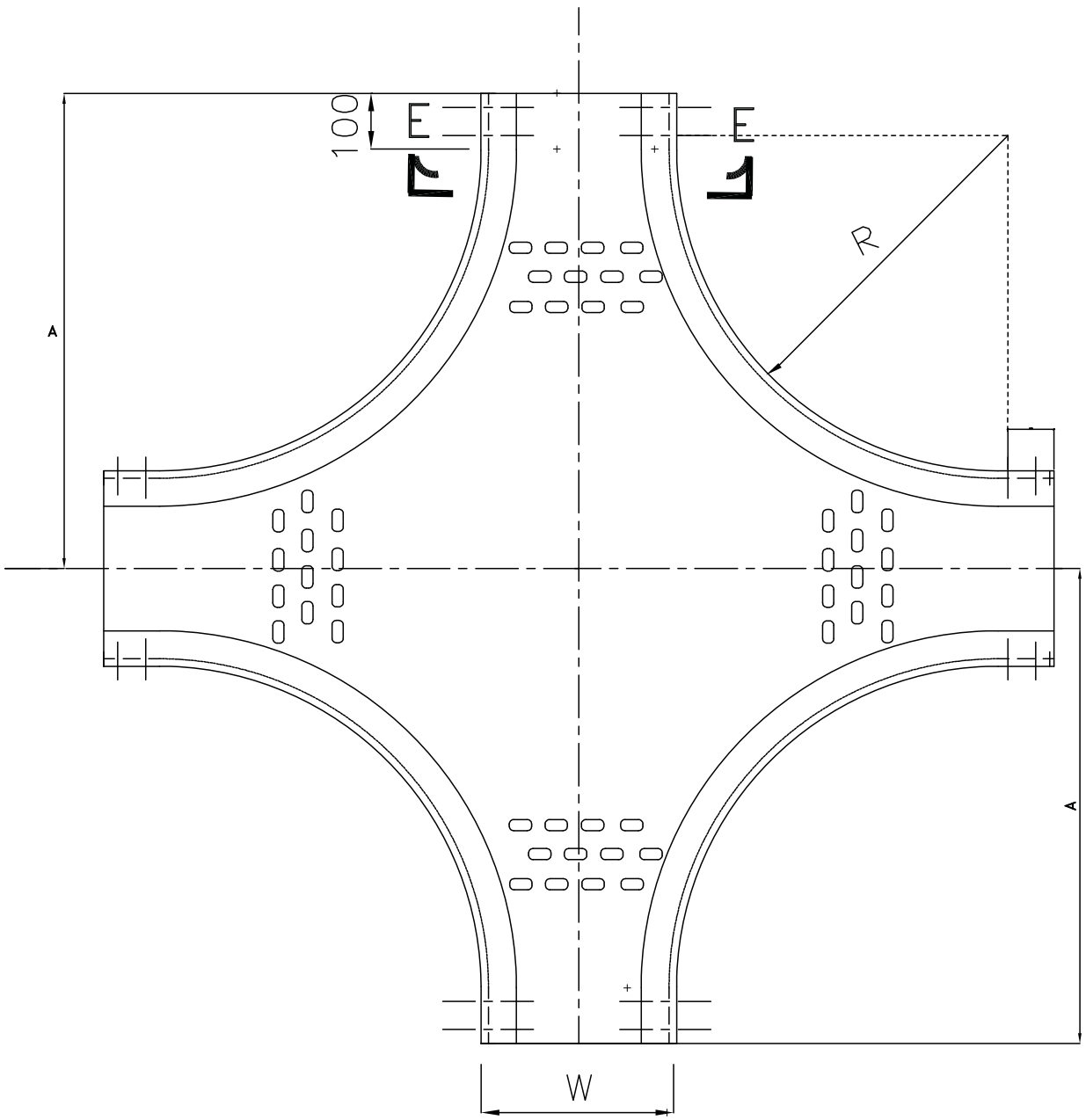
PERFORATED TYPE

भेल BHEL

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES

DRAWING NO.

SH 7 OF 12 | REV 00



CROSS

WIDTH W	BENDING RADIUS R	A=R+W/2+100
600	600	1000
300	600	850

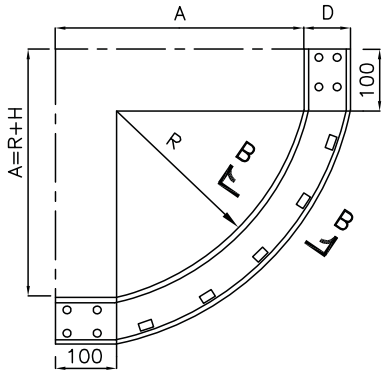
SEE GENERAL NOTES IN SHEET 12.

भेल BHEL

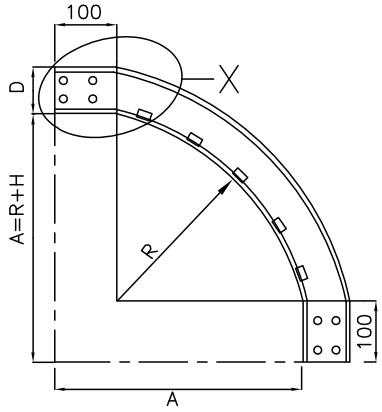
TYPICAL DETAILS OF
CABLE TRAYS AND ACCESSORIES

DRAWING NO.

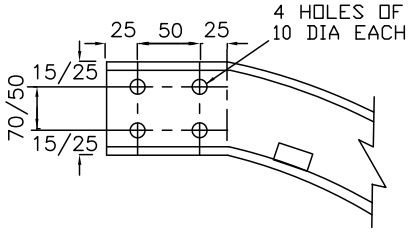
SH 8 OF 12 | REV 00



INSIDE TYPE



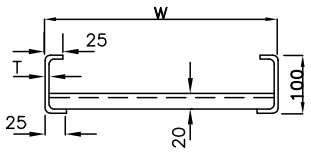
OUTSIDE TYPE



ENLARGED VIEW OF "X"

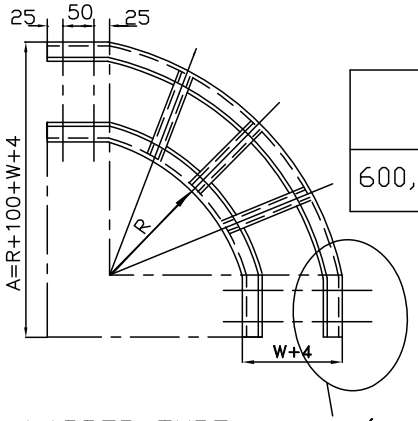
VERTICAL ELBOW 90 DEG UP/DOWN

INSIDE WIDTH W	BENDING RADIUS R	DEPTH	A
600, 300 & 150	600	100	700



SECTION B–B

90° VERTICAL BEND – LADDER TYPE



LADDER TYPE

X (AS ABOVE)

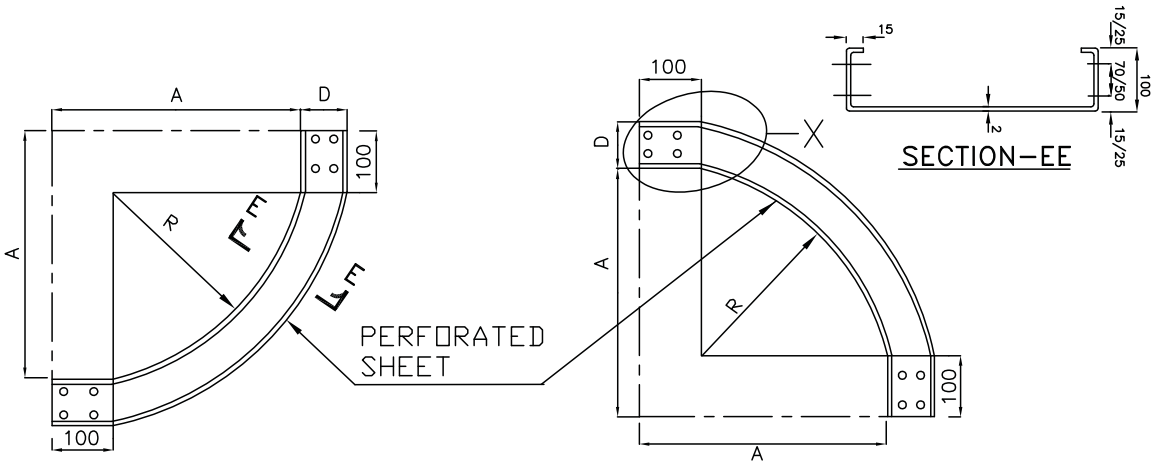
HORIZONTAL ELBOW 90 DEG

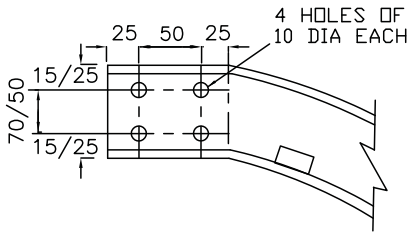
INSIDE WIDTH W	BENDING RADIUS R	DEPTH	A		
			W		
			150	300	600
600, 300 & 150	600	100	854	1004	1304

90° HORIZONTAL BEND – LADDER TYPE

SEE GENERAL NOTES IN SHEET 12.

BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DRAWING NO.
		SH 9 OF 12 / REV 00



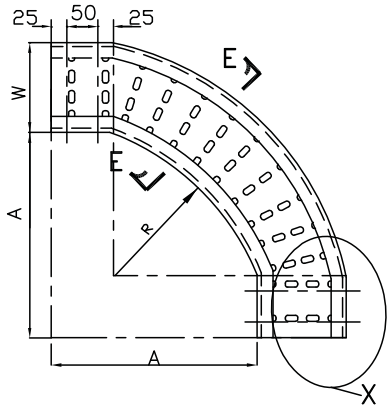


ENLARGED VIEW OF "X"

VERTICAL ELBOW 90 DEG UP/DOWN

INSIDE WIDTH W	BENDING RADIUS R	DEPTH	A
600, 300 & 150	600	100	700

90° VERTICAL BEND – PERFORATED TYPE



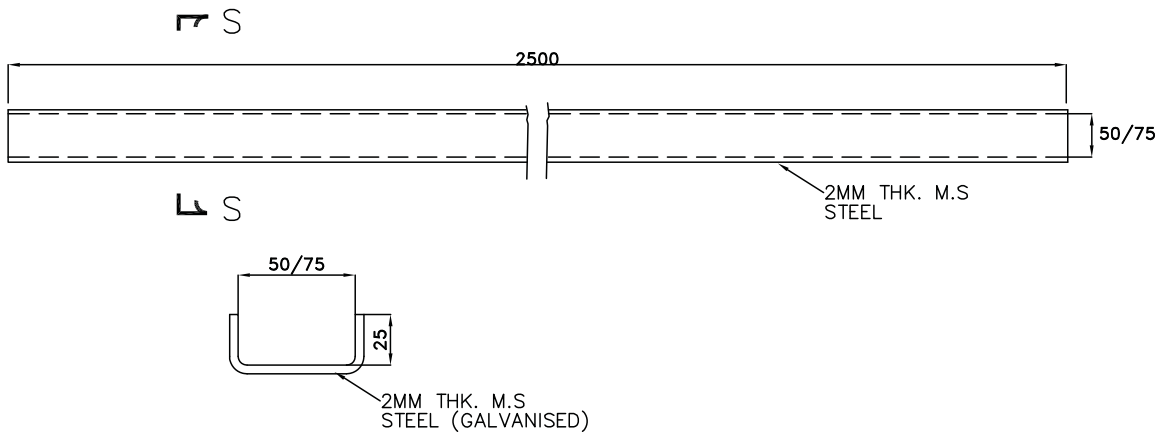
HORIZONTAL ELBOW 90 DEG

INSIDE WIDTH W	BENDING RADIUS R	DEPTH	A		
			W		
			150	300	600
600, 300 & 150	600	100	854	1004	1304

90° HORIZONTAL BEND – PERFORATED TYPE

SEE GENERAL NOTES IN SHEET 12.

BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DRAWING NO.
		SH 10 OF 12 / REV 00



SECTION S–S

CABLE TROUGHS

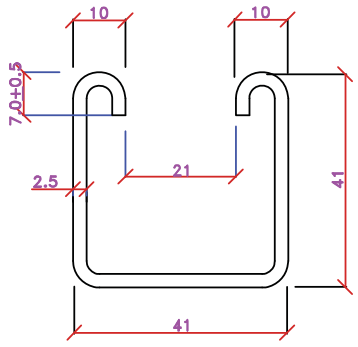
SEE GENERAL NOTES IN SHEET 12.

TYPICAL DETAILS OF CABLE TRAY AND ACCESSORIES	BHEL DRAWING NO.	
	SH 11 OF 12	REV 00

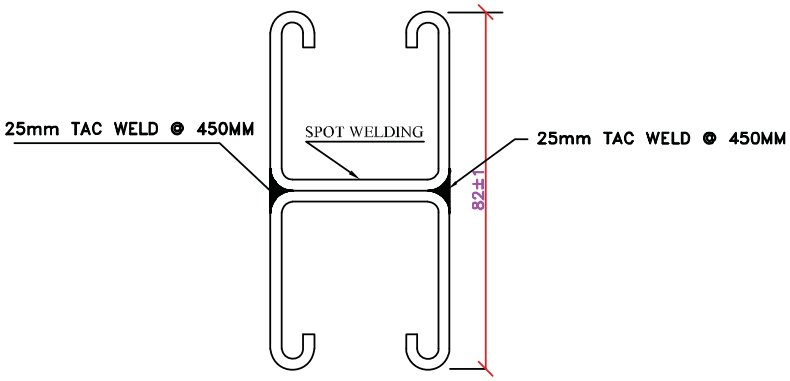
NOTES:-

1. THE CABLE TRAYS AND ACCESSORIES SHALL BE MADE OF 2mm HOT ROLLED M.S.SHEET CONFIRMING TO IS:1079. ALL THE COUPLER PLATE SHALL BE OF 3 MM THICK.
2. THE CABLE TRAYS AND ACCESSORIES SHALL BE HOT DIP GALVANISED AS PER IS 2629.
3. FOR LADDER TYPE CABLE TRAYS AND ACCESSORIES, ALL RUNGS SHALL BE SLOTTED.
4. PERFORATED TRAYS SHALL BE FABRICATED OUT OF A SINGLE M.S. SHEET.
5. THE DIMENSIONS OF ALL BENDS, TEES, CROSSES, ETC. FOR PERFORATED CABLE TRAYS SHALL BE THE SAME AS FOR LADDER TYPE TRAY FITTINGS.
6. SIDE CHANNELS OF PERFORATED TRAY ACCESSORIES SHALL BE WELDED WITH THE PERFORATED SHEET AT INTERVALS OF 100mm.
7. LENGTH OF WELDING SHALL NOT BE LESS THAN 25mm. WELDING SHALL BE AS PER IS 9595.
8. PREFERABALY SINGLE MS PERFORATED SHEET SHALL BE USED AS BASE OF ALL PERFORATED TYPE TRAY ACCESSORIES. HOWEVER, IF USE OF PIECES OF PERFORATED SHEET IS UNAVIODABLE FOR BASE, PIECES SHALL BE WELDED WITH EACH OTHER IN LINE WITH THE ABOVE.
9. ALL TRAY CORNERS SHALL BE FREE OF SHARP EDGES & SMOOTH.
10. THE DEPTH, WIDTH AND LENGTH OF TRAYS AND ACCESSORIES SHALL BE WITHIN A TOLERANCE OF +/−2MM.
11. TO FACILITATE ASSEMBLY, ALL ACCESSORIES AT ENDS SHALL HAVE 100mm STRAIGHT PORTION.
12. ALL NUTS, BOLTS, WASHERS ETC., SHALL BE HOT DIP GALVANISED AS PER IS 1367 FOR SIZES ABOVE 12MM AND ELECTROPLATED/ELECTROGALVANISED FOR SIZES UPTO 12MM.
13. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.
14. TRAY ACCESSORIES SHOWN IN THIS DRAWING SHALL BE FACTORY FABRICATED FOR USE AT SITE AS PER APPROVED LAYOUT DRAWINGS. FOR SPECIFIC SITE REQUIREMENTS (E.G. IRREGULAR ANGLE BENDS SUCH AS 30°/60° BENDS, ETC) AS PER SITE LAYOUT CONDITIONS, TRAY ACCESSORIES SHALL BE FABRICATED AT SITE FROM THE STRAIGHT LENGHT OF RESPECTIVE SIZES AS REQUIRED. GALVANISATION DAMAGED DURING CUTTING/WELDING OPEARTIONS SHALL BE BRUSHED AND RED LEAD PRIMER, OIL PRIMER AND ALUMINIUM PAINT SHALL BE APPLIED BEFORE INSTALLATION OF THE ACCESSORIES.
15. WIDTH OF CABLE TRAYS PROPOSED TO BE USED FOR PROJECT ARE AS UNDER :
    LADDER TYPE CABLE TRAY (MM) : 600,300 & 150.
    PERFORATED TYPE CABLE TRAY (MM) : 600,300,150.
16. 600MM WIDE CABLE TRAY SHALL BE SUITABLE FOR WEIGHT OF 100KG/M INCLUDING LIVE LOAD OF RUNNING LENGTH OF CABLE TRAY.
17. MAKE OF ALL ITEMS SHALL BE AS PER NTPC QA APPROVAL.
18. CABLE TROUGHS OR 50/75MM WIDE PERFORATED TYPE SHALL BE USED FOR LOCAL CABLING/BRANCHING OUT FEW CABLES FROM MAIN ROUTE.
19. AMOUNT OF ZN DEPOSIT OVER THREADED PORTION OF BOLTS, NUTS, SCREWS AND WASHERS SHALL BE AS PER IS 1367.
20. MASS OF ZN COATING SHALL BE 610gm PER SQ METER.

भेल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DRAWING NO. PE−DG− −507−E005
		SH 12 OF 12 | REV 00



SINGLE CHANNEL SC1



DOUBLE CHANNEL DC1

TWO LENGTHS OF SINGLE CHANNEL

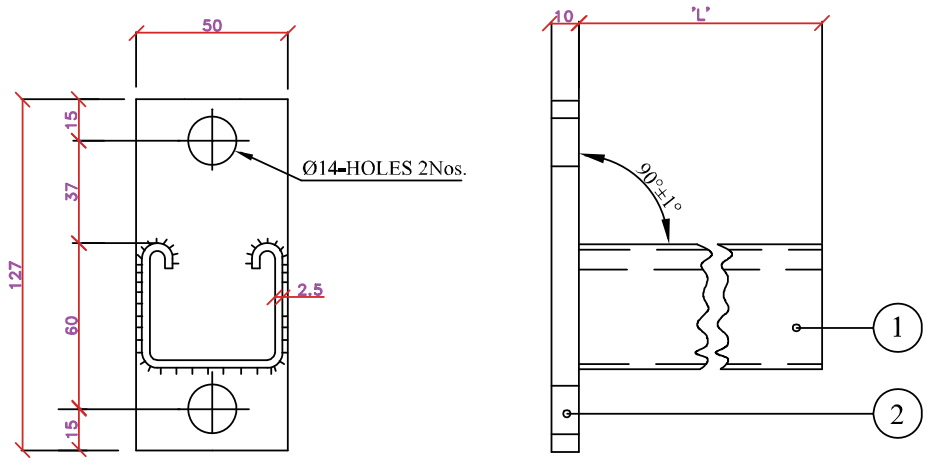
SPOT WELDED BACK TO BACK

AT 75MM C/C

NOTE:

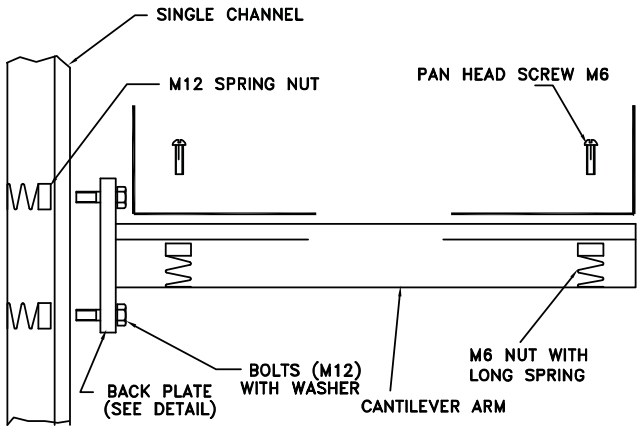
1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : 2.5MM THICK HOT/ COLD ROLLED M.S. AS PER IS:1079.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

बी एच ई एल BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	NTPC DOC. NO: [illegible]
		BHEL DRWG NO:
		REV.01 / SH 02 OF 37



CANTILEVER ARMS

TRAY WIDTH IN MM	CANTILEVER ARM LENGTH (L) IN MM
150	170 (FOR OVERHEAD TRAYS)
300	320 (FOR OVERHEAD TRAYS
600	620 (FOR OVERHEAD TRAYS)
600	750 (FOR TRENCH)



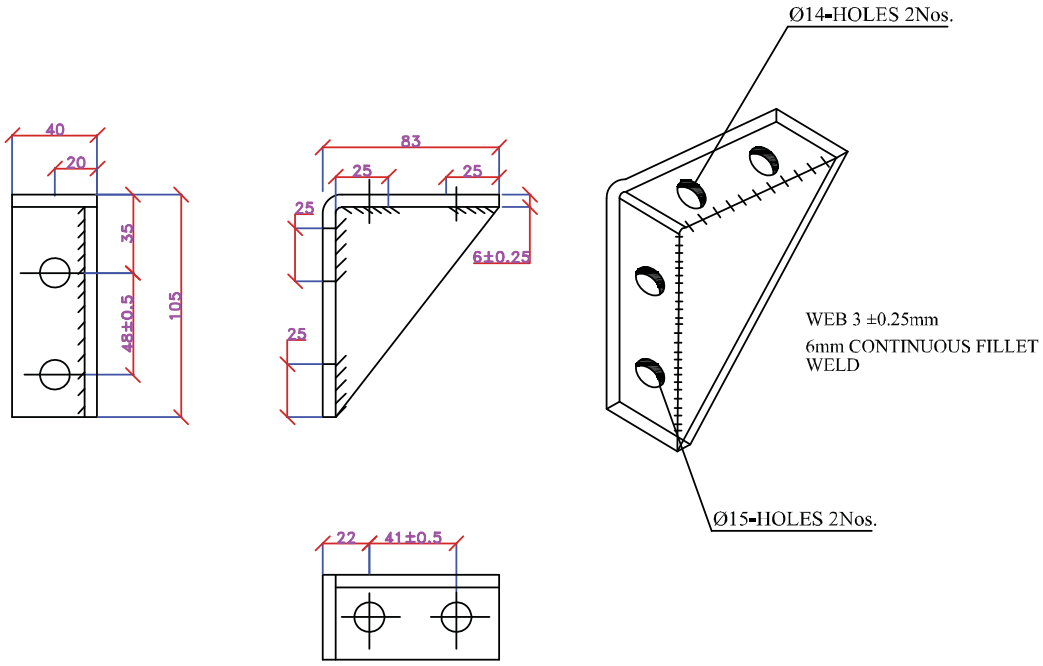
TYPICAL ASSEMBLY OF CHANNEL SUPPORTS AND CABLE TRAY

M12 HEX BOLT & WASHER–2NOs.
M12 SPRING NUTS–2NOs.
M6 PAN HEAD SCREWS & WASHER–2NOs.
M6 SPRING NUTS–2NOs.

NOTES :

1. ALL DIMENSIONS ARE IN mm.
2. ITEM NO.1 MATERIAL : HOT/ COLD ROLLED M.S. AS PER RELEVANT IS.
3. ITEM NO.2 MATERIAL : M.S AS PER IS-2062
4. FINISH : HOT DIP GALVANISED AS PER IS:2629
5. TOLERANCE ON THICKNESS IS AS PER IS:1852
6. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
7. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 03 OF 37



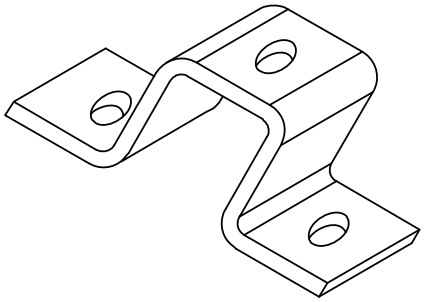
90 ANGLE FITTING HL1 (HEAVY DUTY TYPE)

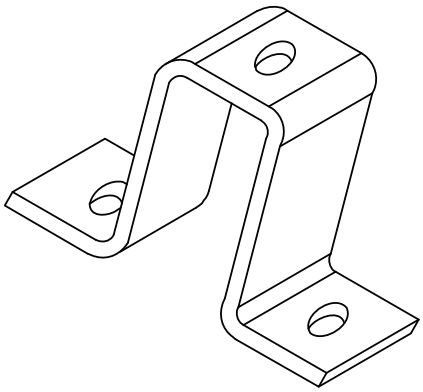
ANCHOR FASTENER–2NOs.
SPRING NUT & WASHER–2NOs.

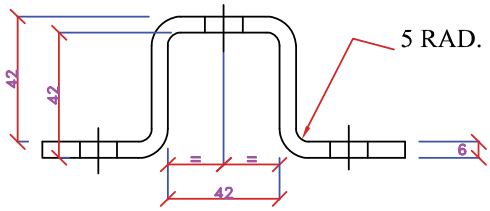
NOTES :

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

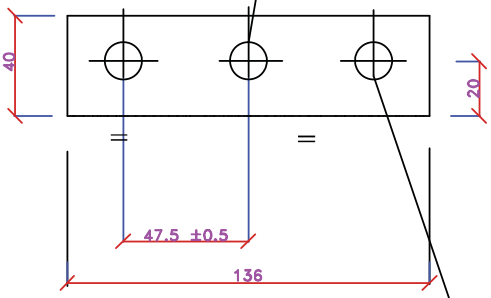
	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 04 OF 37





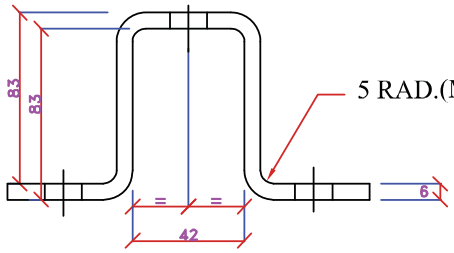


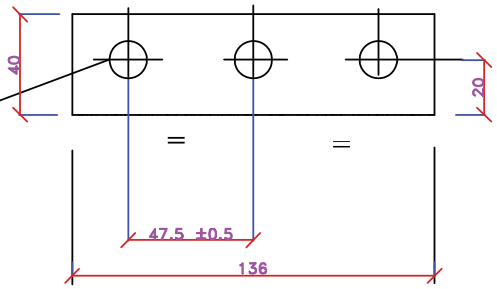
Ø14 HOLES
1 Nos



Ø15 HOLES
2 Nos

CLAMP FOR SINGLE CHANNEL CC1





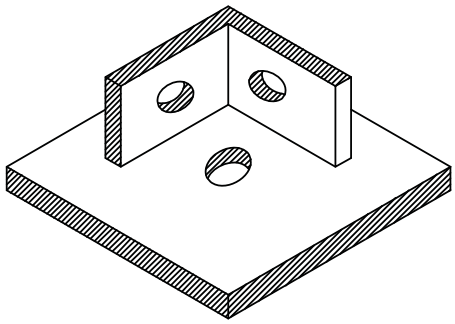
CLAMP FOR DOUBLE CHANNEL CC2

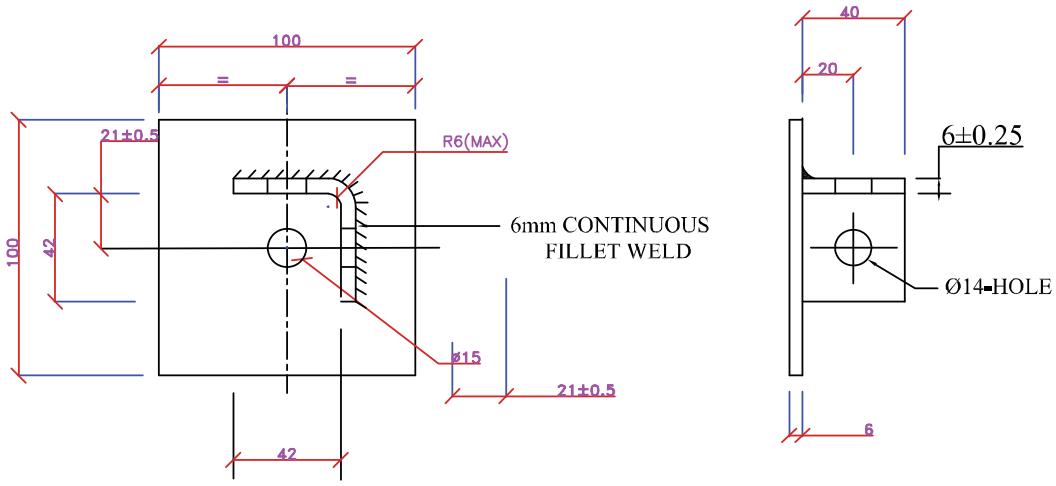
NOTES

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

ANCHOR FASTENER–2NOs.
SPRING NUT & WASHER–1NO.

	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 / SH 05 OF 37





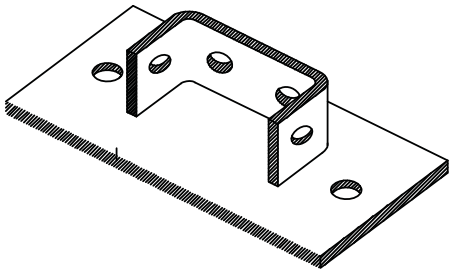
BASE PLATE FOR SINGLE CHANNEL BP1

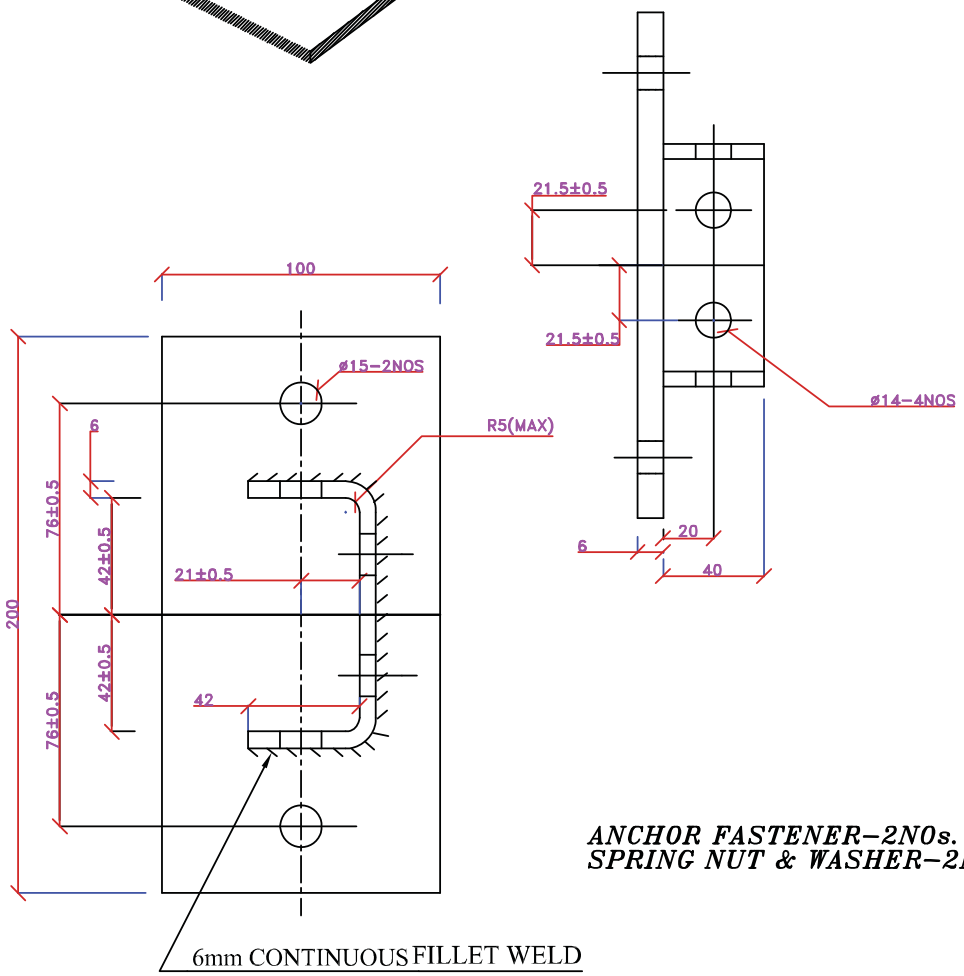
NOTE

ANCHOR FASTENER–1NO.
SPRING NUT & WASHER–1NO.

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

भेल BHEL	**TITLE:**	**TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM**	REV.01 / SH 06 OF 37





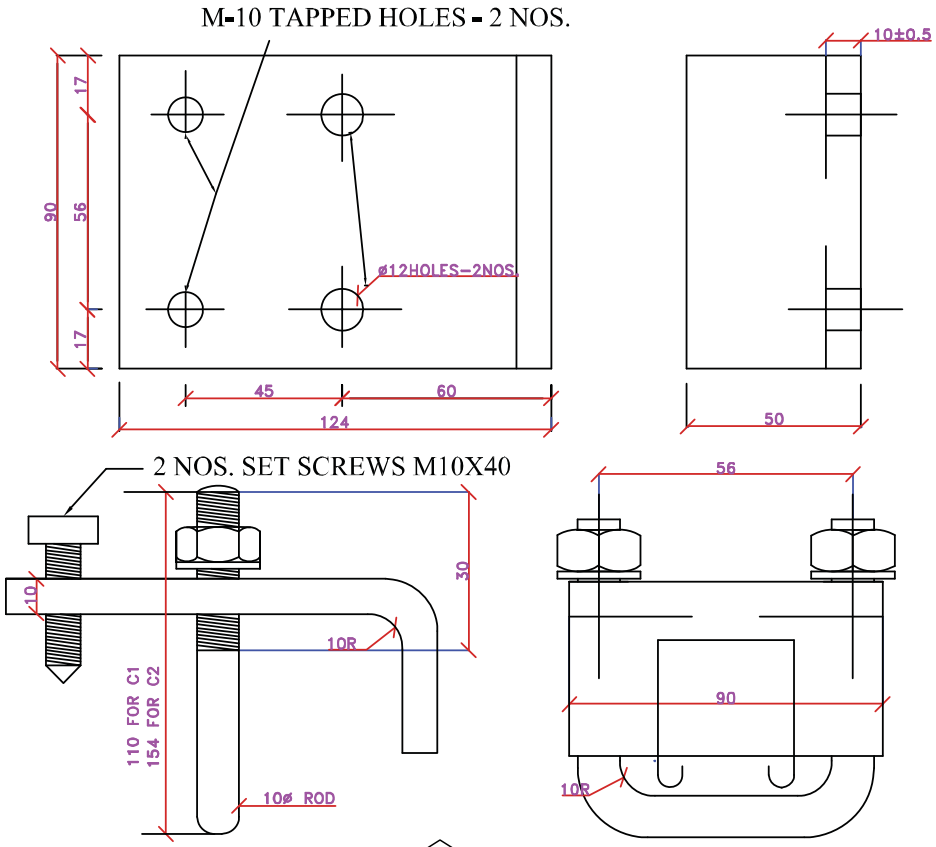
ANCHOR FASTENER–2NOs.
SPRING NUT & WASHER–2NOs.

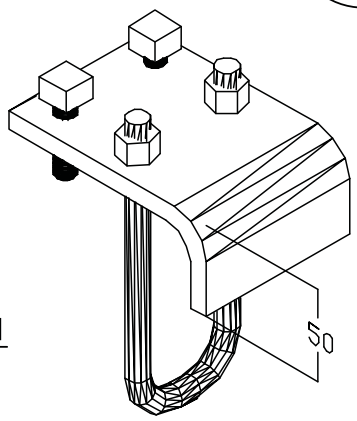
BASE PLATE FOR DOUBLE CHANNEL BP2

NOTE

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 07 OF 37





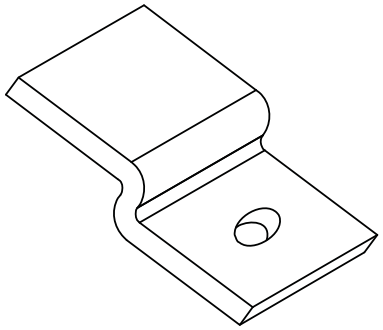
BEAM CLAMP - BC1

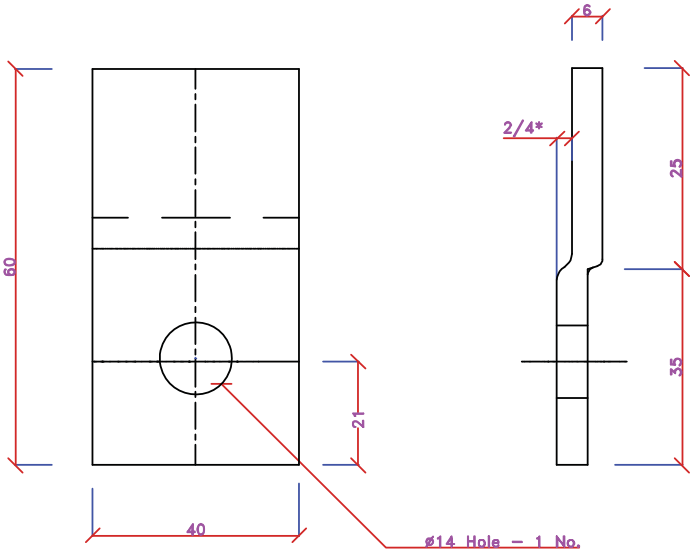
M–10 U–BOLT WITH
2Nos PLAIN WASHERS & NUTS
110 mm FOR SC 1
154 mm FOR DC1
2 NOs. SET SCREWS M10X40

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 08 OF 37





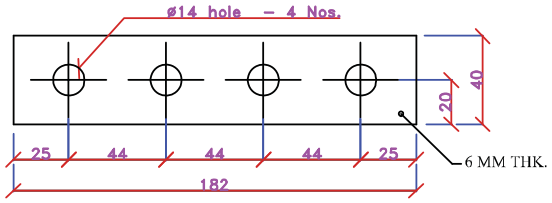
TRAY FIXING CLAMP - TC1

SPRING NUT & WASHER–1NO.
** :–2MM FOR TRAY FIXING CLAMP TC1*
4MM FOR FRP–TRAY FIXING CLAMP

NOTES

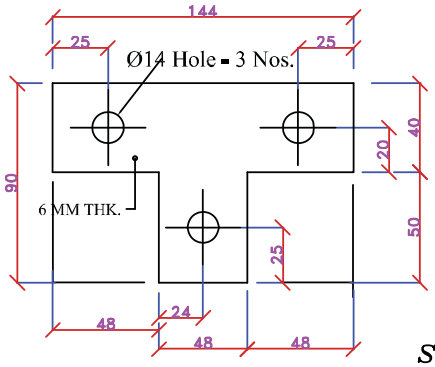
1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 09 OF 37



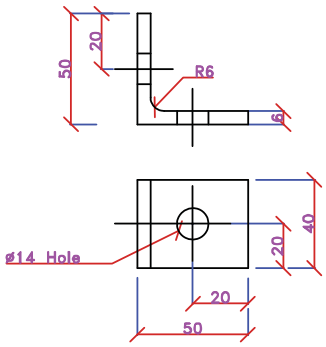
SPRING NUT & WASHER–4NOs.

FLAT PLATE STRAIGHT FITTING PF2



SPRING NUT & WASHER–3NOs.

FLAT PLATE TEE FITTING PF1



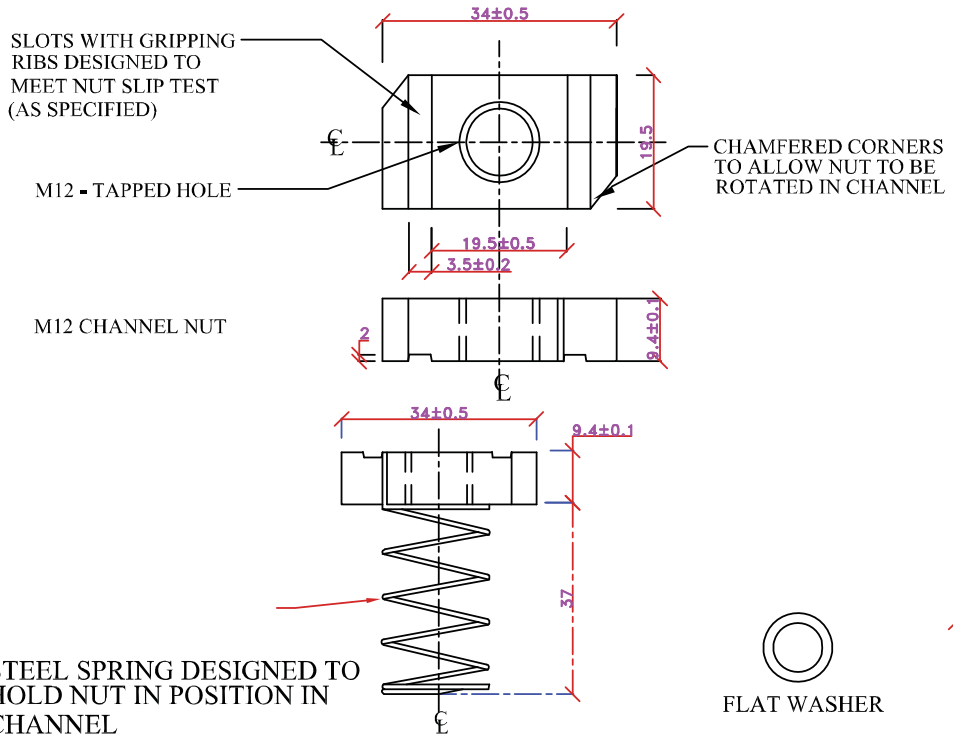
SPRING NUT & WASHER–2NOs.

90^0 ANGLE FITTING LA1

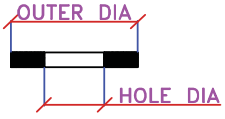
NOTES

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

भीएचईएल BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01	SH 10 OF 37



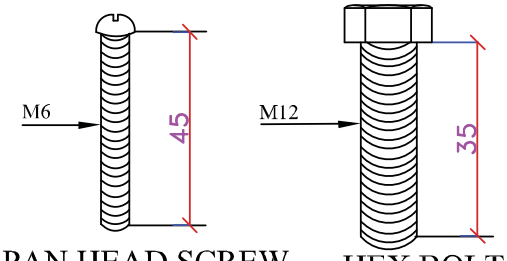
SPRING NUT ASSEMBLY



TYPICAL DETAILS OF WASHER

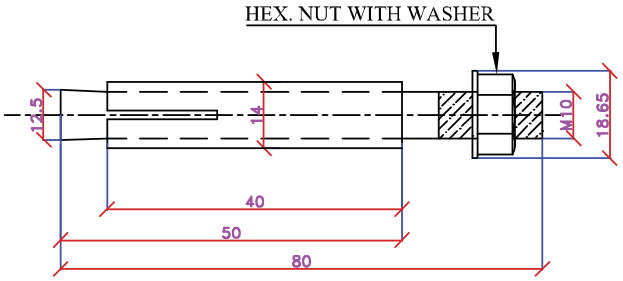
WASHER SIZE DETAILS

Sl.No.	BOLT/SCREW SIZE	HOLE DIA (IN MM)	OUTER DIA (IN MM)	WAHER THICKNESS (IN MM)
1	M6 PAN HEAD SCREW	6.4	12	1.6
2	M12 HEXA BOLT	13	24	2.5



PAN HEAD SCREW

HEX BOLT

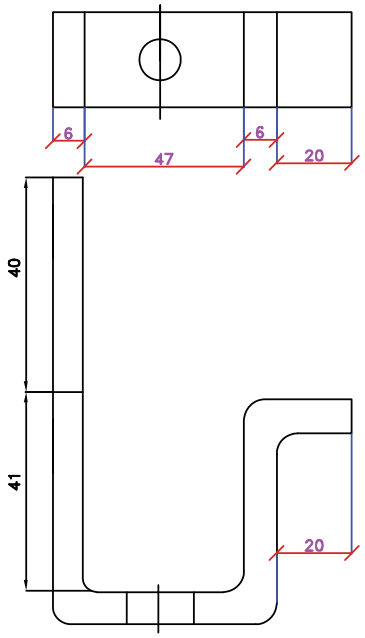


ANCHOR BOLT M10

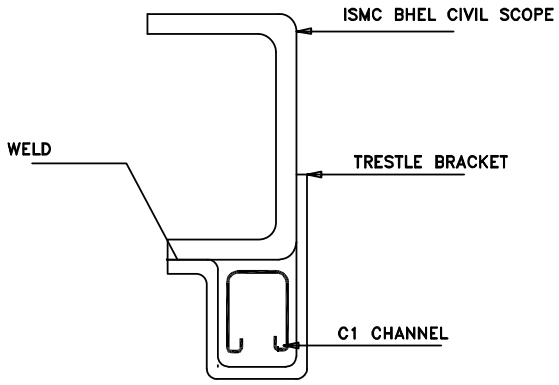
NOTES:

1. MATERIAL - MS AS PER IS - 2062.
2. M6 CHANNEL NUT DIMENSIONAL SIMILAR TO M12.
   EXCEPT HOLE DRILLED AND TAPPED TO M6 PAN HEAD SCREWS.
3. TAPPED HOLE THREADING TO MATCH WITH THREADING OF BOLTS.
4. SURFACE PROTECTION ELECTROGALVANISED / CADMIUM PLATED.
5. ALL DIMENSIONS ARE IN MM.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

बीएचईएल BHEL	**TITLE:** TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 | SH 11 OF 37



TRESTLE BRAKET



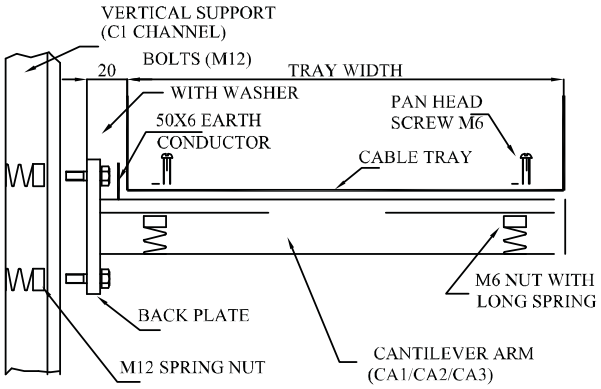
FIXING ARRANGMENT OF TRESTLE BRACKET

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL :MILD STEEL AS PER IS-2062
3. FINISH : HOT DIP GALVANISED AS PER IS:2629
4. TOLERANCE ON THICKNESS AS PER IS:1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRONS/ 610 G/SQ. M.

