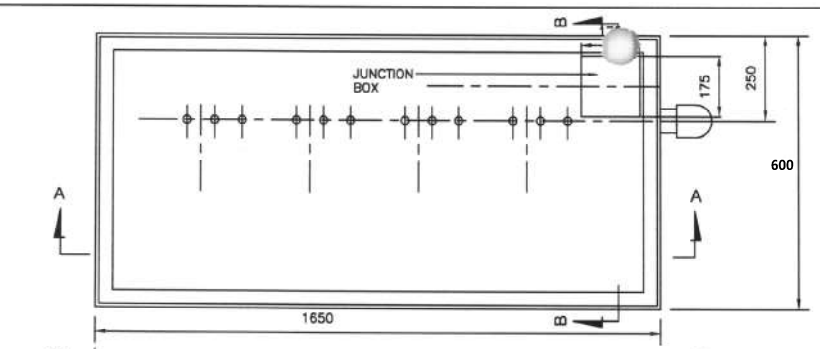
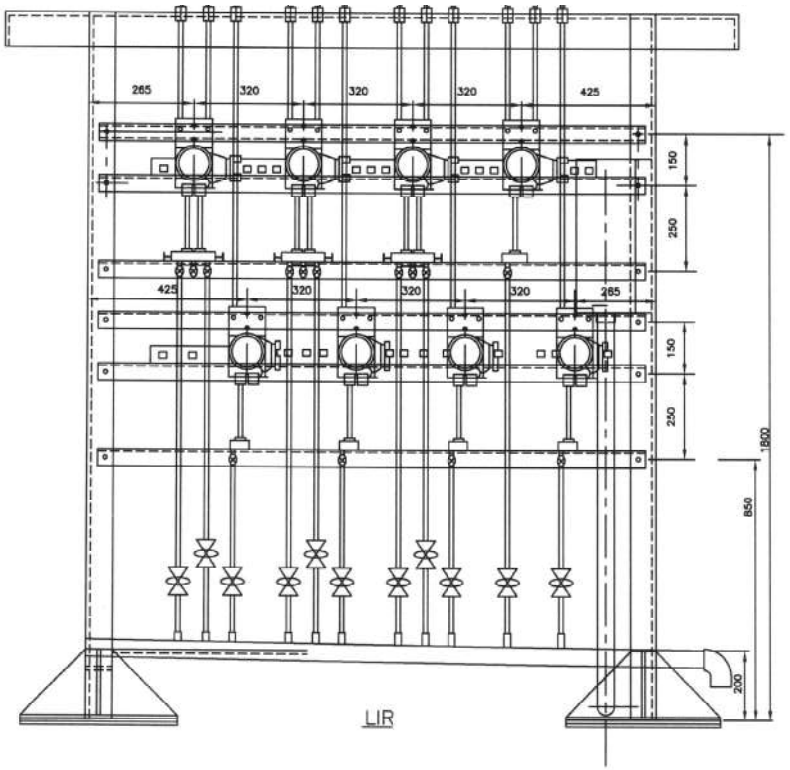
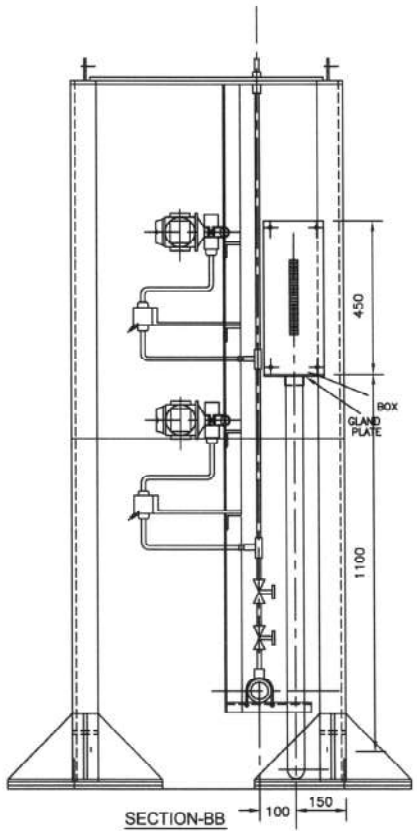




LIR



SECTION-BB

SECTION-AA
LIR WITHOUT PURGING

NOTE:-

1. MATERIAL OF JBs FOR LIRs SHALL BE SAME AS THAT OF LIR.

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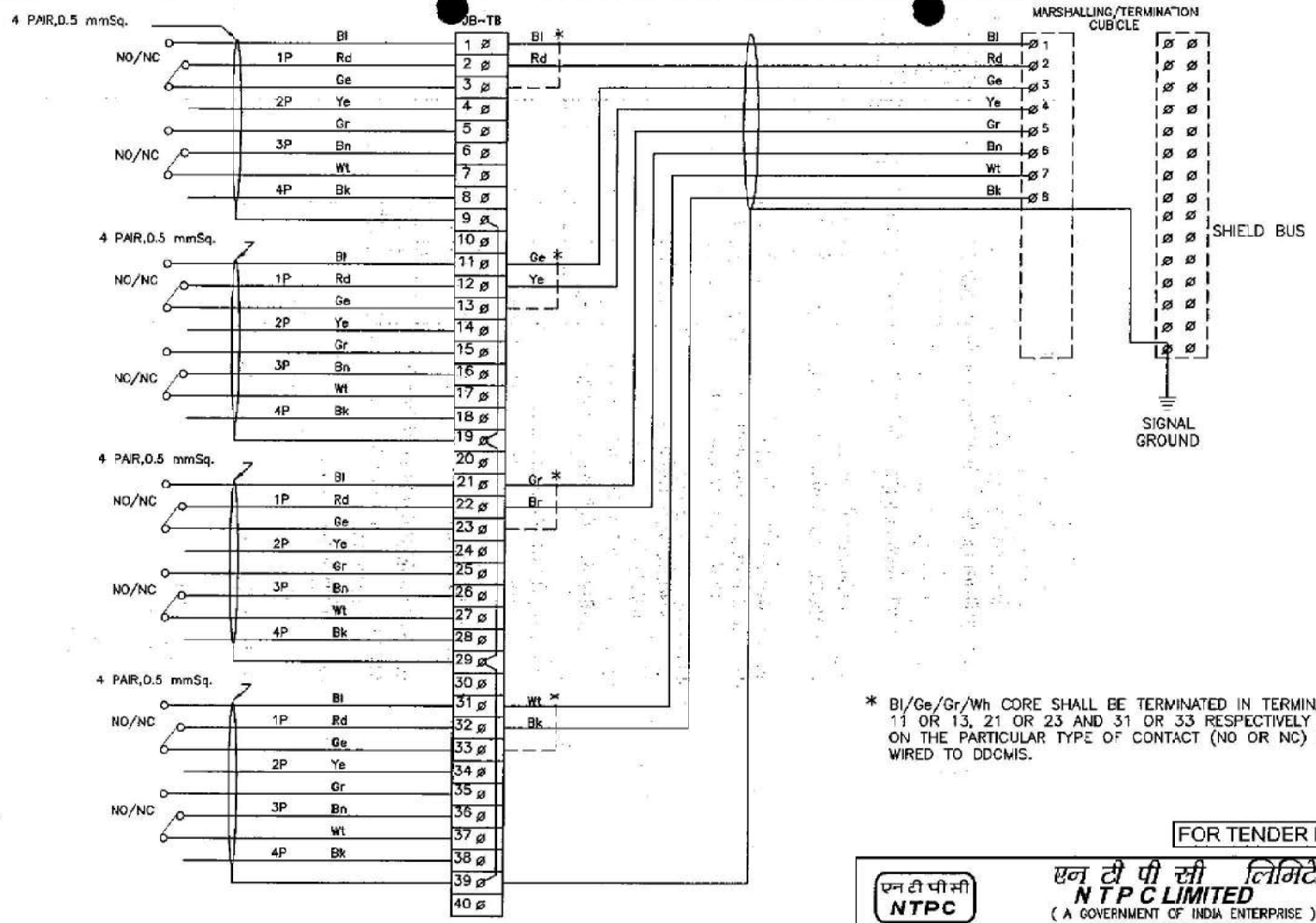
ENGINEERING DIVISION