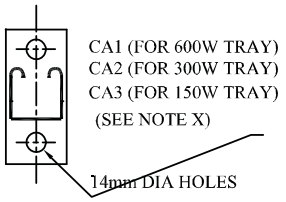
भेल BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01	SH 12 OF 37

INDEX

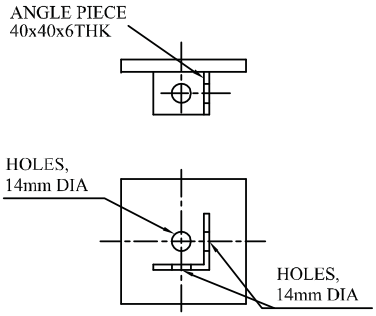


TYPICAL ASSEMBLY OF CHANNEL SUPPORTS AND CABLE TRAY

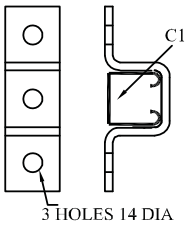
1) 600mm TRAY-1 T0 6 TIER -C2
2) 300mm TRAY-1 T0 3 TIER -C1
3) 300mm TRAY-4 T0 6 TIER -C2
4) 150mm TRAY-1 T0 6 TIER -C1



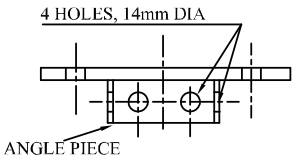
END VIEW OF CANTILEVER ARM

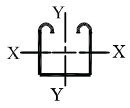


BASE PLATE FOR SINGLE CHANNEL (BP1)

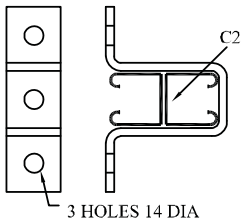


C1 CHANNEL CLAMP (CC1)

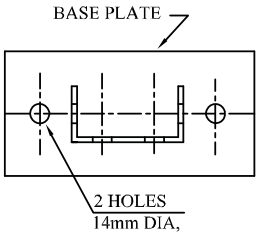




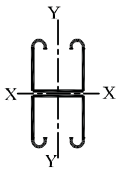
SECTION OF C1 (SINGLE CHANNEL)



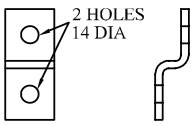
C2 CHANNEL CLAMP (CC2)



BASE PLATE FOR DOUBLE CHANNEL (BP2)



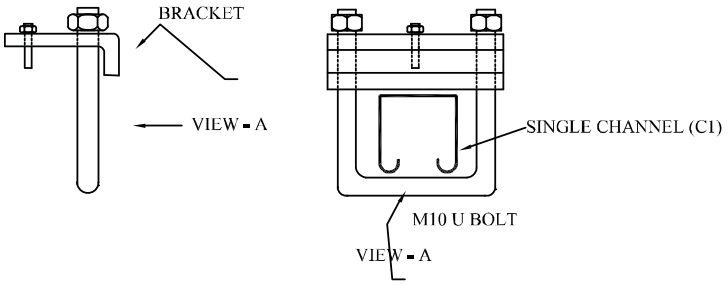
SECTION OF C2 (DOUBLE CHANNEL)



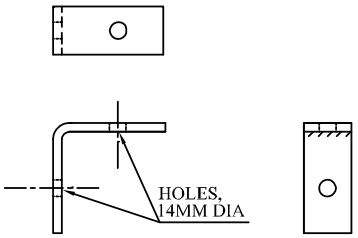
TRAY CLAMP (TC1)
(SEE NOTE VI)

TYPICAL SUPPORT SYSTEM ELEMENTS

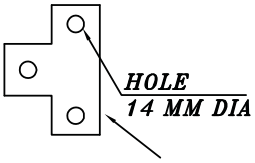
BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 14 OF 37



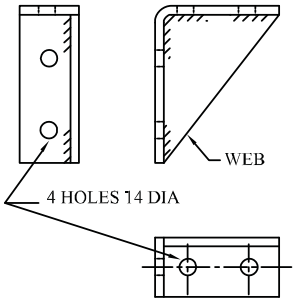
BEAM CLAMP (BC1)
(SEE FIXING DETAIL ON SHEET 30)



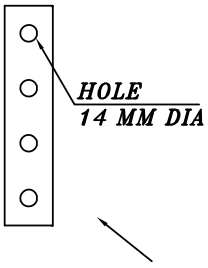
ANGLE FITTING (LA1)



FLAT PLATE TEE FITTING (PF1)



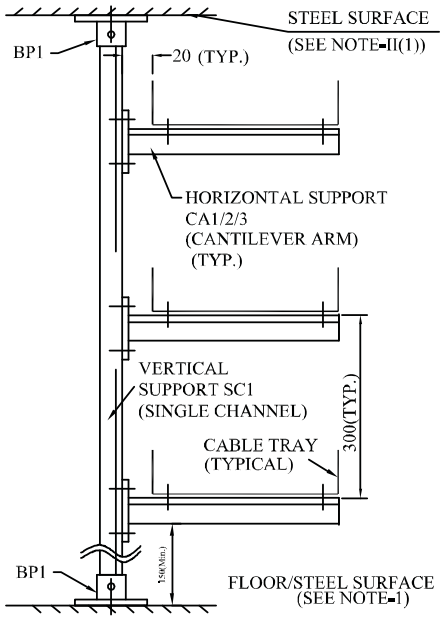
HEAVY DUTY RIGHT ANGLE FITTING HL1



FLAT PLATE STRAIGHT FITTING PF2

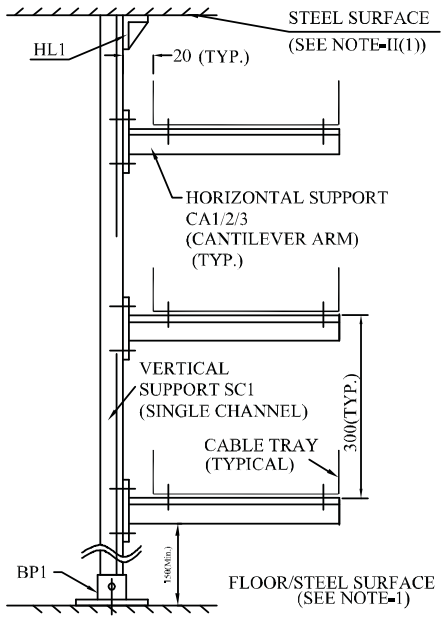
TYPICAL SUPPORT SYSTEM ELEMENTS

TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01	SH 15 OF 37



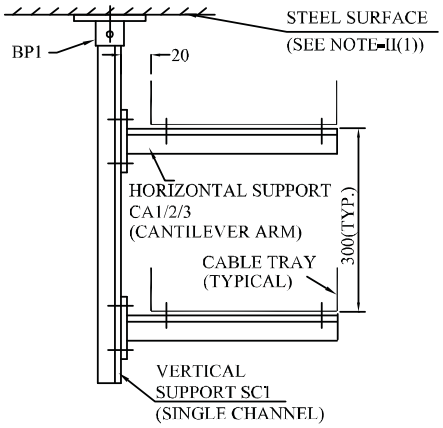
INSTALLATION DETAIL TYPE SB1:
SINGLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON SINGLE SIDE
WITH BP1 AT TOP BOTTOM
APPLICABLE FOR THREE TRAYS AND MORE

(SEE NOTE IX)



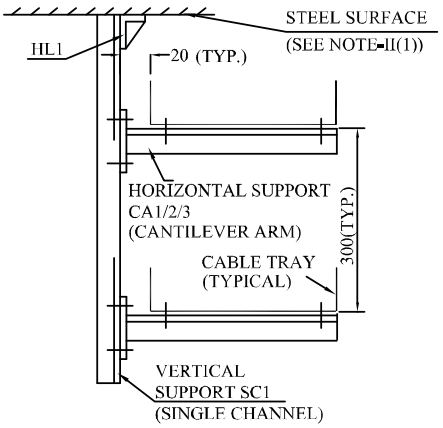
INSTALLATION DETAIL TYPE SB2:
SINGLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON SINGLE SIDE
WITH HL1 AT TOP & BP1 AT BOTTOM
APPLICABLE FOR THREE TRAYS AND MORE

(SEE NOTE IX)



INSTALLATION DETAIL TYPE SS1:
SINGLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED, TRAYS ON SINGLE SIDE
WITH BASEPLATE BP1 AT TOP
APPLICABLE FOR UPTO & INCLUDING TWO TRAYS

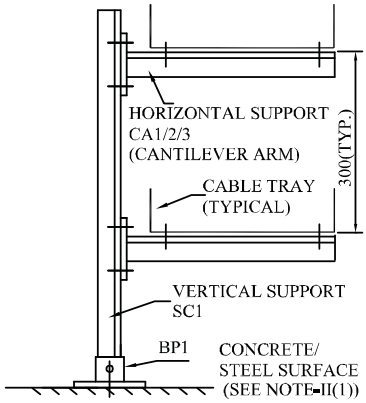
(SEE NOTE IX)



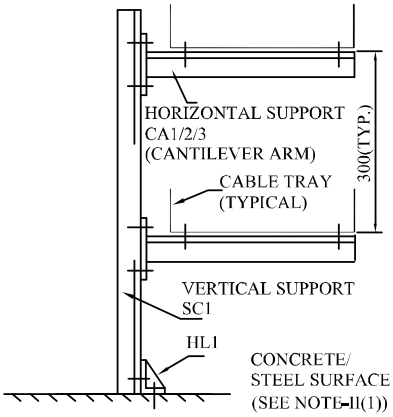
INSTALLATION DETAIL TYPE SS2:
SINGLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED, TRAYS ON SINGLE SIDE
WITH ANGLE FITTING HL1 AT TOP
APPLICABLE FOR UPTO & INCLUDING TWO TRAYS

(SEE NOTE IX)

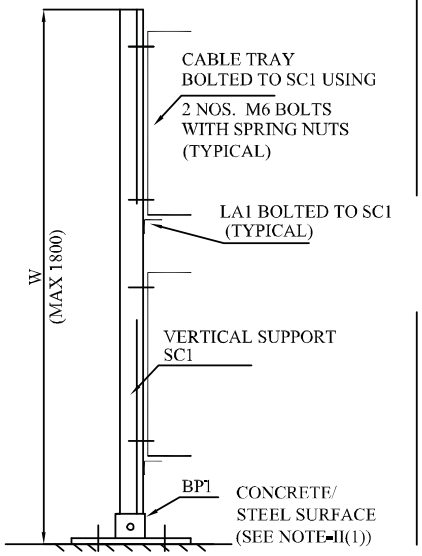
BISEE VM	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 16 OF 37



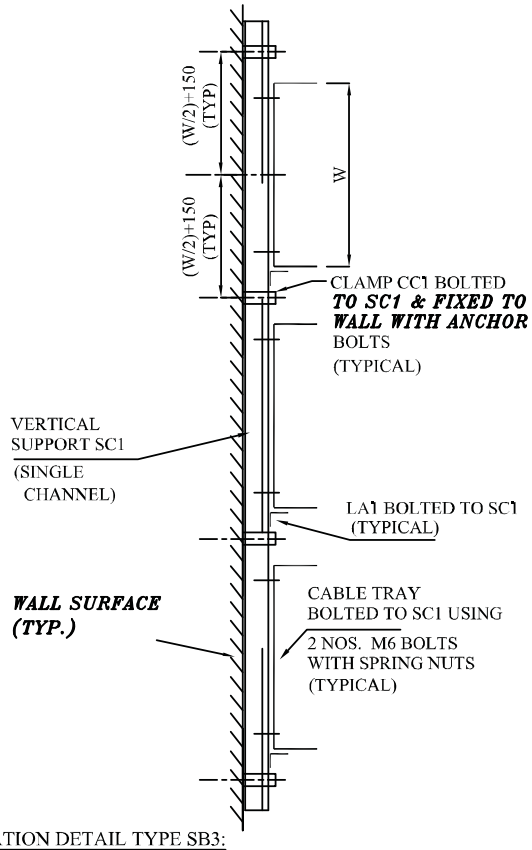
INSTALLATION DETAIL TYPE SS3:
SINGLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED TRAYS ON SINGLE SIDE
BASEPLATE BP1 AT BOTTOM
APPLICABLE FOR UPTO & INCLUDING TWO TRAYS



INSTALLATION DETAIL TYPE SS4:
SINGLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED TRAYS ON SINGLE SIDE
WITH ANGLE FITTING HL1 AT BOTTOM
APPLICABLE FOR UPTO & INCLUDING TWO TRAYS

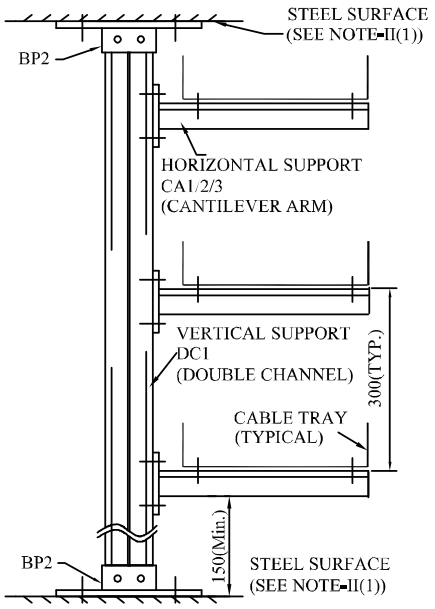


INSTALLATION DETAIL TYPE SS5:
SINGLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED,
TRAYS ORIENTED VERTICALLY
BASEPLATE AT BOTTOM
APPLICABLE FOR UPTO &
INCLUDING TWO TRAYS

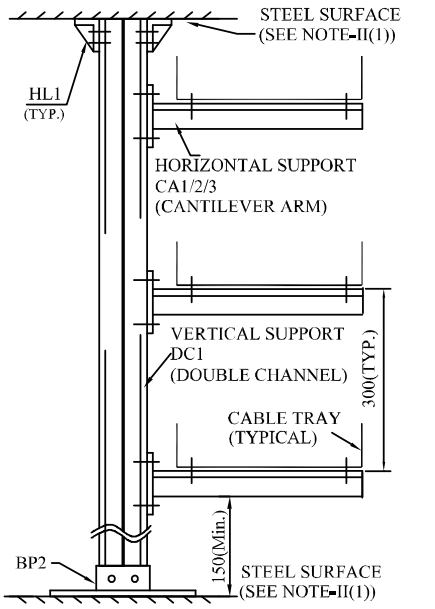


INSTALLATION DETAIL TYPE SB3:
SINGLE CHANNEL SUPPORT INSTALLATION, BOTH ENDS FIXED
TRAYS ON SINGLE SIDE, APPLICABLE FOR SUPPORTING TRAYS
IN VERTICAL ORIENTATION ALONG BUILDING WALLS

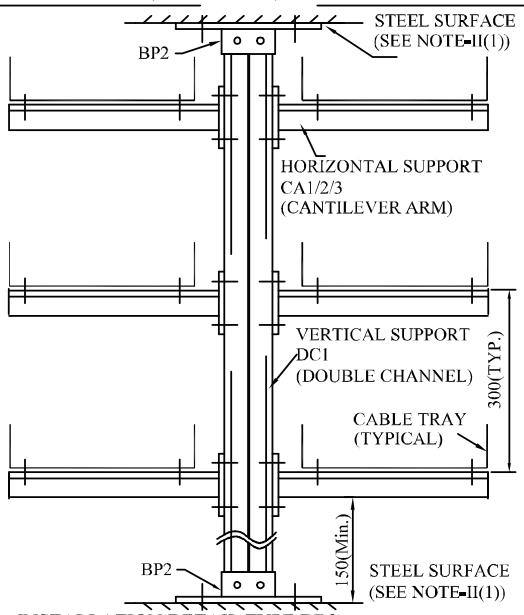
BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
			REV.01 | SH 17 OF 37



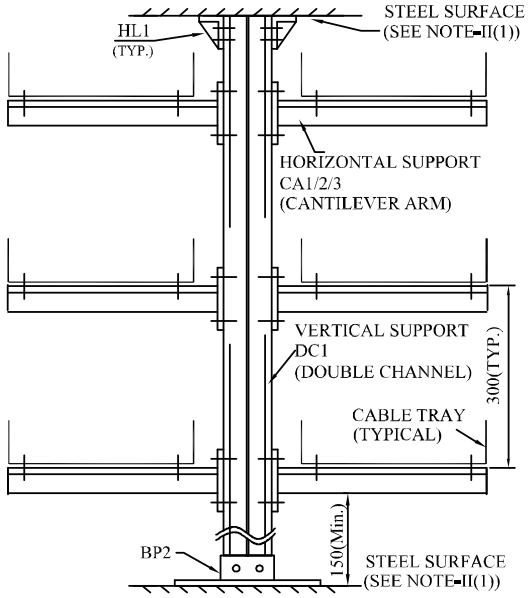
INSTALLATION DETAIL TYPE DB1:
DOUBLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON SINGLE SIDE
WITH BASEPLATE BP2 AT TOP & BOTTOM
APPLICABLE FOR MORE THAN THREE TRAYS
(SEE NOTE IX)



INSTALLATION DETAIL TYPE DB2:
DOUBLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON SINGLE SIDE
WITH HL1 AT TOP & BP2 AT BOTTOM
APPLICABLE FOR MORE THAN THREE TRAYS
(SEE NOTE IX)



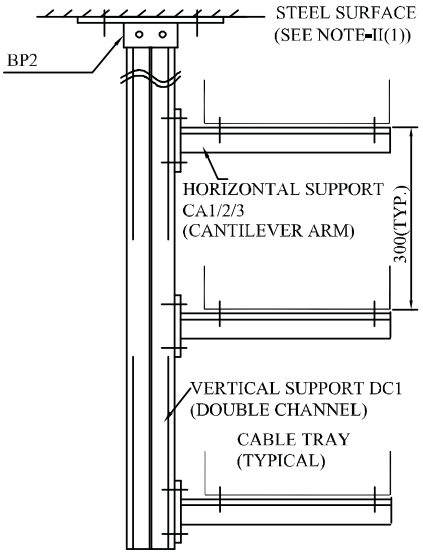
INSTALLATION DETAIL TYPE DB3:
DOUBLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON BOTH SIDES
WITH BASEPLATE BP2 AT TOP & BOTTOM
(SEE NOTE IX)



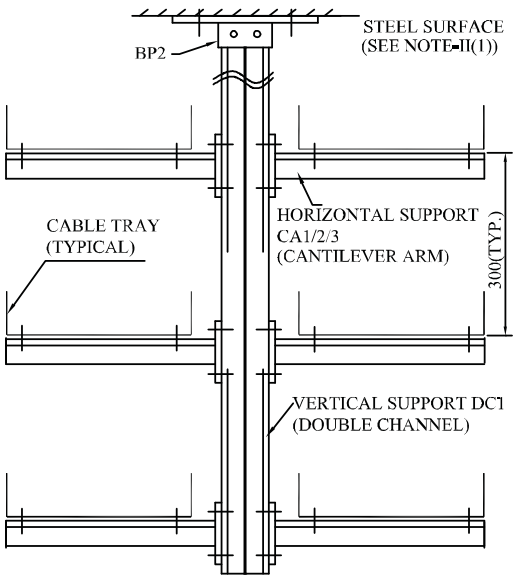
INSTALLATION DETAIL TYPE DB4:
DOUBLE CHANNEL SUPPORT INSTALLATION
BOTH ENDS FIXED, TRAYS ON BOTH SIDES
WITH HL1 AT TOP & BP2 AT BOTTOM
(SEE NOTE IX)

BHEL

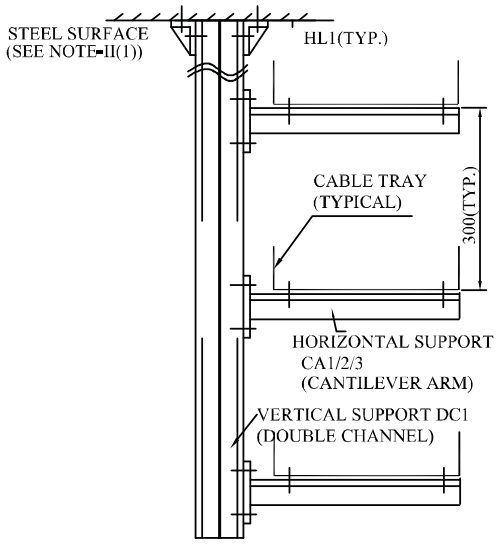
TITLE: **TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM**



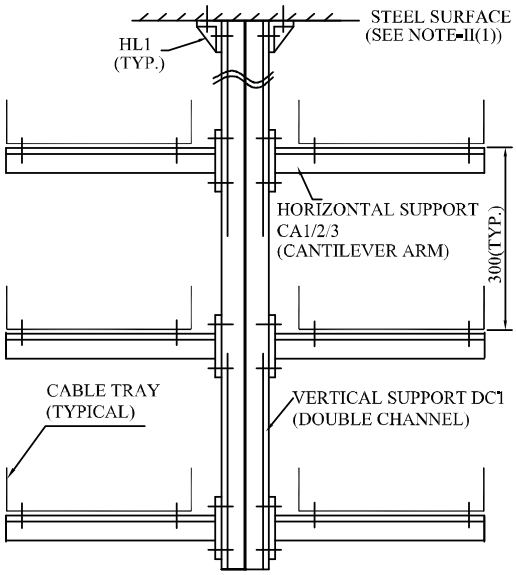
INSTALLATION DETAIL TYPE DS1:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
BASEPLATE AT TOP
APPLICABLE FOR THREE TRAYS ON SINGLE SIDE
(SEE NOTE IX)



INSTALLATION DETAIL TYPE DS2:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
BASEPLATE AT TOP
APPLICABLE FOR UPTO THREE TRAYS ON BOTH SIDES
(SEE NOTE IX)

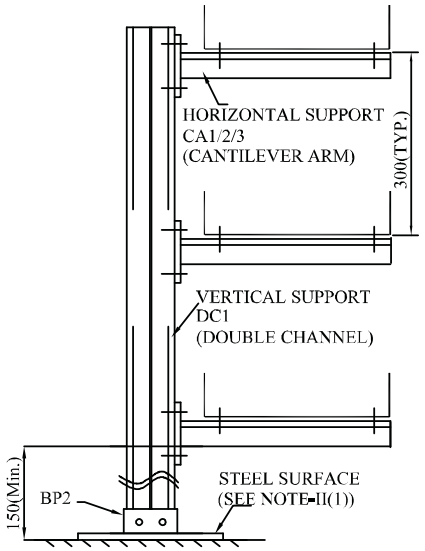


INSTALLATION DETAIL TYPE DS3:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
WITH ANGLE FITTING HL1 AT TOP
APPLICABLE FOR MORE THAN TWO TRAYS
ON SINGLE SIDE
(SEE NOTE IX)

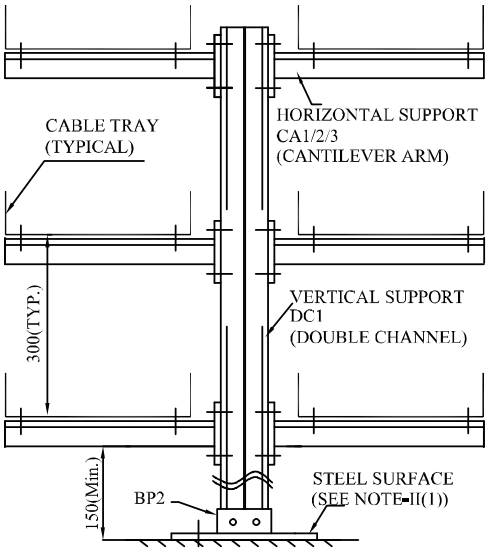


INSTALLATION DETAIL TYPE DS4:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
WITH ANGLE FITTING HL1 AT TOP
APPLICABLE FOR UPTO THREE TRAYS ON BOTH SIDES
(SEE NOTE IX)

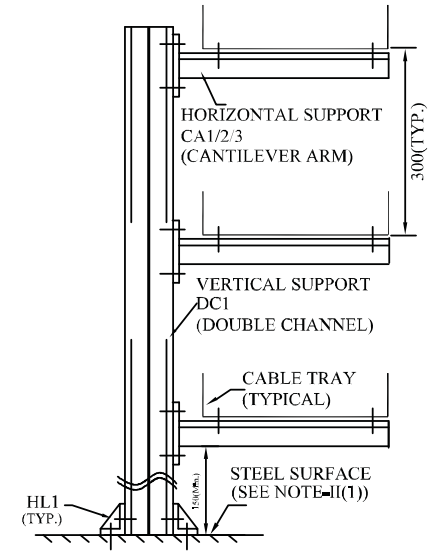
TITLE: **TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM**



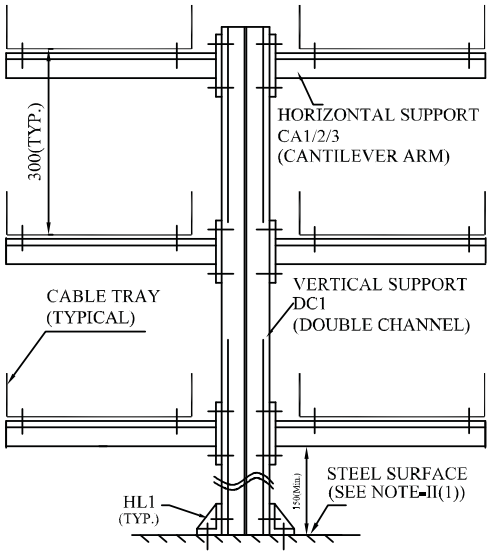
INSTALLATION DETAIL TYPE DS5:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED TRAYS ON SINGLE SIDE
BASEPLATE AT BOTTOM



INSTALLATION DETAIL TYPE DS6:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED
UPTO THREE TRAYS ON BOTH SIDES
BASEPLATE AT BOTTOM



INSTALLATION DETAIL TYPE DS7:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED TRAYS ON SINGLE SIDE
WITH ANGLE FITTING HL1 AT BOTTOM

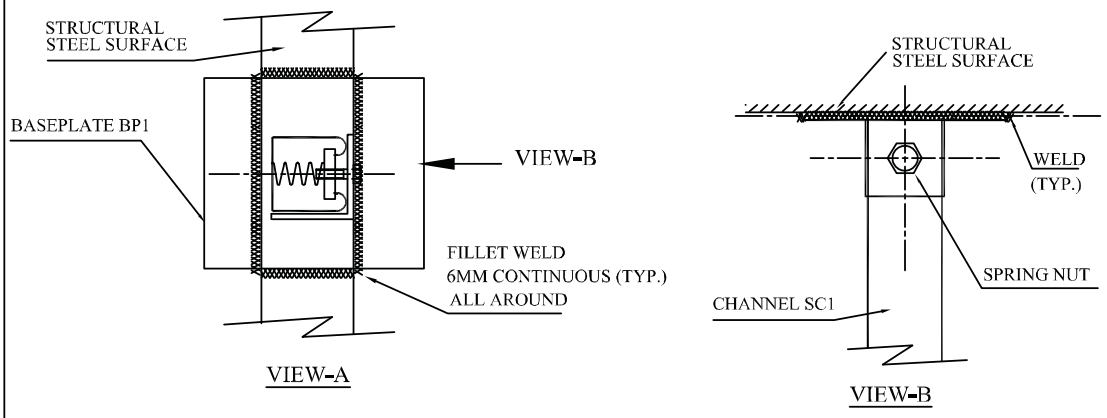


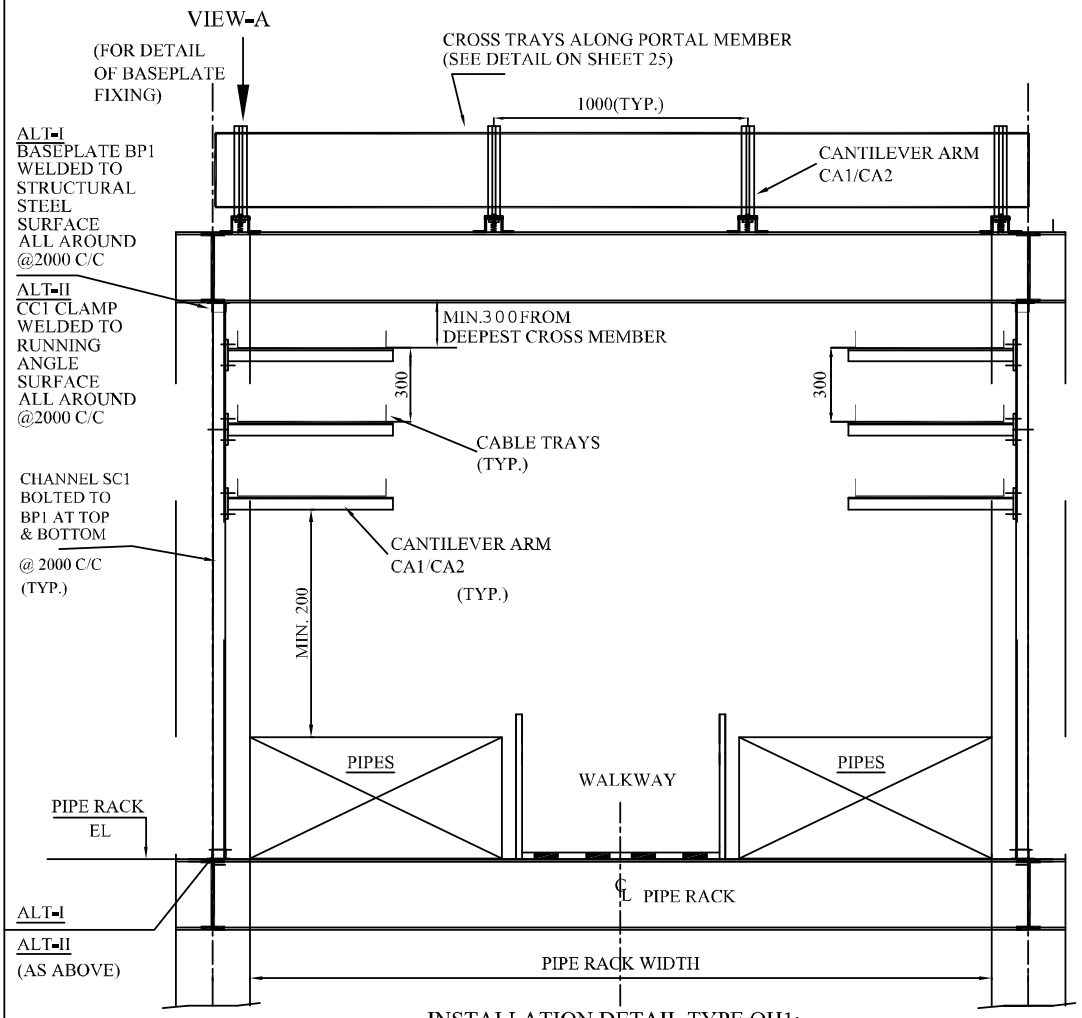
INSTALLATION DETAIL TYPE DS8:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY BOTTOM END FIXED
UPTO THREE TRAYS ON BOTH SIDES
WITH ANGLE FITTING HL1 AT BOTTOM

BHEL

TITLE: **TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM**

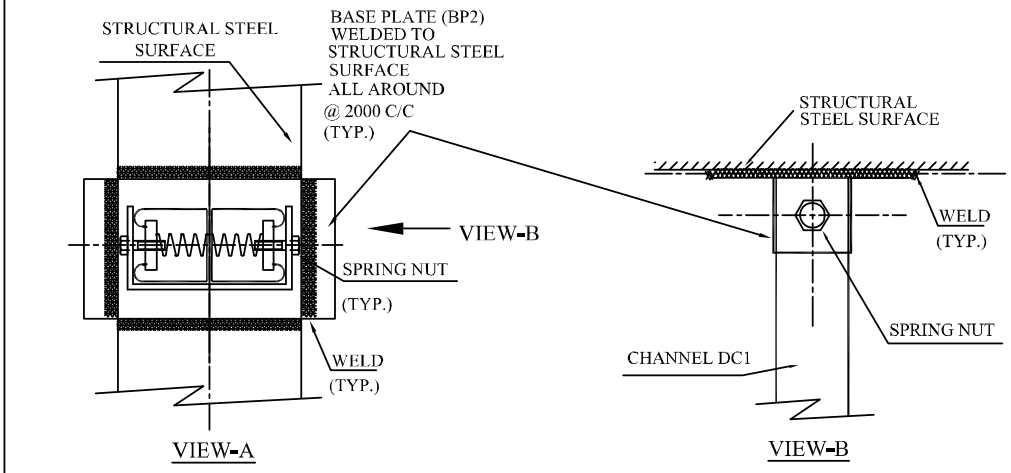
REV.01 | SH 20 OF 37

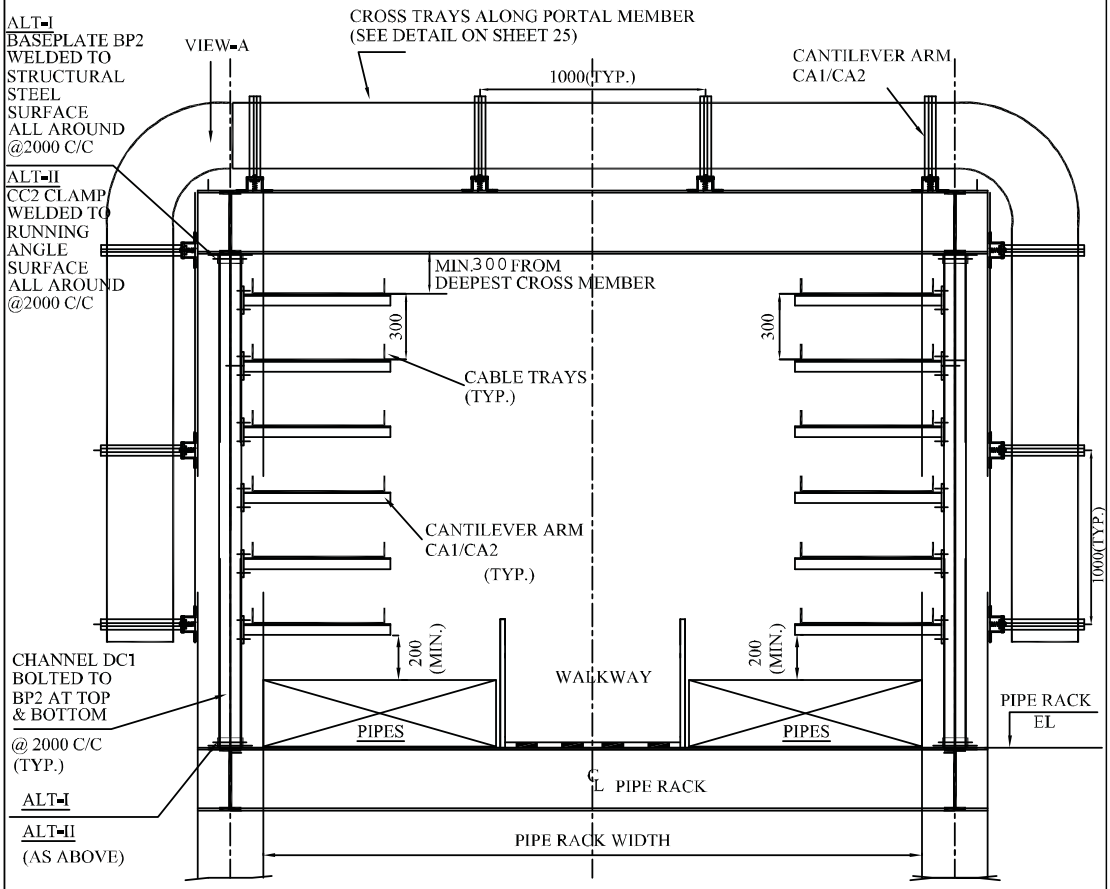




INSTALLATION DETAIL TYPE OH1:
TYPICAL TRAY SUPPORT ARRANGEMENT ALONG PIPERACK
(UPTO AND INCLUDING THREE TRAYS) (SEE NOTE IX)

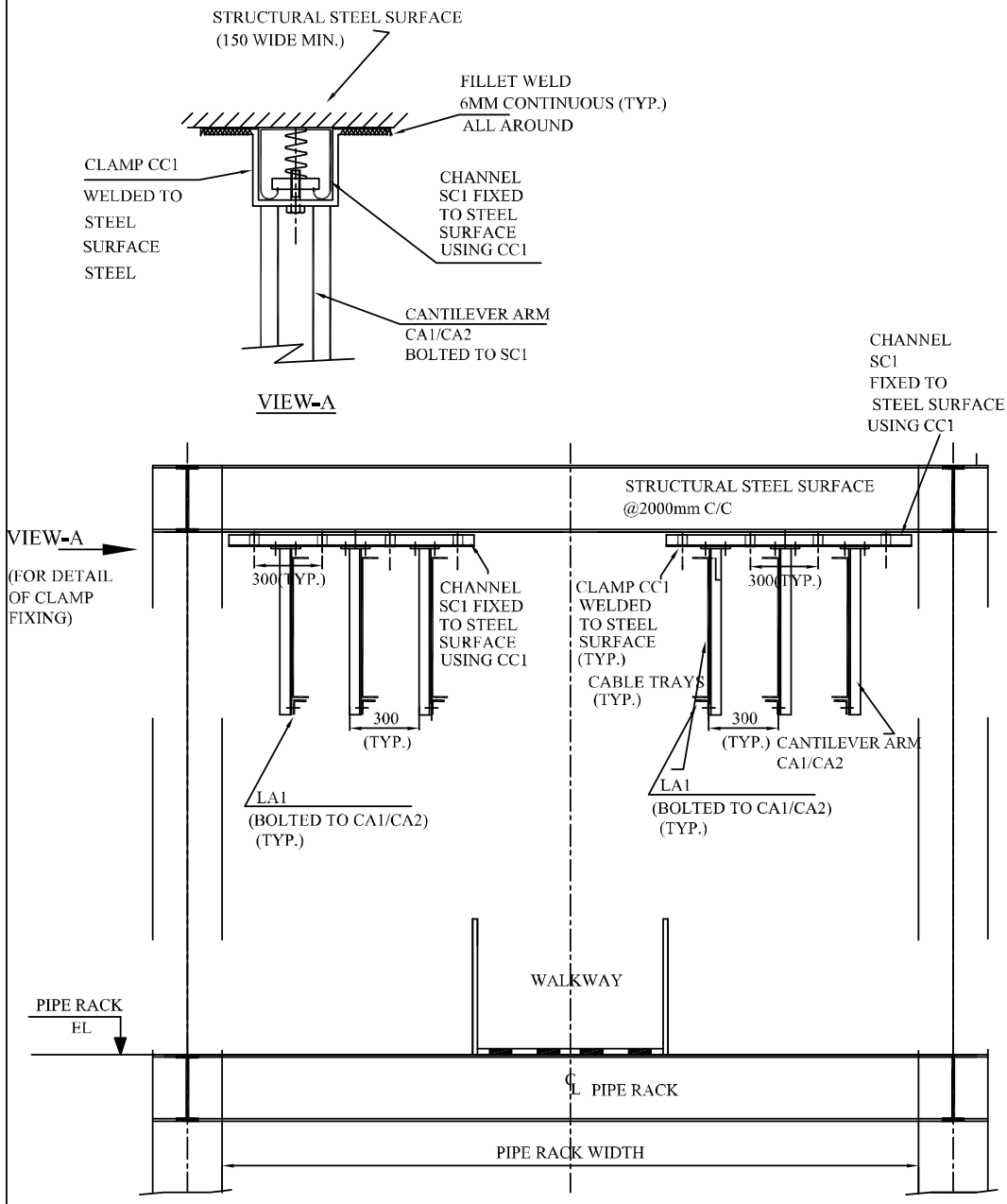
	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 21 OF 37





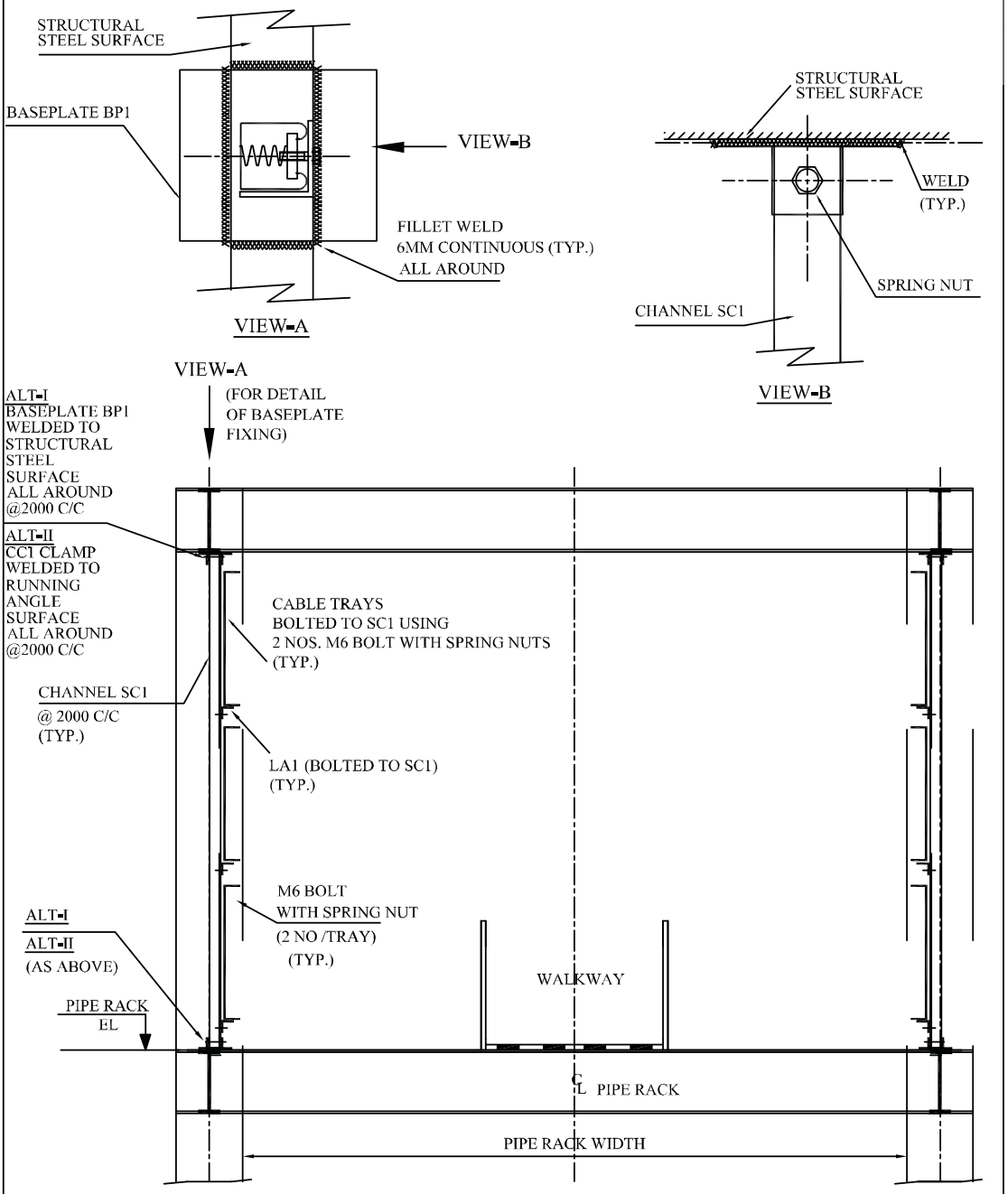
INSTALLATION DETAIL TYPE OH2:
TYPICAL TRAY SUPPORT ARRANGEMENT ALONG PIPERACK
(MORE THAN THREE TRAYS)
(SEE NOTE IX)

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 22 OF 37



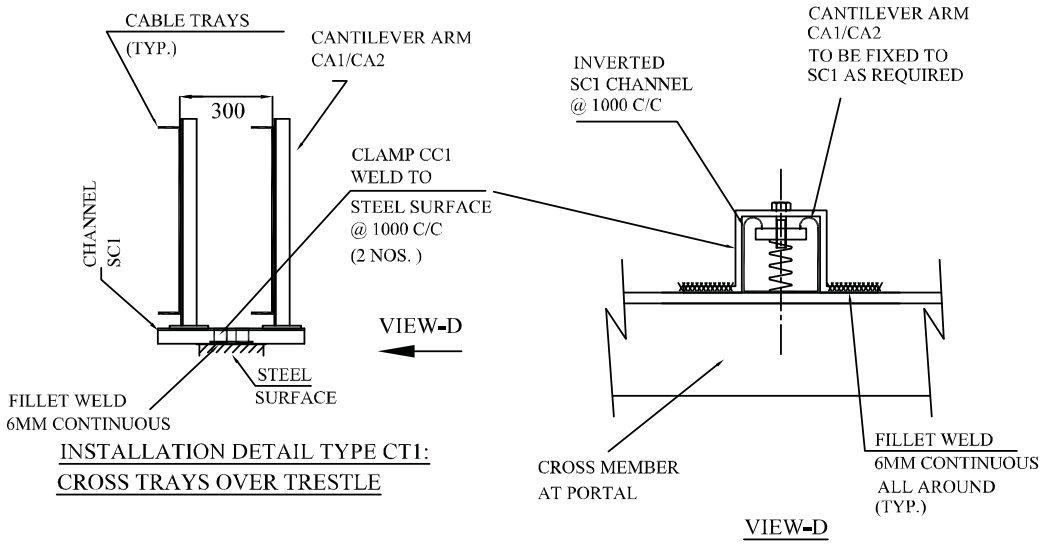
INSTALLATION DETAIL TYPE OV1
TYPICAL VERTICALLY ORIENTED TRAY SUPPORT ARRANGEMENT ALONG PIPERACK

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
	REV.01	SH 23 OF 37

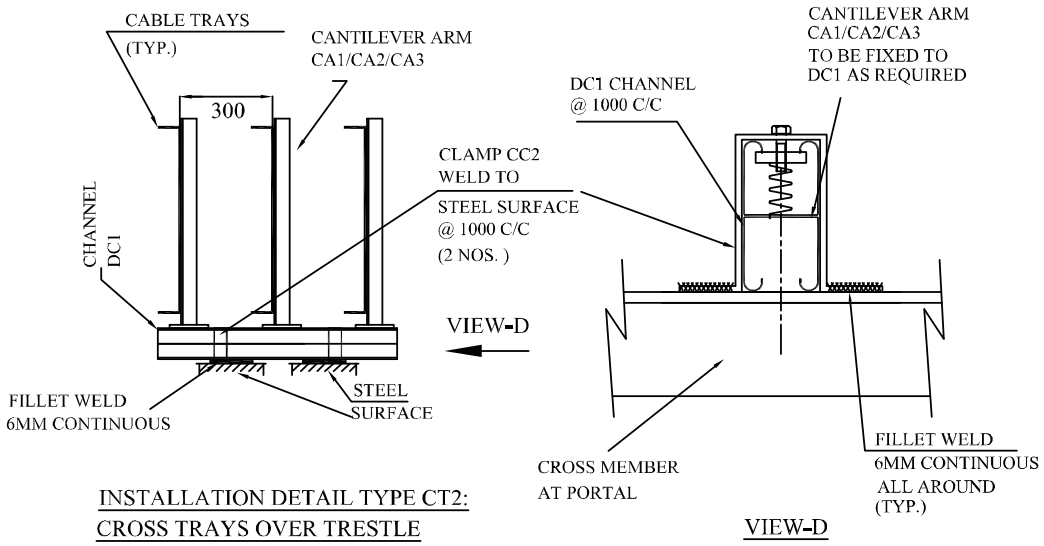


INSTALLATION DETAIL TYPE OV2:
VERTICALLY ORIENTED TRAY SUPPORT ARRANGEMENT ALONG PIPERACK (USING BP1)
(SEE NOTE IX)

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 24 OF 37

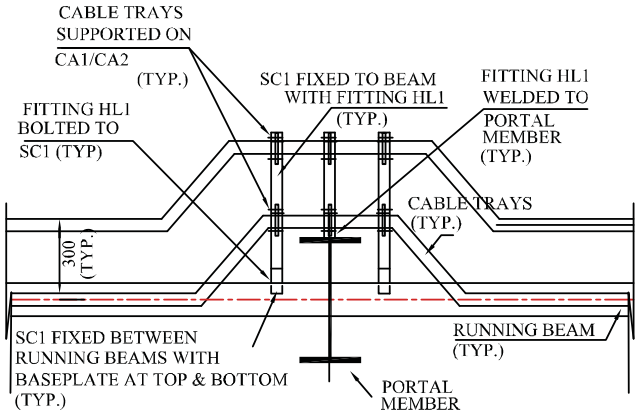


INSTALLATION DETAIL TYPE CT1:
CROSS TRAYS OVER TRESTLE

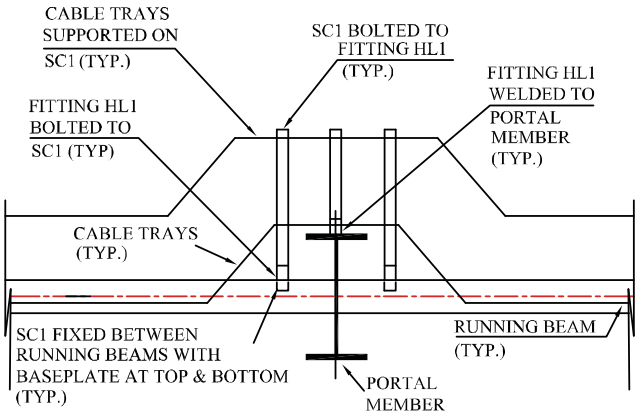


INSTALLATION DETAIL TYPE CT2:
CROSS TRAYS OVER TRESTLE

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 25 OF 37

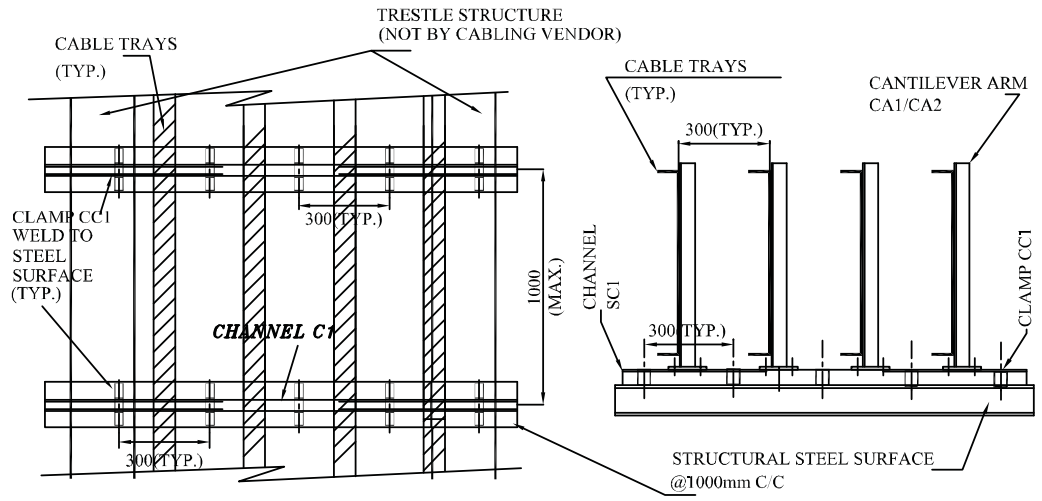


INSTALLATION DETAIL TYPE PM1:
CABLE TRAYS ROUTED AROUND PORTAL MEMBER
FOR VERTICALLY ORIENTED TRAYS
(SEE NOTE-III(3))

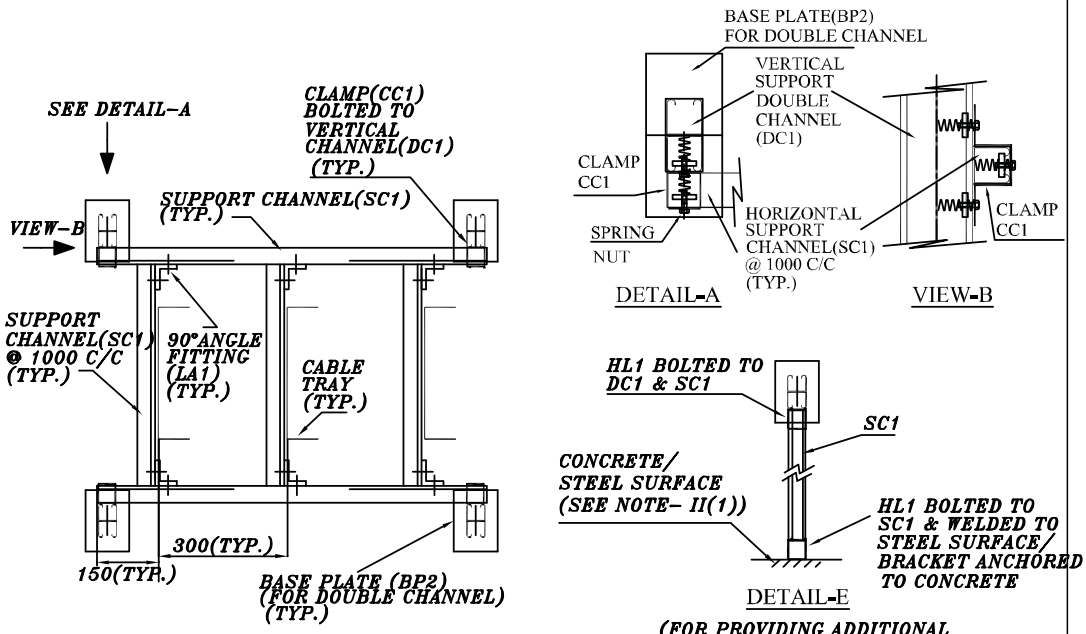


INSTALLATION DETAIL TYPE PM2:
CABLE TRAYS ROUTED AROUND PORTAL MEMBER
FOR HORIZONTALLY ORIENTED TRAYS
(SEE NOTE-III(3))

	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 26 OF 37



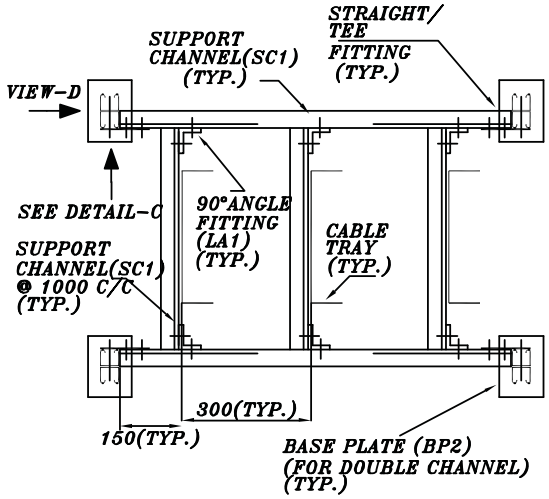
INSTALLATION DETAIL TYPE CR1:
RISER ALONG STRUCTURAL STEEL



INSTALLATION DETAIL TYPE CR2:
(USING CC1 CLAMPS UPTO 3 TRAYS)

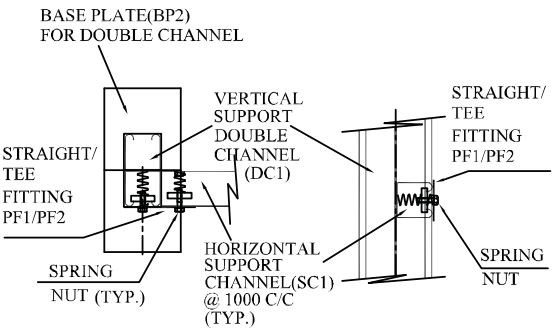
(TYPICAL CHANNEL FRAME WORK FOR CABLE TRAY RISER UPTO & INCLUDING THREE CABLE TRAYS)

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 27 OF 37

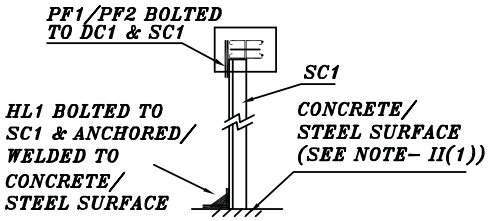


INSTALLATION DETAIL TYPE CR3:
(USING FITTINGS PF1/PF2)

(TYPICAL CHANNEL FRAME WORK FOR CABLE TRAY RISER UPTO & INCLUDING THREE CABLE TRAYS)



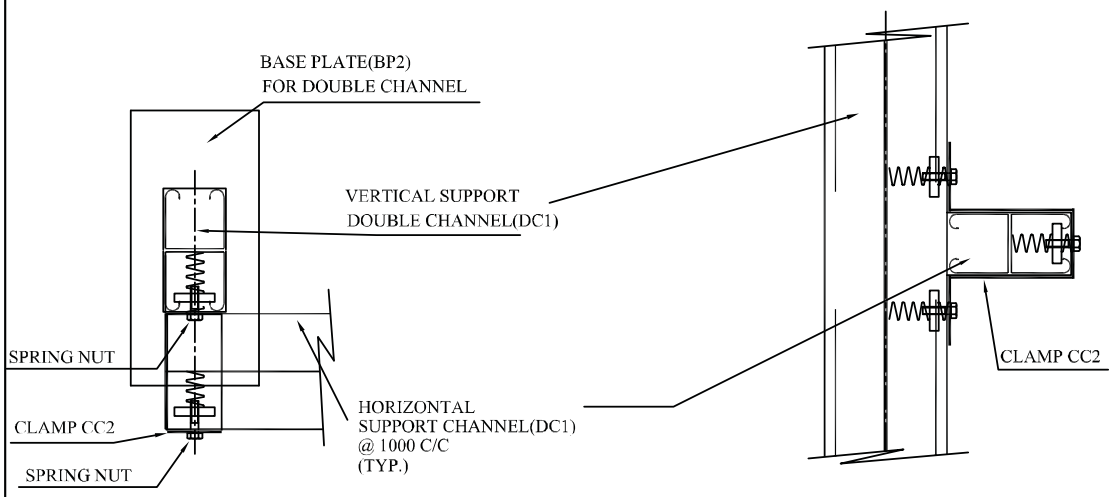
DETAIL-C VIEW-D

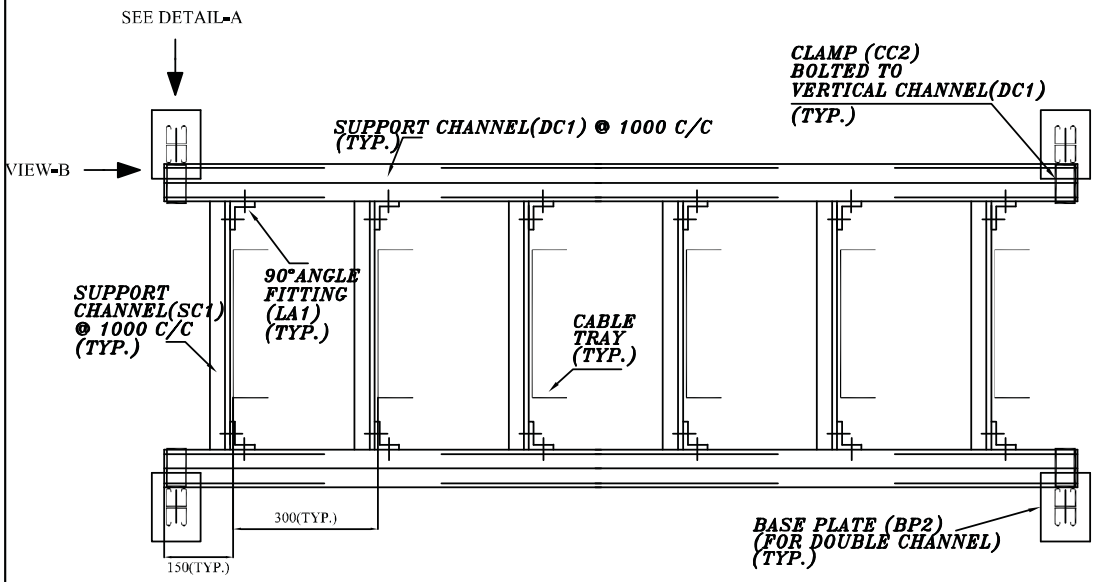


DETAIL-F

(FOR PROVIDING ADDITIONAL SUPPORT TO RISER COLUMN (DC1))
(SEE NOTE- V)

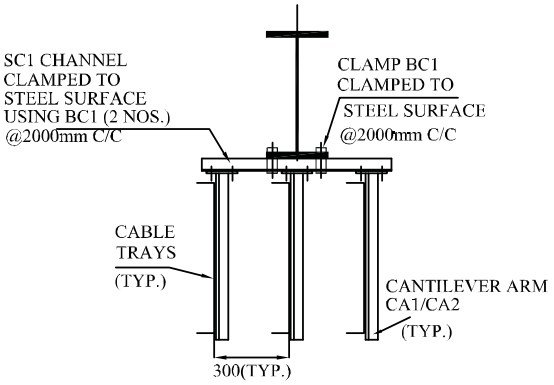
BHEL	**TITLE:** TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 28 OF 37



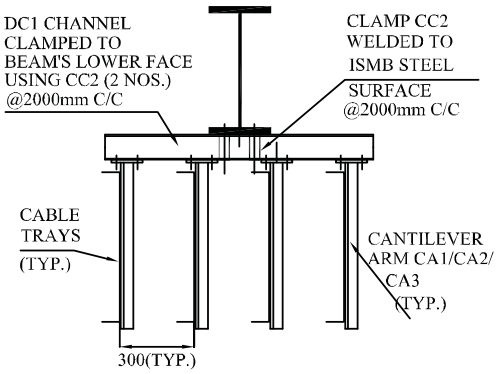


INSTALLATION DETAIL TYPE CR4:
TYPICAL CHANNEL FRAME WORK FOR CABLE TRAY RSIER
(FOR MORE THAN THREE CABLE TRAYS)

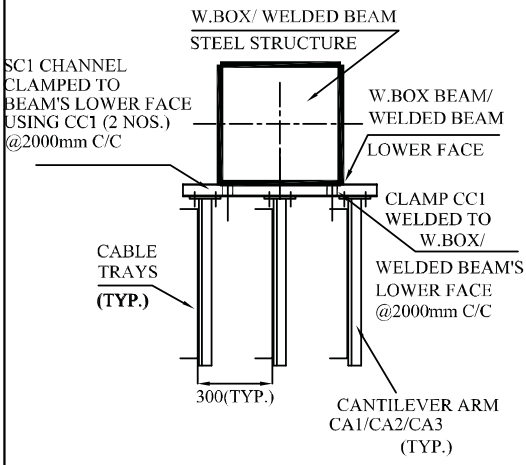
	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 29 OF 37



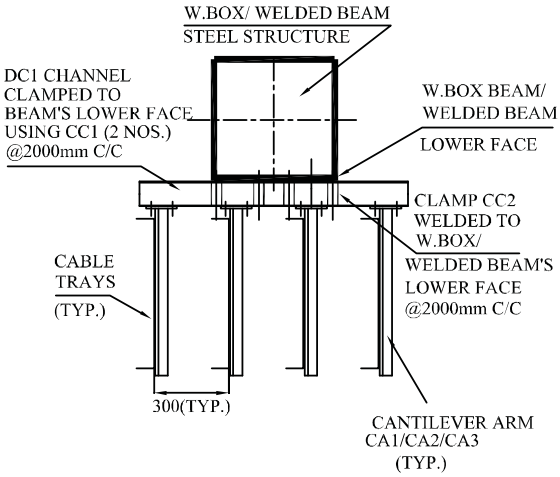
INSTALLATION DETAIL TYPE BB1:
CABLE TRAYS BELOW I-BEAMS
(UPTO & INCLUDING THREE TRAYS)



INSTALLATION DETAIL TYPE BB2:
CABLE TRAYS BELOW I-BEAMS
(MORE THAN THREE TRAYS)

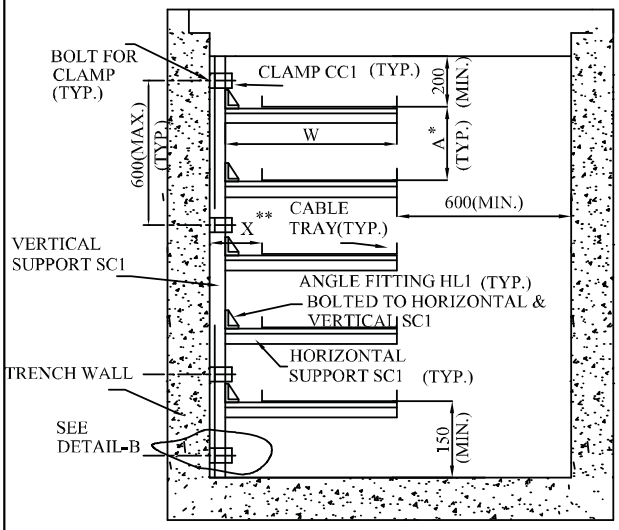


INSTALLATION DETAIL TYPE BB3:
CABLE TRAYS BELOW W. BOX/
WELDED BEAM'S (APPLICABLE FOR
UPTO & INCLUDING THREE TRAYS)



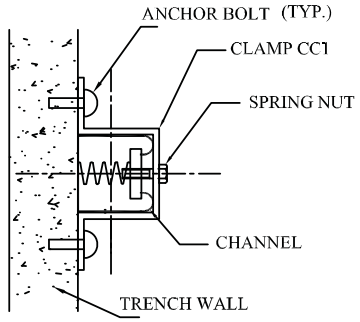
INSTALLATION DETAIL TYPE BB4:
CABLE TRAYS BELOW W. BOX/
WELDED BEAM'S (APPLICABLE FOR
MORE THAN THREE TRAYS)

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 30 OF 37



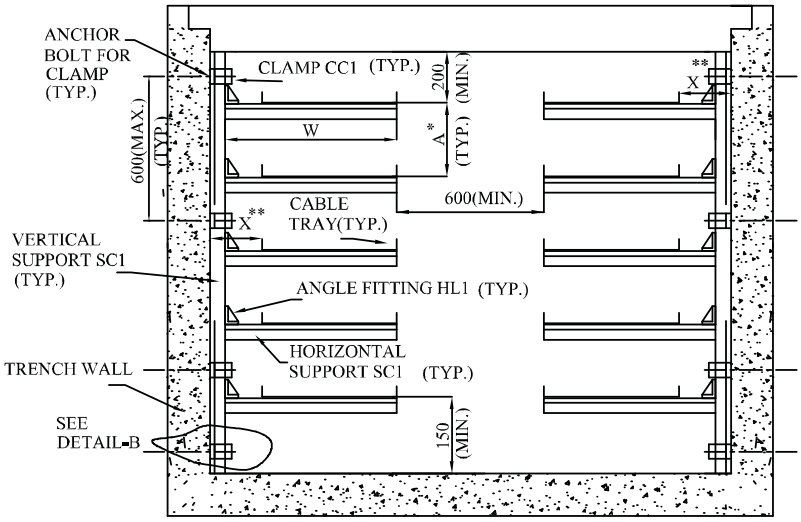
* A : MIN. 300 FOR POWER CABLES
MIN. 250 FOR CONTROL & SCREENED CABLES

** X=100 : CLEAR GAP BETWEEN TRENCH WALL & TRAY FOR PASSAGE OF CABLES APPLICABLE BELOW SWITCHGEAR/ CONTROL PANELS ONLY.



DETAIL-B

INSTALLATION DETAIL TYPE TR1:
SUPPORTING ARRANGEMENT IN CABLE TRENCH, TRAYS ON SINGLE SIDE



* A : MIN. 300 FOR POWER CABLES
MIN. 250 FOR CONTROL & SCREENED CABLES

** X=100 : CLEAR GAP BETWEEN TRENCH WALL & TRAY FOR PASSAGE OF CABLES APPLICABLE BELOW SWITCHGEAR/ CONTROL PANELS ONLY.

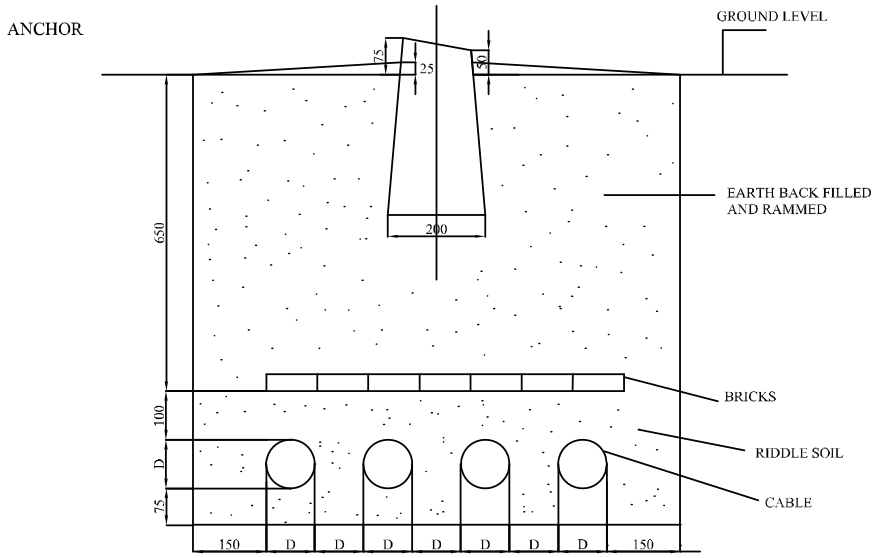
TRAY WIDTH	W (MM)
600MM	750
300MM	320
150MM	170

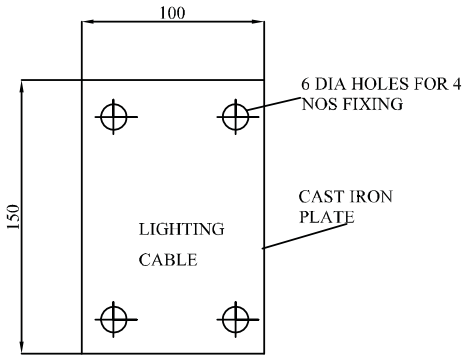
INSTALLATION DETAIL TYPE TR2:
SUPPORTING ARRANGEMENT IN CABLE TRENCH
TRAYS ON BOTH SIDE

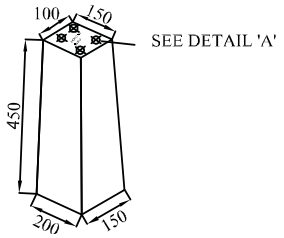
BHEL

TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM

REV.01 | SH 31 OF 37





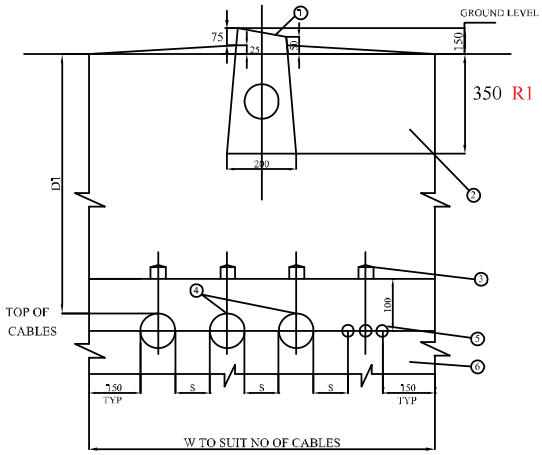


ROUTE MARKER

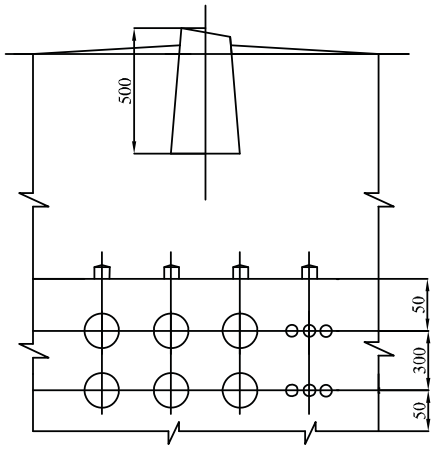
NOTES:

1. ALL DIMENSION ARE IN mm.
2. ROUTE MARKERS SHALL BE CONSTRUCTED OF CONCRETE WITH CAST IRON PLATE, WITH THE ROUTE INFORMATION ENGRAVED ON IT, BOLTED ON TOP OF THE CONCRETE BLOCK AS SHOWN.
3. CAST IRON PLATE SHALL BE OF MIN 6.0mm THICKNESS.

TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
	REV.01	SH 32 OF 37



DIRECTLY BURIED CABLES
IN SINGLE LAYER



DIRECTLY BURIED CABLES
IN TWO LAYER

LEGEND

1. CABLE ROUTE MARKER
2. EARTH BACK FILLED & RAMMED
3. PROTECTIVE COVERS
   a.) BRICK FOR LOW VOLTAGE CABLES
   b.) RCC FOR HIGH VOLTAGE CABLES WITH HOLE AT EACH END TO TIE EACH OTHER WITH G.S. WIRE
4. ARMOURED POWER CABLE
5. ARMOURED CONTROL CABLE
6. FINE SAND/RIDDLED SOIL COMPACTED

DIMENSION MIN	1100V GRADE CABLES	FOR 3.3 KV TO 11KV	ABOVE 11KV & UPTO 33KV
D1	750	900	1050
S	= d BETWEEN CABLES OF SAME CLASS = *300MM BETWEEN CABLES OF DIFFERENT CLASS = *400MM BETWEEN 1/C POWER CABLE AND COMMUNICATION CABLE = *300MM BETWEEN MULTICORE POWER CABLE & COMMUNICATION CABLE		

d= OVERALL DIAMETER OF THE BIGGER OF THE TWO CABLES

D1= MINIMUM DEPTH OF LAYING FROM GROUND SURFACE TO TOP OF CABLES.

* = SPACING SHALL BE TAKEN BOTH HORIZONTALLY AND VERTICALLY

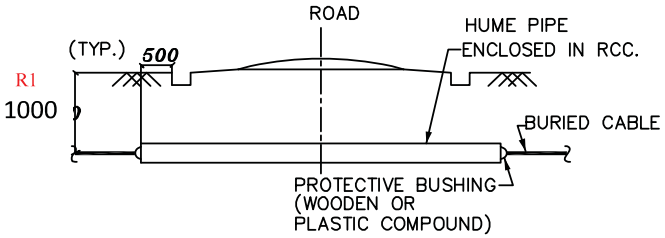
NOTE

1. SINGLE CORE CABLES SHALL BE RUN IN TREFOIL FORMATION AND SHALL BE BOUND BY SELFLOCKING CABLE TIES AT EVERY 750 MM.
2. CABLE IDENTIFICATION TAG SHALL BE TIED AT BOTH ENDS OF THE CABLE
3. IF THE MINIMUM CLARENCE AS INDICATED IN THE ABOVE TABLE FOR CABLES OF DIFFERENT CLASSES ARE NOT FEASIBLE BRICK BARRIERS SHALL BE USED BETWEEN ADJACENT CABLES.

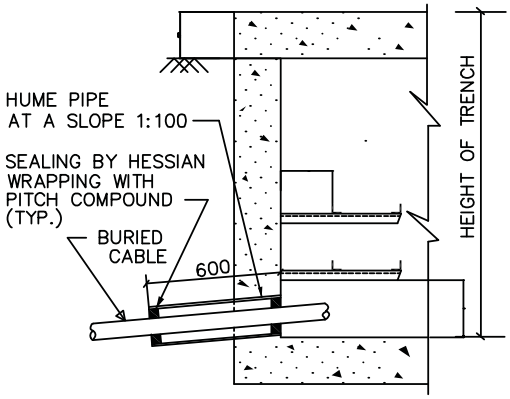
R1 4. G.I/HUME /HDPE PIPES SHALL BE PROVIDED FOR ROAD CROSSING AT A MINIMUM DEPTH OF 1000 FROM THE GRADE LEVEL AS DECIDED FRO THE PROJECT.

5. ALL DIMENSION ARE IN MM.

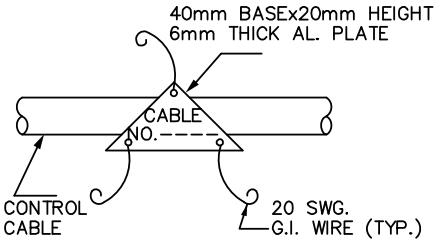
TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	
		REV.01 | SH 33 OF 37



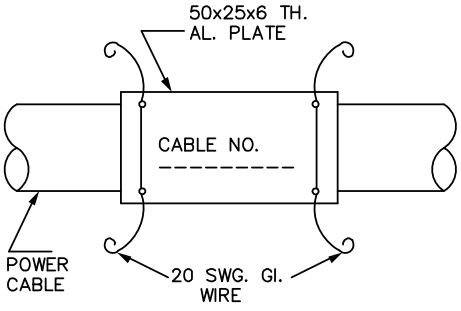
ROAD CROSSING
OF BURIED CABLE



TYP. DETAILS OF BURIED CABLE
ENTRY TO BLDG. OR CABLE TRENCH



CABLE TAG
CONTROL CABLE

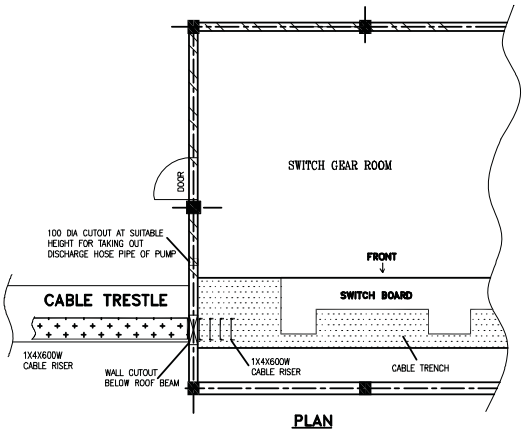


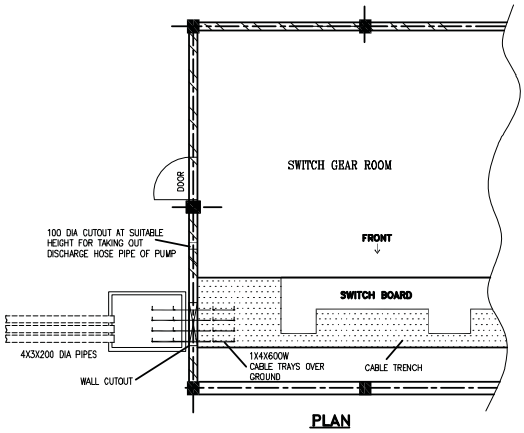
CABLE TAG
POWER CABLE

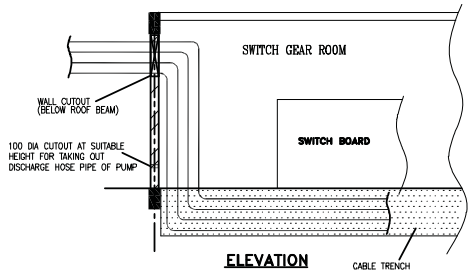
NOTE:

1. ALL DIMENSIONS ARE IN 'MM'.
2. BURIED CABLE DETAILS ARE SUBJECT TO CHANGE AS PER LAYOUT OF RESPECTIVE AREA.

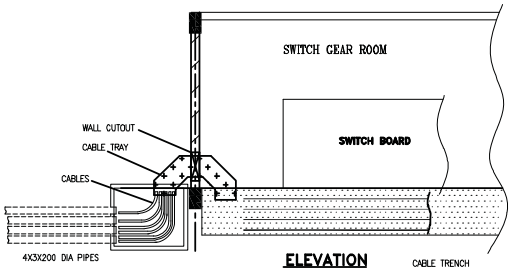
BHEL	**TITLE:**	**TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM**	
			REV.01 / SH 34 OF 37



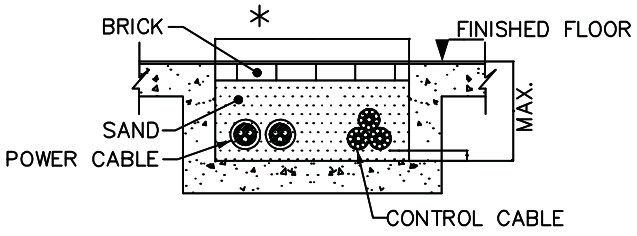




TYP. SECTION OF OVERHEAD CABLE ENTRY TO BOP AREA BUILDING



TYP. SECTION OF CABLE ENTRY FROM CABLE PULL PIT TO BOP AREA BUILDING

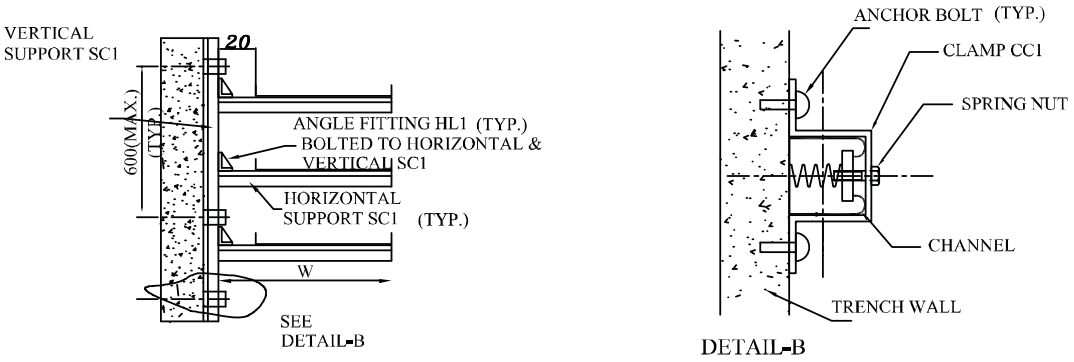


CABLE LAYING IN SHALLOW TRENCH (INDOOR)

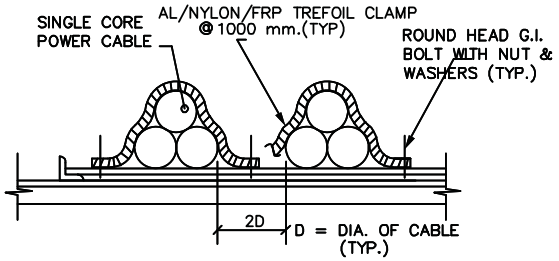
NOTE:

1. ALL DIMENSIONS ARE IN 'MM'.
2. ABOVE DETAILS ARE SUBJECT TO CHANGE AS PER LAYOUT OF RESPECTIVE AREA.
3. THE PORTION OF FLOOR ABOVE THE TRENCH MARKED ' * ' SHALL BE FINISHED WITH WEAK MORTER.

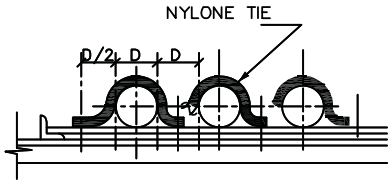
BHEL	TITLE:	TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 / SH 35 OF 37



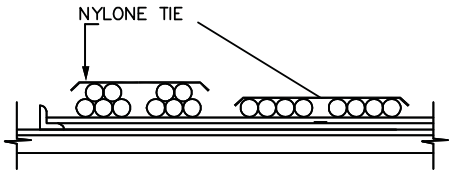
SUPPORTING ARRANGEMENT FOR BRICK OR CONCRETE WALL/COLUMN



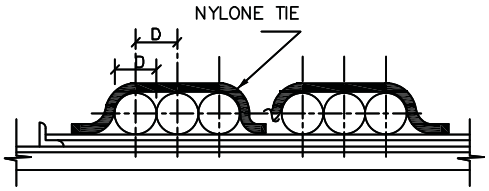
CABLE CLAMPS IN TREFOIL FORMATION FOR SINGLE CORE POWER CABLES



CABLE CLAMPS FOR MULTICORE POWER CABLES (NOT TOUCHING EACHOTHER)



CLAMPING ARRANGEMENT OF CONTROL CABLES



CABLE CLAMPS FOR MULTICORE POWER CABLES (TOUCHING EACHOTHER)

NOTE:

For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables cables shall be secured at every one meter by nylon cable strap.

After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

BHEL	TITLE: TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM		
		REV.01	SH 36 OF 37

NOTES:–

I. THIS DRAWING SHALL BE REFERRED ONLY FOR INSTALLATION OF CABLE TRAY SUPPORT SYSTEM.

II. SUPPORTING ARRANGEMENT IN CABLE VAULTS

1. BASEPLATES/ANGLE FITTINGS SHALL BE CONTINUOUSLY WELDED ALL ROUND TO STEEL MEMBERS/ PLATE INSERTS PROVIDED. BRACKETS/ CLAMPS SHALL BE WELDED TO STEEL SURFACE WITH CHANNEL SC1/DC1 (AS APPLICABLE) IN POSITION TO ENSURE ALIGNMENT OF CLAMPS/CHANNEL. WELD THICKNESS SHALL BE 6MM MINIMUM. IN CASE STEEL SURFACE IS NOT AVAILABLE FOR WELDING, ANCHOR BOLTS SHALL BE USED FOR FIXING THE BASEPLATE/ANGLE FITTING.
2. MAIN SUPPORTS FOR ALL LONGITUDINAL CABLE TRAY RUNS IN THE CABLE VAULTS SHALL BE FIXED AT BOTH ENDS AT THE TOP AS WELL AS AT THE BOTTOM AS OUTLINED ABOVE, FOR MORE THAN THREE TRAYS.
3. SINGLE CHANNEL SUPPORT SC1 WHEREVER SUPPORTED FROM TOP ONLY SHALL BE USED FOR UPTO AND INCLUDING TWO TRAYS ONLY. WHEREVER MORE THAN TWO TRAYS ARE TO BE SUPPORTED IN THIS FASHION, DOUBLE CHANNEL DC1 SHALL BE USED.
4. GALVANISATION DAMAGED DUE TO WELDING/CUTTING SHALL BE BRUSHED & RED LEAD PRIMER, OIL PRIMER AND ALUMINIUM PAINT SHALL BE APPLIED.

III. SUPPORTING ARRANGEMENT ALONG PIPERACK

1. BRACKETS/CLAMPS SHALL BE WELDED TO STEEL SURFACE WITH CHANNEL C1/C2 (AS APPLICABLE) IN POSITION TO ENSURE ALIGNMENT OF CLAMPS/CHANNEL. WELD THICKNESS SHALL BE 6MM MINIMUM.
2. GALVANISATION DAMAGED DUE TO WELDING/CUTTING SHALL BE REPAIRED WITH COLD GALVANISING PAINT.
3. WHEREVER PORTAL MEMBERS ARE ENCOUNTERED IN THE PATH OF THE TRAYS, THE TRAYS SHALL BE BENT INWARDS SUFFICIENTLY TO CLEAR THE OBSTRUCTION. FOR THIS PURPOSE, THE CANTILEVER ARMS PRECEDING & SUCCEEDING IMMEDIATELY THE PORTAL MEMBERS SHALL BE REPLACED BY SUITABLE LENGTHS OF HORIZONTAL SC1 CHANNEL FIXED TO THE VERTICAL SUPPORT BY MEANS OF ANGLE FITTING LA1. ADDITIONAL SUPPORT ALONG PORTAL MEMBER CAN SIMILARLY BE PROVIDED USING THE SC1 CHANNEL & LA1 COMBINATION.
4. ALONG OVERHEAD CABLE TRAY ROUTES TRAYS SHALL BE ORIENTED VERTICALLY IN AREAS PRONE TO COAL DUST/ ASH (E.G. BOILER AREA & ESP AREA). ALONG OTHER ROUTES TRAYS SHALL GENERALLY BE ORIENTED HORIZONTALLY. HOWEVER IF SO REQUIRED DUE TO LAYOUT/ AESTHETIC CONSIDERATIONS, TRAYS MAY BE ORIENTED VERTICALLY IN OTHER AREAS ALSO. EXACT ORIENTATION SHALL BE AS PER APPROVED LAYOUT DRAWINGS.