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE							T.G.			21.08.12

CLEARED BY

PROJECT	TITLE	SIZE	SCALE	DRG. NO.	REV. NO.
TYPICAL THERMAL POWER PROJECT	TYPICAL GA OF LOCAL INSTRUMENT ENCLOSURE / RACK	A3	N.T.S.	0000-999-POI-A-064 SH- 03 OF 03	A



* 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.

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NTPC LIMITED
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ENGINEERING DIVISION

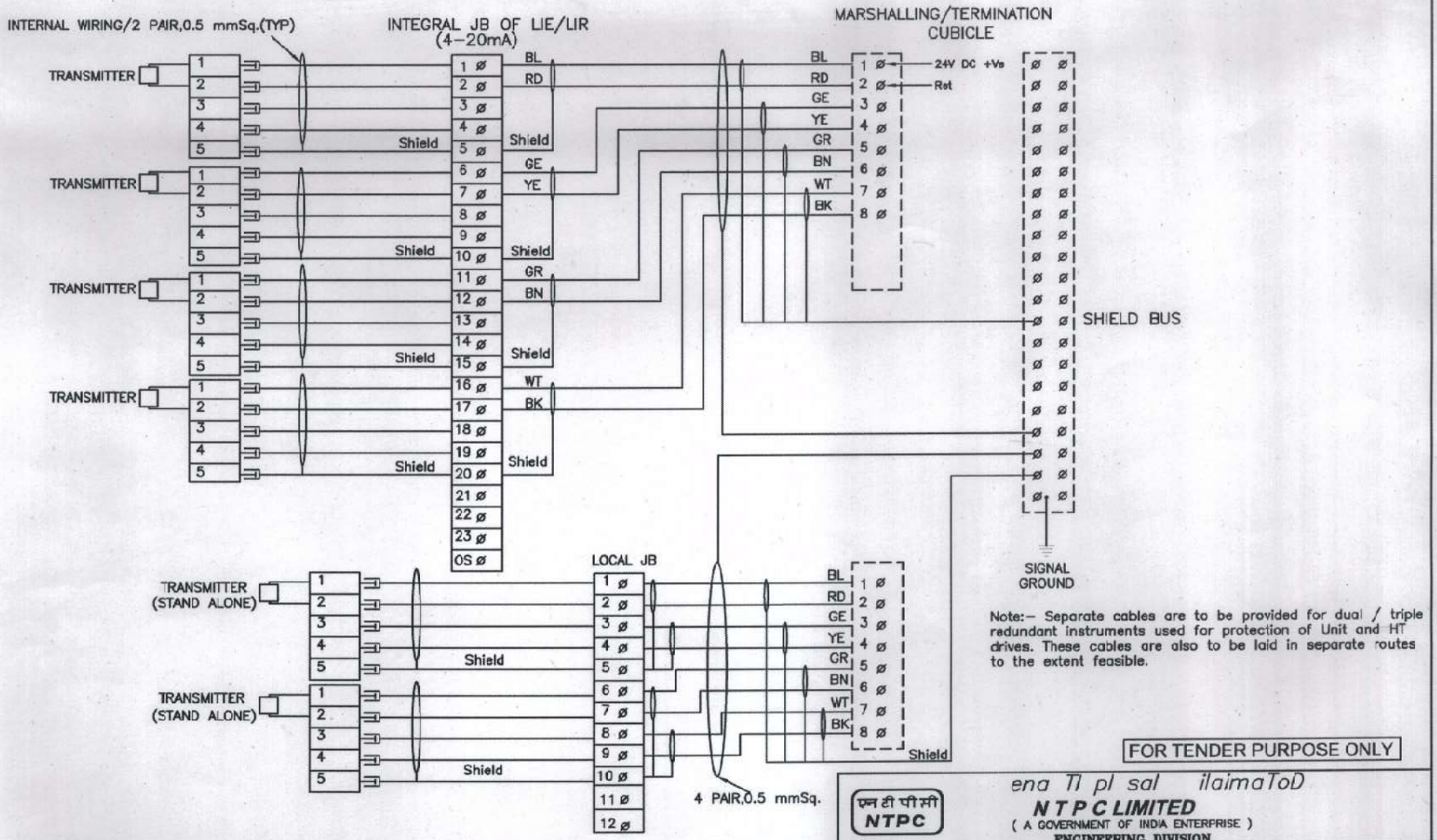
PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
SWITCH TERMINATION DETAILS
NO/NC

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										29.04.06

CLEARED BY

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 02 OF 14	A



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.

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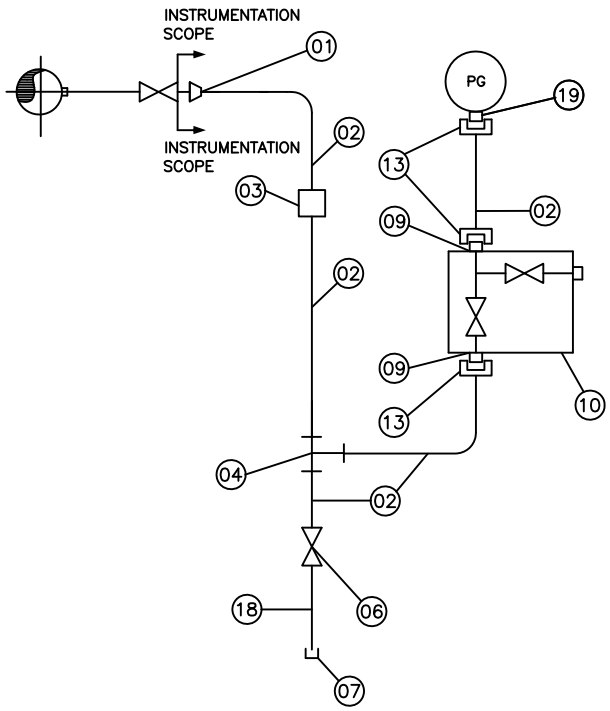
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
C	NOTE REGARDING CABLE IS ADDED.										10.12.13
B	INTERNAL WIRING FOR LIE/LIR MOUNTED SHOWN WIRING OF STAND ALONE TXTR SHOWN										10.12.06
A	FIRST ISSUE										12.1.05
					CLEARED BY						