IV. SUPPORTING ARRANGEMENT IN TRENCHES

1. CHANNEL SUPPORT SHALL BE PROVIDED AT 2.0M SPACING & SHALL BE FIXED AGAINST TRENCH WALL FOR EVERY TWO TRAYS USING CLAMPS (SPACED AT 600MM MAX.) AS SHOWN.
2. 2NOS.-M12, ANCHOR BOLTS & 1NO.- SPRING NUT SHALL BE USED WITH EACH CLAMP FOR THE ARRANGEMENT SHOWN.
3. ARRANGEMENT TR1 & TR2 SHALL BE USED

V. CHANNEL FRAME WORK FOR RISERS

IN ADDITION TO THE SUPPORT FROM GROUND, THE RISER FRAMEWORK SHALL BE CONNECTED TO THE AVAILABLE BUILDING STEEL AT HIGHER ELEVATIONS WHEREVER AVAILABLE. THIS SHALL BE DONE BY USING ANGLE FITTINGS BOLTED TO THE RISER STRUCTURE ON ONE END & WELDED WITH SUITABLE STRUCTURAL STEEL MEMBER ON THE OTHER WHICH IN TURN SHALL BE WELDED TO BUILDING STEEL. IN CASE CONCRETE SURFACE IS AVAILABLE IN PLACE OF STEEL NECESSARY CONNECTION WILL BE REALISED BY USE OF BRACKETS/ CLAMPS FIXED TO CONCRETE SURFACE WITH ANCHOR FASTENERS.

VI. CABLE TRAYS SHALL NORMALLY BE FIXED TO CANTILEVER ARMS BY MEANS OF PAN HEAD SCREW & NUT SUPPLIED AS PART OF CANTILEVER ARMS. TRAY CLAMP TC1 SHALL BE USED FOR CLAMPING THE TRAY TO CANTILEVER ARM WHEREVER DUE TO MANUFACTURING/ERECTION/SITE LIMITATIONS, THE CENTER LINES OF CANTILEVER ARM AND THE HOLES IN TRAY BOTTOMS ARE NOT MATCHED.

VII. WHEREVER DIFFERENT ALTERNATIVES FOR SIMILAR SUPPORT ARRANGEMENT ARE SHOWN, SITE SHALL DECIDE THE EXACT ALTERNATIVE TO BE USED DEPENDING UPON SITE CONDITIONS.

VIII. WHEREVER CANTILEVER ARM CANNOT BE USED FOR DIRECT SUPPORTING OF TRAYS DUE TO LAYOUT CONSTRAINTS (E.G. BENDING OF TRAYS TO AVOID OBSTRUCTION), SUFFICIENT LENGTHS OF SC1 SHALL BE USED AS DIRECT SUPPORT IN PLACE. THESE SHALL BE FIXED BY MEANS OF ANGLE FITTING LA1.

IX. BEAM CLAMP SHALL BE USED WHEREVER STRUCTURAL BEAM OF SUITABLE SECTION & ORIENTATION IS AVAILABLE.

X. FOR INSTALLATION DETAIL TYPE DB3, DB4, DS2, DS4, DS6 & DS8 WHEREVER DISSIMILAR TYPE OF CABLES ARE INSTALLED AT THE SAME LEVEL ON EITHER SIDE OF THE MAIN SUPPORT (e.g. LTP & HTP, LTP & CONTROL, CONTROL & SCREENED CABLE), MINIMUM 300MM OF HORIZONTAL CLEARANCE SHALL BE ENSURED BETWEEN SUCH TRAYS BY USING LOWER SIZE TRAYS.

XI. TRAY SUPPORTS SHALL BE PROVIDED @2.0M SPACING FOR HORIZONTAL RUNS AND @1.0M FOR CABLE SHAFTS/ RISERS.

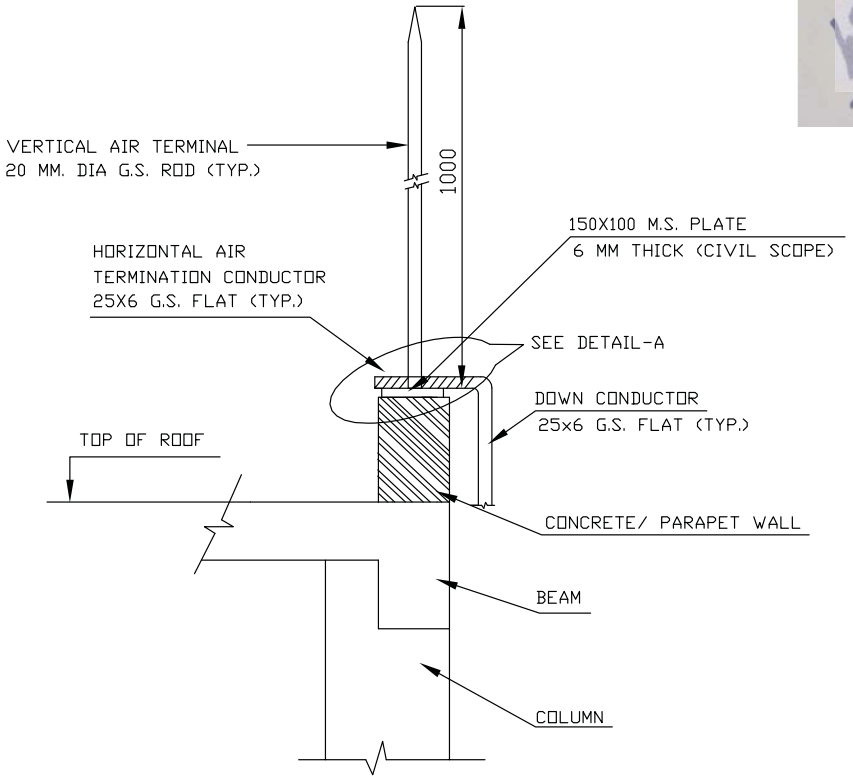
BHEL	**TITLE:** TYPICAL INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM	REV.01 | SH 37 OF 37

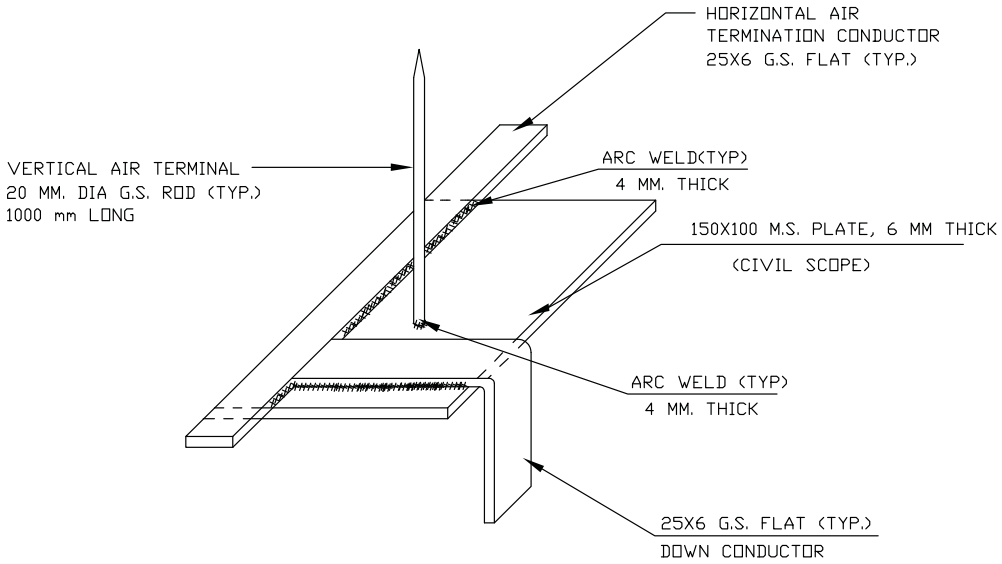
TECHNICAL SPECIFICATION OF CABLE GLANDS AND LUGS

Cable glands shall conform to BS:6121. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and Hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.

Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections

ANNEXURE-V

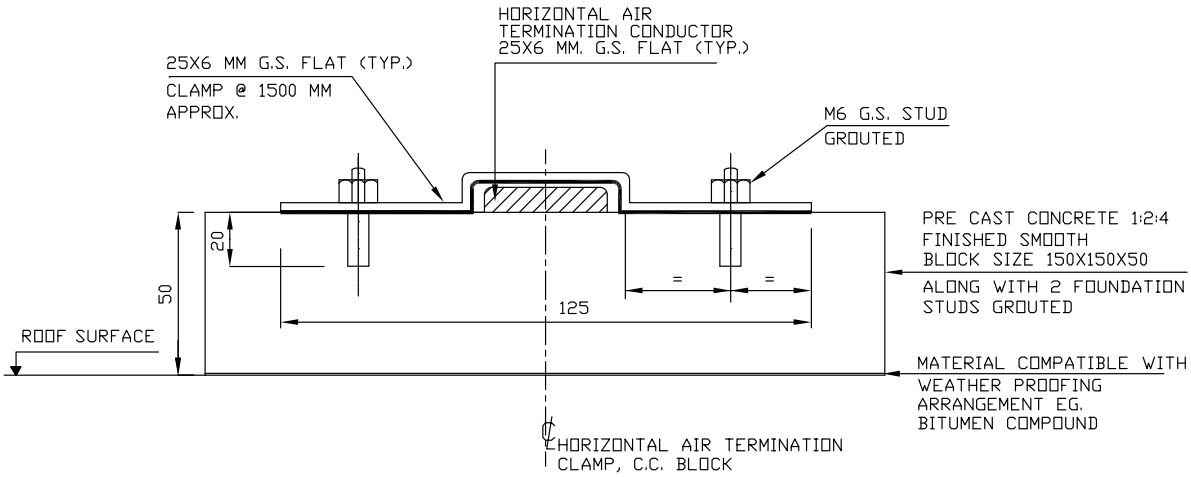




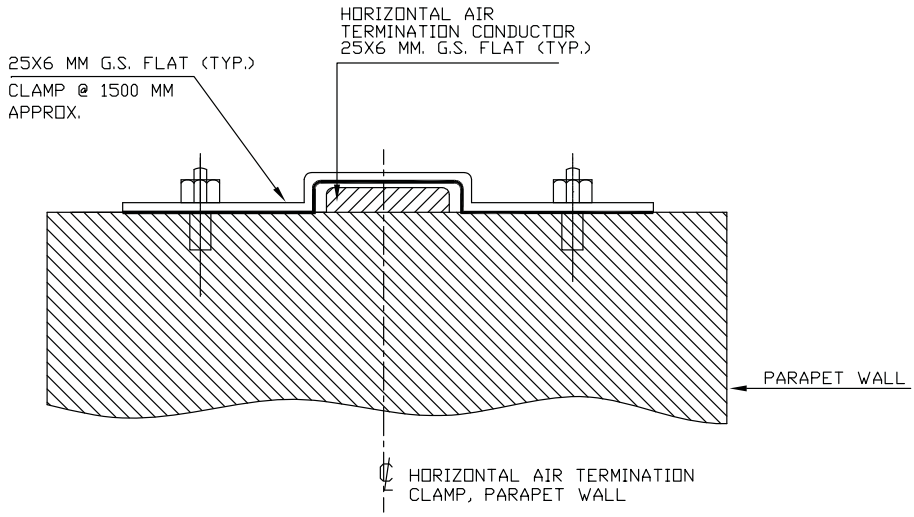
DETAIL-A

TYPICAL FIXING/CONNECTION DETAILS OF VERTICAL AIR TERMINAL ROD ON THE ROOF OF BUILDING

TITLE	
TYPICAL LIGHTNING PROTECTION DETAILS	REV. No. 0
	SHEET 2 OF 8



(A) OVER ROOF SURFACE

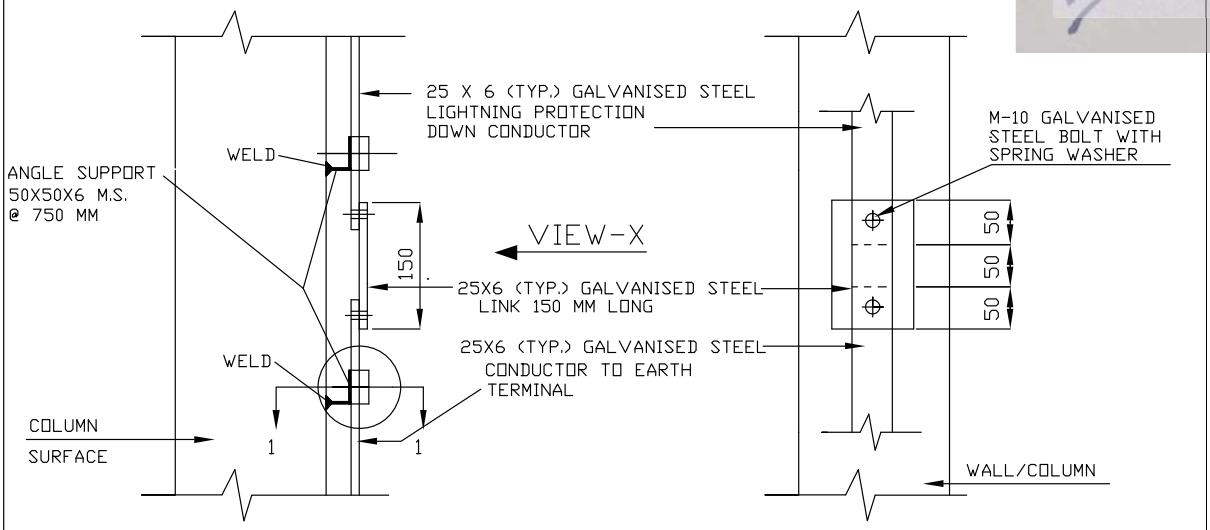


(B) OVER PARAPET WALL

TYPICAL DETAILS OF CLAMPING HORIZONTAL AIR TERMINATION

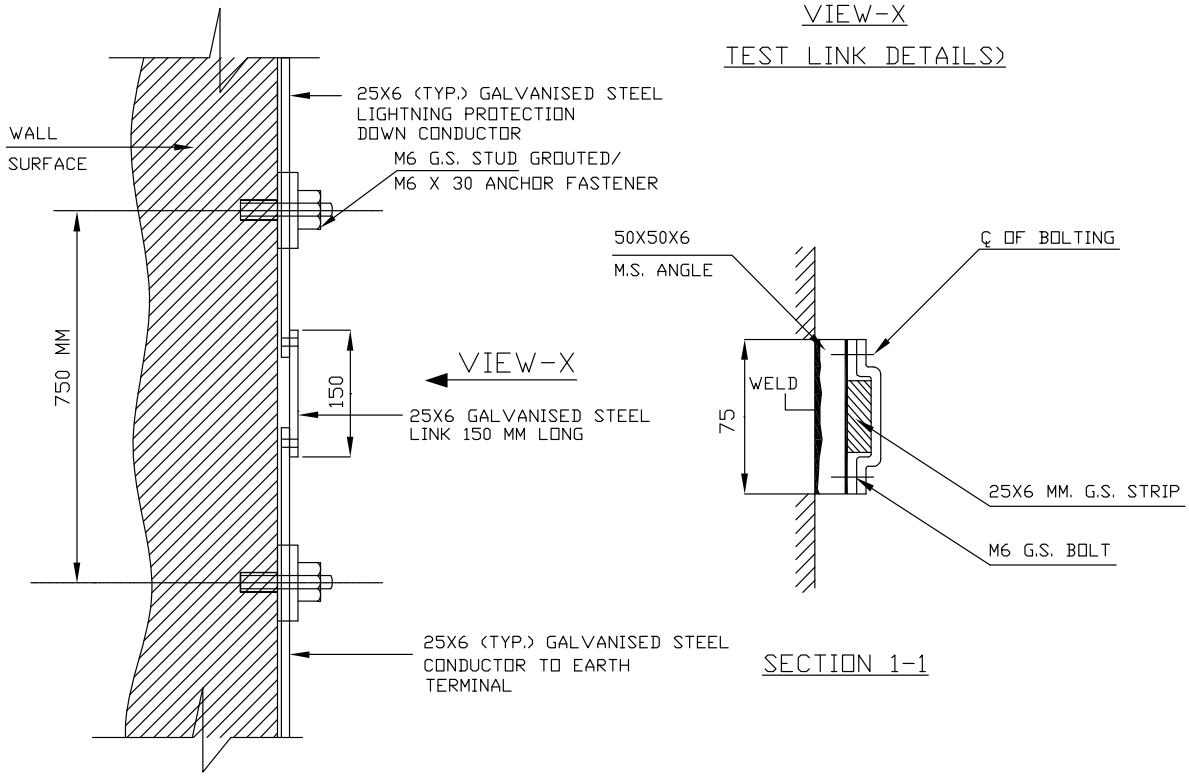
CLAMPING OVER ROOF

TITLE TYPICAL LIGHTNING PROTECTION DETAILS	REV. No. 0 SHEET 3 OF 8



VIEW-X

TEST LINK DETAILS)



SECTION 1-1

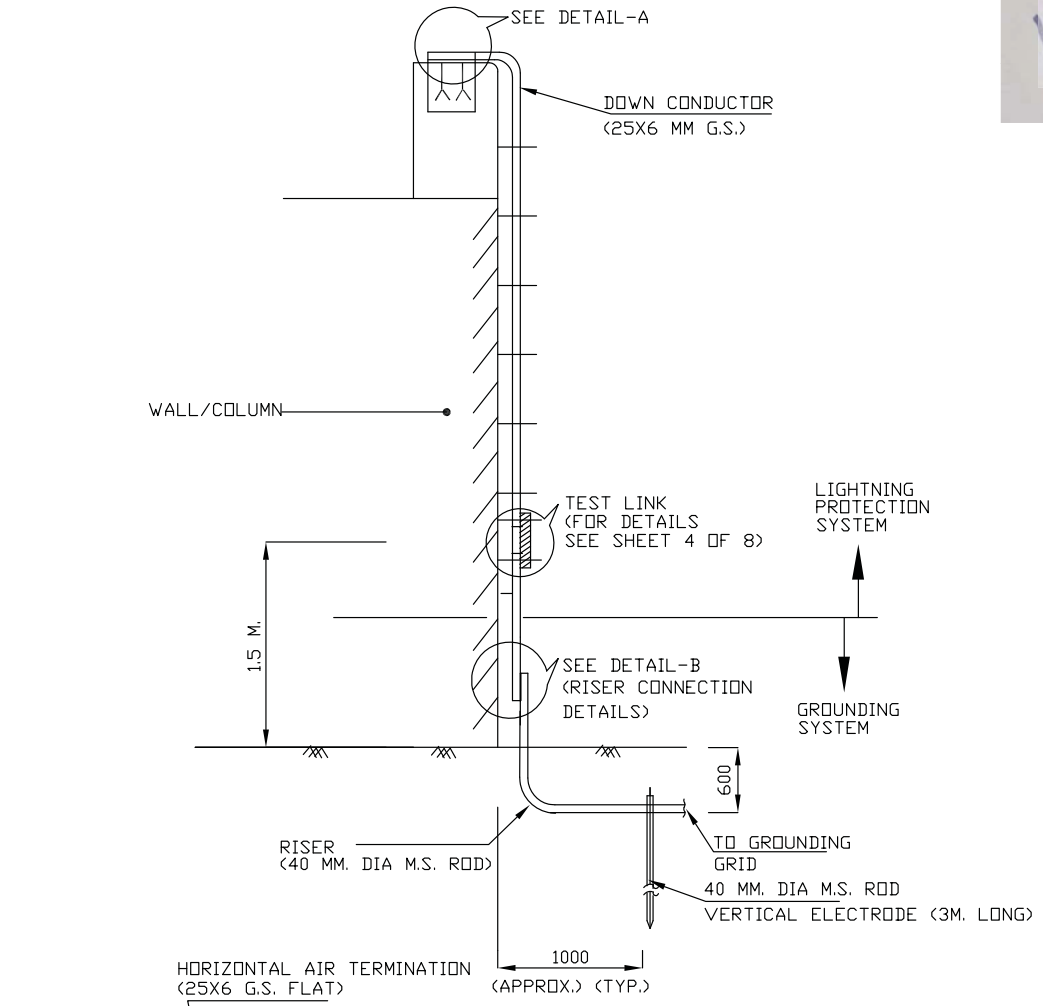
TYPICAL DETAILS OF DOWNCONDUCTOR FIXING AND TEST LINK

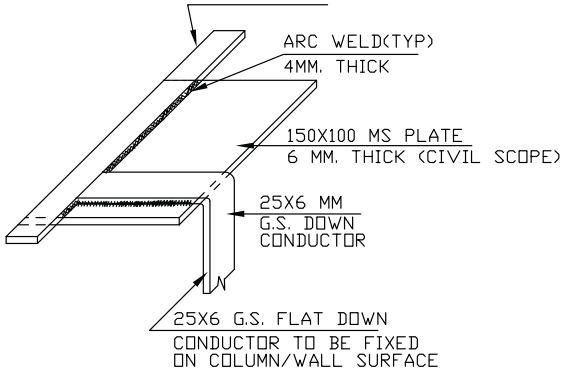
TITLE

TYPICAL LIGHTNING PROTECTION DETAILS

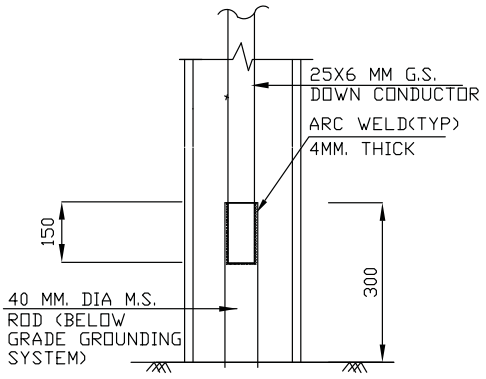
REV. No. 0

SHEET 4 OF 8





DETAIL-A



DETAIL-B

(RISER CONNECTION DETAILS)

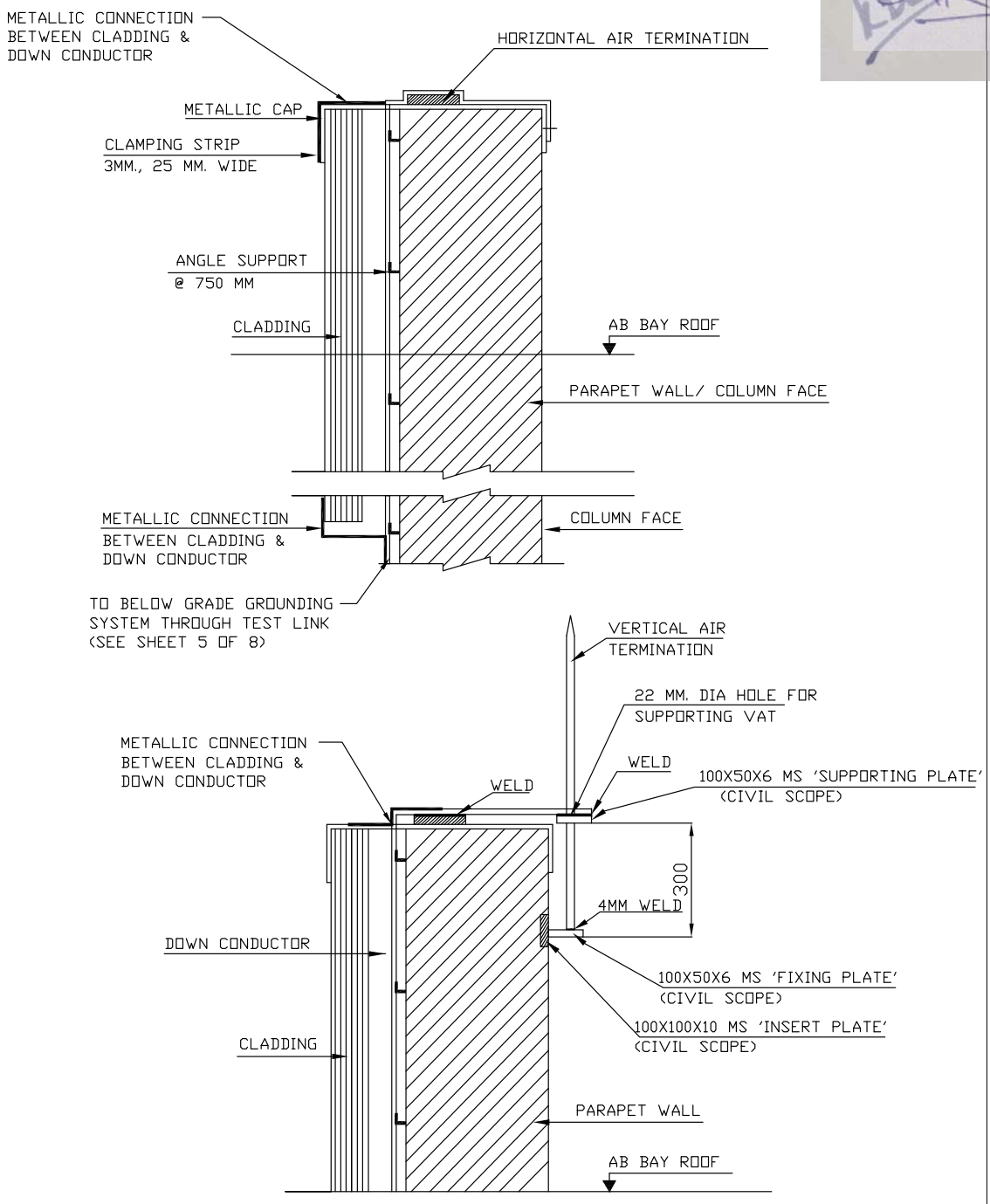
TYPICAL DETAILS OF CONNECTION AMONG HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR AND RISER

TITLE

TYPICAL LIGHTNING PROTECTION DETAILS

REV. No. 0

SHEET 5 OF 8



TYPICAL DETAILS OF CONNECTION AMONG
HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR FOR 'A' ROW CLADDING

TITLE

TYPICAL LIGHTNING PROTECTION DETAILS

REV. No. 0

SHEET 6 OF 8

NOTES:–

1.0 AIR TERMINATIONS

1.1 HORIZONTAL/ VERTICAL AIR TERMINATION NETWORK WILL BE INSTALLED ON THE TOP OF ALL STRUCTURE/ BUILDINGS TO BE PROTECTED FROM LIGHTNING STROKES. THE INSTALLATION WORK SHALL BE DULY COORDINATED BY SITE WITH THE OTHER ACTIVITIES SUCH AS WEATHER PROOFING APPLICATION ON ROOF, ETC.

1.2 HORIZONTAL AIR TERMINATIONS SHALL BE OF 25MM x 6MM GALVANISED STEEL FLATS CLAMPED TO THE SURFACE AT EVERY 1500 MM. HORIZONTAL AIR TERMINATION SHALL NOT BE DIRECTLY CLEATED ON SURFACE OF ROOF. SUPPORTING BLOCKS OF PRE CAST CONCRETE 1:2:4 SHALL BE USED FOR CONDUCTOR FIXING AT AN INTERVAL OF 1500MM. VERTICAL AIR TERMINATION'S SHALL BE 20 MM DIA GALVANISED MILD STEEL ROD 1000 MM LONG.

1.3 THE VERTICAL AIR TERMINATION ROD WILL BE PROPERLY FIXED AS PER DETAILS GIVEN IN THE DRAWING ON THE TOP OF THE BUILDING/ STRUCTURE TO WITHSTAND VERY HIGH WIND PRESSURE. THE HORIZONTAL & VERTICAL AIR TERMINATIONS SHALL BE PROPERLY FIXED ON THE TOP OF ROOF OF THE BUILDINGS SUCH AS NOT TO MAKE ANY PENETRATION IN THE WATER PROOFING LAYER.

2.0 DOWN CONDUCTORS

2.1 THE DOWN CONDUCTORS SHALL BE 25MM X 6MM GALVANISED STEEL FLATS. ONE END OF THESE FLATS SHALL BE CONNECTED TO THE VERTICAL / HORIZONTAL AIR TERMINATION NETWORK ON TOP OF ROOF / STRUCTURE AND THE OTHER END TO THE NEAREST EARTH TERMINALS.

2.2 EACH DOWN CONDUCTOR WILL HAVE AN INDEPENDENT GROUND TERMINATION. IN NO CASE CONDUCTORS OF THE LIGHTNING PROTECTION SYSTEM WILL BE CONNECTED WITH THE CONDUCTORS OF THE GROUNDING SYSTEM ABOVE GROUND LEVEL. THE INDEPENDENT GROUND TERMINATION WILL COMPRISE OF A RISER CONNECTION FROM A 3000 MM LONG GROUND ELECTRODE WHICH IN TURN WILL BE CONNECTED TO THE BELOW GRADE GROUNDING SYSTEM. DETAILS OF THE ELECTRODE CONNECTION SHALL BE AS PER DRG No. PE–DG–508–509–E005 (9587–001–215–PVE–C–048–TYPICAL BELOW GROUND EARTHING DETAILS).

2.3 THE CONNECTION BETWEEN EACH DOWN CONDUCTOR AND EARTH TERMINAL WILL BE MADE VIA A TEST LINK LOCATED AT APPROXIMATELY 1500MM ABOVE GROUND LEVEL. THE TEST LINK SHALL BE ENCLOSED IN A PROTECTIVE GALVANISED MS BOX.

2.4 THE DOWN CONDUCTORS WILL BE LAID STRAIGHT AND SHARP BENDS WILL BE AVOIDED AS FAR AS PRACTICABLE. THESE WILL BE FIXED ON THE OUTSIDE OF THE BUILDING WALL AND OR COLUMNS/STRUCTURES AT INTERVALS OF ABOUT 750 MM, AS INDICATED IN THE DRAWINGS.

2.5 ALL EXPOSED METALLIC PARTS OF A BUILDING WILL BE BONDED TO THE DOWN CONDUCTORS. SUCH PARTS WILL INCLUDE LADDERS, BALCONIES, CONDUITS, METALLIC SHEET CLADDING, ETC.

2.6 ALL METALLIC STRUCTURES WITHIN A VICINITY OF TWO METERS OF THE CONDUCTORS SHALL BE BONDED TO CONDUCTORS OF LIGHTNING PROTECTION SYSTEM.

2.7 LIGHTNING CONDUCTORS SHALL NOT PASS THROUGH OR RUN INSIDE GI CONDUITS.

2.8 TESTING LINK SHALL BE MADE OF GALVANIZED STEEL OF SIZE 25X6 MM.

TITLE	
TYPICAL LIGHTNING PROTECTION DETAILS	REV. No. 0
	SHEET 7 OF 8

3.0 JOINTING

3.1 MINIMUM NUMBER OF JOINTS IN THE LIGHTNING CONDUCTORS WILL BE PROVIDED.

3.2 ALL THE JOINTS WILL BE DONE BY ARC WELDING PROCESS. OVERLAPPING OF CONDUCTORS AT STRAIGHT JOINTS WILL NOT BE LESS THAN 150MM. THE CONTACT SURFACES WILL BE PROPERLY CLEANED BEFORE JOINTING.

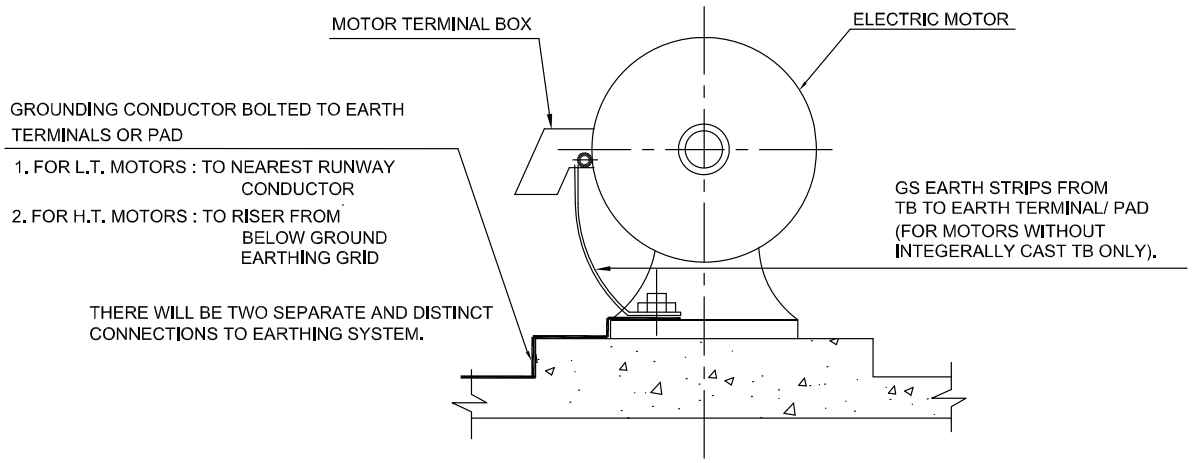
3.3 THOSE PORTIONS OF GALVANISED STEEL FLATS, WHICH HAVE BEEN WELDED AT SITE, SHALL BE COATED WITH TWO (2) COATS OF RED OXIDE PAINT FOLLOWED BY TWO COATS OF ZINC PAINT.

3.4 THE VERTICAL AIR TERMINATION RODS WILL BE COATED WITH WEATHER RESISTANT ANTI-CORROSIVE PAINT. (ZINC CHROMATE FOLLOWED BY TWO COATS OF ALUMINIUM PAINT)

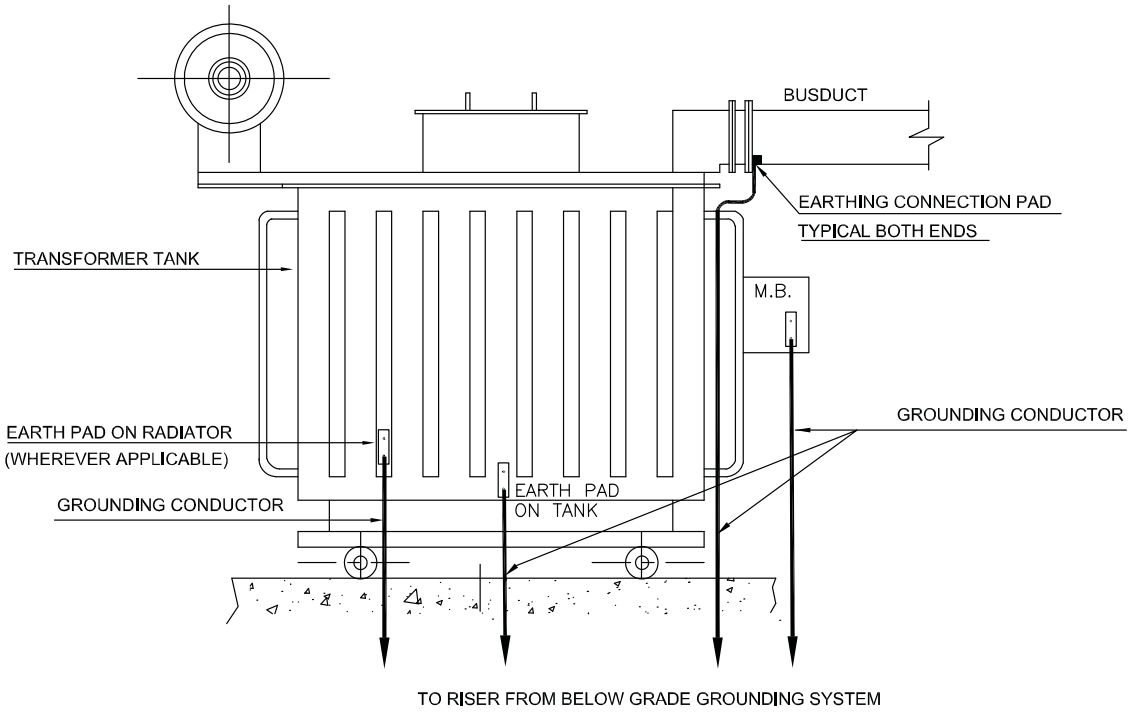
4.0 LIGHTNING PROTECTION SYSTEM SHALL BE IN ACCORDANCE WITH IEC 62305.

5.0 AS PER IEEE : 142, STEEL TANKS (CONTAINING FLAMMABLE LIQUIDS OR GASES) WITH STEEL ROOFS OR FLOATING METAL ROOF HAVING STEEL THICKNESS OF 4.76 MM OR MORE ARE TO BE CONSIDERED SELF-PROTECTING TYPE AGAINST LIGHTNING, & SHALL BE PROVIDED WITH MINIMUM TWO EQUALLY SPACED CONNECTIONS TO THE NEAREST BELOW GRADE GROUNDING SYSTEM.

TITLE	
TYPICAL LIGHTNING PROTECTION DETAILS	REV. No. 0
	SHEET 8 OF 8



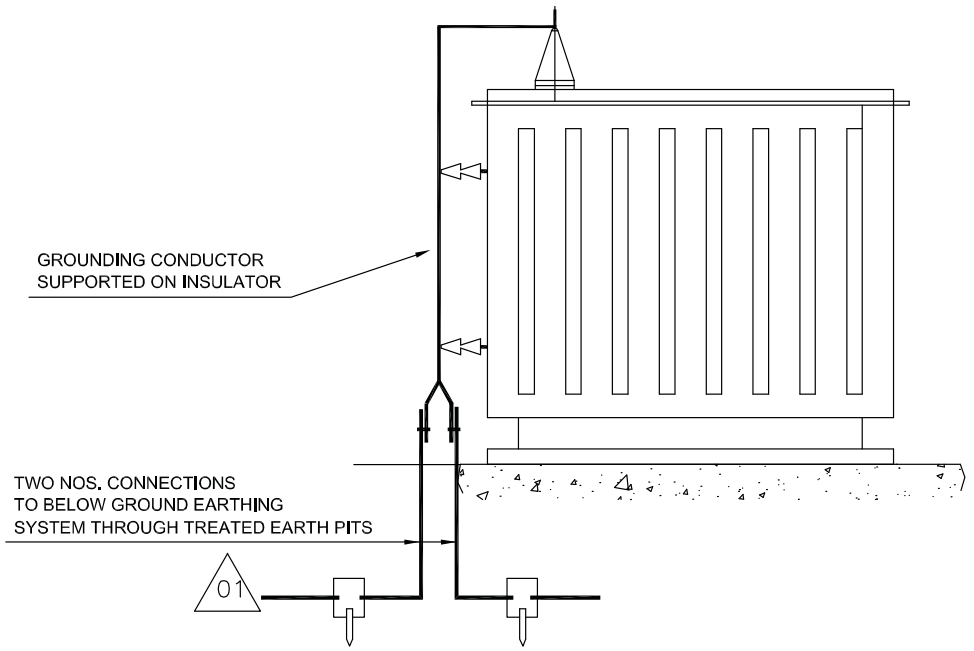
E1 : TYPICAL MOTOR GROUNDING DETAILS



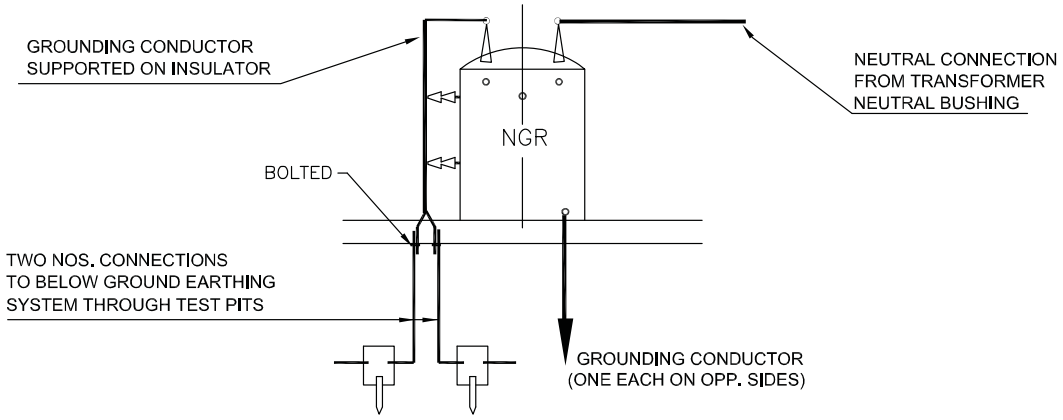
E2 : TRANSFORMER GROUNDING

FOR GENERAL NOTES REFER SHT 12 & 13

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No. I
	REV. No. 02
	SHEET 2 OF 14



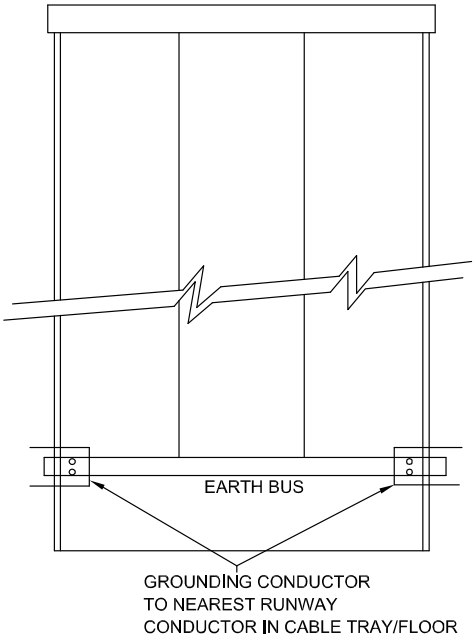
E3A : NEUTRAL EARTHING (DIRECTLY GROUNDED)



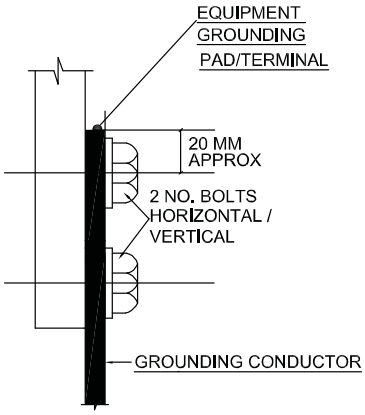
E3B : NEUTRAL EARTHING (THROUGH RESISTOR)

FOR GENERAL NOTES REFER SHT 12 & 13

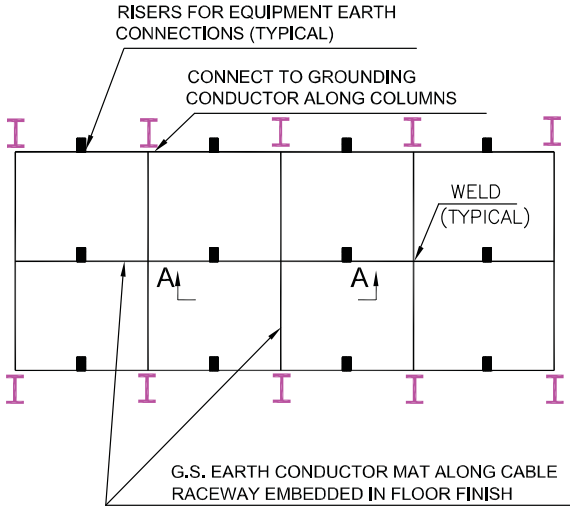
TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 3 OF 14

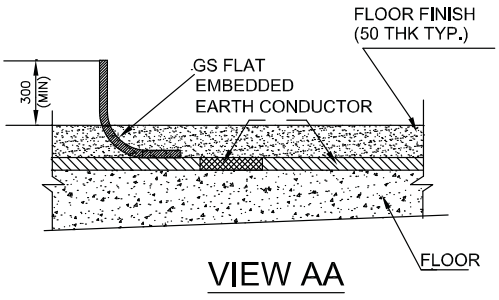


E4 : FLOOR MOUNTED PANEL GROUNDING



E5 : TYPICAL ARRANGEMENT BOLTED JOINT FOR EQUIPMENT GROUNDING



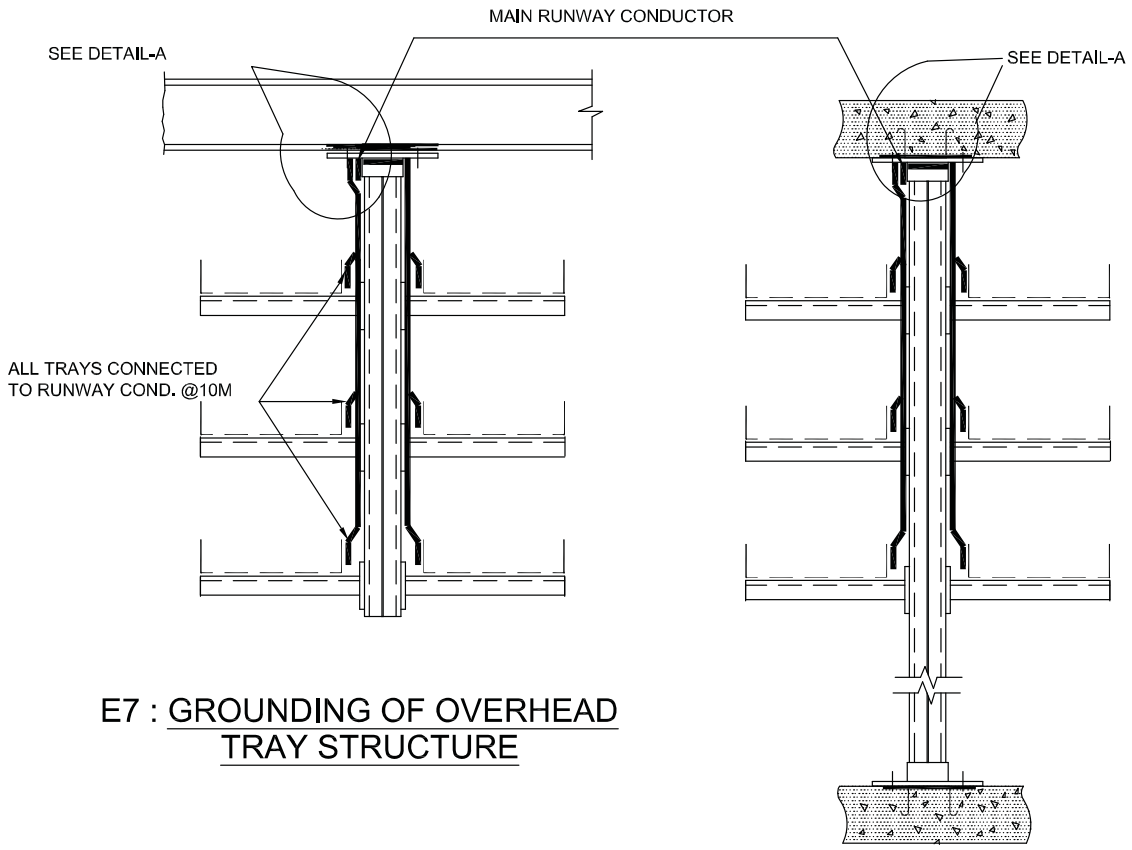


VIEW AA

E6 : FLOOR EARTH MAT TYPICAL DETAILS

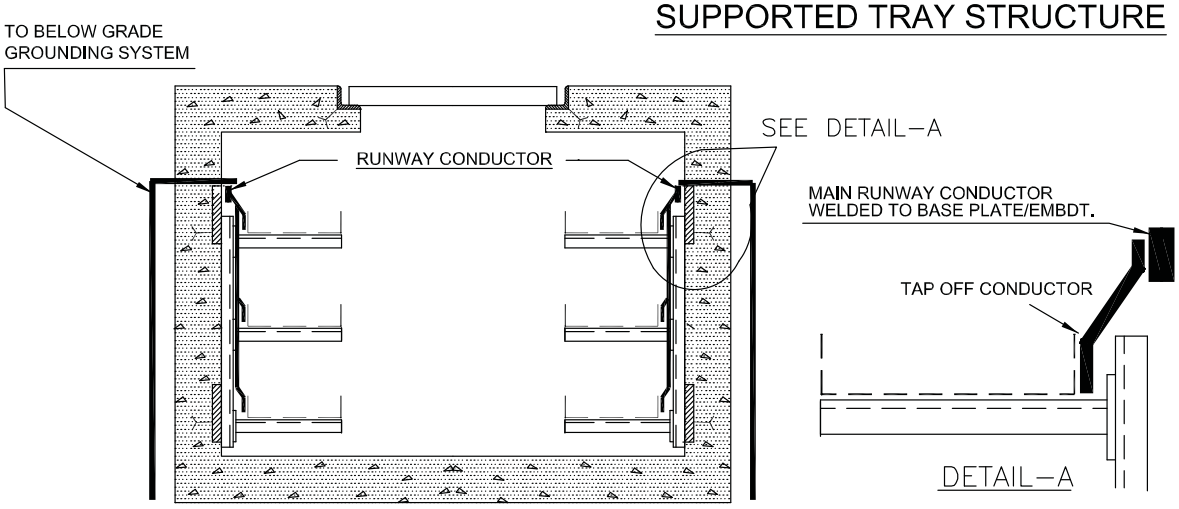
FOR GENERAL NOTES REFER SHT 12 & 13

TITLE TYPICAL ABOVE GROUND EARTHING DETAILS	NTPC DOCUMENT NO: ..... BHEL DRAWING No. REV. No. 02 SHEET 4 OF 14



E7 : GROUNDING OF OVERHEAD TRAY STRUCTURE

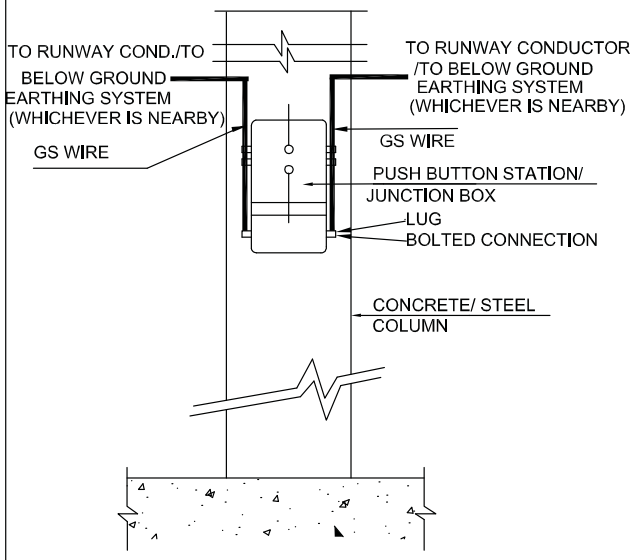
E8 : GROUNDING OF FLOOR SUPPORTED TRAY STRUCTURE



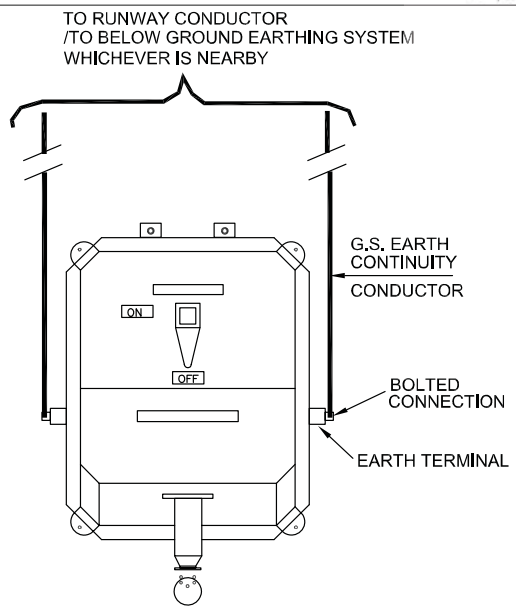
E9 : GROUNDING OF TRAYS IN CABLE TRENCH

FOR GENERAL NOTES REFER SHT 12 & 13

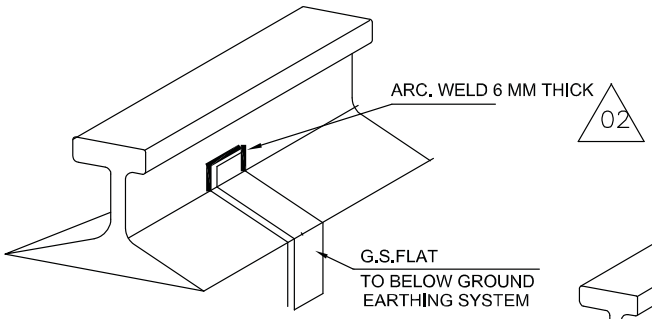
TITLE TYPICAL ABOVE GROUND EARTHING DETAILS	NTPC DOCUMENT NO: ..... BHEL DRAWING No. REV. No. 02 SHEET 5 OF 14

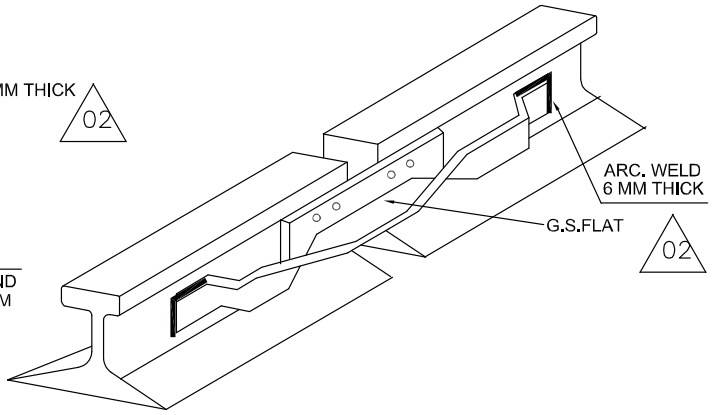


E10 : PUSH BUTTON STATION/ JUNCTION BOX GROUNDING

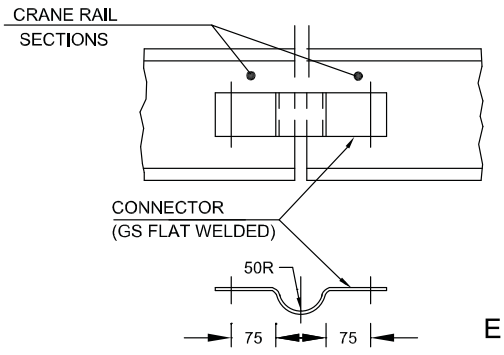


E11 : 3-PHASE WELDING RECEPTACLE GROUNDING





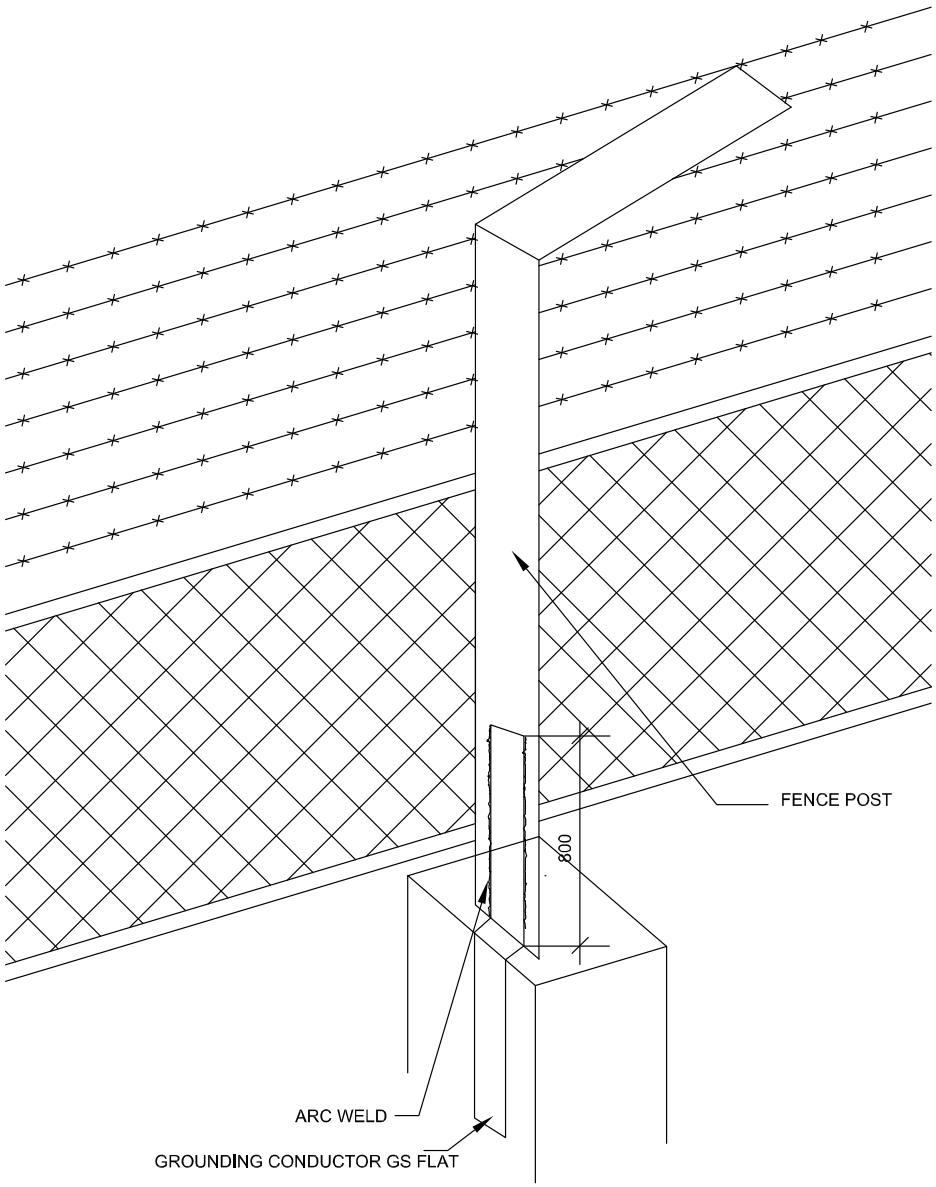
E12 : RAIL BONDING/GROUNDING



E13 : BONDING OF CRANE RAIL

FOR GENERAL NOTES REFER SHT 12 & 13

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 6 OF 14

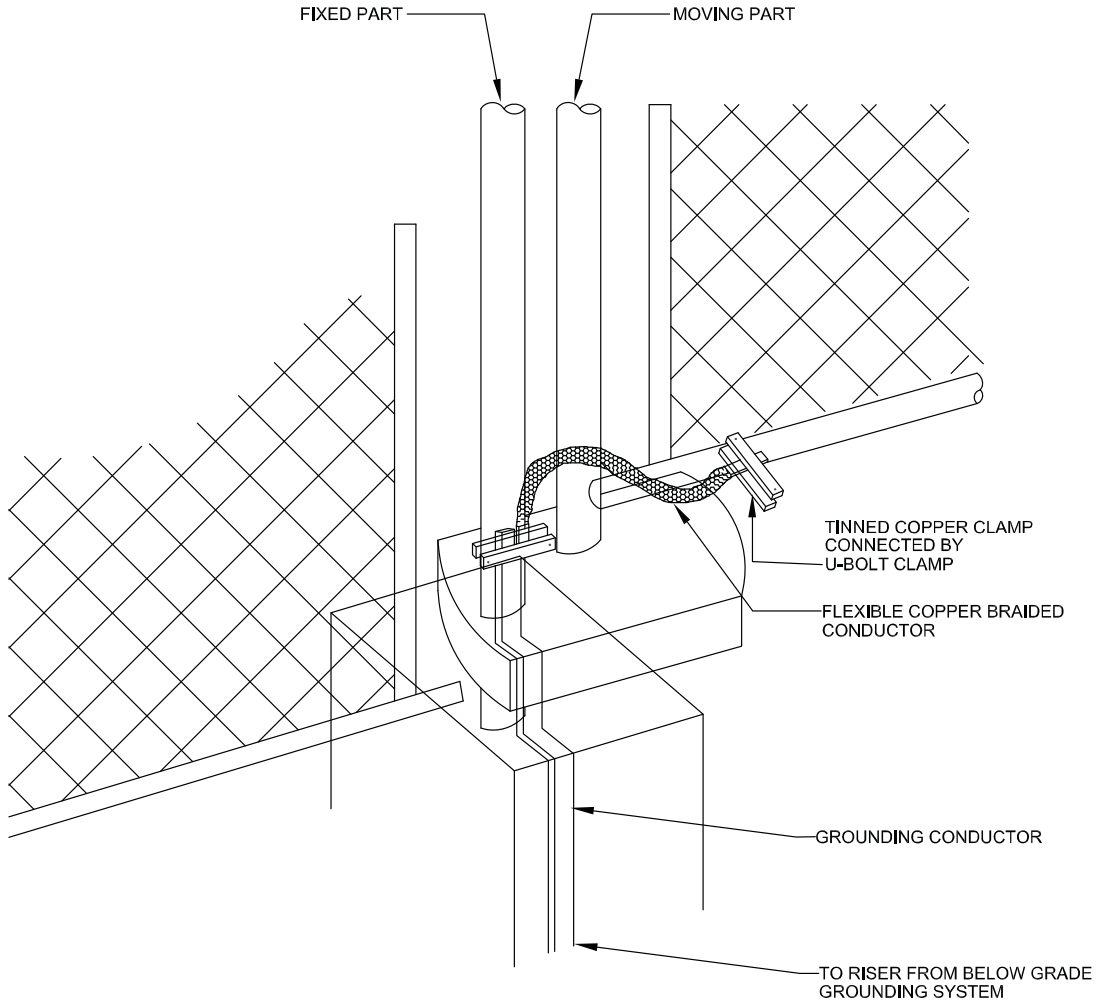


E14: FENCE GROUNDING

NOTE: EVERY ALTERNATE POST OF THE FENCE SHALL BE CONNECTED SHALL BE CONNECTED TO THE EARTHING GRID BY GS FLAT.

FOR GENERAL NOTES REFER SHT 12 & 13

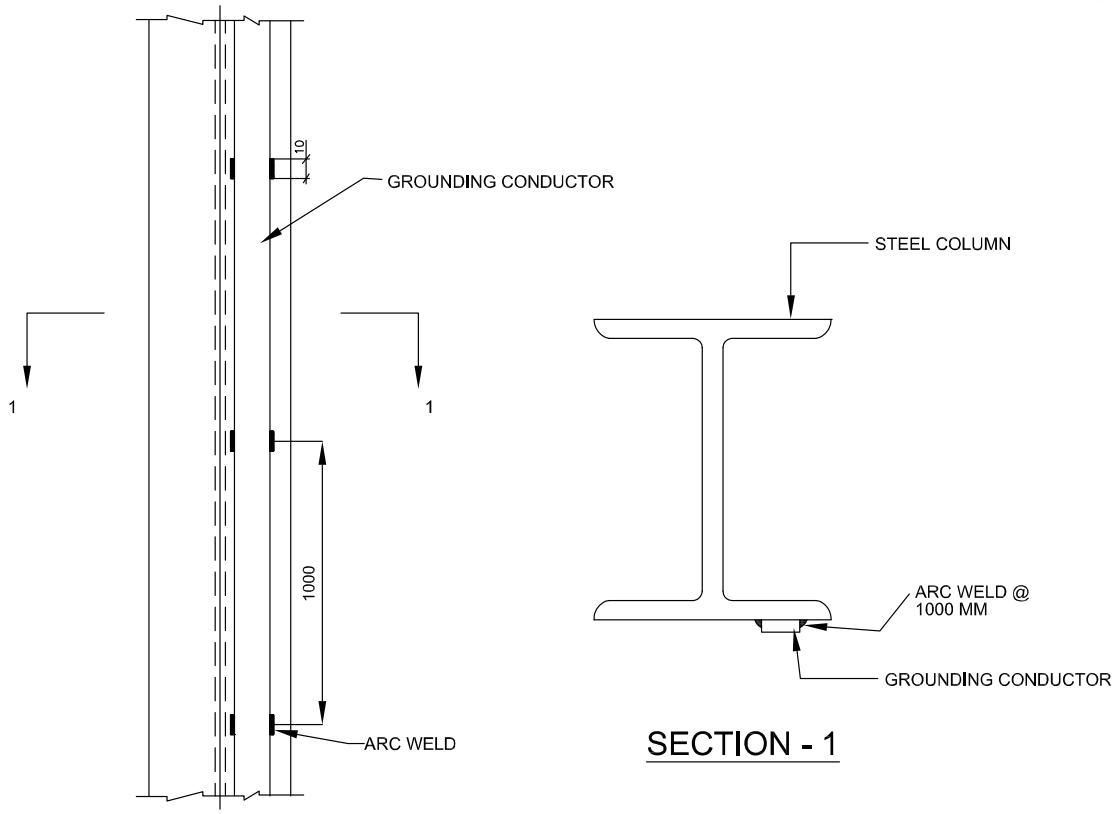
TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 7 OF 14



E15: FENCE GATE GROUNDING

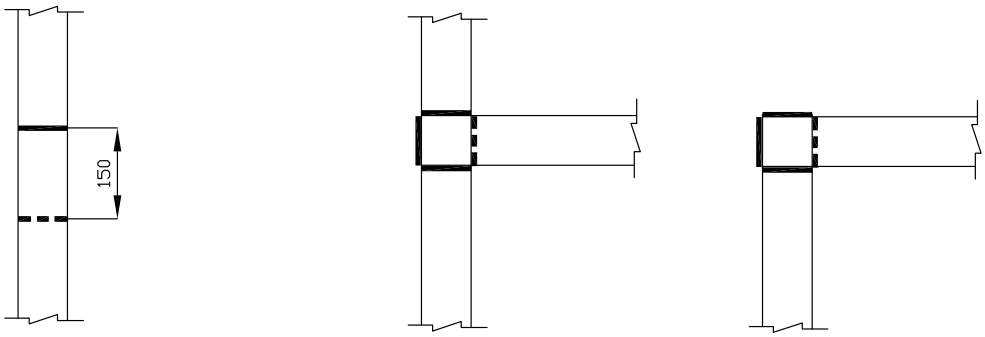
FOR GENERAL NOTES REFER SHT 12 & 13

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 8 OF 14



SECTION - 1

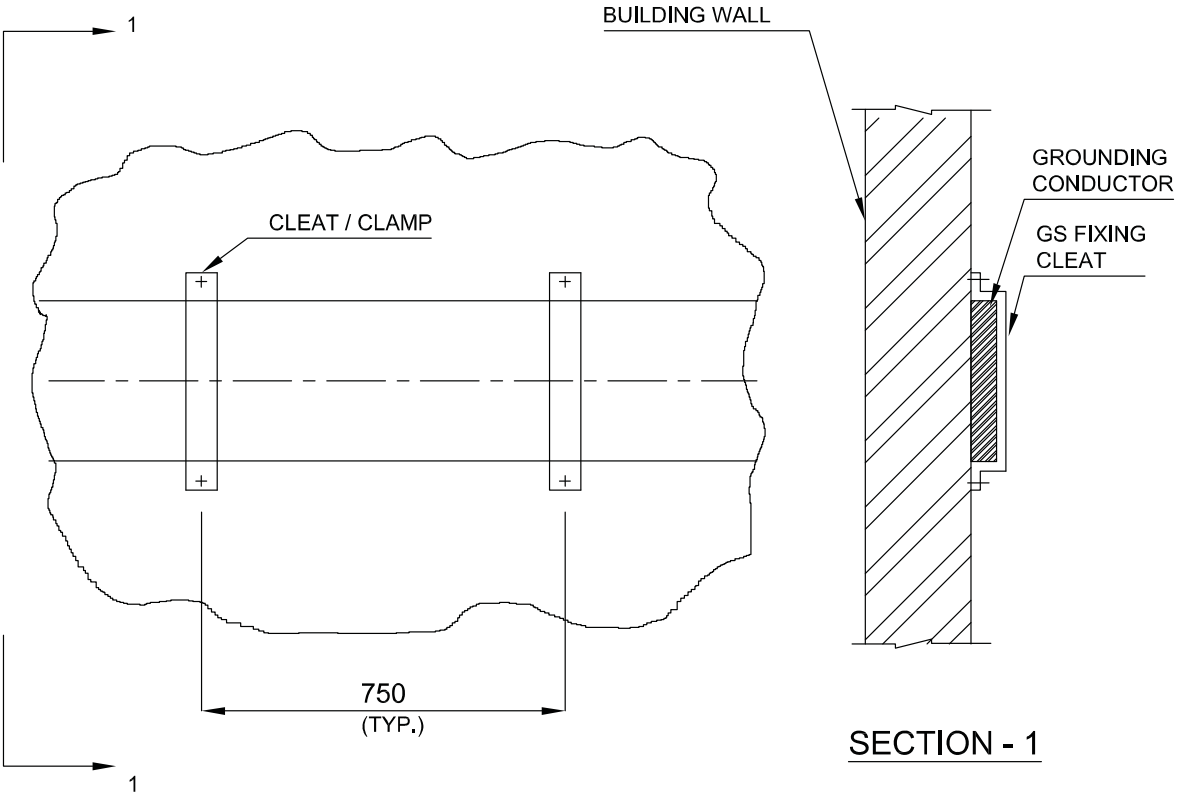
E16: GROUNDING CONDUCTOR ALONG STEEL COLUMN



STRAIGHT INCONNECTION T-OFF 90° CHANGE

FOR GENERAL NOTES REFER SHT 12 & 13

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 9 OF 14

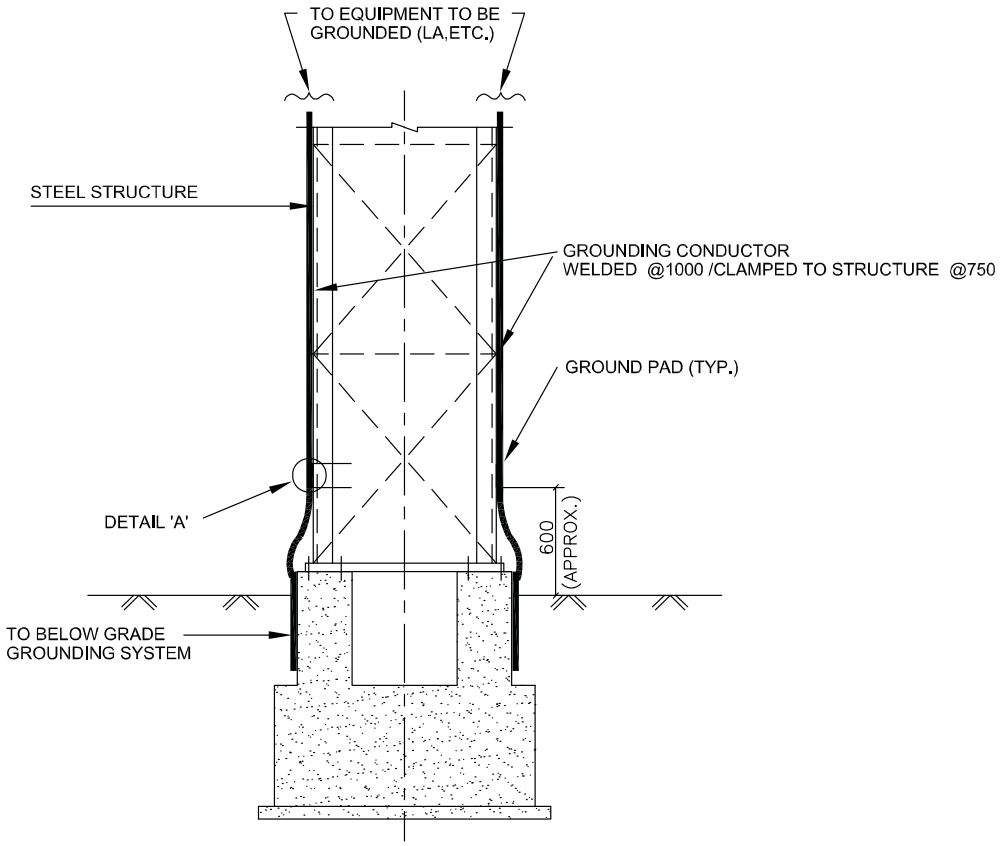


SECTION - 1

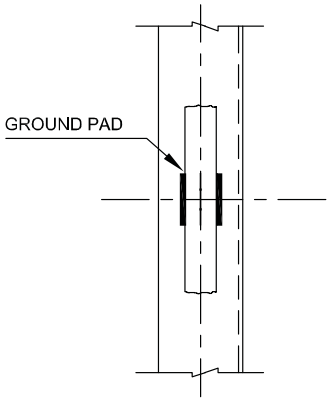
E17: GROUNDING CONDUCTOR ALONG BUILDING WALL

FOR GENERAL NOTES REFER SHT 12 & 13

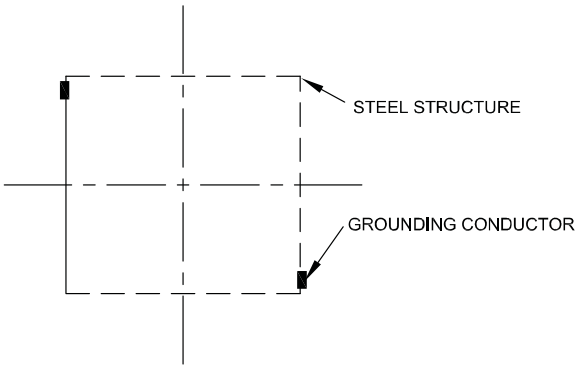
TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 10 OF 14



SECTION



DETAIL - A



PLAN

E18: STRUCTURE AND EQUIPMENT GROUNDING

FOR GENERAL NOTES REFER SHT 12 & 13

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 11 OF 14

NOTES:

1. THE DETAILS SHOWN IN THIS DRAWING ARE APPLICABLE TO THE ABOVE GRADE LEVEL GROUNDING FOR MAIN PLANT AREA, AND AUXILIARY PLANTS IN BHEL SCOPE. FOR DETAILS OF EQUIPMENT GROUNDING IN SWITCHYARD AND PLANTS & FACILITIES NOT PART OF MAIN PLANT TURNKEY PACKAGE SEPARATE DOCUMENTS SHALL BE REFERRED.

2. GALVANISED M.S. CONDUCTORS ARE USED FOR EQUIPMENT GROUNDING. SIZE OF GROUND CONDUCTOR SHALL BE AS PER TABLE ON SHEET 14.

3. ALL GROUND CONDUCTOR CONNECTIONS AT EQUIPMENT ENDS ARE BOLTED.

4. ALL FASTENERS (NUTS/BOLTS/WASHERS) SHALL BE GALVANISED / ZINC PASSIVATED.

5. FROM BELOW GRADE GROUNDING SYSTEM, RISERS OF 40 MM. DIA. MILD STEEL ROD SHALL BE BROUGHT OUT AND CONNECTED TO MAIN GROUND CONDUCTOR (65X8 MM GALVANISED MS FLAT) RUN ALONG BUILDING COLUMNS/ WALLS AND SECURELY FIXED TO THE SAME BY WELDING/ CLEATING AT INTERVALS OF 1000 MM AND 750MM RESPECTIVELY.
CONNECTIONS FROM EQUIPMENT EARTH TERMINALS, RUNWAY CONDUCTOR,FLOOR SUBMAT, ETC. SHALL BE CONNECTED TO THESE MAIN CONDUCTORS.

6. A CONTINUOUS 65X8 MM. GALVANISED M.S. FLAT EARTH CONDUCTOR (RUNWAY CONDUCTOR) SHALL BE INSTALLED ALONG ALL COLUMNS & STRUCTURES WHICH SHALL SERVE AS THE MAIN GROUNDING CONDUCTOR FOR RECEIVING INDIVIDUAL GROUND CONNECTIONS. ALL TRAY TIERS OF EACH SECTION SHALL BE CONNECTED TO THE RUNWAY CONDUCTOR AT AN INTERVAL OF ABOUT 10 M.
THE RUNWAY CONDUCTORS AT DIFFERENT BUILDING ELEVATIONS SHALL BE INTERCONNECTED BETWEEN THE MAIN RISERS ALONG COLUMNS/WALLS & SHALL ALSO BE CONNECTED TO THE NEAREST RISER/ STRUCTURAL COLUMNS AND THE DISTANCE BETWEEN EARTHING POINT SHALL NOT EXCEED 30M.
WHEREVER EARTH MAT IS NOT AVAILABLE,NECESSARY CONNECTIONS SHALL BE DONE BY DRIVING AN EARTH ELECTRODE IN THE GROUND.

7. ALL ELECTRICAL EQUIPMENT AND ASSOCIATED NON CURRENT CARRYING METAL WORKS, SUPPORTING STRUCTURES, ETC. SHALL BE CONNECTED TO MAIN RUNWAY CONDUCTOR OR BELOW GROUND EARTHING SYSTEM BY TWO SEPARATE & DISTINCT CONNECTIONS EACH OF 100% CAPACITY. ELECTRICAL CONTINUITY SHALL BE ENSURED BY BONDING DIFFERENT SECTIONS OF HAND RAILS & METALLIC STAIRS.

8. TWO SEPARATE AND DISTINCT GROUND CONNECTIONS SHALL BE PROVIDED FOR GROUNDING OF EACH ELECTRICAL EQUIPMENT FRAMEWORK.

9. ALL BUILDING STEEL COLUMNS, STRUCTURAL STEEL COLUMNS, DEVICES SUCH AS JUNCTION BOXES, PULL BOXES, PUSH BUTTON STATIONS, LOCKOUT SWITCHES, CABLE END BOXES ETC. SHALL BE GROUNDED WHETHER SPECIFICALLY SHOWN IN THE DRAWING OR NOT AS PER TABLE ON SHEET 14 OF 14.

10. GROUND CONDUCTOR CONNECTIONS ABOVE GRADE LEVEL SHALL BE GENERALLY MADE BY ELECTRIC ARC WELDING EXCEPT AT EQUIPMENT TERMINALS. M.S. GROUND CONDUCTOR ABOVE GROUND LEVEL SHALL BE TREATED WITH RED LEAD OXIDE AND AFTERWARDS THICKLY COATED WITH BITUMEN COMPOUND TO PREVENT CORROSION. DAMAGED PORTIONS OF GALVANISED MS SHALL BE COATED WITH TWO COATS OF COLD GALVANISING AND ANTI-CORROSIVE PAINT AFTER WELDING.

11. AT EQUIPMENT ENDS, ONLY BOLTED CONNECTION SHALL BE MADE FOR GROUNDING OF EQUIPMENT/ DEVICES AND REMOVABLE STRUCTURES. THE CONTACT SURFACE SHALL BE THROUGHLY CLEANED

TITLE	NTPC DOCUMENT NO: .....
TYPICAL ABOVE GROUND EARTHING DETAILS	BHEL DRAWING No.
	REV. No. 02
	SHEET 12 OF 14

BEFORE CONNECTION TO ENSURE GOOD ELECTRICAL CONTACT.

12. GROUNDING CONDUCTORS ON FLOORS (I.E. SUBMATS) SHALL BE PROVIDED AS AN ALTERNATIVE TO THE SYSTEM DESCRIBED AT 5 & 6 ABOVE ONLY WHERE DIRECT CONNECTION OF EQUIPMENT/ PANELS TO RUNWAY CONDUCTOR/ MAIN GROUND LEADS IS NOT POSSIBLE DUE TO LAYOUT CONSTRAINT. IN SUCH CASES GROUND CONDUCTORS ON FLOORS SHALL BE LAID ON RCC SLAB BEFORE FLOOR FINISHING IS DONE AND CONNECTED TO THE BELOW GROUND EARTHING SYSTEM THROUGH TWO RISERS LOCATED PREFERABLY DIAMETRICALLY OPPOSITE TO EACH OTHER. SUITABLE RISER STUBS SHALL BE PROVIDED ABOVE THE FINISHED FLOOR IF THE EQUIPMENT IS NOT AVAILABLE AT THE TIME OF LAYING THE MAIN GROUNDING CONDUCTOR.

13. EACH STREET LIGHTING POLE, FLOOD LIGHTING POLE AND LIGHTING MAST WILL BE GROUNDED BY 25X3 MM GS FLAT, WHICH WILL BE CONNECTED TO ONE NO. 40 MM DIA & 3M LONG EARTH ROD DIRECTLY DRIVEN INTO GROUND. THE JUNCTION BOX AT EACH LIGHTING POLE IS GROUNDED AT ONE POINT FROM 1 NO. EARTHING TERMINAL BY 14 SWG GI WIRE.
A SEPARATE EARTHING CONDUCTOR SHALL BE PROVIDED FOR EARTHING LIGHTING FIXTURES, RECEPTACLES, SWITCHES, JUNCTION BOXES, LIGHTING CONDUITS, POLES ETC. THIS CONDUCTOR IN TURN SHALL BE CONNECTED TO MAIN EARTH GRID.

14. ELECTRICAL CONDUITS, PIPES AND CABLE TRAY SECTIONS SHALL BE BONDED TO ENSURE ELECTRICAL CONTINUITY AND CONNECTED TO EARTHING CONDUCTORS AT REGULAR INTERVALS.
STEEL/RCC COLUMNS, METALLIC STAIRS, HANDRAILS, CABLE TRAYS, METALLIC CONDUITS AND PIPES SHALL NOT BE USED AS EARTH CONTINUITY CONDUCTOR.

15. NEUTRAL CONNECTION SHALL NOT BE USED FOR THE EQUIPMENT EARTHING.

16. JOINTS SHALL BE AVOIDED AS FAR AS POSSIBLE. JOINTS SHALL BE MINIMUM FOR GENERATORS AND TRANSFORMER NEUTRAL CONNECTION TO EARTHING PIT TO MINIMIZE EARTH IMPEDANCE.

17. FLEXIBLE CONDUITS ARE CONNECTED TO RIGID CONDUITS BY GI WIRE TO ENSURE CONTINUITY.

18. CABLE TRAY PIPE RACK/ TRESTLE COLUMNS SHALL BE GROUNDED THROUGH GI FLAT THAT WILL BE CONNECTED TO BELOW GROUND EARTHING SYSTEM.

19. ALL BIMETALLIC CONNECTIONS (IF ANY) SHALL BE BRAZED TYPE AND SHALL BE TREATED TO PREVENT MOISTURE INGRESSION.

19. GROUNDING INSTALLATION SHALL CONFORM TO THE FOLLOWING:
(A) IS:3043
(B) BHEL DRAWING NO. PE–DG–508–509–E005 (TYPICAL BELOW GROUND EARTHING DETAILS)
(C) INDIAN ELECTRICITY RULE.

TITLE TYPICAL ABOVE GROUND EARTHING DETAILS	NTPC DOCUMENT NO: ..... BHEL DRAWING No. REV. No. 02 SHEET 13 OF 14

TABLE : ABOVE GRADE GROUNDING SYSTEM - CONDUCTOR SIZES

SL. NO.	TYPE OF EQUIPMENT	SIZE (MM)	MATERIAL	NO. OF LEADS
01	RISERS	65X8	GALVANISED MS FLAT	N.A.
02	SUB-MAT BURIED IN FLOOR FINISH	65X8	GALVANISED MS FLAT	N.A.
03	RUNWAY CONDUCTOR/ MAIN EARTH LEAD ALONG COLUMNS & STRUCTURES	65X8	GALVANISED MS FLAT	N.A.
04	11KV/ 3.3 KV/415V SWITCHGEAR/ MCC	65X8	GALVANISED MS FLAT	TWO
05	SYSTEM NEUTRALS	65X8	GALVANISED MS FLAT	TWO
06	415V DISTRIBUTION BOARDS	50X6	GALVANISED MS FLAT	ONE FOR EACH SECTION
07	FUSE DISTRIBUTION BOARDS, LDBS	50X6	GALVANISED MS FLAT	TWO
08	11KV & 3.3 KV MOTORS	65X8	GALVANISED MS FLAT	TWO
09	415V MOTORS : ABOVE 125KW	50X6	GALVANISED MS FLAT	TWO
10	415V MOTORS : ABOVE 25KW UPTO 125KW	25X6	GALVANISED MS FLAT	TWO
11	415V MOTORS : UPTO 25KW	25X3	GALVANISED MS FLAT	TWO
12	415V MOTORS : FRACTIONAL KW	8SWG	GS WIRE	TWO
13	CONTROL PANEL & CONTROL DESK	25X3	GALVANISED MS FLAT	TWO
14	PUSH BUTTON STATION & JUNCTION BOX	8SWG	GS WIRE	TWO
15	CABLE TRAYS, COLUMNS & STRUCTURES	50X6	GALVANISED MS FLAT	ONE
16	BUSDUCT ENCLOSERS			
i)	ISOLATED PHASE BUSDUCT	65X8	GALVANISED MS FLAT	TWO
ii)	SEGREGATED PHASE / NON SEGREGATED PHASE BUSDUCT	65X8	GALVANISED MS FLAT	TWO
17	RAILS & METAL PARTS,STEEL TANKS, FENCE	25X6	GALVANISED MS FLAT	TWO
18	TRANSFORMER TANKS / RADIATORS	65X8	GALVANISED MS FLAT	TWO
19	TRANSFORMER NEUTRAL GENERATOR ENCLOSURE	65X8	GALVANISED MS FLAT	TWO
20	WELDING OUTLETS 3-PHASE RECEPTACLES	50X6	GALVANISED MS FLAT	TWO
21	LOCAL PANELS, LIGHTING PANELS	25X3	GALVANISED MS FLAT	TWO
22	LIGHTING POLE/ MASTS	25X3	GALVANISED MS FLAT	ONE
23	LIGHTING FIXTURES, CONDUITS,SINGLE-PHASE RECEPTACLES, LIGHTING JBs , SWITCH BOXES	14SWG	GS WIRE	ONE

TITLE

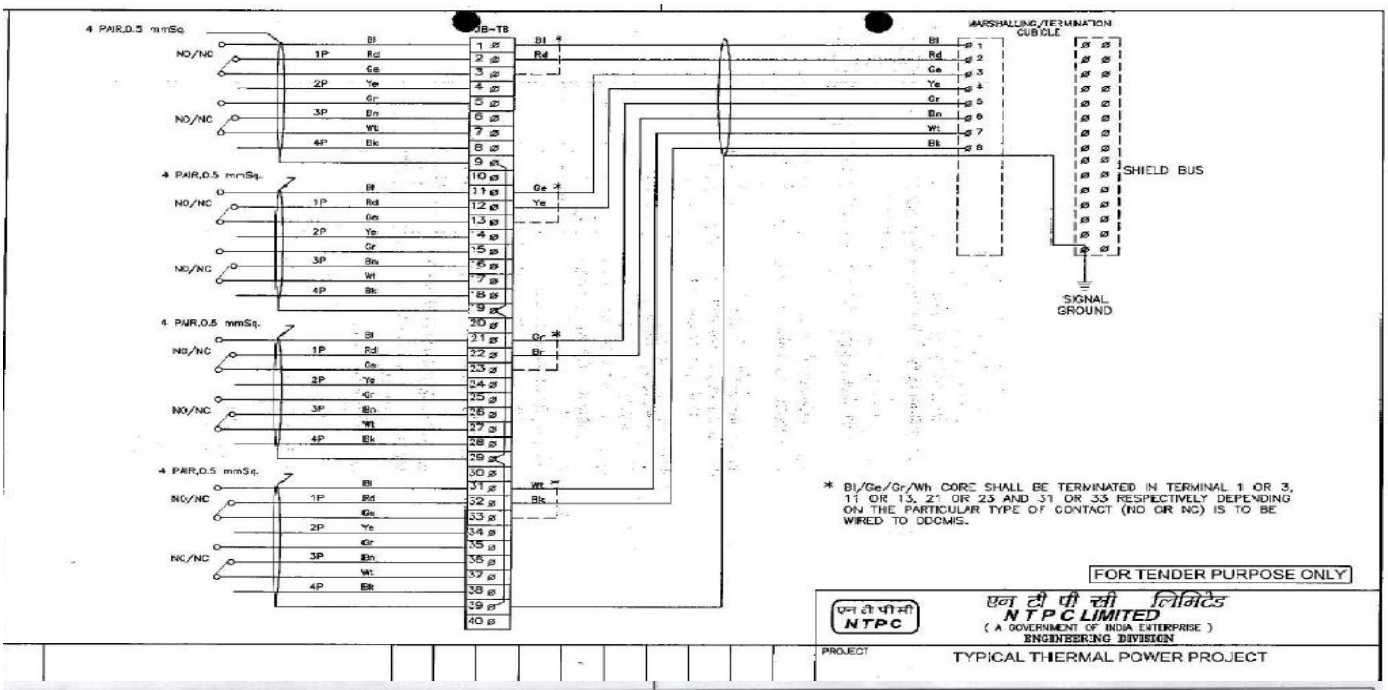
TYPICAL ABOVE GROUND EARTHING DETAILS

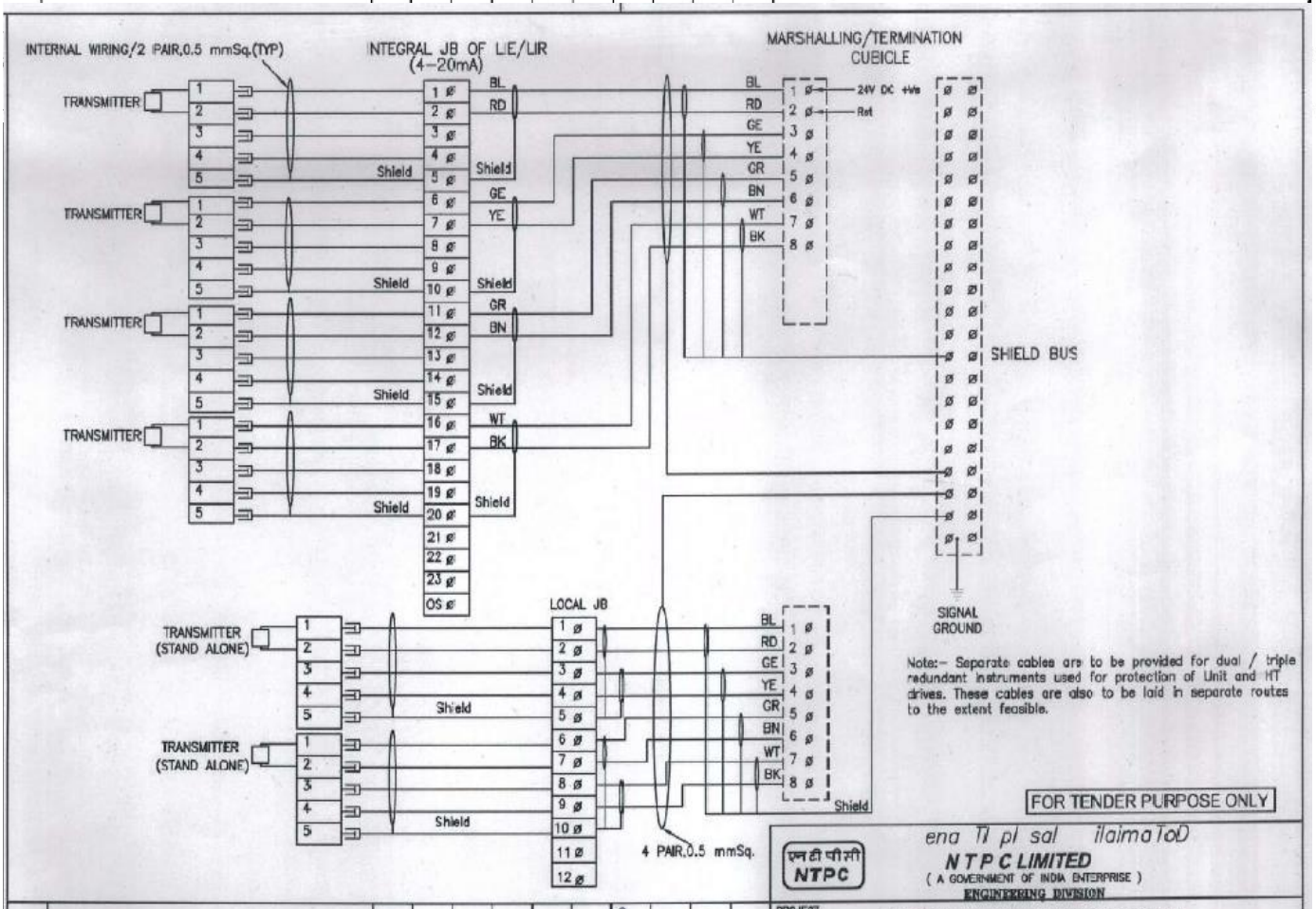
NTPC DOCUMENT NO: .....