PROJECT: TYPICAL THERMAL POWER PROJECT

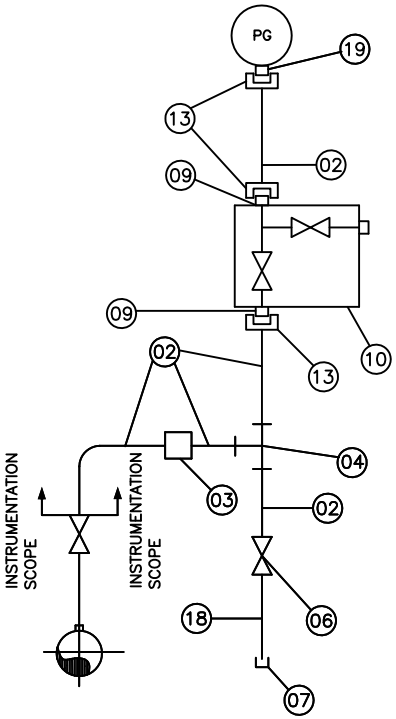
TITLE: INTERFACING OF FIELD INSTRUMENTS 4-20mA

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 04 OF 14	C

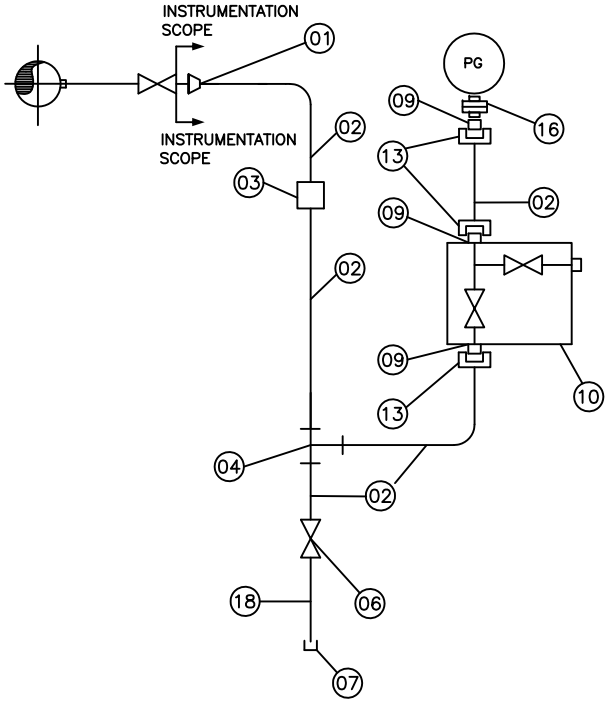


WATER SERVICE

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	3 OF 9	



AIR SERVICE

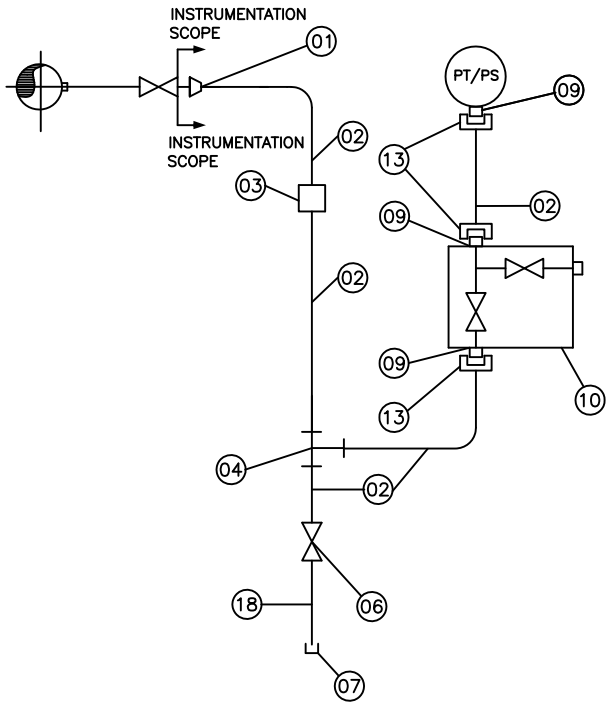


WITH CHEMICAL SEAL

(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

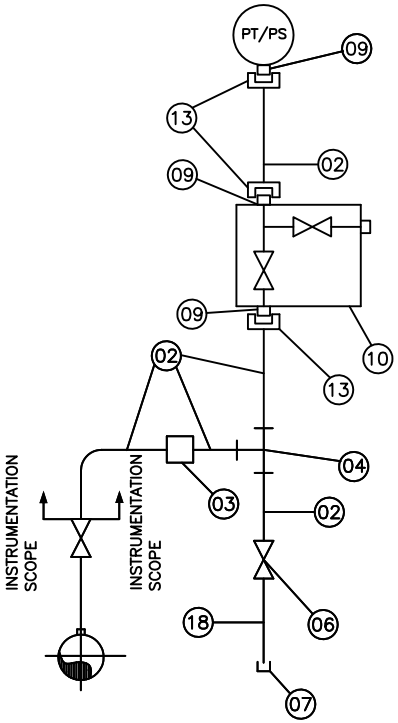
ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02	02	02	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	SS316	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01
19	ADAPTER – M TO F	SS316	M20X1.5M X 1/2" NPTF	01	01	01	01	00

BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE–DG–999–145–IXXX
		REV. NO.	00 DATE 05.11.13
		SHT	4 OF 9