BHEL DRAWING No.

REV. No. 02

SHEET 14 OF 14


4 PAIR,0.5 mmSq.
NO/NC
1P
2P
3P
4P
JB-TB
MARSHALLING/TERMINATION CUBICLE
SHIELD BUS
SIGNAL GROUND
* BL/Ge/Gr/Wh CORE SHALL BE TERMINATED IN TERMINAL 1 OR 3, 11 OR 13, 21 OR 23 AND 31 OR 33 RESPECTIVELY DEPENDING ON THE PARTICULAR TYPE OF CONTACT (NO OR NC) IS TO BE WIRED TO DDCMIS.
FOR TENDER PURPOSE ONLY
NTPC
NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION
PROJECT
TYPICAL THERMAL POWER PROJECT


INTERNAL WIRING/2 PAIR,0.5 mmSq.(TYP)
INTEGRAL JB OF LIE/LIR (4-20mA)
MARSHALLING/TERMINATION CUBICLE
TRANSMITTER
Shield
24V DC +Ve
Ret
SHIELD BUS
SIGNAL GROUND
LOCAL JB
TRANSMITTER (STAND ALONE)
4 PAIR,0.5 mmSq.
Note:- Separate cables are to be provided for dual / triple redundant instruments used for protection of Unit and HT drives. These cables are also to be laid in separate routes to the extent feasible.
FOR TENDER PURPOSE ONLY
NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION
PROJECT
TYPICAL THERMAL POWER PROJECT
TITLE
INTERFACING OF FIELD INSTRUMENTS 4-20mA
SIZE A3
SCALE NTS
DRG. NO. 0000-999-POI-A-065
SH 04 OF 14
REV. NO. C
C NOTE REGARDING CABLE IS ADDED. 10.12.13
B INTERNAL WIRING FOR LIE/LIR MOUNTED SHOWN WIRING OF STAND ALONE TXTR SHOWN 10.12.06
A FIRST ISSUE 12.1.05
REV.NO. DESCRIPTION DRAWN DESIGN CHKD. M E C C&I ARCH. APPD DATE
CLEARED BY

PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SITE

1	**PERFORMANCE GUARANTEES:**
1.1	Each equipment shall be guaranteed to meet the performance requirement as specified.
1.2	The cold-water temperature of 32.5 Deg C shall be guaranteed for the design conditions of CW flow, range, ambient WBT and RH as per the performance test procedure of cooling tower attached herewith.
1.3	"Predicted cold water temperature" shall be arrived from the guaranteed cold-water temperature by correcting the same for the test conditions of range, ambient conditions and circulating water flow using the performance curves furnished by the contractor. In case the "Test cold water temperature" is higher than the "Predicted cold water temperature", Employer reserves the right to accept the tower after assessing the liquidated damages. The liquidated damages for shortfall in cold water temperature shall be worked out for all the cooling towers as per relevant clause & sub-section.
1.4	All costs associated with the tests including cost associated with the supply, calibration shall be included in the bid price.
1.5	Instruments required for conducting the PG Test shall be as per 'CT PG Test Procedure' attached in the specification.
1.6	The Performance / Acceptance test shall be carried out as per the standard procedure included in the specification.
1.7	The performance test of the Cooling Tower shall be carried out by the Contractor through CTI approved/listed testing agency in presence of NTPC. The testing agency proposed by the Contractor shall be approved by NTPC.
1.8	The data logged in the data logger shall be given to NTPC in soft form for reference immediately after the test, which should be readable in NTPC computer. In case, any software is required, the same shall be supplied to NTPC without any extra cost to NTPC/BHEL. The CTI agency shall simultaneously submit their final report to both Contractor as well as NTPC.
1.9	To ascertain the fulfillment of Guarantees of the Cooling Towers, the test results of the tower tested through CTI approved testing agency shall be considered for PG test evaluation and based on the test result, the liquidated damage if applicable shall be levied for all the Cooling Towers.
1.10	PG test of Cooling Tower (IDCT) shall be carried out by the contractor within one year of successful completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified, preferably in the period from May to September. If Unit trial operation falls in these months then PG test of IDCT can be clubbed with Unit trial operation.
1.11	In case during performance guarantee tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL / NTPC and re-conduct the performance guarantee test(s) with BHEL /NTPC's consent.
1.12	However, if the specified performance guarantee(s) are still not met even after the above modifications/ replacements within ninety (90) days or a reasonable period allowed by the customer, after the tests have been completed, BHEL/ NTPC will have the right to accept the equipment / system after levying Liquidated Damages as specified hereunder.
1.13	It is bidder's responsibility to design the cooling tower and its components to meet the performance requirements at given design conditions while complying to all the technical constraints specified in technical specification.
1.14	Apart from above performance guarantees, bidder shall guarantee the total Power consumption per Cooling Tower, for the cooling tower fans.
2	**Fan Power Consumption (KW) and CW Pumping Head:**
2.1	The total fan Power Consumption (KW) and the CW Pumping head (MWC) within bidder's terminal points shall not exceed the respective maximum limits specified in Technical Data Part-A.
2.2	Bidder shall submit the total fan Power Consumption (KW) and CW pumping head calculation along with his technical offer for reference.

2.3	The CW pumping head specified limit is inclusive of static head plus frictional losses including 10% margin on frictional losses.	
2.4	Bids with total fan power consumption (KW) and the CW pump head (MWC) more than the specified maximum limits shall not be accepted.	
2.5	No advantage shall be given to any bidder for total fan power consumption (KW) and CW pumping head (MWC) offered less than specified maximum limits.	
2.6	The bidder's Cooling Tower thermal design shall take care of above aspects including maximum and minimum permissible plan dimensions indicated in Technical Data Part-A.	
2.7	The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subjected to approval. CW pumping shall be calculated as follows:	
2.7.1	The static head for calculating CW pumping head shall be considered up to top elevation of top most hot water distribution header.	
2.7.2	Frictional losses for pipes shall be as per William & Hazen formula with C = 100. Frictional losses for various valves & fittings e.g. Miter bends, valves, tees, reducers etc. shall be as per crane handbook. Ft Value for fitting friction drop calculation to be considered as 0.01 for all sizes greater than 600NB.The frictional losses shall be computed considering 10% margin on same. William & Hazen formula: V = 0.85 X C X (i)^0.54 X (d/4)^0.63.	
3	**AMOUNT OF LIQUIDATED DAMAGES FOR SHORTFALL IN GAURANTEED PARAMETERS:**	
3.1	If the performance guarantee(s) are not met by the Contractor during PG Test, it will be concluded that, the equipment has failed to meet the guarantee(s) and action shall be taken as per the Contract Requirement.	
3.2	If the performance guarantee(s) specified above are not met by the Contractor even after the modifications and/or replacements mentioned, BHEL / NTPC will accept the equipment / system only after levying liquidated damages against the Contractor and such liquidated damages shall be deducted from the Contract Price.	
3.3	The liquidated damages shall be prorated for the fractional parts of the deficiencies.	
	Guarantee	
	Per Cooling Tower - For every 0.2 deg. C rise in Cold Water Temperature from the guaranteed value	US$ 7,70,370
	Per Cooling Tower - For every KW of aux power consumption	US$ 4661
3.4	Each of the liquidated damages specified above shall be independent and these liquidated damages shall be levied concurrently as applicable.	
4	The purchaser is, however, not bound to accept the equipment and reserves the right to reject it if the actual values exceed beyond the plant design limits.	

CT PG Test Procedure

INTRODUCTION

1.1 Scope

This document, hereinafter referred to as the "Test Procedure", describes the procedures for conducting the Cooling Tower Thermal Performance Test at NTPC Station, hereinafter referred to as the "Plant". This Test Procedure contains guidelines for conducting the test, the test set-up, list of test instrumentation, data to be acquired, and equations to be used for the calculation of results.

1.2 Test Goal

The goal of the Test is to accurately determine the thermal performance of the cooling tower for contractual acceptance.

1.3 Tower Description

The cooling tower, located at the ------ (Name of the Plant) is --- (no.) cell mechanically induced draft cooling tower with ……..type fill. The cooling tower operates with …. No of cells in service and ------ cell in standby mode. Each cell has one (1) fan. The cooling tower guaranteed power consumption at motor inlet is …….. KW. Hot circulating water is supplied to the tower through a ….. (dia of header) return header and distributed to both sides of each cell through risers. Cold water drains from each cell into a common basin beneath the tower, and exits the tower through a common channel.

1.4 Commercial Items

Testing shall be in accordance with CTI ATC-105 (2000), and in accordance with the Contract. Any inconsistencies between any of the provisions in this Test Procedure, and/or any of the Appendices herein, shall be resolved by giving precedence in the following order:

I. The Contract
II. This Test Procedure and any Authorized Modifications
II. Governing Performance Test Code(s) and Standards

1.5 Parties to the Test

The three (3) parties to the performance test are as follows:
Owner: NTPC
Contractor / Manufacturer:
Testing Subcontractor

The Testing Subcontractor shall appoint a Test Director to be in charge of all testing activities. Representatives for each party identified above shall be designated to observe the test, confirm that it was conducted in accordance with this Test Procedure, and if necessary, shall have the authority to approve any agreed upon test exceptions in writing. A joint protocol should be signed by all the parties before the test declaring that cooling tower is fit for the test in all respect.

2.0 References and Definitions

2.1 Test Codes and Standards

The following list of Codes and Standards shall be used in part in the testing of the Cooling Tower as deemed applicable by the Contractor:

- *CTI ATC-105 (2000) Acceptance Test Code for Water Cooling Towers*

2.2 Constants and Unit Conversions

Code-specific conversion factors required for use in the determination of test results shall be in accordance with CTI Bulletin STD-145(95).

2.3 Property Data

The psychometric calculations are based on ASHRAE formulations, if required.

2.4 Defined Terms and Abbreviations

Any capitalized terms that are not separately defined in this Test Procedure shall have the meaning for that term as defined by the Contract.

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME American Society of Mechanical Engineers
Guarantee Performance parameter guaranteed by the Contract
DAS Data Acquisition System
RTD Resistive Temperature Device
Test Director Responsible for the coordination and direction of the performance tests in accordance with this Test Procedure
Test Procedure This document
Test Run Period of time in which testing parameters are collected.

3.0 Test Overview

3.1 Test Description

The goal of the Test is to accurately determine the thermal performance of the cooling tower. The Test will be performed under the general guidelines of the CTI ATC-105 (2000). The Test will consist of measurements of circulating water flow rate, fan motor power consumption, air and water temperatures, wind speed and direction, and barometric pressure.

"These measured test parameters will be evaluated with the manufacturer supplied thermal performance curves to determine the thermal performance of the tower by comparing predicted cold water temperature with test cold water temperature."

3.2 Responsibilities

The responsibilities for each of the involved parties to the test are as follows:

Owner Responsibilities

- Operate the tower such that the manufacturer specified limits are not exceeded.
- Provide a stable heat load to the tower sufficient for testing.
- Provide a stable electrical power source for all temporary test instrumentation and equipment required to perform the Test. The Test equipment will require a standard 110 volt single phase AC power source for the data acquisition system and the psychrometers.
- Allow full access for the Testing Subcontractor to setup temporary instrumentation, and to record measurements manually if applicable.

Contractor / Manufacturer Responsibilities

- Overall Test coordination of all on-site logistical activities in support of the Performance Test.
- Designate the necessary personnel to witness the execution of the Performance Test, including a witness who shall have the authority to agree to any revisions/deviations to the Test Procedure.
- Provide an electrician to obtain fan power measurements at the direction of the Testing Subcontractor.
- Correct any defects that may occur that prevent the safe and reliable operation of the Tower.
- Coordinate with control room operations prior to and during the test.
- Provide access via ladders, man lifts, or scaffolding as needed including access to pitot taps.

Testing Subcontractor Responsibilities

- Provide temporary test instrument data acquisition system and NIST-traceable, calibrated, temporary test instrumentation.
- Calibrate temporary test instrumentation prior to the Test.
- Install temporary test instrumentation with Contractor assistance as needed.
- Prepare this Test Procedure and make changes, as needed.
- Analyse the test results and prepare a Test Report following the completion of the Test.
- Provide a Test Director who shall direct, coordinate and oversee the Test activities, and ensure that the Test is executed per this Test Procedure.

Test Director Responsibilities

- The Test Director, or acting designee, shall be present during the entire testing period.
- Keep a test log to note any Plant Upsets which may cause the test data to violate the stability criteria listed in this Test Procedure.

- Ensure that the Test is conducted in accordance with this Test Procedure, or record any deviations with agreement by the parties to the Tests, where necessary / applicable.
- Coordinate and direct the Test.
- Train and organize test data collectors, as needed.
- Effect proper safety compliance for onsite Testing Subcontractor personnel.
- Communicate with the Contractor and Owner
- Distribute copies of all raw Test data to all parties following the Test

3.3 Condition of Equipment

At the time of testing, the tower shall be clean and in good operating condition. Specific items that shall be checked prior to the start of testing are listed in Table 3-1.

Table 3-1: Required Conditions of the Tower

 # Condition

1. The water distribution system shall be essentially free of foreign materials that may impede the normal flow of water.
2. All mechanical equipment shall be in good operating condition. Fans shall be rotating in the correct direction, and pitched properly.
3. The fill and drift eliminators shall be essentially free of algae and other foreign materials that may impede normal air flow.
4. The water in the cold water basin shall be at normal operating elevation.

3.4 Pre-Test Preparation

The following pre-test preparations shall be executed under the direction of the Test Director:

Contractor / Manufacturer

1. Verify the condition of the equipment meets the requirements of Section 3.3.
2. Verify the tower is well balanced prior to flow measurements. If required, appropriate rectification action to be taken to make it ready for the test

Testing Subcontractor

1. Verify the primary measurements against the secondary measurements and station indications if applicable.
2. Verify all data acquisition systems are running and recording data per Section 4.0.
3. Manual data sheets, shown in Appendix B and data collector requirements shall be determined and made available prior to testing.

4. Any deviations to this Test Procedure identified prior to testing shall be identified and agreed upon in writing by the parties to the test.
5. Test equipment will be checked to insure proper operation prior to testing including temperature comparisons.

Design Operating Conditions

The Design Operating Conditions of the cooling tower are given in Table 3-2 below.

Table 3-2: Design Operating Conditions

Parameter Units Value

- Circulating Water Flow Rate (m3/hr)
- Hot Water Temperature (°C)
- Cold Water Temperature (°C)
- Inlet Air Wet-Bulb Temperature (°C)
- Ambient Wet-Bulb Temperature (°C)
- Guaranteed Power consumption at motor inlet /cell (KW)
- Guaranteed Power consumption at motor inlet /tower (KW)
- Barometric Pressure (in Hg)

Every effort shall be made to conduct the Test as close to the design operating conditions as possible. The maximum permissible variations from the design operating conditions are given in Table 3-3 below.

Table 3-3: Maximum Permissible Variation from Design Operating Conditions

Parameter Limit

- Circulating Water Flow Rate ± 10 %
- Range ± 20 %
- Ambient Air Wet-Bulb Temperature (As per manufacturer's performance curve) not exceeding +_8.5 deg C
- Fan Motor Power Per Cell ± 10 %
- Barometric Pressure 1 in Hg
- Wind Speed
    - < 4.5 m/s for the 60 Minute Average,
    - < 7.0 m/s for the 1 Minute Moving
    - Average Throughout the 60 Minutes

The Test conditions shall meet the constancy requirements of ATC-105 given in Table 3-4 below.

Table 3-4: Required Constancy of Test Conditions During the Test

Parameter **Constancy of Test Conditions**

Circulating Water Flow Rate	± 2 %
Heat Load & Range	± 5 %
Ambient/Inlet Air Wet-Bulb Temperature*	± 1 °C / hour
Ambient/Inlet Air Wet-Bulb Temperature maximum deviation of a reading from the test	± 1.5 °C

* Limit on the liner least squares trend

3.6 Test Methodology

3.6.1 The Test shall be conducted in general accordance with CTI ATC-105.

3.6.2 The Test shall be performed on the entire tower as a whole. The circulating water flow rate and fan power of all operating cells shall be within ± 10% of the average of the tower. Fan blades shall be adjusted within allowable range of operation so that test power consumption shall be as close as possible to guaranteed power consumption.

3.6.3 The heat load on the tower should be steady for a minimum of thirty (30) minutes prior to the start of testing.

3.6.4 Test parameters should be measured for as long as Test conditions permit. The Test director will review the data and select one (1) Test Run that is one (1) hour in duration based on stability criteria. The most stable hour of data will be utilized to calculate the tower performance. Data stability will be determined by the Test Agency engineer and DAS software. The averaged data from the most stable Test run shall be evaluated with the manufacturer's performance curves given in Appendix A to determine the tower performance.

3.6.5 Test parameters will be measured from a combination of temporary test instruments supplied by the Performance Testing Agency and permanent plant instrumentation, see Appendix C. The calibrated accuracy of all instruments shall meet the requirements of ATC-105. Instrument readings will be recorded by the plant control systems, temporary data acquisition system, and manually by test personnel.

3.6.6 Prior to testing, all thermal probe outputs will be compared in a water bath to verify that the probes were not damaged in shipment. Only probes which read less than ±0.1°C from the water bath average will be used.

3.6.7 Manufacturer's recommended operating guidelines shall be followed throughout all testing. No equipment shall be operated outside of its design limits. To the extent practical, systems will be in automatic control during the tests. Any deviation from standard operation should be noted and approved by all parties to the Test.

3.6.8 Should any adjustment to the tower circulating water flow rate be necessary, throttling should be attempted at the pump discharge and condenser valves in order

to maintain clean full flow profiles in the risers for the water flow measurements. After Testing, any flow control will be at the discretion of plant operations.

3.6.9 All flows to and from the tower shall remain steady during each Test Run. If possible, the blow down shall be isolated and the makeup flow shall remain steady during each Test Run.

3.6.10 A test log should be kept by the Test Director to note any Plant Upsets which may cause the test data to violate the stability criteria or operational limits listed in the Test Procedure and cause test interruption.

3.6.11 Data recorded during a Plant Upset (Plant Upsets may include circulating pump trip, fan power trip or unexpected weather changes) shall be omitted from the test average and not included in the calculation of the test results. Unless otherwise specified, the Performance Test shall resume at a minimum of thirty (30) minutes following the re covery of stability. The Test Runs shall be extended for a period of time equal to the duration of the test interruption.

3.7 Proposed Test Schedule

The proposed test schedule is provided in Table 3-5 below. The schedule is subject to change.

Table 3-5: Proposed Schedule for Test Agency Personnel

Activities	Estimated Hours
Install Equipment	10
Measure water flow at the header, Conduct Test	8
Pack equipment, Calculate Preliminary Results	8

4.0 Test Measurements

4.1 Measurement Methodology

4.1.1 Test measurements shall be recorded with a combination of temporary installed and permanent plant instrumentation. A complete list of measurements can be found in Appendix C.

4.1.2 Primary measurements are defined as those used to calculate test results.

4.1.3 Secondary measurements are defined as those that do not enter into the calculation of the results. These measurements shall be used as a quality indicator of the test.

4.1.4 All instrumentation for the recording of primary measurements shall be calibrated prior to the performance test in accordance with ATC-105 (2000). Calibration

records prior to for all test instrumentation will be provided when equipment arrives on site testing.

4.1.5 A temporary installed data acquisition system (DAS) shall be utilized to acquire the majority of the test data. Data recorded digitally shall be collected every thirty (30) seconds.

4.1.6 Manually recorded data shall be recorded once per test run unless specified other wise.

5.0 Calculation Methodology

5.1 Calculation Overview

This section outlines the steps for determining the Cooling Tower Thermal Performance.

The following test parameters are evaluated as part of the Test:

1. Water Flow Rate
2. Hot Water Temperature
3. Cold Water Temperature
4. Ambient Air Wet-Bulb Temperature
5. Ambient Air Dry-Bulb Temperature
6. Barometric Pressure
7. Fan Motor Power
8. Wind Speed

The calculation of Tower Performance will be estimate as described in the Section 5.2 and 5.3 below.

5.2 Determination of predicted Cold Water Temperature for Cooling Tower

The data for each parameter is displayed and averaged for a sliding one hour window throughout the entire data set. Limits from the ATC-105 code are applied to the parameter averages.

The cold water temperature shall be read from the performance curves for 90%, 100% and 110% of rated flows at test wet bulb temperature andrange. The three points thus obtained from performance curves are plotted to obtain a cross plot, which is a relation between water flow and cold water temperature.

The test water flow is corrected for difference in fan power consumption from design values as follows:

Corrected test water flow

= (Test Water Flow) x (Design Power Consumption/ Test Power Consumption)$^{1/3}$

From the cross plot obtained above the predicted cold water temperature shall be read at corrected test water flow.

5.3 Test Acceptance Criteria

The acceptance criteria of the test is defined as: "For the cooling tower, if the test cold water temperature is less than or equal to the predicted cold water temperature as calculated based on methodology given in Section 5.2,the tower is deemed to have met the guarantee."

A maximum tolerance of 0.3 deg C in cold water temperature shall be allowed to take care of design and instrument inaccuracies.

6.0 Reporting Requirements

6.1 Data Delivery

A copy of all data sheets and logged data will be furnished to all parties at the completion of the test prior to demobilization.

6.2 Test Report Delivery

The Performance Test Report shall be completed within thirty (30) days of the completion of the Test. The final thermal performance report for the cooling tower detailing shortfall in test cold water temperature from predicted cold water temperature to be issued. The reports to be electronically submitted in an Acrobat PDF format to the test purchaser and owner of the tower, NTPC also at the same time.

6.3 Final Test Report Requirements

The Performance Test Report shall include:

- A copy of all data sheets and raw data required by this procedure.
- A copy of the manufacturer's data including the performance curves.
- A description of the cooling tower with its orientation.
- A sketch of the installation showing the measurement location of circulating water flows, temperatures, wind speed, barometric pressure, etc.
- Date and time of test runs start and finish.
- Description of conditions under which the test runs were conducted.
- Summary and discussion of the Test results.
- Notes on any unusual observations, data, or conclusions.
- Signed pre-test agreements.
- Any mutually-agreed upon deviations to the Test Procedure (if applicable).
- Instrument calibration data including instrument calibration forms will be supplied for any temporary test instrumentation used to obtain data for the test.

Appendices

Appendix	Title
A.	Manufacturers Performance Curves
B.	Manual Data Sheets
C.	Primary and Secondary Measurements

APPENDIX A
Manufacturers Performance Curves

APPENDIX B
Manual Data Sheets

APPENDIX C
Primary and Secondary Measurements

PRIMARY TEST MEASUREMENTS

Primary measurements are defined as those used to calculate test results. They will be recorded if an electronic interface to the data can be established. A temporary test Data Acquisition System (DAS) shall be used to monitor the majority of the precision test pressures and temperatures. The test DAS will include at least one (1) data logger connected to a laptop computer. Automatically monitored parameters will be scanned a minimum of once every 30 seconds using the test DAS. If the data acquisition system is not available for testing, primary measurements will be manually recorded every five (5) minutes. Location of instruments shall be as per specification.

Primary measurements will be based on the following:

1. Circulating water flow rate will be determined by Pitot tube traverses provided at site. An air-over-water manometer will be used to measure the differential pressure between the impact and the static ports of the pitot. The circulating water flow rate is anticipated to remain steady throughout the mobilization. The water flow to the tower will be measured once, and then checked before each test run by monitoring the manometer differential pressure at the midpoint of the header. The discharge pressure of the circulating pumps, the power consumption of the pumps, and other plant data shall be monitored if available to insure the circulating water flow rate to the tower is steady throughout the test.
2. Hot water temperature shall be measured with two (2) RTDs installed in a flowing well in at least one (1) of the taps at the supply header upstream of first riser. Hot water temperature may be measured in multiple taps if necessary.
3. Cold water temperature shall be measured in cooling tower outlet channel with a grid of at least nine (9) RTD’s installed in the channel at the discharge of the cold water basin.
4. Ambient air wet-bulb temperature will be measured in front of the air inlets using RTDs installed in sixteen (16) CTI - compliant mechanically aspirated psychrometers located at eight (8) equal area points suspended from ropes on each side of the tower.
5. Ambient air dry-bulb temperature will be measured in front of the air inlets using RTDs installed in two (2) of the psychrometers used to measure ambient air wet-bulb temperature. To measure Ambient WBT & DBT, RTDs are to be installed preferably

at location approximately 1.5 m above basin curb elevation, not less than 15 m or more than 100 m to windward of the cooling tower or at a suitable location after mutual agreement.

6. Fan motor power readings for the tower will be made at the motor control switchgear with a test agency calibrated wattmeter. Voltage and amperage measurements will be taken for plant reference and line loss calculations as required.

7. Barometric pressure will be measured with a calibrated barometer near the temporary DAS.

8. Make up water flow and temperature shall be measured with permanent plant instrumentation. If permanent plant instrumentation is not available, makeup water flow shall be approximated from the tower evaporation rate, and makeup water temperature shall be measured with a temporary installed RTD.

SECONDARY MEASUREMENTS

Secondary variables are measured variables that do not enter into the calculation of the results. Secondary measurements are recorded as a quality indicator of the test. Information Only variables may be recorded for the Test Director's information.

Secondary measurements shall include the following:

The ambient wind speed will be measured with a calibrated RM Young meteorological station placed upwind of the tower in an open and unobstructed location beyond the influence of the inlet air

SUB VENDOR LIST

All sub vendors / makes of equipment shall be subject to BHEL/ Customer approval in the event of order without any implication

Sl No	Item	Supplier	Place	Remark
1	PIPES-MS- (BLACK/ GI) AS PER IS IS:3589 >1000NB			
		STEEL AUTHORITY OF INDIA LIMITED	ROURKELA	
		WELSPUN	ANJAR	SAW UPTO 2600 NB
		WELSPUN	BHARUCH	SAW UPTO 1300 NB
		MAN INDUSTRIES	INDORE	SAW UPTO 1400 NB
		SAMSHI	VADODARA	SAW 450 TO 2540 NB
		MUKAT TANKS & VESSELS	TARAPUR	SAW 200 TO 1200 NB
		MUKAT PIPES	RAJPURA	SAW UPTO 1800 NB
		LALIT PIPES AND PIPES LTD	THANE	SAW 350 TO 1400 NB
		RATNAMANI	CHATRAL	SAW 600 TO 2600 NB
		RATNAMANI	KUTCH	SAW 400 TO 3600 NB
		PSL HOLDINGS LIMITED	DAMAN	SAW 450 TO 1600 NB
		PSL INTERNATIONAL LTD.	CHENNAI	SAW 450 TO 1600 NB
		PSL LIMITED	KUTCH	SAW 450 TO 1600 NB
		PSL LIMITED	VISAKHAPATNAM	SAW 450 TO 1600 NB
		JCO PIPES	CHHINDWARA	SAW UPTO 1600 NB
		SURYA GLOBAL STEEL TUBE LTD	ANJAR	SAW UP TO 2032 OD
		CAPACITE STRUCURES PVT LTD	THANE	406.4 MM TO 3874 MM
2	PUMP -SUBMERSIBLE>= 30KW			
		KSB	NASHIK	130 KW
		KIRLOSKAR BROTHERS LTD	KIRLOSKARWADI	
		AQUA MACHINERY	AHMEDABAD	UP TO 235 KW
		WPIL	GHAZIABAD	
3	FAN ASSEMBLY-COOLING TOWER			
		PAHARPUR COOLING TOWERS LTD	SAHIBABAD	WITH SOLID FAN BLADES 288" AND 336 " DIA, WITH FOAM CORED FAN BLADES WITH 10 METERS AND 10.97
		PAHARPUR COOLING TOWERS LTD	BHASA	60" TO 288" FAN DIA
		PAHARPUR COOLING TOWERS LTD	KOLKATA	60" TO 288" FAN DIA
		M/s MAYA FANS AIR ENGG PVT LTD	DEWAS	UP TO 11 METER FAN
		AMALGAMATED INDUSTRIAL COMPOSITES PVT LTD	NASHIK	UP TO 11 METER FAN DIA
4	GEAR BOX -COOLING TOWER			
		PAHARPUR COOLING TOWERS LTD	SAHIBABAD	
		PAHARPUR COOLING TOWERS LTD	KOLKATA	
		NEW ALLENBERRY WORKS	KOLKATA	
		ELECON ENGINEERING	VALLABH VIDYANAGAR	
		PREMIUM ENERGY TRANSMISSION	FALTA	
5	DRIVE SHAFT-CARBON FIBRE -COOLING TOWER			

		M/S EUROFLEX TRANSMISSION (INDIA) PVT LTD		
		PAHARPUR COOLING TOWERS LTD	SAHIBABAD	
		AMALGAMATED INDUSTRIAL COMPOSITES PVT LTD	NASHIK	
		NORTH STREET COOLING TOWERS	GHAZIABAD	
6	DRIVE SHAFT SS-COOLING TOWER			
		PAHARPUR COOLING TOWERS LTD	SAHIBABAD	
		PAHARPUR COOLING TOWERS LTD	KOLKATA	
		NORTH STREET COOLING TOWERS	GHAZIABAD	
7	LT MOTOR			
		ABB	FARIDABAD	UPTO 55KW
		ABB	BANGALORE	
		JYOTI LTD.	VADODARA	
		TIPM	JAPAN	UPTO 15 KW (NON FLAME PROOF)
		HYOSUNG	SOUTH KOREA	
		WEG	BRAZIL	
		HYUNDAI	SOUTH KOREA	
		LHP	SOLAPUR	
		CGL	AHMEDNAGAR	RQP, FOR FLAME PROOF MOTOR
		TMEIC	JAPAN (NAGASAKHI)	
		NGEF	BANGALORE	UPTO 15 KW
		BHARAT BIJLEE	MUMBAI	RQP, FOR FLAME PROOF ALSO
		KEC	BANGALORE/ HUBLI*	*UPTO 90KW, RQP, FOR FLAME PROOF ALSO
		MARATHON	KOLKATA	RQP (UPTO 690V & 600 KW) FOR FLAME PROOF ALSO
		ABB	SWEDEN	UPTO 55KW
		HAVELL	NEEMRANA	UP TO 90KW
		KAWAMATA	JAPAN	UP TO 75 KW
		TIPS	JAPAN	UP TO 45KW
8	GI CONDUITS			BIS APPROVED MAKE
9	GI CONDUIT (EPOXY PAINTED)			BIS APPROVED MAKE
10	FLEXIBLE CONDUITS (LEAD COATED)			
		PLICA INDIA PVT. LTD	GHAZIABAD	
11	FLEXIBLE CONDUIT (PVC COATED)			REPUTED MAKE
12	CABLE GLANDS			
		ALLIED TRADERS & EXPORTERS	NOIDA	
		ARUP ENGG & FOUNDARY WORKS	KOLKATA	
		BALIGA LIGHTING EQPT.PVT.LTD.	CHENNAI	
		COMMET BRASS PRODUCTS	MUMBAI	
		DOWELLS	MUMBAI	
		ELECTROMAC INDUSTRIES	MUMBAI	

		INCAB	KOLKATA	
13	CABLE LUGS			
		DOWELLS	MUMBAI	
		UNIVERSAL MACHINES LTD.	KOLKATA	
14	CABLE CLAMPS & CABLE TIES			
		ELECTROMAC IND.CORPN.	MUMBAI	
		INCAB	KOLKATA	
		NOVOFLEX MARKETING PVT. LTD.	KOLKATA	
15	AC LOAD BREAK SWITCH			
		GE-POWER	CHENNAI	
		L&T	NEW DELHI	
		SIEMENS	GURGAON	
		KAYCEE	NEW DELHI	
		C&S ELECTRIC LTD.	NEW DELHI	
16	CONTROL SWITCHES/ SELECTOR SWITCH			
		KAYCEE	NEW DELHI	
		GE-POWER	CHENNAI	
		ALSTOM LTD	NOIDA	
		SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
		M/s Shrenik & Co.	AHMEDABAD	
		RECOM PVT. LTD.	MUMBAI	
17	LIGHTING SWITCH , SOCKET & S/F UNIT			
		ELEXPRO ELECTRICALS PVT/ LTD.	NAVSARI	
		ANCHOR	MUMBAI	
		KAYCEE	NEW DELHI	
		L&T	NEW DELHI	
		SIEMENS	GURGAON	
		INDO ASIAN	NOIDA	
18	MODULAR SWITCH BOARD			
		ANCHOR	MUMBAI	
		ELEXPRO ELECTRICALS PVT/ LTD.	NAVSARI	
		HAVELLS INDIA LIMITED	NOIDA	
19	SWITCH BOX			
		ANCHOR	MUMBAI	
		ELEXPRO ELECTRICALS PVT/ LTD.	NAVSARI	
		BAJAJ ELECTRICALS	NEW DELHI	
		AJMERA INDUSTRIES & ENGG. WORKS	MUMBAI	
		S.B. ELECTRICAL ENGINEERING CORPORATION	MUMBAI	
20	CONTROL TRANSFORMER/ WINDING HEATING TRANSFORMER			
		AUTOMATIC ELECTRIC LTD.	LONAVALA	
		INDCOIL	MUMBAI	
		KAPPA ELECTRICALS	CHENNAI	
		LOGICSTAT	NEW DELHI	
		PRECISE ELECTRICALS	MUMBAI	
		UNILEC ENGINEERS PVT. LTD.	NAVI MUMBAI	

		M/s Newtek Electricals	Aurangabad	
21	MCB			
		MDS SWITCHGEAR LTD	NEW DELHI	
		INDO ASIAN	NOIDA	
		SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
		S&S POWER SWITCHGEAR LTD,	CHENNAI	
22	AUXILIARY RELAYS			
		ABB	FARIDABAD	
		ALSTOM LTD	NOIDA	
		JYOTI LTD.	VADODARA	
		OEN INDIA LTD	COCHIN	
		SIEMENS	GURGAON	
23	BIMETAL RELAYS			
		L&T	NEW DELHI	
		GE-POWER	CHENNAI	
		SIEMENS	GURGAON	
		TELEMECHANIQUE/ SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
24	FUSE BASE			
		INDO ASIAN	NOIDA	
		GE-POWER	CHENNAI	
		L&T	NEW DELHI	
		C&S ELECTRIC LTD.	NEW DELHI	
		SIEMENS	GURGAON	
		ABB	FARIDABAD	
		SPACEAGE SWITCHGEARS LTD.	GURGAON	
		SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
		ALSTOM LTD	NOIDA	
		ESSEN DEINKI	NEW DELHI	
25	HRC FUSES			
		INDO ASIAN	NOIDA	
		GE-POWER	CHENNAI	
		L&T	NEW DELHI	
		C&S ELECTRIC LTD.	NEW DELHI	
		SIEMENS	GURGAON	
		ABB	FARIDABAD	
		SPACEAGE SWITCHGEARS LTD.	GURGAON	
		SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
		ALSTOM LTD	NOIDA	
		ESSEN DEINKI	NEW DELHI	
26	AC CONTACTORS			
		SIEMENS	GURGAON	
		GE-POWER	CHENNAI	
		TELEMECHANIQUE/ SCHNEIDER ELECTRIC INDIA PVT. LTD.	GURGAON	
		L&T	NEW DELHI	

		BCH	FARIDABAD	
27	GI WIRE & FLAT			
		INDUSTRIAL PERFORATION (I)	KOLKATA	
		INDIA ELECTRICALS SYNDICATE	KOLKATA	
		INDMARK FORMTECH PVT. LTD.	PUNE	
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	KOLKATA	
		PATNY SYSTEMS (P) LTD	SECUNDRABAD	
		PASSIVE INFRA PROJECTS PVT. LTD.	NEW DELHI	
		RUKMANI ELECTRICAL & COMPONENTS PVT LTD	KOLKATA	
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	KOLKATA	
		RABI ENGINEERING WORKS PVT. LTD.	KOLKATA	
		RAJASTHAN METAL SMELTING CO.	JAIPUR	
		SARAL INDUSTRIES	Rae Bareli	
		PARCO Engineers Pvt. Ltd.	Vidhyavihar	
		UNITECH FABRICATORS and ENGINEERS PVT LTD	KOLKATA	
28	CABLE TRAYS & ACC.			
		ADVANCE POWER PRODUCTS LLP	KOLKATA	
		EROS METAL WORKS (P) LTD.	NAGPUR	
		INDUSTRIAL PERFORATION (I)	KOLKATA	
		NAMDHARI INDUSTRIAL TRADERS PVT. LTD	Ludhiana	
		PARMAR METALS PVT.LTD.	RAJKOT	
		PATNY SYSTEMS (P) LTD	SECUNDRABAD	
		PENTAX FERRO INCORPORATE	MUMBAI	
		Pinax Steel Industries Pvt. Ltd.	Patna	
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	KOLKATA	
		R.K. Engineering Works	Thane	
		RABI ENGINEERING WORKS PVT. LTD.	KOLKATA	
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	KOLKATA	
		RUKMANI ELECTRICAL & COMPONENTS PVT LTD	KOLKATA	
		Saral Industries	Rae Bareli	
		UNITECH FABRICATORS and ENGINEERS PVT LTD	KOLKATA	
29	CABLE TRAY SUPPORT SYSTEM -BOLTABLE			
		AM-TECH ENGG.SERVICES	PUNE	
		INDUSTRIAL PERFORATION (I)	KOLKATA	
		Maheshwari Electrical Mfrs. Pvt. Ltd.,	NOIDA	
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	KOLKATA	

		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	KOLKATA	
30	LIGHTING FIXTURES (LED)			
		Neev Luminaries	NEW DELHI	
		HAVELLS INDIA LIMITED	NOIDA	
		BAJAJ ELECTRICALS	NEW DELHI	
		SURYA ROSHNI LIMITED		
		PHILIPS	GURGAON	
		M/S HPL ELECTRIC & POWER PVT. LTD	NONEPAT	
		INSTA POWER	GURGAON	
		Pyrotech Electronics Pvt. Ltd.	UDAIPUR	
		M/s Halonix Technologies Limited	NOIDA	
		M/s JAQUAR & COMPANY PVT. LTD.	GURGAON	
		M/s CROMPTON GREAVES CONSUMER ELECTRICALS LTD.	MUMBAI	
		M/s WIPRO ENTERPRISES PRIVATE	Aurangabad	
		M/s Nessa Illumination Technologies Pvt. Ltd.	Ahmedabad	
		M/s. Forus Electric Pvt. Ltd.	NEW DELHI	
		M/s. ORIENT ELECTRIC LIMITED.	NOIDA	
		M/s Mika Engineers	Thane	
		M/s Kalingia Illuminaton Pvt Ltd.	GHAZIABAD	
31	JUNCTION BOXES (NON FLAME PROOF)			
		JASPER ENGNIREES PVT. LTD.	NOIDA	
		Electro Controls & Devices	GREATER NOIDA	
		M/s Shrenik & Co.	Ahmedabad	
		M/s PHOENIX MECANO LTD.,	Thane	
		Adroit Control Engineers Pvt.Ltd.	FARIDABAD	
		M/s PHOENIX MECANO LTD.,	PUNE	
		MIKA ENGINEERS	MUMBAI	
		M/s PHOENIX MECANO LTD.,	PUNE	
		BAJAJ ELECTRICALS	NEW DELHI	
		AJMERA INDUSTRIES & ENGG. WORKS	NAVI MUMBAI	
		S.B. ELECTRICAL ENGINEERING CORPORATION	MUMBAI	
		RITTAL INDIA PVT. LTD.	NEW DELHI	
		HPL ELECTRIC AND POWER LTD.	SOLAN	
32	TERMINAL BLOCKS			
		WAGO-CONTROLS	NOIDA	
		CONNECT WELL	NEW DELHI	
		ELMEX CONTROLS PVT. LTD.	VADODARA	
		ESSEN DEINKI	NEW DELHI	
		TECHNOPLAST	AMROHA	
		M/s PHOENIX MECANO LTD.,	PUNE	
		ESSEN DEINKI	NEW DELHI	
33	TIMERS - ELECTRONIC			

		ESSEN DEINKI	NEW DELHI	
34	RECEPTACLE (NON FLAME PROOF)			
		AJMERA INDUSTRIES & ENGG. WORKS	MUMBAI	
		CROMPTON GREAVES	NEW DELHI	
		CYCLO ELECTRIC DEVICE & SERV.CO.	BANGALORE	
		BCH	FARIDABAD	
		BEST & CROMPTON	CHENNAI	
35	PVC WIRES			BIS APPROVED MAKE
36	HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM			CECRI LICENSED SOURCES
37	Impulse Pipes/Tubes			
		Mahrashtra Seamless	Raigarh	For CS Pipes only
		Ratnamani Metals and Tubes	Gandhinagar	For SS only
		Heavy Metals and Tubes	Gandhinagar	For SS & CS only
		ISMT	Ahamadnagar	For CS/ AS upto Gr 22 Pipes only

		Nippon Steel & Sumitomo Metals corporation	Japan	
		TPS Tecnitube	Germany	
		Veluric & Manessmann	Germany	
		Trouvay and Cauvin	France	
		Sandvik	Sweden	For SS only
38	Temp Transmitter -Field Bus basedSingle/Dual Input			
		ABB India Ltd	Bangalore	One no of TT will be available at DCS supplier for function testing of field bus communication with DCS during FAT
39	Level switch- Conductivity type			
		Raman Instruments (System integrator of Delta Morbey/ Emerson Mobrey/ Solartron - Mobrey)	DELHI	
		HI Tech System & services Ltd (System Integrator of Levelstate systems Ltd ,UK)	KOLKATA	
		BHEL	Trichurapalli	
		Emerson -Mobrey (Solartron mobrey)	UK	
		Levelstate Systems Ltd	UK	
		Yarway	USA	
40	APPROVED GALVANIZERS			
		M/s M J Engg	Delhi	
		M/s A.V. Engg	KoLKATA	
		M/s Inar Profiles	Vishakhapatnam	
		M/s Anand Udyog	MUMBAI	
		M/s Techno Engg	Chandigarh	
		M/S Steelite Engg	MUMBAI	
		M/s National Galvanizer	KOLKATA	
		M/s Unistar GalvanizeR	kOLKATA	
		M/s B.P. Project	KOLKATA	
		M/s Bajaj	PUNE	
		M/s Electrocare Industries	MUMBAI	
		M/s B.G. Shirke	PUNE	
		M/s Gurpreet Galvanizer	HYDERABAD	
		M/s Sigma	MUMBAI	
		M/s Radhakrishnan Shetty	CHENNAI	
		Karamtara	MUMBAI	
		Poona Galvanizers	PUNE	
		Neha Galvanizer	KOLKATA	
		Unitech Fabricators & Galvanizers	Hoogly	
41	LIGHTING PANEL (NON FLAME PROOF)			
		MIKA ENGINEERS	MUMBAI	
		ELEXPRO ELECTRICALS PVT/ LTD.	NAVSARI	
		Vidhyut Controls (India) Pvt. Ltd.	GHAZIABAD	
		KMG ATOZ SYSTEMS	NOIDA	

		UNILEC ENGINEERS PVT. LTD.	GURGAON	
		AVAIDS TECHNOVATORS LTD.	GURGAON	
		Adroit Control Engineers Pvt.Ltd.	FARIDABAD	
		JACKSON ENGINNEERS	NOIDA	
		MILESTONE SWITCHGEARS PVT. LTD.	GURGAON	
		Positronics Pvt. Ltd.	VADODARA	
		Pyrotech Electronics Pvt. Ltd.	Udaipur	

QUALITY PLAN

General points related to Quality Assurance:	
1	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc.
2	Equipments for which quality plan is not covered in the specification, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.
3	Purchaser / Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.
4	The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of specification and in full compliance with the requirements spelt out in applicable codes and standards
4.1	Material identification and testing of gear reducers, regulating valve assemblies, screen assemblies, fan blades and hubs, all supporting structural assemblies, fill supports, all nuts and bolts, sluice valves, fan shafts, fills packs, gear sets, nozzles and all other applicable components constituting each cooling tower.
4.2	Oil leakage and oil temperature rise, backlash, noise level & amperage at full load torque with reduced speed shall be checked for each gear reducer assembly.
4.3	Dynamic balancing of drive shaft assembly and all other rotating components.
4.4	Measurement of proof strength and contour for each fan blade.
4.5	Static balancing test, checking of fan blade moment weight and blade track variation of fan blades, with checking of pitching and blade tip variation at site.
4.6	Complete assembly of drive shaft, Fan hub and Fan blades shall be statically balanced at Site
4.7	Visual, dimensional checking of all components of each cooling tower.
4.8	Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.
4.9	Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.
5	Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.