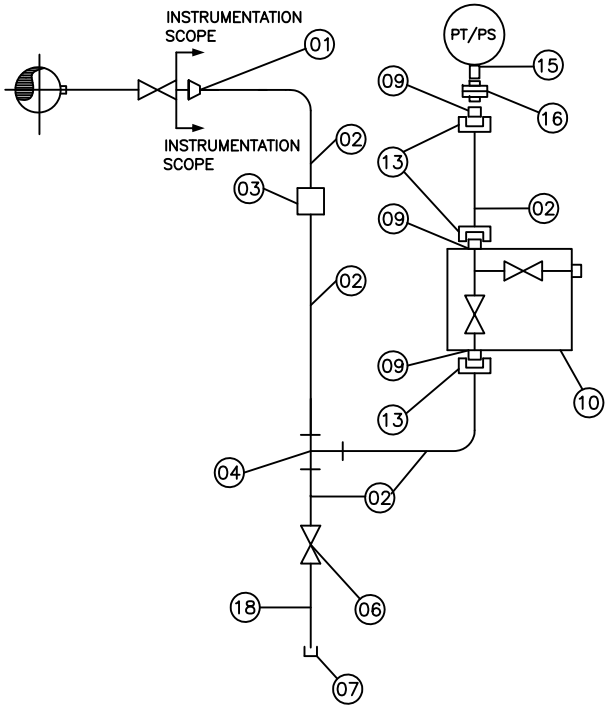


WATER SERVICE

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	5 OF 9	



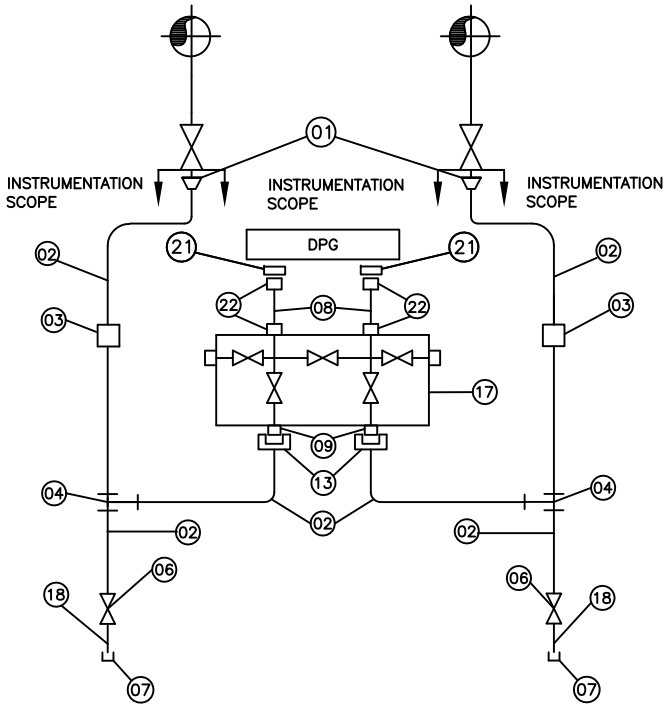
AIR SERVICE



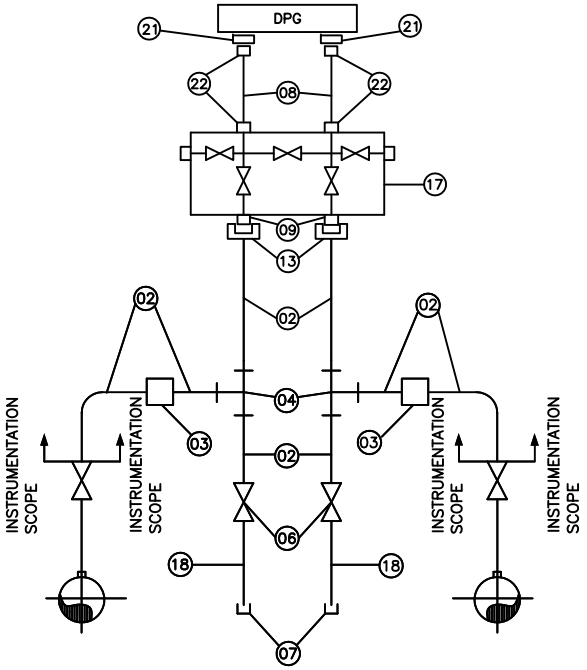
WITH CHEMICAL SEAL
(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	03	03	03	03	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	CS	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00	00	00	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01

BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE–DG–999–145–IXXX
		REV. NO.	00 DATE 05.11.13
		SHT	6 OF 9



WATER SERVICE



AIR SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	02	02
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	02	02
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	02	02

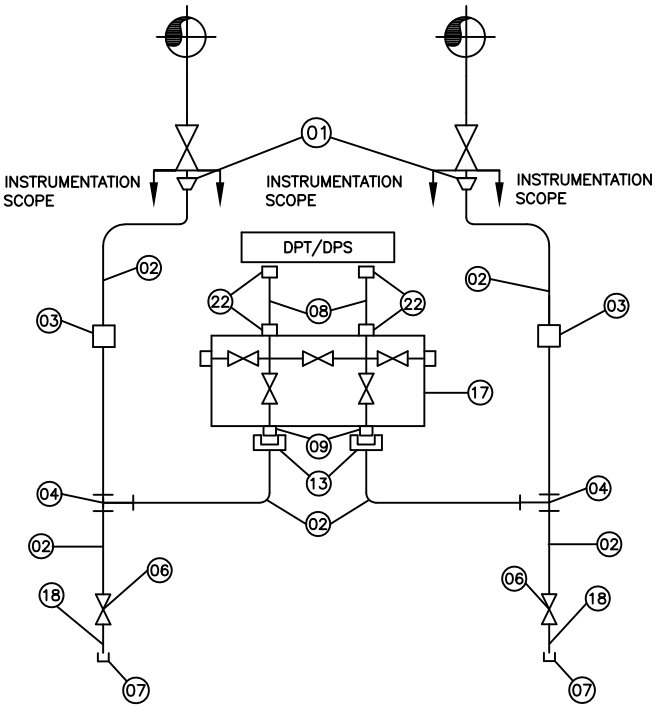
BHEL

TITLE :-

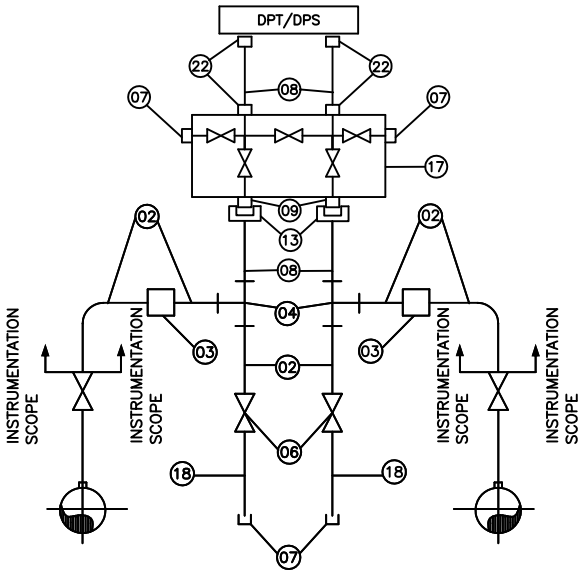
INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE GAUGES