COOLING TOWERS(IDCT)

SN	TESTS/CHECK / ITEMS / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	Ultrasonic test	DPT/MPI	Balancing	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Test as per relevant Std/ Approved Data Sheets	Other Tests
1	**GEAR BOX**						Y[1]	Y				Y[2]
1.1	Shaft and gear blanks	Y[a]		Y	Y[b]							
1.2	Gear Box Casing	Y[a]								Y		
2	**FAN ASSEMBLY**					Y	Y	Y				Y[3]
2.1	Fan hub	Y[a]	Y		Y[b]				Y[4]			Y[3]
2,2	Fan blades	Y[a]						Y				Y[3]
3A	**DRIVE SHAFT (SS) FOR FAN**	Y[a]	Y	Y	Y[b]	Y		Y				
3B	**CARBON FIBER DRIVE SHAFT**	SEE NOTE - 15										
4	**PVC FILL & DRIFT ELIMINATOR**	Y[5]					Y	Y			Y	Y[6]
5	**GATE/ GLOBE/ CHECK VALVES**	Y[a]			Y[b]		Y			Y	Y	Y[8]
6	**BUTTERFLY VALVES**				Y		Y	Y		Y	Y	Y[9]
6.1	Body (Cast) , Disc (Cast)	Y[a]			Y[b]			Y				
6.2	Body & Disc both fabricated	Y[a]	Y	Y	Y[b]			Y	Y[10]			
6.3	Shaft	Y[a]		Y[c]	Y[b]			Y				
7	**ROLLED & WELDED PIPES.**	Y[a]	**REFER NOTE – 11 FOR ALL CHECKS**									
8	**WRAPPING & COATING OF PIPES**	Y[12]						Y			Y	Y
9	**HOISTS & CHAIN PULLEY BLOCKS**	Y[a]	Y		Y		Y	Y			Y	Y[13]
10	**VENTILATION FANS**	Y[a]	Y	Y[c]	Y[b]	Y	Y	Y			Y	Y[14]
11	**FRP STRUCTURE**											
11.1	**Fibre Glass- Pultruded Structural Products**	See Note- 16 & 18										
11.2	**Fiber Glass- Reinforced Plastic Panels**	See Note 17 & 18										
11.3	**Fiber Glass- Reinforced Pipes**	The FRP pipes shall conform to CTI-154										

	Legend/ Notes:	
a.	One per Heat/Heat Treatment batch/Lot	
b.	On machined surfaces only of castings and forgings. Also 100% after root run/ back gauging for butt welds and 10% after final butt welds and fillet welds.	
c.	UT shall be done for shafts with Diameter 50 mm or above & Plates of Thickness 25 mm or above.	
1.	Blue Matching and Backlash of the gears shall be checked.	
2.	No load run test for 4 hours to check noise, vibration, oil leakage and temperature rise.	
3.	Proof load test, moment weight test on blades, blade track variation & tip clearances shall be checked. Galvanizing tests as per relevant IS.	
4.	10% RT on Butt welds of Fan Hub only (in case fabricated).	
5.	PVC material shall meet the requirements of CTI Bulletin STD-136. However impact test may be done as per ASTM-D-256 and Flammability test may be done as per ASTM-D-635 with extinguishing type PVC. Density & VICAT softening temperature tests shall also be conducted.	
6.	UV exposure shall be carried out on samples, at reputed third party laboratories as per ASTM -G26 method- C/standard specified in engineering portion of the specification for cooling tower. Impact test before and after UV exposure shall be conducted as per ASTM D-256.	
7.	--NA---.	
8.	Blue matching, Wear travel for Gate valves & reduced pressure test for Check valves shall be conducted as per relevant standards.	
9.	For POD of Butterfly Valves refer respective engineering section of the technical specification.	
10.	In case of fabricated construction of Butterfly Valves and companion flanges, UT on Plates of Thickness 20 mm or above for body and disc, and RT on 100% Butt welds shall also be carried out. Welders and WPS shall be qualified as per ASME section -IX. Stress reliving after complete welding shall be carried out as per ASME Section - IX	
11.	Tests	Quantum of Check
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% on pipes up to 1200 mm diameter
	DPT after back gauging	100% on pipes above 1200 mm diameter
	RT/ UT by TOFD Technique/PAUT	5% (covering 100% of `T'-joints)
	DPT on finished welds	10%
	Hydraulic Test	100%, Test pressure = 1.5 times the design pressure or 2 times the working pressure whichever is higher.
	Note:- After erection, the complete piping system shall be tested at 1.5 times, the design pressure or two times the maximum working pressure whichever greater. No leakage/seepage is acceptable. Butt weld joints which would not be hydro-tested shall be subjected to 100% RT test/ 100% UT by TOFD /PAUT Technique.	
12.	Spark test, adhesion test and material tests for primer & enamel and coal tar tapes as per AWWA-C-203.	

13.	Ropes shall meet relevant Code requirements. All motions & safety features shall be tested at Works. Full load & 25% overload test shall also be conducted at works. At site, Full load test shall be conducted with all motions and safety features.
14.	One Fan of each type & size will be performance tested as per corresponding Code, for Air Flow, Static pressure, Total pressure, Speed, Efficiency, Power Consumption, Noise, and Vibration & Temperature rise. Also, all fans shall be subjected to run test of 4 hours during which Noise, Vibration, Temperature rise & current drawn shall be measured.
15.	In case of Carbon Fiber Shaft, following checks are applicable a. Manufacturer Test Certificate for Carbon Fiber and Resin b. Dimensional Check, Run out Test and Dynamic Balancing Test on Finished Shaft c. Torsional Test on Drive Shaft Assembly along with flange as a type test to verify the factor of safety. d. Type test for bonding strength at joint between shaft & shaft flange. In case of proven design, test reports of the previous test conducted shall be reviewed. e. UV test for demonstrating the compliance with respect to requirement of UV ray stabilization. Acceptance criteria of the above tests shall be mutually discussed during pre-award discussions based on proven practices of the manufacturer or relevant standards as available
16.	The physical and mechanical properties of FRP pultruded sections as specified in CTI- Standard 137 shall be tested. Fire retardant property as specified shall be tested.
17.	The physical properties of FRP Panels as specified in CTI- Standard 131 shall be tested.
18.	The UV test on identified samples of FRP Pultruded Sections, FRP Panels and FRP Pipes shall be carried out.

LOW PRESSURE PIPING

PIPES, FITTINGS, BENDS, VALVES, COATING-WRAPPING, STRAINERS EXPANSION, JOINTS, TANKS, FASTENERS, LINING ETC.

	Tests/Check / Items / Components	Material Test	DPT/MPI / RT	Ultrasonic Test	WPS/ WQS/PQR	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Other Tests	All Tests as per relevant Std	REMARKS
1	Pipes & Pipe Fittings	Y[a]	Y[b]			Y1			Y			Y	
2	Diaphragm Valves	Y[a]				Y[5]			Y		Y[6]		
3A	Cast Butterfly Valves (Low Pressure)					Y		Y	Y	Y	Y[7]		
	Body	Y[a]	Y[b]										
	Disc	Y[a]	Y[b]										
	Shaft	Y[a]	Y	Y[c]									
3B	Fabricated Butterfly Valves	**REFER NOTE 14**											
4	Gate/ Globe/Swing Check / Ball Valves	Y[a]	Y[b]	Y[c]		Y[5]	Y	Y	Y	Y	Y[8]		
5	Dual Plate Check Valves	Y[a]	Y[b]	Y[c]		Y	Y	Y	Y	Y	Y[4]		
6	Rolled & Welded Pipes and Mitre Bends	Y[a]	Y[3]		Y	Y[3]			Y		Y[3&15]	Y	
7	Coating & Wrapping of Pipes	Y[2]									Y[2]		
8	Tanks & Vessels	Y[a]	Y[b]		Y	Y			Y		Y[16]		
9	Strainers	Y[a]	Y[b]		Y #	Y					Y[11]		#For Fabricated Strainer
10	Rubber Expansion Joints	Y[a]				Y[12]		Y	Y		Y[13]		
11	Internal Lining of Pipes	Y[a]							Y		Y[9]		
12	Site Welding		Y[10]		Y	Y							

NOTES (MEANING OF SUPERSCRIPTS)

a	One per heat/heat treatment batch/lot.
b	On machined surfaces only for castings and on butt welds.
c	For shaft/spindles > or = 40 mm
1	100% Hydraulic test shall be carried out. Weld joints not subjected to hydraulic test due to some unavoidable reasons, shall be subjected to 100% RT/PAUT.
2	Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91/ IS-10221 & IS 15337 as applicable.
3	Followings are the testing requirements for fabrication of pipes at site

TESTS	**QUANTUM OF CHECKS**
WPS, PQR, Welder Qualification Test	100% Welders and WPS shall be qualified as per ASME- section IX
DPT on root run	100% for pipes up to 1200 mm diameter
DPT after back gauging	100% for pipes above 1200 mm diameter
RT / UT by (TOFD/PAUT) Technique	5% (100% of T Joints)

LOW PRESSURE PIPING

	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher.
4	Dry Cycle Test on Dual Plate Check valve spring for one lakh Cycles shall be carried out as a type test. If Dry Cycle test carried out earlier for same material & diameter, Test report shall be reviewed.	
5	Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.	
6	Tests on rubber parts shall be conducted per batch of rubber mix for tensile, Elongation, hardness, adhesion, spark test, bleed resistance test. In addition, type test for 50,000 cycles of each type of diaphragm shall also be conducted.	
7	Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with governing design standard in presence of owner / owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. For Proof of Design Test refer respective chapters of engineering portion in the technical specification.	
8	Blue matching, wear travel for gates, valves, pneumatic seat leakage, and reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives. Valves shall be offered for hydro test in unpainted condition.	
9	Tensile, Elongation, Hardness, Specific Gravity, Lining Thickness, Humidity Check, Pipe temperature check, Adhesion Test and Holiday Detection Test etc as per applicable standard shall be done for all lining material and application.	
10	10% of welds (Root and finished welds) shall be subjected to DPT. (100% DPT for compressed air line and boiler & deaerator fill line.).	
11	Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives.	
12	During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.	
13	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149/IS 3400 Part 20 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.	
14	In addition of all tests as indicated for Cast Butterfly valve being applicable for fabricated butterfly valves, following test shall be done for Fabricated Butterfly Valve: a. UT as per ASTM A-435/IS 11630 & IS 4225 on plate material for body and disc shall be carried out for plate thickness 25mm and above. b. 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done. c. Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc. d. Welders and WPS shall be qualified as per ASME- section IX	
15	Maximum number of segments in segmental flanges shall be four (04) only. All butt weld joints in the segmental flanges shall be examined by RT/UT. Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding.	
16	For pressure vessel welds RT shall be done as per design code requirements.	

All Valves shall be offered for inspection in unpainted condition.

No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.

ANNEXURE-VII

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 50 KW (415V)	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
1	2	3	4	5	6		7	8	9	D	M	C	N	
					M	C/ N								
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:	KUNAL GANDHI	KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 50 KW (415V)	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:	Kunal Gandhi	KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

CLAUSE No.

QP FOR MOTORS ABOVE 50 KW

CHAPTER NAME

MOTOR

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-4722 /IS- 9283/IS 2148/IEC60034\IEC 60079-1/ IS-12615	Vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y			Y										
Magnetic Material	Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium	Y	Y	Y	Y			Y		Y										
Stator copper	Y	Y	Y	Y			Y		Y			Y							
SC Ring	Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material	Y		Y	Y			Y					Y							
Tubes, for Cooler	Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y										
Wound stator	Y	Y					Y	Y											
Wound Exciter	Y	Y					Y	Y											
Rotor complete	Y	Y					Y						Y	Y					
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												

Accessories, RTD, BTD, CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y												Y	Y	Y	Y1	Y

Note:

1. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, following methodology to be followed for Inspection Categorization:

Note for LT Motor:

i) Motor rating up to 50 KW: Inspection CAT- III : Acceptance of Motor up to 50 KW is based on COC of the Manufacturer and Main Contractor confirming as follows:
"It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot s
KVA/KW, temperature rise, distance between center of stud gland plate and tested in accordance with approved drawing /data sheets."

ii) Motor rating above 50 KW & less than 75 KW: Inspection CAT- II as per NTPC approved MQP: Acceptance of Motor rating above 50 KW & less than 75 KW is based on NTPC rev
report as per IS:12615 - 2018 (including latest revision) duly witnessed by main contractor along with COC of the Manufacturer and Main Contractor confirming as follows:
"It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot s
KVA/KW, temperature rise, distance between center of stud gland plate, space heater and tested in accordance with approved drawing /data sheets."

iii) Motor rating 75 KW & above: Inspection CAT-I: As per NTPC approved MQP.

2. Additional routine tests for Flame proof motors shall be applicable as per relevant standard
3. Makes of major bought out items for HT motors will be subject to NTPC approval.
4. Y1 = for HT Motor / Machines only.
5. For LT Motors, stator core stack length & grade, no load loss and winding resistance w.r.t. type tested motor for IE2/IE3 shall be checked/verified in addition to Compliance of relevant standard IS:12615/IEC requirement. In case actual results are not within the tolerance limit as declared by manufacturer during QP submission, the motor shall be subjected to efficiency test.

BHARAT HEAVY ELECTRICALS LTD.
PROJECT ENGINEERING MANAGEMENT
(QUALITY & BE)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from the contractual obligation.

APPROVAL CATEGORY AWARDED: CAT I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: Mintoo

Signature: Mintoo

Digitally signed by Mintoo
DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US
Date: 2023.06.15 15:29:56 +05'30'

QUALITY PLAN FOR ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIAL

NTPC DOC NO:

CUSTOMER

NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)

PROJECT:

REV	DATE	ALTD	CHD	APPD	APPD

JOB NO.	434				
STATUS	CONTRACT				
DISTRIBUTION					
TO					
NO.					

BHARAT HEAVY ELECTRICAL LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA	DEPT CODE		NAME	SIGN	DATE
	E	DSGN	DG		25-05-2023
		CHKD	PJ		25-05-2023
		APPD	HR		25-05-2023
TITLE: QUALITY PLAN FOR ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIAL	DOC. NO.	PE-V1-434-509-E903			
	SHEET	1 OF 7		REV. 0	

MANUFACTURING QUALITY PLAN			
CUSTOMER : NTPC LIMITED		QP: PE-V1-434-509-E903	25/05/2023
PROJECT:		**PO NO.:**	22/05/2023
ITEM: ABOVE GROUND EARTHING MATERIALS	**SYSTEM:** EARTHING	**SECTION: II**	**SHEET 1 OF 5**

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	**RAW MATERIAL:**													
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1. CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION OF TC'S	100%	-	IS 2062	IS 2062	MILL TC	✓	P	V	-	REFER REMARKS AT SL. NO. 3
		2. DIMENSIONS	MA	MEASUREMENT	100%	-	IS 1730	IS 1730	QC RECORD	✓	P		-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	IS 1079	IS 1079	QC RECORD	✓	P		-	
1.2	ZINC	1.CHEMICAL COMP.	MA	CHEM. TEST	SAMPLE	-	IS 209	IS 209	QC RECORD	✓	P	V	-	
2.0	**IN PROCESS:**													
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	-	APPROVED DATA SHEET / DRAWING	APPROVED DATA SHEET / DRAWING	QC RECORD	✓	P	V	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM DEFECTS/ SLAG	TEST/ INSPN. REPORT	✓	P	V	-	

SUPPLIER QUALITY ASSURANCE			BHEL PEM QUALITY & BE		
	Sign & Date	Name		Sign & Date	Name
Prepared by			Reviewed by	Mintoo	Digitally signed by Mintoo DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US Date: 2023.06.15 14:21:14 +05'30'
Approved by			Approved by	Harish Kumar	Digitally signed by Harish Kumar DN: cn=Harish Kumar, o=PEM, ou=BHEL, email=Harish_kumar@bhel.in, c=US Date: 2023.06.15 14:45:53 +05'30'

	MANUFACTURING QUALITY PLAN			
	CUSTOMER : NTPC LIMITED		QP: PE-V1-434-509-E903	25/05/2023
	PROJECT:		**PO NO.:**	22/05/2023
	ITEM: ABOVE GROUND EARTHING MATERIALS	**SYSTEM:** EARTHING	**SECTION: II**	**SHEET 2 OF 5**

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.2	SURFACE PREPARATION	1. CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	MEASUREMENT	CONTINUOUS	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	Galvanization is to be done at galvanization plant listed in annexure-1 to quality plan.
		2. DROSS	MA	VISUAL	PERIODIC	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		3.RATE OF IMMERSION	MA	VISUAL / MEASUREMENT	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN	QC RECORD	✓	P	-	-	
3.0	**FINISHED ITEMS:**													Note: sample for chemical test shall be

SUPPLIER QUALITY ASSURANCE			BHEL PEM QUALITY & BE		
	Sign & Date	Name		Sign & Date	Name
Prepared by			Reviewed by	Mintoo	Digitally signed by Mintoo DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US Date: 2023.06.15 14:22:04 +05'30'
Approved by			Approved by	Harish Kumar	Digitally signed by Harish Kumar DN: cn=Harish Kumar, o=PEM, ou=BHEL, email=Harish_kumar@bhel.in, c=US Date: 2023.06.15 16:41:16 +05'30'

	MANUFACTURING QUALITY PLAN		
	CUSTOMER : NTPC LIMITED	QP: PE-V1-434-509-E903	25/05/2023
	PROJECT:	**PO NO.**	22/05/2023
	ITEM: ABOVE GROUND EARTHING MATERIALS **SYSTEM:** EARTHING	**SECTION: II**	**SHEET 3 OF 5**

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	

														selected by BHEL& testing shall be done at NABL/ govt. approved Lab.
3.1	MS FLATS	1. CHEMICAL COMP.	MA	CHEM. TEST	1 No./LOT /SIZE	-	IS 2026	IS 2026	LAB TC	✓	P	V	-	Sampling plan for galvanization test: Inspection shall be as per table 2 of IS 4759 and same is mentioned below:-
		2. DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	APPROVED DATA SHEET / DRAWING	APPROVED DATA SHEET / DRAWING	INSPECTION REPORT	✓	P	W	-	
		3. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	-	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	✓	P	W	-	

No. of units in a Lot	No. of units to be selected in a sample	Acceptance No.
(1)	(2)	(3)
Upto 25	3	0
26-100	5	0
101-150	8	1
151-500	13	1
501-1000	20	2
1001-10000	32	3

SUPPLIER QUALITY ASSURANCE			BHEL PEM QUALITY & BE		
	Sign & Date	Name		Sign & Date	Name
Prepared by			Reviewed by	Mintoo Digitally signed by Mintoo DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US Date: 2023.06.15 14:22:24 +05'30'	
Approved by			Approved by	Harish Kumar Digitally signed by Harish Kumar DN: cn=Harish Kumar, o=PEM, ou=BHEL, email=Harish_kumar@bhel.in, c=US Date: 2023.06.15 14:46:24 +05'30'	

	MANUFACTURING QUALITY PLAN			
	CUSTOMER : NTPC LIMITED		QP: PE-V1-434-509-E903	25/05/2023
	PROJECT:		**PO NO.:**	22/05/2023
	ITEM: ABOVE GROUND EARTHING MATERIALS	**SYSTEM:** EARTHING	**SECTION: II**	**SHEET 4 OF 5**

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N				* D	** M	C	N	
1	2	3	4	5	6		7	8	9					

		4.MASS OF ZINC COATING	MA	CHEM. TEST	REFER REMARKS	REFER REMARKS	IS-6745 /APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	✓	P	W	-	10001 and above: 50: 5
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP. REPORT	✓	P	W	-	Note:- If the number of defective units in a lot exceeds the acceptance number as specified in col (3) of the table, the lot shall be rejected, else accepted.
		6. THICKNESS OF ZINC COATING	MA	MEASUREMENT	IS-4759	IS-4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	✓	P	W	-	
		7. ADHESION	MA	MECH. TEST	IS-4759	IS-4759	IS 2629	IS 2629	INSP. REPORT	✓	P	W	-	
	Note: Items like Pipes/ Flexible Copper Braid/ GI wire/ GS Rod/ Shielding Mast/ Test link will be cleared based on COC (certificate of Compliance)													
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD/ APP. DOCUMENT	AS PER MFG. STANDARD/ APP. DOCUMENT	INSPC. REPORT	✓	P	W	-	

NOTES:
1. BHEL reserves the right to perform repeat test, if required.

SUPPLIER QUALITY ASSURANCE			BHEL PEM QUALITY & BE		
	Sign & Date	Name		Sign & Date	Name
Prepared by			Reviewed by	Mintoo Digitally signed by Mintoo DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US Date: 2023.06.15 14:22:44 +05'30'	
Approved by			Approved by	Harish Kumar Digitally signed by Harish Kumar DN: cn=Harish Kumar, o=PEM, ou=BHEL, email=Harish_kumar@bhel.in, c=US Date: 2023.06.15 14:46:45 +05'30'	

	MANUFACTURING QUALITY PLAN			
	CUSTOMER : NTPC LIMITED		QP: PE-V1-434-509-E903	25/05/2023
	PROJECT:		**PO NO.:**	22/05/2023
	ITEM: ABOVE GROUND EARTHING MATERIALS	**SYSTEM:** EARTHING	**SECTION: II**	**SHEET 5 OF 5**

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	

2. Photographs of items duly placed inside the box just before the final packing and Photographs of the box just before dispatch to be sent to BHEL purchase group for review before issuing MDCC.
3. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/Customer.
4. Material shall be packed suitably in order to avoid damage during transit and also during storage in tropical climate conditions. Packing shall be suitable for storage at site in tropical climate conditions.
5. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:
*RECORDS, IDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **C**: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **N**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

SUPPLIER QUALITY ASSURANCE		BHEL PEM QUALITY & BE		
			Sign & Date	Name
Prepared by		Reviewed by	Mintoo	Digitally signed by Mintoo DN: cn=Mintoo, o=BHEL, ou=PEM,Noida, email=mintookumar@bhel.in, c=US Date: 2023.06.15 14:23:11 +05'30'
Approved by		Approved by	Harish Kumar	Digitally signed by Harish Kumar DN: cn=Harish Kumar, o=PEM, ou=BHEL, email=Harish_kumar@bhel.in, c=US Date: 2023.06.15 14:47:09 +05'30'

एनटीपीसी NTPC	ITEM: (MATERIAL, CLASS, GRADE, RATING, SIZE ETC.) GALVANISED FLEXIBLE CABLE TRAYS SUPPORT SYSTEM	STANDARD QUALITY PLAN CONFORMING TO CODE: Design as per NTPC Specification	QP NO. 0000-999-QOE-S-38 REV.:00 DATE : 01.09.04 PAGE 1 OF 2 VALID UPTO:31.08.07	REVIEWED BY S.D.SINGH O.P.NIRANJAN I.J.SINGH	APPROVED BY ANIL GUPTA

SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7	8	9	D*	**	10		11
	Flexible cable trays Support Structure	1. In Black Condition a) Weld Quality	Major	Visual	100%	Random	Manufacturer's Plant Std	Manufacturer's Plant Std	Inspection Report		P	V	V	o
		b) Burs	Major	Visual	Rando m	-	No Burs	No Burs	-do-		P		-	
2.	Finished Galvanized	2. After Galvanising												
		2.1 General physical inspection including Galvanizing Quality/Defects, Dicromating, White Rusting etc.	Major	Visual	100%	5 Sample/L ot	IS-2629-1985 IS-4759-1996	IS-2629-1985 IS-4759-1996	-do-		P	W	W	
		2.2 Dimensional Check & Thickness Check	Major	Measurem ent	-do-	-do-	NTPC/Main Supplier Approved Drg.	NTPC/Main Supplier Approved Drg.	-do-		P	W	W	
		2.3 Galvanizing Tests												
		a) Coating thickness measurement survey by Elcometer	Critical	Measurem ent	IS-4759-1996	-do-	IS-4759-1996 IS-3203-1982	IS-4759-1996 IS-3203-1982	-do-		P	W	W	
		b) Mass of zinc coating	Critical	Measurem ent	-do-	1 coupon sample of each thickness	IS-6745-1972 IS-4759-1996	IS-6745-1972 IS-4759-1996	-do-		P	W	W	
		c) Uniformity of zinc coating/dip test	Critical	Measurem ent	-do-	-do-	IS-2633-1986 IS-4759-1996	IS-2633-1986 IS-4759-1996	-do-		P	W	W	
		d) Adhesion Test	Critical	Visual	-do-	-do-	IS-2629-1985	IS-2629-1985	-do-		P	W	W	

LEGEND: RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY THE CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-SUPPLIER, C: **Main Supplier: NTPC, N: NTPC. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE

"CHP" BY NTPC SHALL BE IDENTIFIED IN COLUMN "N" AS "W"

एनटीपीसी NTPC	ITEM: (MATERIAL, CLASS, GRADE, RATING, SIZE ETC.)	STANDARD QUALITY PLAN CONFORMING TO CODE: Design as per NTPC Specification	QP NO. 0000-999-QOE-S-38 REV.:00 DATE : 01.09.04 PAGE 2 OF 2 VALID UPTO: 31.08.07	REVIEWED BY S.D.SINGH O.P.NIRANJAN I.J.SINGH	APPROVED BY ANIL GUPTA QUALITY ASSURANCE APPROVED NTPC, New Delhi

SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY		
					M	C/N					M	C	N
1.	2.	3.	4.	5.	6.		7	8	9	D*	**	10	
		Proof Load Test as per note 6 Followed by Die Penetration Test (For 600 mm and above cable tray support system)	A	Meas/Visual	One Sample from each offered lot	One Sample from each offered lot	NTPC Technical Specification/ No visible cracks should develop on the weld part	NTPC Technical Specification/ No visible cracks should develop on the weld part	Inspection Report		P	W	W

Note :

1. The supplier to ensure procurement of steel from main producers like SAIL/TISCO, Rastriya Ispat/Ispat Ind. Jindal/Esser/Lloyds/IIS Co. and Zinc from Hindustan Zinc Ltd.
2. Welding shall be done by qualified welders as per supplier system.
3. Material shall be galvanized at NTPC approved sources only.
4. Pre-treatment of cable trays support system shall be carried out in seven tank process as per IS-2629. All the process parameters e.g. Concentration, temperature, density etc. to be maintained and recorded by the galvaniser.
5. The process of pre-treatment shall be verified by NTPC on surveillance basis during inspection of Galvanised Flexible Cable Trays support system.
6. (i) Test on Main support Channel shall be done if only CI channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test as per tech. Spec.

   (ii) Test on Main Support Channel shall be done with C2 Channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2 A of type tests. Then test at (i) above shall not be repeated.

   (iii) Nut slip characteristic test (It shall support minimum load of 350 Kg. Before Nut Slips with bolt torque of 65 NM). This test shall be same as test 5 B of type tests.

   (iv) The procedure for carrying out above test shall be as per details given in Type Tests Specification.

LEGEND: RECORDS IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY THE CONTRACTOR IN QA DOCUMENTATION
M: MANUFACTURER/SUB-SUPPLIER, C: **Main Supplier, N: NTPC. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE
"CHP" BY NTPC SHALL BE IDENTIFIED IN COLUMN "N" AS "W"

ANNEXURE-B

3X800 MW NTPC PARTRATU STPP

QUALITY PLAN FOR CABLE TRAY SUPPORT SYSTEM-BOLTABLE

NOTES:

1. BHEL reserves the right for conducting repeat test, if required.
2. The latest revisions/year of issue of all the Standards indicated in the QP shall be referred at the time of inspection.

	ITEM:(MATERIAL,CLASS,GRADE,RATING, SIZE ETC.) GALVANIZED CABLE TRAYS (Perforated & Ladder type) & ACCESSORIES	STANDARD QUALITY PLAN CONFORMING TO CODE :	QP NO. 0000-999-QOE-S-021 REV.: 1 DATE: 06.02.04 PAGE : 1 OF 1 VALID UPTO :05.02.07	REVIEWED BY A.K. Sharma Rana Vohra O.P. Niranjan	APPROVED BY ANIL GUPTA

SL. NO.	COMPONENT & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N				D*	M	C	N	
1	2	3	4	5	6		7	8	9		**	10		11
	FINISHED CABLE TRAYS & ACCESSORIES	1 **In Black Condition**												A)The cable trays shall be galvanised at NTPC approved sources only.
		a) Weld Quality	Major	Visual	100%	Random	Manufacturer's Plant Std	Manufacturer's Plant Std	Inspection report		P		-	
		b) Burs	Major	Visual	Random		-	No Burs	-do-		P		-	B) The supplier to ensure procurement of steel from main producers like SAIL/TISCO,Rastriya Ispat/Ispat Ind. Jindal/Esser/Lloyds/IIS Co. and Zinc from Hindustan Zinc Ltd.
		2 **After Galvanising**												
		2.1 General Physical inspection including Galvanising Quality/ Defects, Dicromating, White rusting etc.	Major	Visual	IS-4759 -1996	5 sample/lot	IS-2629-1985 IS-4759-1996	IS-2629-1985 IS-4759-1996	-do-		P	W	W	C)Welding shall be done by qualified welders as per supplier system.
		2.2 Dimensional check & Sheet Thickness	Major	Measur ement	-do-	-do-	NTPC/Main Supplier Approved Drawing	NTPC/Main Supplier Approved Drawing	-do-		P	W	W	D)Pre-tretment of fabricated cable trays shall be carried out in seven tank process as per IS 2629.All the process parameters e.g. Concentration, temperature, density etc. to be maintained and recorded by the Galvanizer
		2.3 Galvanising tests												
		a) Coating thickness measurement survey by Elcometer	Critical	Measure ment	-do-	-do-	IS-4759-1996 IS-3203-1982	IS-4759-1996 Table-I	-do-		P	W	W	
		b) Mass of zinc coating	Critical	Measur ment	-do-	1 coupon sample of each thickness	IS-6745-1972 IS-2633-1986	IS-4759-1996 Table - I	-do-		P	W	W	E)The process of pretreatment shall be varified by NTPC on surveillance basis during Inspection of cable trays
		c) Uniformity of zinc coating/dip test	Critical	Measur ment	-do-	-do- -do-	IS-2629-1985 IS-2633-1986 IS-4759-1996	IS-4759-1996 cl. 9.3	-do-		P	W	W	
		d) Adhesion test	Critical	Visual	-do-	-do-	IS-2629-1985	IS-2629-1985	-do-		P	W	W	*F* One piece each of 2.5 meter length size of cable tray of 300 mm & above shall be taken as sample from each offered lot for inspection. It shall be supported at both ends & loaded with uniformly distributed load of 76kg/ meter along the length of cable tray. The maximum deflection at mid span of each sample shall not exceed 7mm.
		2.4 Deflection Test	Critical	Measu rement	1 sample from each size type/ lot	1 sample from each size type/ lot	*F*	*F*	-do-		P	W	W	

LEGEND: RECORDS IDENTIFIED IDENTIFIED WITH "TICK" SHALL BE ESSENTIALLY INCLUDED BY THE CONTRACTOR IN QA DOCUMENTATION
** M: MANUFACTURER/SUB-SUPPLIER, C:CONTRACTOR/NOMINATED INSPECTION AGENCY. N: NTPC. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE
"CHP" BY NTPC SHALL BE IDENTIFIED IN COLUMN "N" AS "W".

ANNEXURE-B
3X800 MW NTPC PATRATU STPP
QUALITY PLAN FOR CABLE TRAY & ACCESSORIES

NOTES:

1. BHEL reserves the right for conducting repeat test, if required.
2. Latest revisions/year of issue of all the Standards indicated in the QP shall be referred at the time of inspection.

Suman Nakwal

Digitally signed by Suman Nakwal
DN: cn=Suman Nakwal, o=BHEL, ou=Q&BE, email=sumannakwal@bhel.in, c=IN
Date: 2021.11.24 17:33:43 +05'30'

MQP FOR LUMINARIES

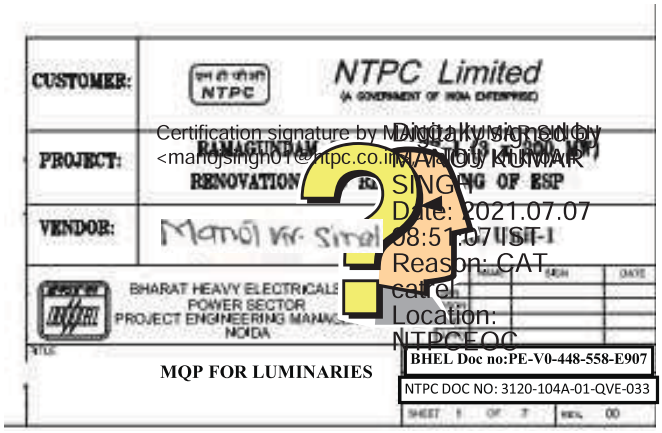
BHARAT HEAVY ELECTRICALS LTD
PROJECTS ENGINEERING MANAGEMENT
(ELECTRICAL)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractul obligations.

APPROVAL CATEGORY AWARDED

CAT I	=	Approved
CAT II	=	Approved with comments as noted
CAT III	=	Not Approved
CAT IV	=	Reference Drawing

Name: MANOJ KUMAR MEENA
Signature: Manoj
Date: 18.08.2021



NTPC	ITEM : LIGHTING FIXTURES (Conventional and LED type)	STANDARD QUALITY PLAN	QP.NO:0000-999-QOES-062	REVIEWED BY	APPROVED BY
		CONFORMING TO CODE : As applicable	Rev No.: 00	SWAPNESWAR MISHRA	
			Date: 02/11/15	VIKRAM TALWAR	
			VALID UPTO: 01/11/17	SUNIL MALAN	

Sl No	COMPONENT & OPERATIONS		CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD					REMARKS
						6 M	6C/N					M	C	N	
1	2		3	4	5			7	8	9	D*	10			11
	Note: 1): Lighting fixtures supplier to ensure that constructional features of the lighting fixture (conventional & LED type) are as per NTPC specification requirements 2): Lighting fixture supplier to maintain all quality control records identified in this QP whether it is identified for NTPC verification or witness or not.														
	Conventional type Lighting Fixture														
A	Bought out items /in-process checks														
1	Lamps		Make, rating & type	Major	Visual	1 sample per type	1 sample per type	NTPC specification requirements for rating & type, Make to be BIS approved with CML number	NTPC specification requirements for rating & type, Make to be BIS approved with CML number			V	-	-	
1.1	Electronic Ballast (if applicable)	a	Certificate of compliance	Major	Visual	-	-	NTPC specification requirements	Certificate of compliance by ballast manufacturer / lighting fixture supplier that ballst meets all NTPC specification requirements	Certificate of compliance		V	-	-	
		b	THD and pf check	Major	Electrical	Mnfr std.	-	NTPC specification requirements	THD < =10% , pf >= 0.9 for FH type and pf >= 0.95 for other type of florescent lighting fixtures	Inspection report		P/ V *	-	-	P/V * - means test will be performed either by lighting fi supplier or their sub-vendor as Verified by lighting fixture sup
1.2	Castings		Freedom from defects	Major	Visual	Mnfr std.	-	NTPC specification requirements	Castings shall be free from any defects such as blow holes, surface blisters, cracks and cavities etc.	Inspection report		P/ V *	-	-	P/V * - means test will be performed either by lighting fi supplier or their sub-vendor as Verified by lighting fixture sup
1.3	Sheet metal forming and fibrication		Freedom from defects	Major	Visual	Mnfr std.	-	NTPC specification requirements	sheet metal fabrication / forming etc should be as per manufacturer drgs	Inspection report		P/ V *	-	-	P/V * - means test will be performed either by lighting fi supplier or their sub-vendor as Verified by lighting fixture sup
1.4	Pre-treatment and powder coating		Pre-treatment process checks, Powder coating finish, thickness, uniformity of coating and adhesion	major	Visual, chemical & mech	Mnfr std.	-	Mnfr standard , NTPC specification requirements	Nominal coating thickness 50 microns or more	Inspection report		P/ V *	-	-	P/V * - means test will be performed either by lighting fi supplier or their sub-vendor as Verified by lighting fixture sup

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/ SUB-SUPPLIER: C: MAIN SUPPLIER, N: NT
P: PERFORM W: WITNESS AND V: VERIFICATION. CHP: CUSTOMER HOLD POINT BY NTPC SHALL BE IDENTIFIED UNDER AGENCY COLUMN "N" AS 'W'.

N/A

PYROTECH ELECTRONICS UDAIPUR

19.6.21

एनटीपीसी NTPC	ITEM : LIGHTING FIXTURES (Conventional and LED type)			STANDARD QUALITY PLAN				QP.SO.8000-999-QOC-S-062	REVIEWED BY					APPROVED BY
				CONFORMING TO CODE : As applicable				Rev No.: 00	SWAPNESWAR MISHRA					
								Date: 02/11/15	VIKRAM TALWAR					
								VALID UPTO: 01/11/18	SUNIL MALAV					
Sl No	COMPONENT & OPERATIONS		CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD					REMARKS
						6 M	6 C/N					M	C	N	
1	2		3	4	5			7	8	9	10*	**			11
3	Acceptance Tests on conventional Lighting fixture	a	Details of lot offered and Certificate of compliance that lighting fixture supplier has inspected the offered lot as per their own standard.	Major	Visual	-	-	lighting fixture supplier to submit the details of lot offered for NTPC inspection (Type of lighting fixtures, their batch number, sub-vendor name, quantity)	COC	List		P	V	V	The list may be used by NTPC for sample selection
		b	Lamp make	Major	Visual	100%	100%	Make to be BIS approved with CML number	Make to be BIS approved with CML number	Certificate of compliance		V	V	V	
		c	Constructional features including: Internal wiring, terminal block, earthing terminal, safety chain(if applicable)	Major	Visual	1 sample per type	1 sample per type	NTPC specification and NTPC approved data sheet/drg	NTPC specification and approved data sheet/drg.	Inspection report		P	W	W	
		d	Electronic Ballast (if applicable for offered lighting fixtures) THD and pf check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	THD <=10% , pf >= 0.9 for FH type and pf >= 0.95 for other type of florescent lighting fixtures	Inspection report		P	W	W	At lighting fixture supplier test lab
		e	Resistance to moisture test in case of lighting fixtures having IP X4 and above rating	Major	Mechanical	1 sample per type	1 sample per type	NTPC approved data Sheet	IS 10322 Part 1	Inspection report		P	W	W	
		f	Resistance to dust (applicable if IP5X and above)	Major	eptical	Mnfr std.	Mnfr std	NTPC approved Data sheet and accepted type test reports	Certificate of compliance	Certificate of compliance		P/V *	V	V	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
		f	Photometry check	Major	eptical	Mnfr std.	Mnfr std	NTPC accepted type test reports	Certificate of compliance for the batch that offered lighting fixture LOR is not be less than 90% (refer IS 16107) with reference to type test reports	Certificate of compliance		P/V *	V	V	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
		g	Dimensions	Major	Visual	1 sample per type	1 sample per type	NTPC specification and approved data sheet/drg.	NTPC specification and approved data sheet/drg.	Inspection report		P	W	W	
		h	HV & IR test	Major	Visual	#	#	IS 10322 part 1	IS 10322 part 1	Inspection report		P	W	W	# As per Table 1 (inspection Level S2) and Table 2C AQL 2.5 of IS 2500

N/A

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PYROTECH ELECTRONICS UDAIPUR

10.6.21

	ITEM : LIGHTING FIXTURES (Conventional and LED type)		STANDARD QUALITY PLAN				QP.NO:0000-999-QOE-1-042	REVIEWED BY					APPROVED BY	
			CONFORMING TO CODE : As applicable				Rev No.: 03	SWAPNESWAR MISHRA						
							Date: 02/10/15	VIKRAM TALWAR						
							VALID UPTO:31/12/18	SUNIL WALANJ						
SI.	COMPONENT & OPERATIONS	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD					REMARKS
					6.M	6.CN				M	C	N		
	2	3	4	5			7	8	9	D*	**			11
	LED type Lighting fixture													
	Boughtout items / in-process checks													
	LED Chip	LED chip efficacy	Major	Visual	Mnfr Std.	Mnfr Std.	NTPC Spec/ Appd. Data sheet/ LM 80 report	NTPC Spec/ Appd Data sheet	LM 80 report		V	V	V	At the time of final inspection
		LED chip CRI and CCT	Major	Visual	Mnfr Std.	Mnfr Std.	NTPC Spec/ Appd. Data sheet/ LM 80 report	NTPC Spec/ Appd Data sheet	LM 80 report		V	V	V	At the time of final inspection
		Reported TM21 (L80) lifetime of LED chip	Major	Visual	Mnfr Std.	Mnfr Std.	NTPC Spec/ Appd. Data sheet/ LM 80 report	NTPC Spec/ Appd Data sheet	LM 80 report		V	V	V	At the time of final inspection
.1	LED Driver	a Compatibility with LED module/chip controls & protection features as per NTPC spec	Major	Visual	-	-	NTPC spec requirements	Certificate of compliance by LED driver manufacturer / lighting fixture supplier that driver meets all NTPC specification requirements	Certificate of compliance		V	V	V	
		b THD and pf check	Major	Electrical	Mnfr std.	-	NTPC specification	THD < 10% and pf >= 0.9	Inspection report		P/V *	-	-	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
	Castings	Freedom from defects	Major	Visual	Mnfr std.		NTPC specification requirements	Castings shall be free from any defects such as blow holes, surface blisters, cracks and cavities etc.	Inspection report		P/V *	-	-	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
	Sheet metal forming and fabrication	Freedom from defects	Major	Visual	Mnfr std.	-	NTPC specification requirements	sheet metal fabriaction / forming etc should be as per manufacturer standards and good engg practices	Inspection report		P/V *	-	-	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
	Pre-treatment and powder coating	Pre-treatment process checks, Powder coating finish, thickness, uniformity of coating and adhesion	major	Visual, chemical & mech	Mnfr std	-	Mnfr standard , NTPC specification requirements	Nominal coating thickness 50 microns or more	Inspection report		P/V *	-	-	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier

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PYROTECH ELECTRONICS UDAIPUR 19.6.21

एनटीपीसी NTPC			ITEM: LIGHTING FIXTURES (Conventional and LED type)		STANDARD QUALITY PLAN				QP.NO.000-999-QOE-S-002 Rev No: 00 Date: 00/1/15 VALID UPTO: 01/1/18	REVIEWED BY SWAPNESWAR MISHRA VIKRAM TALWAR SUNIL MALANI					APPROVED BY
					CONFORMING TO CODE : As applicable										
Sl No	COMPONENT & OPERATIONS		CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD					REMARKS
						B.M.	s/Cly.					M	C	N	
1	2		3	4	5			7	8	9	10*	**	10		11
B	Acceptance Tests on LED Lighting fixture	a	Details of lot offered and Certificate of compliance that lighting fixture supplier has inspected the offered lot as per their own standard	Major	Visual	-	-	lighting fixture supplier to submit the details of lot offered for NTPC inspection (Type of lighting fixtures, their batch number, sub-vendor name, quantity)	-	List		P	V	V	The list may be used by NTPC for sample selection
		b	LED chip make	Major	Visual	-	-	NTPC accepted type test reports (LM80/LM79) report	Certificate of compliance	Certificate of compliance		V	V	V	
		c	Constructional features including: Internal wiring, terminal block, earthing terminal, safety chain (if applicable)	Major	Visual	1 sample per type	1 sample per type	NTPC specification and NTPC approved data sheet/drg.	NTPC specification and approved data sheet/drg.	Inspection report		P	W	W	
		e	Resistance to moisture test in case of lighting fixtures having IP X4 and above rating	Major	Mechanical	1 sample per type	1 sample per type	NTPC approved data Sheet	IS 10322 Part I	Inspection report		P	W	W	
		f	Resistance to dust (applicable if IP5X and above)	Major	optical	Mnfr std.	Mnfr std	NTPC accepted type test reports	Certificate of compliance	Certificate of compliance		P/V *	V	V	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier
		f	Photometry check	Major	optical	Mnfr std.	Mnfr std	NTPC accepted type test reports, LM 79, IS 16106, IS 16107	Certificate of compliance for the batch that offered lighting fixture LOR and lighting fixture efficacy is not be less than 90% (refer IS 16107) with reference to type test reports	Certificate of compliance		P/V *	V	V	P/V * - means test will be performed either by lighting fixture supplier or their sub-vendor and Verified by lighting fixture supplier

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PYROTECH ELECTRONICS LTD. UDAIPUR

19.6.21

एनटीपीसी NTPC	ITEM : LIGHTING FIXTURES (Conventional and LED type)	STANDARD QUALITY PLAN	QP.NO:000/999-QOE-S-062	REVIEWED BY	APPROVED BY
		CONFORMING TO CODE : As applicable	Rev No.: 00	SWAPNESWAR MISHRA	
			Date: 05/13/15	VIKRAM TALWAR	
			VALID UPTO: 01/11/18	SUNIL MALANI	

Sl No	COMPONENT & OPERATIONS		CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD					REMARKS
						6.M	6.C/N					M	C	N	
1	2		3	4	5			7	8	9	D*	**	10		11
		g	Dimensions	Major	Visual	1 sample per type	1 sample per type	NTPC specification and approved data sheet/drg.	NTPC specification and approved data sheet/drg.	Inspection report		P	W	W	
		i	LED driver: THD and pf check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	THD < 10% and pf >= 0.9	Inspection report		P	W	W	At lighting fixture supplier test lab
		j	LED driver: Precision current control check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	NTPC specification and NTPC approved data sheet	Inspection report		P	W	W	
		k	LED driver: Open circuit protection simulation check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	NTPC specification and NTPC approved data sheet	Inspection report		P	W	W	
		l	LED driver: Short circuit protection simulation check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	NTPC specification and NTPC approved data sheet	Inspection report		P	W	W	
		m	LED driver: Over temperature protection simulation check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	NTPC specification and NTPC approved data sheet	Inspection report		P	W	W	
		n	LED driver: Overload protection simulation check	Major	Electrical	1 sample per type	1 sample per type	NTPC specification	NTPC specification and NTPC approved data sheet	Inspection report		P	W	W	
		o	LED driver: Surge protection compliance check	Major	Electrical	-	-	NTPC specification	Certificate of compliance that surge protection is provided	Certificate of compliance		V	V	V	

[redacted]

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Format No.: QS-01-QAI-P-10/F3-R0 Engg. Div./QA&I

PYROTECH ELECTRONICS PVT. LTD. UDAIPUR

19.6.14

NTPC APPROVED GALVANIZERS

1. M/s M J Engg,Delhi
2. M/s A.V. Engg, Kolkata
3. M/s Inar Profiles, Vishakapatnam
4. M/s Anand Udyog, Mumbai
5. M/s Techno Engg,Chandigarh
6. M/S Steelite Engg, Mumbai
7. M/s National Galvanizer, Kolkata
8. M/s Unistar Galvanizer, Kolkata
9. M/s B.P. Project. Kolkata
10. M/s Bajaj Pune
11. M/s Electrocare Industries, Mumbai
12. M/s B.G. Shirke, Pune
13. M/s Gurpreet Galvanizer, Hyderabad
14. M/s Sigma, Mumbai
15. M/s Radhakrishnan Shetty, Chennai
16. Karamtara Mumbai
17. Poona Galvanizers Pune
18. Neha Galvanizer-Kolkata
19. Unitech Fabricators & Galvanizers- Hoogly

STATION LIGHTING

Item Components / Sub System / Assembly — Attributes / Characteristics	Make, Type, Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanization Tests	IP Test	Bought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature as per NTPC spec.	Routine Test as per relevant std and spec	Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1 (non –LED type)	Y					Y		Y			Y	Y	Y
Electronic Ballast	Y										Y	Y	Y
Lighting Wire (IS-694)	Y										Y		
Fans (IS-374)	Y										Y		
Pole (IS-2713)	Y			Y						Y	Y	Y	
Lamps (IS-9800, IS-9974)	Y										Y	Y	
Lighting Mast (with raise & lower lantern type)	Y	Y			Y					Y	Y	Y	
Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station / Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y									Y		
Cable Lug (IS-8309)	Y	Y									Y		
Flexible Conduit	Y										Y		
Lighting Transformer (IS-11171)	Y									Y	Y		
Epoxy & Galvanized Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y

LED Luminaire quality requirements:

1) **LED modules to conform to IS: 16103 part 2. Manufacturer to issue a certificate of compliance for the same.**
2) **Control gear to conform to IS 15885-part 2 section 13. Manufacturer to issue a certificate of compliance for the same.**
3) **LED luminaire to conform to IS 16107-part 2 section 1. Manufacturer to issue a certificate of compliance for the same.**
4) **LED luminaire marking to be as per IS 16107-part 2 section 1. Manufacturer to issue a certificate of compliance for the same.**
5) **Acceptance tests as per IS 16107-part 2 section 1 to be carried out on LED luminaire except long duration tests i.e. a) Chromaticity coordinates & correlated color temperature (CCT); b) Color rendering index (CRI). Manufacturer will submit a COC for above tests i.e. CCT & CRI**
6) **LED driver make, model, type & rating may be as per recommendations of LED module manufacturer**.