DRG. NO.	PE-DG-999-145-IXXX		
REV. NO.	00	DATE	05.11.13
SHT	7 OF 9		



WATER SERVICE

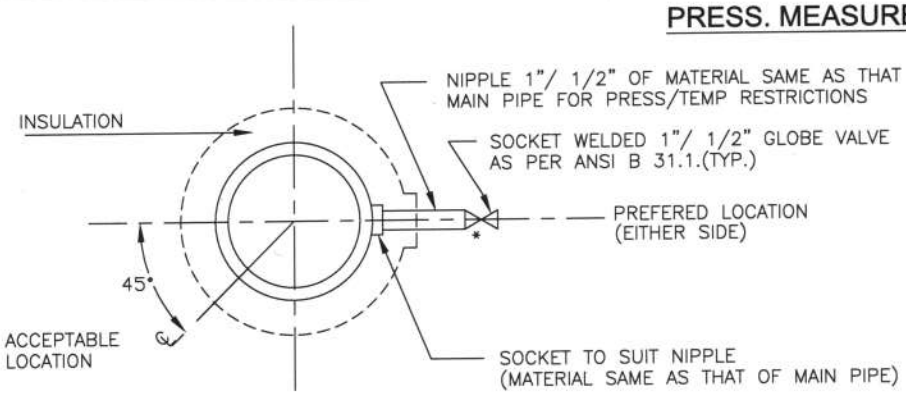


AIR SERVICE

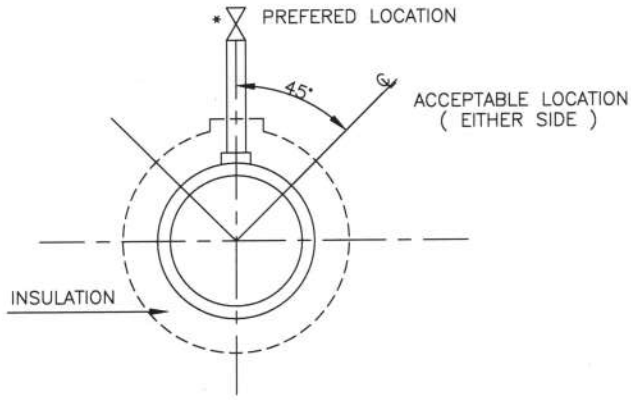
ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SS316	1/2" SW	02	02
06	FORGED GLOBE VALVE	SS316	1/2" SW	02	02
07	CAP	CS	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	00	00
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM DIFFERENTIAL PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	8 OF 9	

PRESS. MEASUREMENT

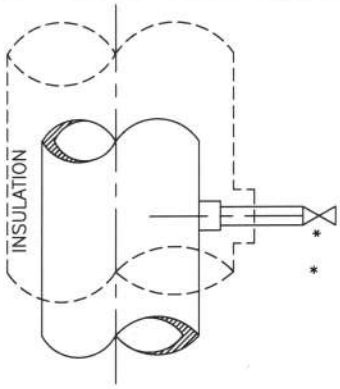


ELEVATION
LIQUID SERVICE



ELEVATION
STEAM SERVICE

PRESSURE CONNECTION ON HORIZONTAL PIPE



* USE DOUBLE ISOLATION VALVES FOR PRESSURE EQUAL TO OR EXCEEDING 40 Kg/Cm2.

ELEVATION
LIQUID OR STEAM SERVICE

PRESSURE CONNECTIONS ON VERTICAL PIPES

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REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE							T.G.			21.08.15
					CLEARED BY						

NTPC — NTPC LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

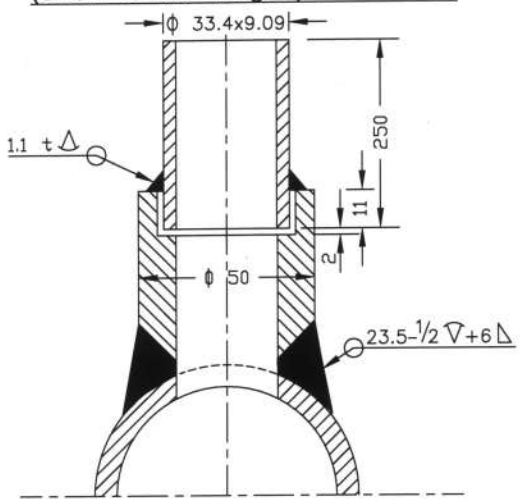
PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

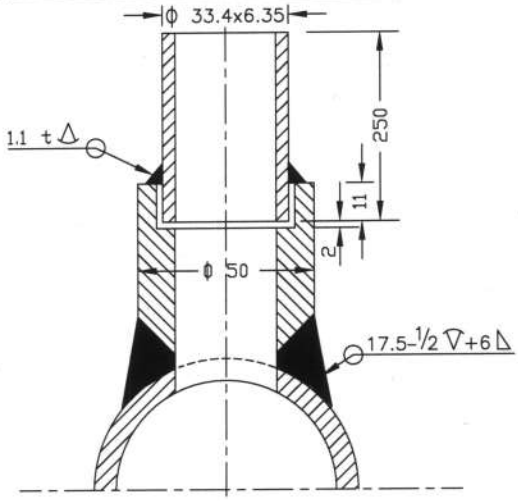
SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-1 Of 14	A

PRESSURE MEASUREMENT

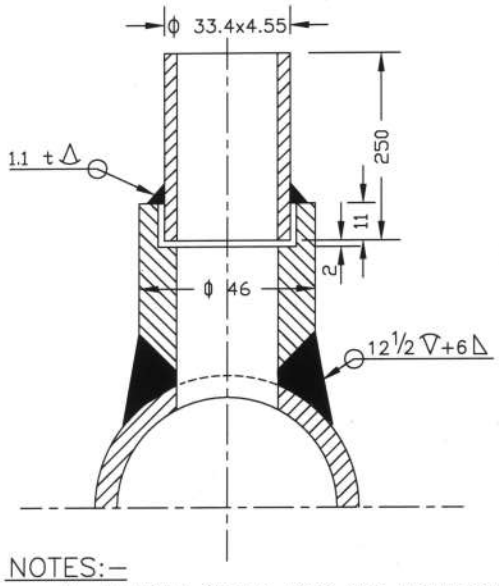
(SYSTEM PR.>40Kg/Sq Cm CL 9000)



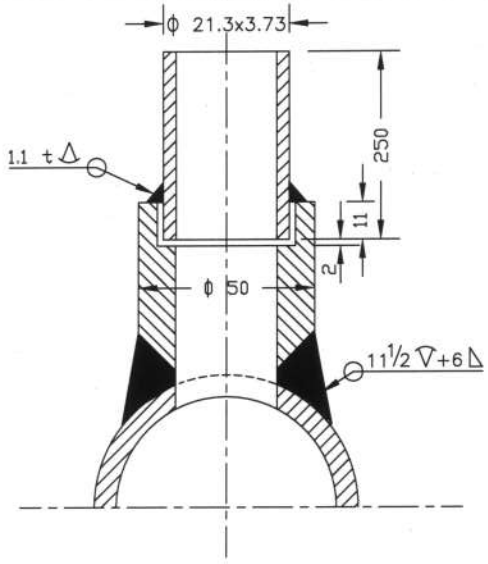
(SYSTEM PR.>40Kg/Sq Cm CL 6000)



(SYSTEM PR. <40Kg/Sq cm Nb 25 CL 3000)



(SYSTEM PR. <40Kg/Sq cm Nb 15 CL 3000)



NOTES:–

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFIRM TO ANSI B 16.11.
2. THE LENGTH OF THE NIPPLE SHOULD BE 250mm.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 16.1.
4. TWO ISOLATED VALVES ARE TO BE USED FOR PRESSURE = >40 Kg/Cm2.
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.
6. ORIENTATION OF TAP WILL BE VARY WITH TYPE OF PROCESS FLUID AND NATURE OF RUN OF THE PIPE.
7. ACTIVITIES TO BE COMPLETED AT THE SHOP, WELD THE COUPLING (OR BOSS) ON THE PIPE AND DRILL PRESSURE CONNECTION HOLE (SAME AS I D OF NIPPLE) IN THE PIPE IN ALLIGNMENT WITH HOLE IN THE COUPLING.
8. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE							T.G.			21.06.18

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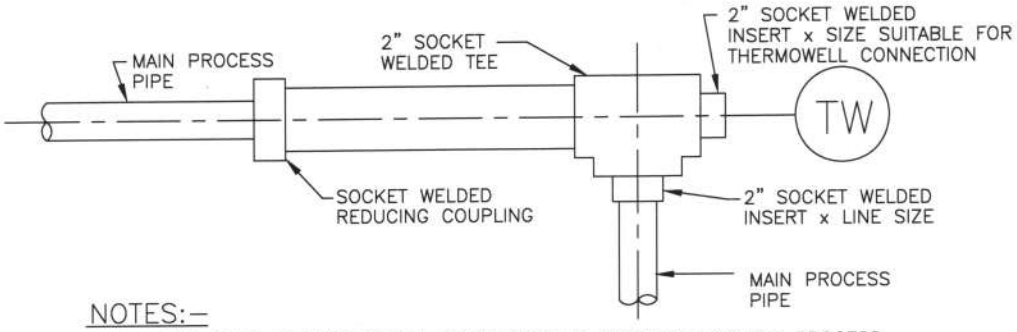
N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

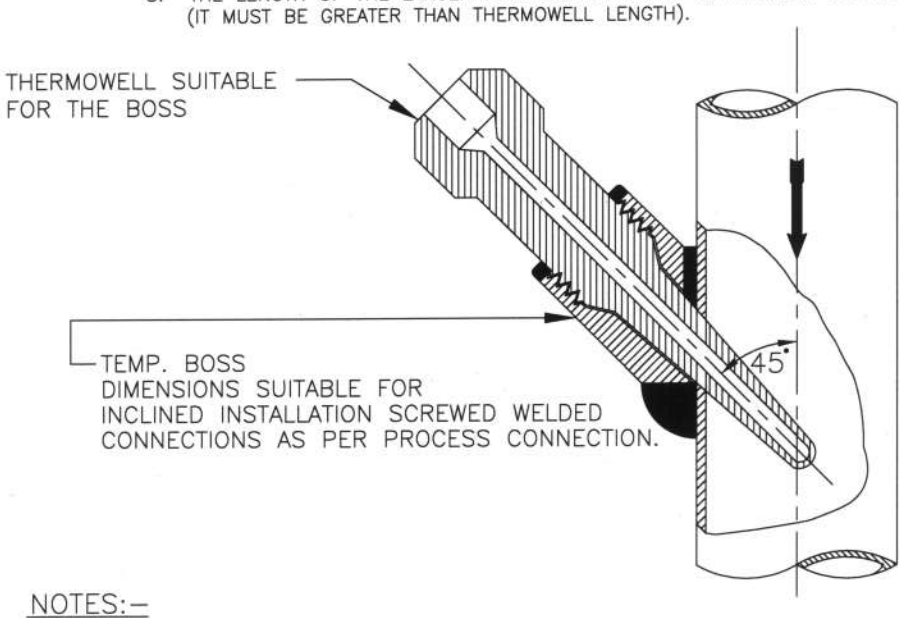
SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh–2 Of 14	A

TEMP. MEASUREMENT



NOTES:–

1. THIS TYPE OF THERMOWELL INSTALLATION IS SUITABLE FOR THE PROCESS PIPE OF 2" NPS AND SMALLER.
2. FOR STEAM SERVICE THIS TYPE OF THERMOWELL INSTALLATION 90° BEND MAY BE USED ONLY IN VERTICAL PLANE.
3. THE LENGTH OF THE LARGER PIPE SECTION SHALL BE MINIMUM 150mm (IT MUST BE GREATER THAN THERMOWELL LENGTH).



NOTES:–

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF MIN. 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION MAY BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (ATLEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF THE INSTALLED THERMOWELL).

FOR TENDER PURPOSE ONLY

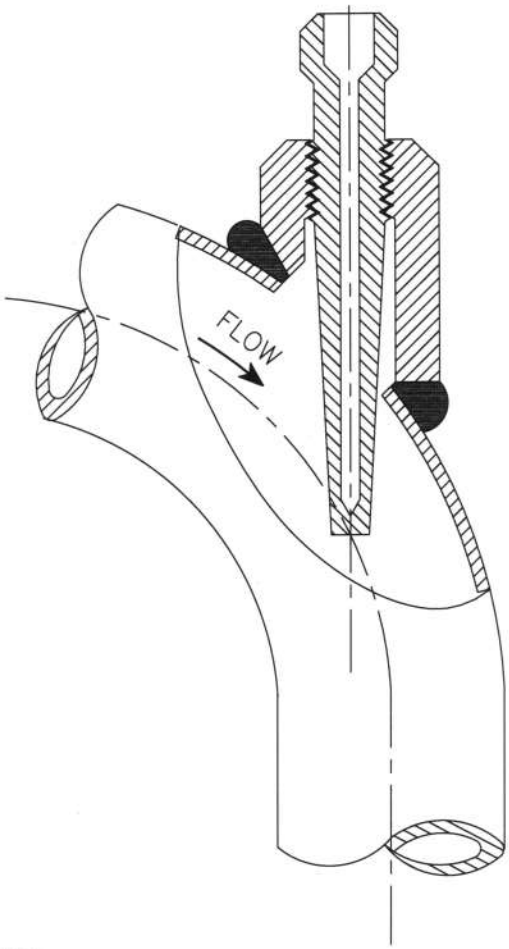
REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE							T.G.			31.08.15
					CLEARED BY						

NTPC — N T P C LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT	TYPICALTHERMAL POWER PROJECT (SG PACKAGE)
TITLE	INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999/102-POI-A-035 Sh–4 Of 14	A

TEMP. MEASUREMENT



NOTES:–

1. FLOW INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF ELBOW FORM (AS SHOWN) OF MINIMUM 3" SIZE SHALL BE USED.
3. ELBOW EXPANDER SECTION IN HORIZONTAL PLANE MAY BE USED FOR LIQUID SERVICES. ONLY STEAM SERVICES EXPANDER SECTION MAY BE USED IN VERTICAL PLAN.