Notes:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to NTPC approval.

Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

MEASURING INSTRUMENTS

Item Components / Sub System Assembly	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (As applicable)(R)	Hydro Test(R)	Material Test certificate (R)
Pressure Gauge (IS-3624)	Y	Y	Y	Y	Y				
Temperature Gauge (BS-5235)	Y	Y	Y	Y	Y				
Temperature Switch	Y	Y	Y	Y	Y	Y			
RTD(IS-2848)	Y	Y	Y	Y	Y	Y			
Thermowell	Y	Y					Y	Y	Y
Electronic Transmitter(IEC-60770)	Y	Y	Y	Y	Y	Y			

R-Routine Test A- Acceptance Test Y – Test applicable

PROCESS CONNECTION AND PIPING

Tests / Items	Visual & Dimensions ®	GA, BOM, Layout of component & construction feature, Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Junction Box	Y	Y*		Y		Y	Y							
Impulse pipes and tubes	Y		Y			Y						Y		
Socket weld fittings ANSI B-16.11	Y					Y						Y		Y
Compression fittings	Y					Y					Y	Y	Y	
Instrument valves & Valve manifolds	Y					Y					Y	Y		
*-applicable for painted junction boxes.														

®-Routine Test A-Acceptance Test Y – Test applicable

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

Tests / Items	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Local/ Remote (Open-Stop-Close) Operation®	Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR with Integral Starter , Non-Intrusive Electrical Actuator (EN15714-2)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

®-Routine Test A-Acceptance Test Y – Test applicable

Note- SIL 2 certificate if applicable

PAINTING REQUIREMENT

Sl no	Condition	Surface Preparation	Primer Coat	No. of Coats	DFT (in Microns)	Intermediate Coat	No. of Coats	DFT (in Microns)	Final Coat	No. of Coats	DFT (in Microns)	Total DFT
EXTERNAL SURFACE - OVER GROUND PIPING												
1	Clarified Water	SHOT BLASTING/ ABRASIVE BLASTING OR POWER TOOL CLEANING.	ZINC CHROME PRIMER (ALKYD BASE) BY BRUSH/ SPRAY TO IS 104. OR RED OXIDE ZINC PHOSPHATE PRIMER (ALKYD BASE) TO IS	2	25	SYNTHETIC ENAMEL (LONG OIL ALKYD) TO IS 2932.	1	30	SYNTHETIC ENAMEL (LONG OIL ALKYD) TO IS 2932	2	35	150
INTERNAL SURFACE (FOR PIPE 1000 NB AND ABOVE)												
2	Clarified Water	SHOT BLASTING/ ABRASIVE BLASTING OR POWER TOOL CLEANING.	EPOXY BASED ZINC RICH PRIMER	1	50	-	-	-	COAL TAR EPOXY	2	75	200
BURRIED CW PIPING (CONCRETE ENCASED)												
3	CW PIPE IN BIDDER'S SCOPE SHALL BE CONCRETE ENCASED STEEL LINED DUCTS. CONCRETE ENCASEMENT SHALL BE OF MIN 500 MM THICK WITH SQUARE SHAPE OUTSIDE. M20 GRADE PCC ENCASEMENT SHALL BE PROVIDED OTHER THAN LOCATIONS OF DUCT CROSSING ROAD, RAIL OR ANY OTHER FACILITY WHERE RCC ENCASEMENT OF GRADE M25 SHALL BE ADOPTED. TOP OF CW DUCT ENCASEMENT SHALL BE MIN. 1.5 M BELOW FGL.										
STRUCTURAL STEEL												
4	Clarified Water	Shot blasting/ Abrasive blasting or Power tool cleaning.	Sealed Zinc spray as per BS 5493.	1	250	zinc Phosphate Epoxy	1	30	coal tar Epoxy paint	3	75	505
CIVIL STRUCTURES												
5	REFER CIVIL SPECIFICATION (BOOK 2 OF 2)											

	TECHNICAL SPECIFICATION INDUCED DRAFT COOLING TOWER 1 X 800 MW NTPC SIPAT STPP Stage-III	PE-TS-520-165-W001 Rev. No. 00 Date : 05/11/2024

DOCUMENTATION REQUIREMENT

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY ALL THE BIDDERS ALONG WITH THE BID

Sl. No.	DOCUMENT TITLE
1	PQR CREDENTIALS
2	COMPLIANCE SHEET (DULY SIGNED AND STAMPED)
7	PERFORMANCE GUARANTEE SCHEDULE (DULY SIGNED AND STAMPED)
3	GENERAL ARRANGEMENT DRAWING FOR COOLING TOWER, INCORPORATING ALL RELEVANT DIMENSIONS, COLD WATER CHANNELS / SLUDGE CHAMBER/ SCREENS/ GATES IN THE COLD WATER CHANNEL, STAIRCASE ETC.
4	PUMPING HEAD CALCULATIONS
5	THERMAL DESIGN CALCULATIONS
6	TOWER PERFORMANCE CURVES
8	TECHNICAL DEVIATION SCHEDULE (IF ANY)
9	UNPRICED COPY OF THE PRICE SCHEDULE (INDICATING “QUOTED” FOR THE LISTED ITEMS).

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY SUCCESSFUL BIDDER AFTER AWARD OF CONTRACT ALONG WITH SUBMISSION SCHEDULE

Sl. No.	DOCUMENT TITLE	SUBMISSION SCHEDULE
A	**BASIC DRAWINGS / DOCUMENTS**	
1	GENERAL ARRANGEMENT OF INDUCED DRAUGHT COOLING TOWER	6 WEEKS FROM LOI
2	GA OF C.W. BASIN OF COOLING TOWER	6 WEEKS FROM LOI
3	THERMAL DESIGN & FRICTION LOSS CALCULATIONS AND CHARACTERISTIC & PERFORMANCE CURVES FOR IDCT	6 WEEKS FROM LOI
4	CIVIL DESIGN BASIS OF IDCT	8 WEEKS FROM LOI
5	LAYOUT AND DETAILS OF FOUNDATION	15 WEEKS FROM LOI
6	GA OF FOUNDATION, POND WALL AND PEDESTAL	15 WEEKS FROM LOI
7	METHODOLOGY STATEMENT FOR PILING WORKS	12 WEEKS FROM LOI
8	STRUCTURAL DESIGN OF 760 MM DIA. BORED CAST IN-SITU TEST PILES FOR COOLING TOWERS PACKAGE	12 WEEKS FROM LOI
9	LOCATION OF BORED CAST IN SITU TEST PILES FOR COOLING TOWERS	12 WEEKS FROM LOI
10	NUMERATION AND RC DETAILS OF TEST PILE	12 WEEKS FROM LOI
11	DESIGN CALCULATION OF SUB STRUCTURE FOR CT	16 WEEKS FROM LOI
12	DESIGN CALCULATION FOR SUPER STRUCTURE OF CT	16 WEEKS FROM LOI
13	ANALYSIS & DESIGN OF POND WALL, POND FLOOR	15 WEEKS FROM LOI
14	LAYOUT AND DETAILS OF PILE/FOUNDATION OF INTERNAL FILL SUPPORT STRUCTURE	16 WEEKS FROM LOI
15	LAYOUT AND DETAILS OF POND FLOOR AND GRILLAGE COLUMN FOOTINGS	16 WEEKS FROM LOI
16	R.C. DETAILS OF PILECAP/FOUNDATION, POND WALL AND PEDESTAL	16 WEEKS FROM LOI
B	**DETAILED DRAWINGS / DOCUMENTS**	
1	SCHEMATIC ARRANGEMENT OF FILL & FILL SUPPORTING DETAILS FOR COOLING TOWER	21 WEEKS FROM LOI
2	SCHEMATIC ARRANGEMENT OF INTERNAL DISTRIBUTION SYSTEM FOR COOLING TOWER	21 WEEKS FROM LOI

3	SCHEMATIC ARRANGEMENT OF EXTERNAL HW DISTRIBUTION SYSTEM OF COOLING TOWER	30 WEEKS FROM LOI
4	SCHEMATIC ARRANGEMENT OF DRIFT ELIMINATORS FOR COOLING TOWER	31 WEEKS FROM LOI
5	SCHEMATIC ARRANGEMENT OF MECHANICAL EQUIPMENT OF COOLING TOWER	31 WEEKS FROM LOI
6	TDS FOR DRIFT ELIMINATOR FOR IDCT	31 WEEKS FROM LOI
7	TDS FOR FILL FOR IDCT	31 WEEKS FROM LOI
8	TDS FOR DISTRIBUTION PIPES	31 WEEKS FROM LOI
9	GAD AND DATA SHEET OF DRIVE SHAFT ASSY. FOR IDCT	31 WEEKS FROM LOI
10	SLUDGE PUMPS-GA & DATA SHEET .	42 WEEKS FROM LOI
11	CHAIN PULLEY BLOCKS-DATA SHEET AND GA FOR IDCT	42 WEEKS FROM LOI
12	TDS FOR FAN MAINTENANCE FACILITIES FOR IDCT	42 WEEKS FROM LOI
13	GAD AND DATA SHEET FOR BFV'S	42 WEEKS FROM LOI
14	GA & TDS FOR CI GATE VALVE .	42 WEEKS FROM LOI
15	GAD AND DATA SHEET OF FAN ASSY FOR IDCT	31 WEEKS FROM LOI
16	GAD AND DATA SHEET OF GEARBOX FOR IDCT	31 WEEKS FROM LOI
17	R.C. DETAILS OF COLD WATER BASIN COLUMN & WALL	15 WEEKS FROM LOI
18	ANALYSIS & DESIGN OF PRECAST BEAMS	21 WEEKS FROM LOI
19	ANALYSIS AND DESIGN OF COLUMNS FOR INTERNAL FILL SUPPORTING STRUCTURE	21 WEEKS FROM LOI
20	GA OF FILL SUPPORTING STRUCTURE	21 WEEKS FROM LOI
21	DETAILS OF DIAGONAL COLUMNS FOR COOLING TOWER	21 WEEKS FROM LOI
22	DESIGN OF LOWER TIER AND TIE BEAMS	21 WEEKS FROM LOI
23	DESIGN OF UPPER TIER BEAMS	21 WEEKS FROM LOI
24	R.C DETAILS OF TRANS BEAM AT ELIMINATOR LEVEL	21 WEEKS FROM LOI
25	R.C DETAILS OF LONG BEAM AT ELIMINATOR LEVEL	21 WEEKS FROM LOI
26	RC DETAILS OF END WALLS & PARTITION WALL	21 WEEKS FROM LOI
27	LAYOUT PLAN OF CT AT FANDECK LEVEL & GENERAL ARRANGEMENT OF FANDECK SLAB	25 WEEKS FROM LOI
28	RC DETAILS OF FAN DECK SLAB	21 WEEKS FROM LOI
29	RC DETAILS OF LONG & TRANS BEAMS AT FAN DECK LEVEL	21 WEEKS FROM LOI
30	DETAILS OF ACCESS DOOR	25 WEEKS FROM LOI
31	RC DETAILS OF FAN CYLINDER	25 WEEKS FROM LOI
32	DETAILS OF C.W. OUTLET, HOIST SUPPORT STRUCTURE AND EMBEDMENT DETS.	25 WEEKS FROM LOI
33	RC DETAILS OF PIPE SUPPORT	25 WEEKS FROM LOI
34	DESIGN CALCULATION FOR STAIRCASE FOR CT	25 WEEKS FROM LOI
35	ANALYSIS & DESIGN OF STAIRCASE	25 WEEKS FROM LOI
36	DETAILS OF STAIRCASE	25 WEEKS FROM LOI
37	R.C. DETAILS OF ACCESS STAIRWAY	25 WEEKS FROM LOI
38	R.C. DETAILS OF GRDR PLINTH SUPPORTING INCLINED COLUMN	28 WEEKS FROM LOI
39	DESIGN CALCULATION FOR OUTLET, SLUDGE PIT & PIPE SUPPORT FOR IDCT	25 WEEKS FROM LOI
40	ANALYSIS & DESIGN OF COLD WATER OUTLET & MONORAIL LIFTING ARRANGEMENT	25 WEEKS FROM LOI

41	R. C. DETAILS OF CW OUTLET, EMBEDMENT DETAILS OF GATES & TRASH RACKS	25 WEEKS FROM LOI
42	ANALYSIS & DESIGN OF DESLUDGE CHAMBER	25 WEEKS FROM LOI
43	R.C. DETAILS OF DRAIN SUMP AND DRAIN BOX	25 WEEKS FROM LOI
44	R.C. DETAILS OF MAIN HOT WATER DUCT	25 WEEKS FROM LOI
45	ANALYSIS & DESIGN OF PLATFORM	25 WEEKS FROM LOI
46	DETAILS OF INTERMEDIATE ACCESS/ CHANGEOVER PLATFORM	25 WEEKS FROM LOI
47	DETAILS OF EXTERNAL TRESTLES FOR HOT WATER PIPING	25 WEEKS FROM LOI
48	RC DETAILS OF INTERMEDIATE TIER BEAMS	25 WEEKS FROM LOI
49	DETAILS OF PRECAST BEAM AT DRIFT ELIMINATOR LEVEL	25 WEEKS FROM LOI
50	NUMERATION AND RC DETAILS OF COLUMN BRACKETS SUPPORTING PRECAST GRID BEAMS	25 WEEKS FROM LOI
51	DESIGN OF PEDESTALS FOR HOT WATER PIPING	25 WEEKS FROM LOI
52	DESIGN OF TEST SETUP ARRANGEMENT FOR INITIAL PILE LOAD TESTING WORKS	25 WEEKS FROM LOI
53	DESIGN OF INTERMEDIATE TIER BEAMS	25 WEEKS FROM LOI
54	DESIGN OF COLUMN BRACKETS	25 WEEKS FROM LOI
55	ANALYSIS & DESIGN OF MISCELLANEOUS ITEMS (STOP LOG GATES, TRASH RACKS, ETC)	25 WEEKS FROM LOI
56	DESIGN CALCULATION FOR STOP LOG GATE/ SLIDE GATE	25 WEEKS FROM LOI
57	DETAILS OF SCREEN TRASH RACK AT OUTLET	42 WEEKS FROM LOI
58	DETAILS OF EXTERANL M.S. LADDER	25 WEEKS FROM LOI
59	PITOT TUBE INSTALLATION & PIT DETAILS FOR COOLING TOWER	30 WEEKS FROM LOI
60	CONTROL & OPERATION PHILOSOPHY	31 WEEKS FROM LOI
61	PG TEST PROCEDURE	50 WEEKS FROM LOI
62	QAP- DRIVES SHAFT FOR IDCT	37 WEEKS FROM LOI
63	QAP-GEARBOX FOR IDCT	37 WEEKS FROM LOI
64	QAP- FILL FOR IDCT	37 WEEKS FROM LOI
65	QAP- PVC ELIMINATOR FOR IDCT	37 WEEKS FROM LOI
66	QAP- DESLUDGE PUMP	45 WEEKS FROM LOI
67	QAP- FAN FOR IDCT	37 WEEKS FROM LOI
68	QAP OF BF VALVE	37 WEEKS FROM LOI
69	QAP OF GATE VALVE/SLUICE VALVE	45 WEEKS FROM LOI
70	QAP OF HOT WATER MANIFOLD	45 WEEKS FROM LOI
71	ELECTRICAL LOAD LIST	10 WEEKS FROM LOI
72	CABLE SCHEDULE AND CABLE INTERCONNECTION	15 WEEKS FROM LOI
73	I/O LIST	15 WEEKS FROM LOI
74	INSTRUMENT CABLE SCHEDULE	15 WEEKS FROM LOI
75	INSTRUMENT SCHEDULE	15 WEEKS FROM LOI
76	CONTROL SCHEME/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	15 WEEKS FROM LOI
77	FIELD JB TERMINATIONS	15 WEEKS FROM LOI

MDL for IDCT shall be finalized after award of contract.

BHEL / Customer comments on drgs/docs shall be furnished within 14 days of submission date. However, drgs/docs 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. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

DRAWINGS & DOCUMENTS TO BE SUBMITTED AS FINAL/AS-BUILT DOCUMENT

Sl. No.	DOCUMENT TITLE
1	APPROVED DOCUMENTS
2	CALIBRATION CERTIFICATES
3	O&M MANUAL
4	ALL TEST CERTIFICATES

Schedule of Performance Guarantees

1	Total CW Pumping head (MWC) permissible, viz. static head plus frictional losses as below: - Static head w.r.t. FGL - Frictional losses within bidder's T.P. with 10% margin	
2	Guaranteed Cold water temperature at design capacity & parameters with the working cells (deg C)	
3.0	Guaranteed power consumption at inlet to motor terminals of fans, at design capacity and design conditions:	
3.1	Per fan motor (KW)	
3.2	Total for the working cells, per Cooling Tower (KW)	

Signature of authorised Representative

Name and Designation :

Name & Address of the Bidder

Date

COMPLIANCE CERTIFICATE

1	It is hereby confirmed that the technical specification (sheet 1 to 223 of Book-1 of 2 and sheet 1 to 359 of Book 2 of 2) has been read and understood. We confirm compliance to the tender specification including any prebid clarification and amendments issued prior to techno-commercial bid opening without any deviation.
2	It is hereby declared that any technical submittals which was not specifically asked by BHEL in NIT shall not to be considered as part of bid and shall not be evaluated by BHEL.

Signature of authorised Representative

Name and Designation :

Name & Address of the Bidder

Date

PRE QUALIFICATION REQUIREMENT (TECHNICAL)

ENQUIRY NO.:

PROJECT: 1 X 800 MW NTPC SIPAT STPP Stage-III

The Bidder should meet the qualifying requirements of any one of the qualifying routes stipulated under clause 4.3.1 or 4.3.2 or 4.3.3.

4.3.1 The bidder should have designed, constructed and commissioned at least one (01) number Induced Draught Cooling Tower in RCC or Pultruded Fiberglass Reinforced Plastic (FRP) Construction of capacity not less than 13000 m3/hr which should have been in successful operation for at least one (1) year as on 10.07.2024.

In case the reference cooling tower was designed by a party other than the Bidder, the Bidder shall employ a cooling tower Design Agency, who has independently designed an Induced Draught Cooling Tower of same type as being offered of capacity not less than 13,000 m3/hr in RCC or Pultruded Fiberglass Reinforced Plastic (FRP) construction and which should have been in successful operation for at least one (1) year as on 10.07.2024.

Further, if such design agency has not carried out the engineering activities by itself in respect of the system of the reference installation against which the design agency is seeking the qualification, then the engineering of the package shall be carried out by an Engineering firm who should have engineered an Induced Draught Cooling Tower of same type & construction as being offered of capacity not less than 13,000 m3/hr in RCC or Pultruded Fiberglass Reinforced Plastic (FRP) construction and which should have been in successful operation for at least one(1) year as on 10.07.2024.

In such a case, the Bidder shall be required to furnish a letter of technical support from the Cooling Tower Design agency and Engineering firm (as applicable) for successful performance of Cooling Tower system, as per the format enclosed in the bidding document. This letter of technical support should be submitted prior to the placement of order on approved bidder.

OR

4.3.2 The Bidder should be a wholly or partially (with minimum 51% holding) held Indian subsidiary of a firm who in turn meets the requirements of clause 4.3.1 above. Further, the Bidder on its own or along with its holding company should have executed / be executing at least one contract involving design, construction and commissioning of at least one (1) number Induced Draft Cooling Tower in RCC / Pultruded Fiberglass Reinforced Plastic (FRP) Construction of capacity not less than 6500 m3/hr.

In such a case, the Bidder should furnish a letter of technical support from Holding Company (i.e. the firm meeting requirements of clause 4.3.1 above) for successful performance of the Cooling Tower as per the format enclosed in the bidding document. This letter of technical support should be submitted prior to the placement of order on approved bidder.

OR

4.3.3 The Bidder who has independently constructed RCC cooling towers of capacity not less than 13,000 Cu.M/Hr can also participate along with its Holding company / Subsidiary / Collaborator / Associate who in turn meets the requirements of clause 4.3.1 above.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking executed by the Bidder and it's Holding company / Subsidiary / Collaborator / Associate for the successful performance of Cooling Tower, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) shall be submitted along with bid/offer. In case of award, Bidder and it's Holding company / Subsidiary / Collaborator / Associate shall each be required to furnish an on-demand bank guarantee for INR 24 million (Twenty-Four Million only) in addition to the contract performance security to be furnished by the bidder.

General notes of the PQR are as under:

1. The Bidder should offer only the same type i.e. counter flow or cross flow and of the same construction type i.e. RCC construction or FRP construction of Cooling Towers for which the bidder / Holding Company / Subsidiary / Collaborator / Associate (i.e., the firm meeting requirements of clause 4.3.1 above) is qualified.

2. Bidder to submit supporting documents in English. If documents submitted by bidder are in language other than English, a self-attested English translated document should also be submitted.

3. Notwithstanding anything stated above, BHEL/Customer reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in overall interest of BHEL/Customer.

4. Consideration of offer shall be subject to customer's approval of bidder.

5. After satisfactory fulfilment of all the above criteria/ requirement, offer shall be considered for further evaluation as per NIT and all other terms of the tender.

PROVENNESS OF INDUCED DRAFT COOLING TOWER

I. (A) Details of Induced draught Cooling Towers (as per clause 4.3.1of Sub-Section-IA, Part-A, Section-VI of Bidding Documents

In support of Sub-Qualifying Requirements of Clause 4.3.1 of Sub-Section-IA, Part-A, Section-VI of Bidding Document, we confirm that We/our Sub-vendor have designed, constructed and commissioned at least one (01) number Induced Draught Cooling Tower in RCC or Pultruded Fiberglass Reinforced Plastic(FRP) Construction of capacity not less than 13000m3/hr which has been in successful operation for atleast one year(1) prior to the date of Techno-commercial bid opening.

The reference Cooling Towers are of the same type i.e. counter flow or cross flow as is being offered and of the same construction type i.e. RCC construction or FRP construction as being offered by us.

The details of the reference cooling tower is furnished below:

Sl. No.	**Description/Details**	**Plant**
1.	Description of Work and Name of Client	.....
2.	Location/Address of the Plant/works	.....
3.	Address of the Client (including Contact Person Name, Telephone No, e-mail etc.)	.....
4.	No. of Cooling Towers	.....
5.	Capacity of each Cooling Tower (Cu.M/hr.)	.....
6.	Type of Fill (splash/modular/trickle type)	.....
7.	Type of Construction	.....
8.	Whether scope of works included	
	(a) Design of Cooling Towers by Bidder/its Sub-vendor	YES*/NO*
	(b) Construction of Cooling towers	YES*/NO*

Signature of authorized signatory.....

	(c) Commissioning of Cooling towers	YES*/NO*
9.	Date of Commissioning of the Cooling tower	
10.	Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3K	YES*/NO*
11.	Whether the reference cooling tower at sl. No. 1 is designed by the bidder/ sub vendor	YES*/NO*
12a.	Whether the reference cooling tower at sl. No. 1 is got designed by bidder/ sub vendor	YES*/NO*
12b.	Name of the Design agency of the reference Cooling tower	
12c.	Whether the reference cooling tower is Engineered by the design agency	YES*/NO*
12d.	Name of the Engineering firm who has engineered the reference cooling tower	
13.	Whether Documentary evidence/ certificate(s) from client enclosed for the above data	Yes* / No*
14.	We confirm to submit a letter of technical support at the time of placement of order on our sub-vendor	

- * Strike off whichever is not applicable.

Date : (Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

(Bidder / Sub vendor / Design Agency / Engineering firm)

Signature of authorized signatory.....

I. (B) Details of Induced draught Cooling Towers (as per clause 4.3.2 of Sub-Section-IA, Part-A, Section-VI of Bidding Documents

In support of Sub-Qualifying Requirements of Clause 4.3.2 of Sub-Section-IA, Part-A, Section-VI of Bidding Document, we confirm that We are a wholly or partially (with minimum 51% holding) held Indian subsidiary of a firm who fulfills the requirements in Clause 4.3.1 of Sub-Section-IA, Part-A, Section-VI of Bidding Documents. We , on our own/ alongwith our holding company have executed/ are executing atleast one contract involving design, construction and commissioning of atleast one(1) number Induced Draft Cooling Tower in RCC/ Pultruded Fiberglass Reinforced Plastic (FRP) Construction of capacity not less than 6500m3/hr.

We shall furnish a letter of technical support from our Holding Company for the satisfactory performance of Cooling Towers as per the format enclosed in the bidding document before placement of award of Cooling Tower.

The details of the reference cooling tower is furnished below:

Sl. No.	Description/Details	Plant
1.	Description of Work and Name of Client	.....
2.	Location/Address of the Plant/works	.....
3.	Address of the Client (including Contact Person Name, Telephone No, e-mail etc.)	.....
4.	No. of Cooling Towers	.....
5.	Capacity of each Cooling Tower (Cu.M/hr.)	.....
6.	Type of Fill (Other than splash/modular/trickle type) Bidder to Specify the type of fill	.....
7.	Type of Construction	.....
8.	Whether scope of works included	
	(a) Design of Cooling Towers by Bidder/its Sub-vendor associate/Collaborator	YES*/NO*
	(Name of Designer)	.....

Signature of authorized signatory.....

	(b) Construction of Cooling towers	YES*/NO*
	(c) Commissioning of Cooling towers	YES*/NO*
9.	Date of Commissioning of the Cooling tower	
10.	Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3K	YES*/NO*
11.	Whether the reference cooling tower at sl. No. 1 is designed by the bidder/ sub vendor	YES*/NO*
12.	Whether the reference cooling tower at sl. No. 1 is designed by Sub-vendor's own engineers	YES*/NO*
13.	Whether Documentary evidence/ certificate(s) from client enclosed for the above data	Yes* / No*
14.	We confirm to submit a letter of technical support at the time of placement of order on our sub-vendor	

- * Strike off whichever is not applicable.

Date :

(Signature).....

Place :

(Printed Name).....

(Designation).....
(Common Seal).....

Date :

(Signature).....

Place :

(Printed Name).....

(Bidder / Sub vendor / Associate/ Collaborate)

Signature of authorized signatory.....

I. (C) Details of Induced draught Cooling Towers (as per clause 4.3.3 of Sub-Section-IA, Part-A, Section-VI of Bidding Documents

In support of Sub-Qualifying Requirements of Clause 4.3.3 of Sub-Section-IA, Part-A, Section-VI of Bidding Document, we confirm that We/our Sub-vendor have independently constructed RCC cooling towers of capacity not less than 13000 m3/hr and our Holding company/Collaborator/Associate fulfills the requirements in Clause 4.3.1 of Sub-Section-IA, Part-A, Section-VI of Bidding Documents.
We shall furnish a Deed of Joint Undertaking executed by us/ our sub-vendor and Holding company/Collaborator/Associate for the successful performance of Cooling Tower, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) shall be submitted along with an on demand bank-guarantee at the time of placement of order on the approved sub-vendor.

The details of the reference cooling tower is furnished below:

Sl. No.	Description/Details	Plant
1.	Description of Work and Name of Client	.....
2.	Location/Address of the Plant/works	.....
3.	Address of the Client (including Contact Person Name, Telephone No, e-mail etc.)	.....
4a.	No. of Cooling Towers	.....
4b.	Capacity of each Cooling tower	.....
5.	Date of commissioning of Cooling tower	……
6.	Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3K	YES*/NO*
7.	Details of ref cooling tower of Holding company /Collaborator/ Associate as per clause 4.3.1	
8.	Whether scope of works included	
	(a) Design of Cooling Towers by Bidder/its Sub-vendor associate/Collaborator	YES*/NO*
	(Name of Designer)	.....
	(Name of Eningeering firm)	……

Signature of authorized signatory.....

	(b)	Construction of Cooling towers	YES*/NO*
	(c)	Commissioning of Cooling towers	YES*/NO*
9.		Date of Commissioning of the Cooling tower	
10.		Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3K	YES*/NO*
11.		Whether the reference cooling tower at sl. No. 1 is designed by the bidder/ sub vendor	YES*/NO*
12.		Whether the reference cooling tower is designed by Sub-vendor's own engineers	YES*/NO*
13.		Whether Documentary evidence/ certificate(s) from client enclosed for the above data	YES* /NO*
14.		We confirm to submit a letter of Deed of Joint Undertaking at the time of placement of order on our sub-vendor	
15.		Documentary evidence / Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3K	YES*/NO*

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 * Strike off whichever is not applicable.

Date : (Signature).....
Place : (Printed Name).....
(Designation).....
(Common Seal) .....
(Bidder / Sub-vendor / Holding Company / Collaborator / Associate)

FORMAT FOR FILLING THE DETAILS OF PROVENNESS
LETTER OF SUPPORT FOR SATISFACTORY PERFORMANCE OF (EQUIPMENT/SYSTEM NAME) FOR SIPAT STPP STAGE-III(1X800MW)

TO
[EMPLOYER'S NAME & ADDRESS]

Sub: Letter of Technical Support submitted From …….. (name of the Associate*/ Collaborator*/ Desginer* / Engineering firm* / Holding Company*/Subsidiary*) undertaking the responsibility for satisfactory performance of …….(Name of the equipment/system*).

Dear Sirs,

1. In accordance with the Award of the Contract by …… (Name of the Contractor) to M/s. ……. (Name of the sub-vendor), we, the aforesaid Associate*/ Collaborator*/ Design agency* / Engineering firm* / Holding Company*/Subsidiary*, (M/s …….) shall be fully responsible for the satisfactory performance of the ……..(Name of the equipment/system*).

2. Further, the manner of achieving the objective set forth in point 1 above shall be as follows
   For …….. (Name of the equipment/system*):
   (a) We shall be fully responsible for design, engineering & commissioning (as applicable) and extending all necessary support for putting in to satisfactory operation and carrying out the Guarantee Tests (as applicable) for ……..(Name of the equipment/system*) to the satisfaction of the Employer.

   (b) We shall depute technical experts to Bidder's/sub-vendor's works for supervision during manufacturing, assembly, inspection, as and when required by Employer. We shall participate in site erection, commissioning and final testing (as and when necessary) of the…….(Name of the equipment/system*).

   (c) We shall participate in Technical Co-ordination meetings (TCMs) from time to time, as and when required by Employer.

   (d) We shall promptly carry out all the corrective measures and shall promptly provide corrected design and shall undertake replacements, rectifications or modifications to the equipment/system* as and when required by Employer in case the equipment/system* fails to demonstrate successful performance as per contract at site.

3. We, the Associate*/ Collaborator*/ Design agency* / Engineering firm* / Holding Company* do hereby undertake and confirm that this Letter of Technical Support shall be valid for a period of seven (7) years or up to the end of defect liability period of the contract, whichever is later.

Signature of the Authorised Representative:……..…
For M/s …….
(Associate*/ Collaborator*/ Design agency* / Engineering firm* / Holding Company*/Subsidiary*)
Name ……
Designation …….
Date:……
Common Seal of the Company

***: Strike off whichever is not applicable..**

Signature of authorized signatory.....

FORM OF DEED OF JOINT UNDERTAKING TO BE PROVIDED FOR INDUCED DRAFT COOLING TOWER AS PER CLAUSE 4.3 OF TECHNICAL SPECIFICATIONS (SECTION -VI PART-A SUB-SECTION-IA)

(ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

DEED OF JOINT UNDERTAKING TO BE EXECUTED BY BIDDER/SUB VENDOR AND ITS HOLDING COMPANY/SUBSIDIARY/COLLABORATOR/ASSOCIATE FOR SUCCESSFUL PERFORMANCE OF COOLING TOWER MEETING THE REQUIREMENTS STIPULATED IN THE TECHNICAL SPECIFICATION.

The DEED OF JOINT UNDERTAKING executed this ……day of ……Two thousand ……. by M/s …… (BIDDER/SUB VENDOR)……. (hereinafter called the BIDDER/ ~~SUB VENDOR~~, which expression shall include its successors, administrators, executors and permitted assigns) AND

The DEED OF JOINT UNDERTAKING executed this ……day of ……Two thousand ……. by M/s …… (HOLDING COMPANY/SUBSIDIARY /COLLABORATOR/ASSOCIATE) a Company incorporated under ……having its Registered Office at …… (hereinafter called the HOLDING COMPANY/SUBSIDIARY /COLLABORATOR/ASSOCIATE, which expression shall include its successors, administrators, executors and permitted assigns) AND

in favour of …….., having its Registered Office at NTPC Bhawan, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi-110003 INDIA ("Employer" which expression shall include its successors, administrators, executors and assigns).

WHEREAS, the Employer invited Bids for design, engineering, manufacture, supply, transportation to site, construction, installation, testing, commissioning and conductance of guarantee tests for the EPC Package for --------- TPP (hereinafter referred to as "Plant") vide its Bidding Document No. ------, which interalia include Cooling tower(s).

WHERAS M/S ----------(Bidder) has submitted its proposal in response to the aforesaid invitation for Bid by the Employer for EPC package for -----TPP against the employer's bidding documents no. -------- interalia including design, engineering, manufacturing, supply, transportation to site, installation, testing and commissioning (including trial operation and performance and guarantee test) of cooling tower(s).

AND WHEREAS vide
clause 4.3.3 of TECHNICAL SPECIFICATIONS (SECTION-VI, PART-A, SUB-SECTION-IA), it has been specified that bidder/ ~~sub-vendor~~ who has independently constructed RCC cooling towers can also participate alongwith it's Holding company/Subsidiary/Collaborator/Associate who in turn meets the requirements of clause 4.3.1 of TECHNICAL SPECIFICATIONS (SECTION-VI, PART-A, SUB-SECTION-IA).

NOW THEREFORE, THIS DEED WITNESSETH AS UNDER:

1. We the bidder/~~sub vendo~~r and our Holding company/Subsidiary/Collaborator/Associate, do hereby declare and undertake that we shall be jointly and severally responsible to the Employer for the successful performance of the Cooling tower(s).

2. In case of any breach of the Contract by the contractor /~~its sub-vendo~~r, we the Holding company/Subsidiary/ Collaborator / Associate do hereby undertake, declare and confirm that we shall be fully responsible for the successful performance of the cooling tower(s) and undertake to carryout all the obligations and responsibilities under this Deed of Joint Undertaking in order to discharge the bidder/~~sub vendor~~ obligations stipulated under the Contract. Further, if the Employer sustains any loss or damage on account of any breach of the Contract for the cooling tower , we undertake to promptly indemnify and pay such loss/damages caused to the Employer on its written demand without any demur, reservation,

Contest or protest in any manner whatsoever. This is without prejudice to any rights of the Employer against the bidder/sub vendor under the Contract and/or guarantees. It shall not be necessary or obligatory for the Employer to first proceed against the bidder/~~sub vendor~~ before proceeding against the Holding company/Subsidiary / Collaborator / Associate nor any extension of time or any relaxation given by the Employer to the bidder/~~sub vendor~~ shall prejudice any rights of the Employer under this Deed of Joint Undertaking to proceed against the Holding company/Subsidiary / Collaborator / Associate. The liability of the contractor, ~~his sub vendor~~ and the Holding company/ Collaborator / Associate shall be limited to an amount equal to 100% of the value of the contract** between the contractor and the sub supplier for the equipments/systems.

3. Without prejudice to the generality of the Undertaking in paragraph 1 above, the manner of achieving the objective set forth in paragraph 1 above shall be as follows:
(a) We, Holding company/Subsidiary / Collaborator / Associate shall ensure that complete design, manufacturing, quality assurance and installation of the cooling tower(s) is carried out inline with drawings and procedures and shall be fully responsible for its compliance so as to ensure satisfactory, reliable, safe and trouble free performance of cooling tower(s) .
Further, we, Holding company/Subsidiary / Collaborator / Associate shall extend our quality surveillance / supervision / quality control to the bidder / sub vendor during Design, engineering, erection, commissioning and performance testing of cooling tower(s).
Further, Holding company/ Collaborator / Associate shall depute their technical experts from time to time to the bidder / ~~sub vendor~~ works / Employer's project site as required by the Employer and agreed to by bidder /~~ sub vendor~~ to facilitate the successful performance of the cooling tower(s) as stipulated in the aforesaid Contract.
Further, Holding company/Subsidiary / Collaborator / Associate shall ensure proper design, manufacture installation, testing and successful performance of the cooling tower under the said contract in accordance with stipulations of Bidding Documents and if necessary, Holding company/Subsidiary / Collaborator / Associate shall advise the bidder/~~sub vendo~~r suitable modifications of design and implement necessary corrective measures to discharge the obligations under the contract.
(b) In the event the bidder/~~sub vendor~~ fail to demonstrate that the cooling tower(s) meet the guaranteed parameters and demonstration parameters as specified in the contract, Holding company/Subsidiary / Collaborator / Associate shall promptly carry out all the corrective measures related to engineering services at their own
expense and shall promptly provide corrected design to the Employer.
(c) Implementation of the corrected design and all other necessary repairs, replacements, rectification or modifications to the cooling tower(s) and payment of financial liabilities and penalties and fulfillment of all other contractual obligations as provided under the contract shall be the joint and several responsibility of the bidder/sub vendor and Holding company/Subsidiary / Collaborator / Associate.

4. We, the contractor/~~sub vendor~~ and Holding company/Subsidiary / Collaborator / Associate do hereby undertake and confirm that this Undertaking shall be irrevocable and shall not be revoked till ninety (90) days after the end of the defect liability period of the last equipment covered under the Contract and further stipulate that the Undertaking herein contained shall terminate after ninety (90) days of satisfactory completion of such defect liability period. In case of delay in completion of defect liability period, the validity of this Deed of Joint Undertaking shall be extended by such period of delay. We further agree that this Undertaking shall be without any prejudice to the various liabilities of the Contractor including Contract Performance Security as well as other obligations of the Contractor in terms of the Contract.

5. The Contractor/sub vendor will be fully responsible for the quality of all the equipment/main assemblies/components manufactured at their works or at their Vendors' works or constructed at site, and their repair or replacement, if necessary, for incorporation in the Plant and timely delivery thereof to meet the completion schedule under the Contract.

6. In case of Award, in addition to the Contract Performance Security for the contract, the Holding company/Subsidiary / Collaborator / Associate shall furnish 'as security' an on demand Performance Bank Guarantee in favour of the Employer as per provisions of the bidding documents. The value of such Bank Guarantee shall be equal to INR 24 Million (Indian Rupees Twenty Four Million only) and it shall be guarantee towards the faithful performance /compliance of this Deed of Joint Undertaking in accordance

with the terms and conditions specified herein. The bank guarantee shall be unconditional, irrevocable and valid till ninety (90) days beyond the end of defect liability period of the last equipment covered under the Contract. In case of delay in completion of the defect liability period, the validity of this Bank Guarantee shall be extended by the period of such delay. The guarantee amount shall be promptly paid to the Employer on demand without any demur, reservation, protest or contest.

7. Any dispute that may arise in connection with this Deed of Joint Undertaking shall be settled as per arbitration procedure/rules mentioned in the Contract Documents. This Deed of Joint Undertaking shall be construed and interpreted in accordance with the Laws of India and the Courts of Delhi shall have exclusive jurisdiction.

8. We, Holding company/Subsidiary / Collaborator / Associate and contractor /sub vendor agree that this Undertaking shall form an integral part of the Contracts from the date of signing of this Deed of Joint Undertaking. We further agree that this Undertaking shall continue to be enforceable till its validity.

9. That this Deed of Joint Undertaking shall be operative from the effective date of signing of this Deed of Joint Undertaking.

IN WITNESS WHEREOF, Holding company/Subsidiary / Collaborator / Associate and contractor / sub vendor through their authorised representatives, have executed these presents and affixed common seal of their respective companies, on the day, month and year first mentioned above.

1. WITNESS For M/s
.....
(Holding company/Subsidiary / Collaborator / Associate)
.....
(Signature of the Authorised representative)

Name.....
(Official Address)
Designation.....
Common Seal of the
Company.....

1. WITNESS ForM/s
.....
(*sub vendor)
.....
(Signature of the Authorised representative)

Name.....
(Official Address)
Designation.....
Common Seal of the
Company.....

1. WITNESS For M/s
.....
(Bidder/Contractor)
.....
(Signature of the Authorised representative)

Name.....
(Official Address)
Designation.....
Common Seal of the
Company.....

Signature of authorized signatory.....

1. WITNESS For M/s
.....
(JV company/Subsidiary company)
.....
(Signature of the Authorised representative)

Name.....
(Official Address)
Designation.....
Common Seal of the
Company.....
Note :
1) Power of Attorney of the executants of this DJU is to be furnished.
2) * Strike out, whichever is not applicable.
3) ** Copy of priced purchase order for the equipment shall be furnished by Bidder.