FOR TENDER PURPOSE ONLY

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A	FIRST ISSUE							T.G.			21.06.12
					CLEARED BY						

एन टी पी सी NTPC **N T P C LIMITED**
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
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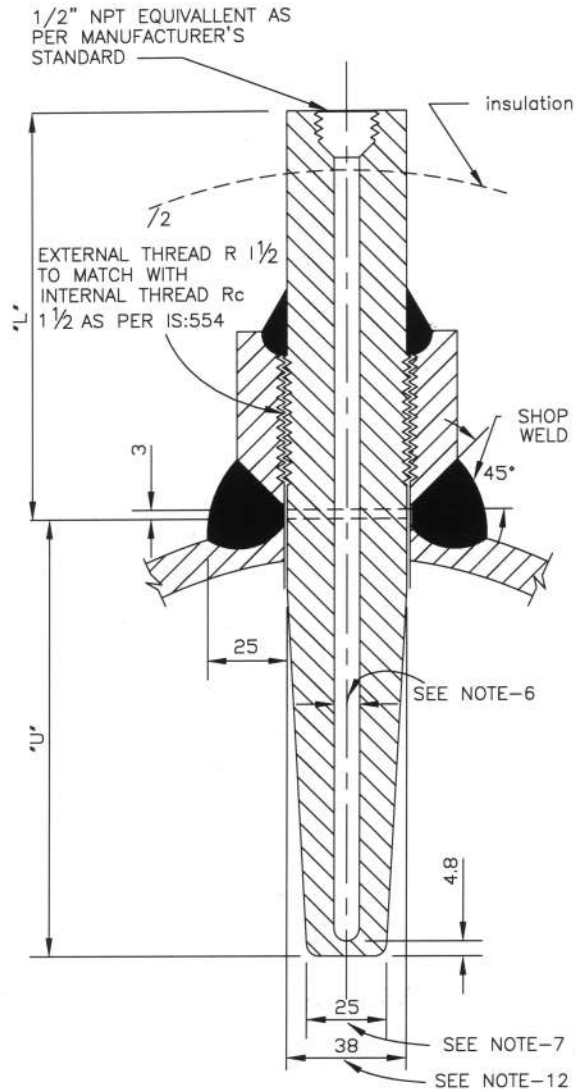
TEMP. MEASUREMENT



NOTES:-

1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE PROCESS PRESS EQUAL/ABOVE 40 Kg/Cm2(g).
2. THE MATERIAL OF THE BOSS SHOULD BE SIMILAR TO THAT OF PIPING MATERIAL OF SPECIFICATION.
3. ALL WELD TO BE TESTED IN ACCORDANCE WITH APPLICABLE CODES BY MANUFACTURER.
4. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
5. THERMOWELL SHALL BE DRILLED BARSTOCK TYPE.
6. INTERNAL BORE OF THE THERMOWELL SHOULD BE SELECTED BASED ON THE NORMAL SIZE OF THE SENSING ELEMENT AS PER ASME,PTC-19.3.
7. THE BOTTOM DIAMETER OF THE THERMOWELL TYPICALLY SHOWN HERE SHALL BE SUBJECT TO VARIATION BASED ON THE INTERNAL BORE OF THERMOWELL AND THICKNESS OF THERMOWELL MATERIAL TO WITHSTAND THE PROCESS PRESS.AND TEMP.,AS PER ASME,PTC-19.3.
8. THE TYPE OF TAPERED THERMOWELL SHALL BE USED FOR LIQUID VELO-CITIES UP TO 92M.P.S.(300F.T.P.S.).
9. THERMOWELL WITH THE INSULATION LAG EXTENSIONS SHALL BE USED WHEREVER APPLICABLE.
10. ACTIVITIES TO BE COMPLETED AT THE SHOP. WELD THE BOSS ON THE PIPE AND DRILL THE HOLE IN THE PIPE IN ALLIGNMENT WITH HOLE IN THE BOSS. PROVIDE INTERNAL THREAD AS PER IS:554 TO MATCH WITH THE THERMO-WELL EXTERNAL THREAD.
11. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
12. WIILL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER RC 1 1/2
13. THE "U" & "L" DIMENSIONS SHALL BE BE SELECTED BASED ON PARTICULAR APPLICATION AND THE SAME SHALL BE SUBJECT TO OWNER'S APPROVAL DURING DETAILED ENGINEERING.
14. ALL DIMENSIONS ARE INDICATIVE ONLY.

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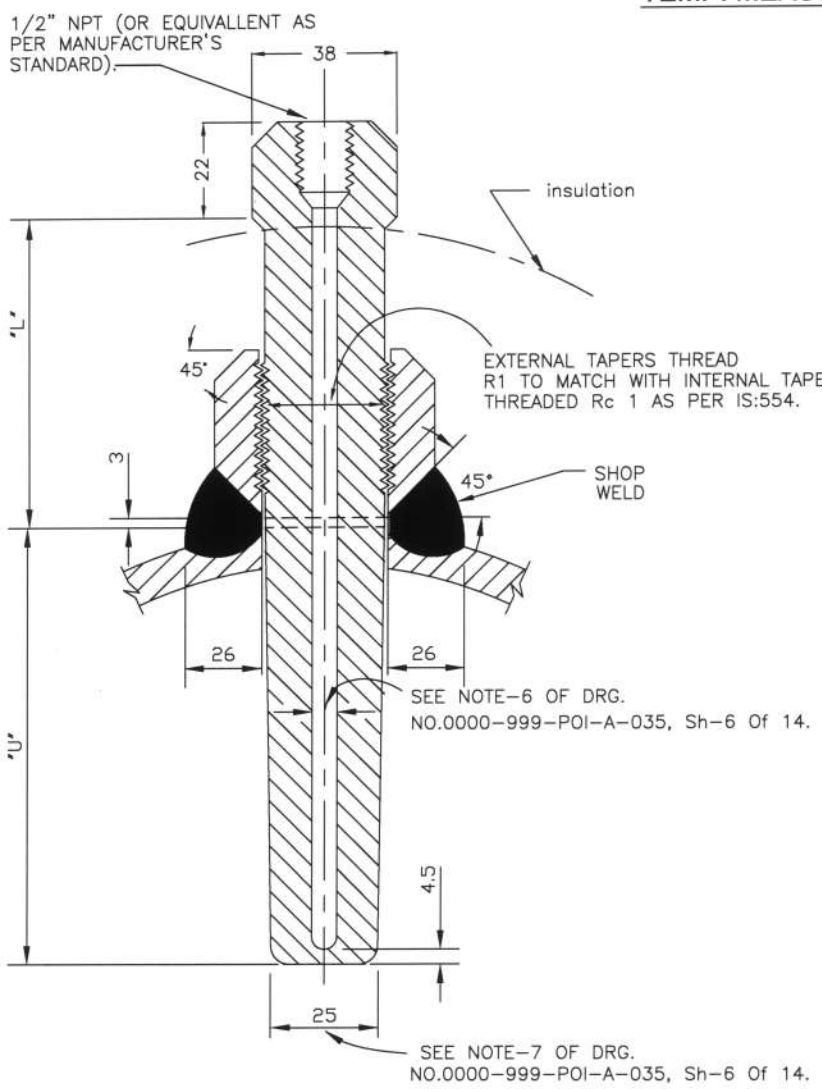
TEMP. MEASUREMENT



NOTES:-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS PRESSURE/TEMPERATURE BELOW 40 Kg/Cm2(g)/400°C
2. FOR PRESSURE TIGHT JOINTS THE BOSS SHOULD HAVE INTERNAL TAPERED PIPE THREAD Rc 1 AS PER IS:554. THE LENGTH OF THREAD ENGAGEMENT SHOULD BE AS PER ABOVE STANDARD.
3. PIPES HAVING PROBABILITY OF PROLONGED VIBRATION SEAL WELDING MAY BE DONE ALL AROUND AFTER TIGHTENING THERMOWELL WITHIN THE BOSS.
4. SEE NOTES-2 TO 14 OF DRG. NO. 0000-999-POI-A-035, Sh-6 Of 14.

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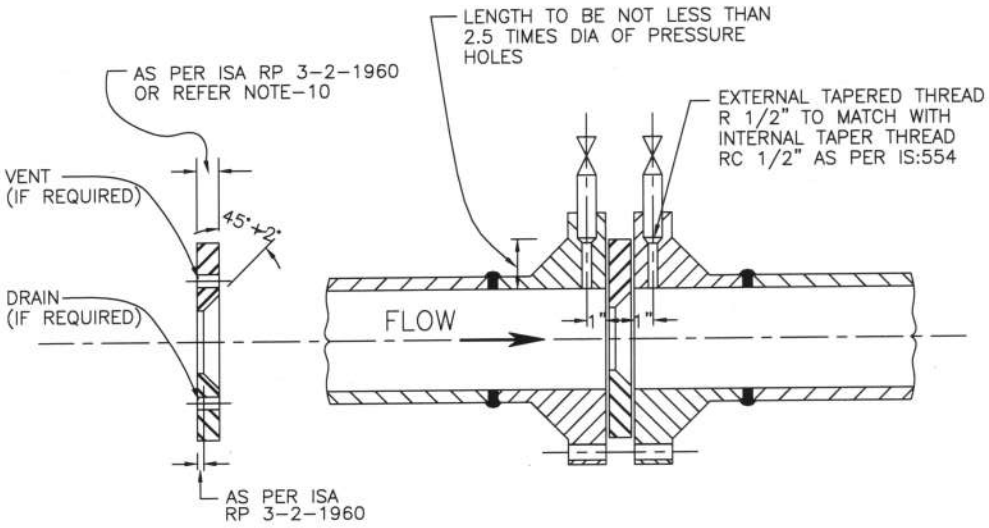
FLOW MEASUREMENT



NOTES:-

1. ORIFICE PLATE MOUNTED BETWEEN FLANGES WITH FLANGE TAPPING (AS SHOWN ABOVE) SHOULD BE LIMITED TO PIPE SIZES OF 2" OR LARGER.
2. ORIFICE PLATE SHALL BE MOUNTED BETWEEN PIPING FLANGES WITH THE SHARP EDGE FACING UPSTREAM SUCH THAT CENTRE OF THE CONCENTRIC ORIFICE SHOULD BE WITHIN 0.79 mm (1/32") OF THE AXIS OF THE PIPE.
3. TWO GASKETS SHALL BE INSERTED BETWEEN THE PLATE AND THE FLANGES AND INSIDE DIAMETER OF THE GASKETS SHOULD BE ATLEAST 1.5 mm (1/16") GREATER THAN THE INSIDE DIAMETER OF THE PIPE SO THAT THEY DO NOT PROTRUDE INTO THE PIPE.
4. PIPING FLANGES SHALL BE ANSI WELD NECK, RAISED FACE TYPE. THE FLANGE IS TO BE ALIGNED WITH THE FACE PERPENDICULAR TO THE FLOW AXIS.
5. BIDDER TO SUPPLY ORIFICE PLATE SPECIAL TYPE (HAVING PRESS. CONNECTIONS) OF FLANGES ALONG WITH GASKETS, NIPPLES AND SOURCE VALVES.
6. ON HORIZONTAL PIPE RUN PRESSURE CONNECTIONS ARE TO BE TAKEN FROM SIDES FOR LIQUID AND STEAM SERVICE AND FROM TOP FOR DRY GAS SERVICE. FOR PROCESS LIQUIDS INSTALLATION OF PRESSURE TAPS MAY BE ALLOWED WITHIN AN ANGLE OF 45° ELBOW THE HORIZONTAL IN SPECIAL CASES BUT NO BOTTOM CONNECTIONS ARE ALLOWED.
7. THE LOCATION OF PRESSURE TAPS MUST BE WITHIN 1.5 mm (1/16") OF THE DISTANCE SPECIFIED.
8. MAXIMUM DIAMETER OF PRESS. CONNECTION HOLES SHALL BE AS PER RECOMMENDATIONS OF ASME PTC 19.5. THE DIAMETER OF THE HOLE SHOULD REMAIN THE SAME FOR A DISTANCE NOT LESS THAN 2.5 TIMES OF THE DIAMETER BEFORE EXPANDING INTO THE PRESSURE PIPE.
9. THERE MUST BE NO BURRS WIRE EDGES OR OTHER IRREGULARTIES ALONG THE EDGE OF THE HOLE AND IT MUST BE SQUARE AND ROUNDED SLIGHTLY (1/64" RADIUS).
10. ORIFICE PLATE SHOULD BE FLAT WITHIN 0.02 mm (0.001") AND THE SURFACE ROUGHNESS SHOULD NOT EXCEED 20 MICRO INCH. THE THICKNESS OF THE ORIFICE PLATE SHOULD BE AS PER EN ISO 5167:2003.
11. FOR HORIZONTAL PIPE RUN DRAIN HOLES IN ORIFICE PLATES ARE AT THE BOTTOM (APPROX. TANGENT TO INSIDE DIA OF PIPE) FOR STEAM OR GAS SERVICE. VENT HOLES SHOULD BE LOCATED ON UPPER SIDE FOR INCOMPRESSIBLE FLUID.
12. ORIFICE PLATE SHOULD BE OF 316 SS (ASTM A167-54 GRADE-II).
13. RECOMMENDED MINIMUM LENGTHS OF STRAIGHT PIPE PRECEDING AND FOLLOWING ORIFICES SHALL BE AS PER EN ISO 5167:2003.
14. THREE PAIRS OF PRESSURE TAPS SHALL BE PROVIDED WITH NIPPLES OF REQUIRED LENGTH AND SOURCE VALVES AND THE UN-USED TAPS ARE PLUGGED.
15. THE INTERNAL TAPERED CONNECTION WITHIN THE FLANGE FOR PRESSURE TAPS SHOULD BE RC 1/2" AND THE NIPPLE SHOULD ALSO OF EXTERNAL THREADED R 1/2" AS PER IS:554. THE LENGTH OF THREADED ENGAGEMENT SHALL BE AS PER ABOVE STANDARD.

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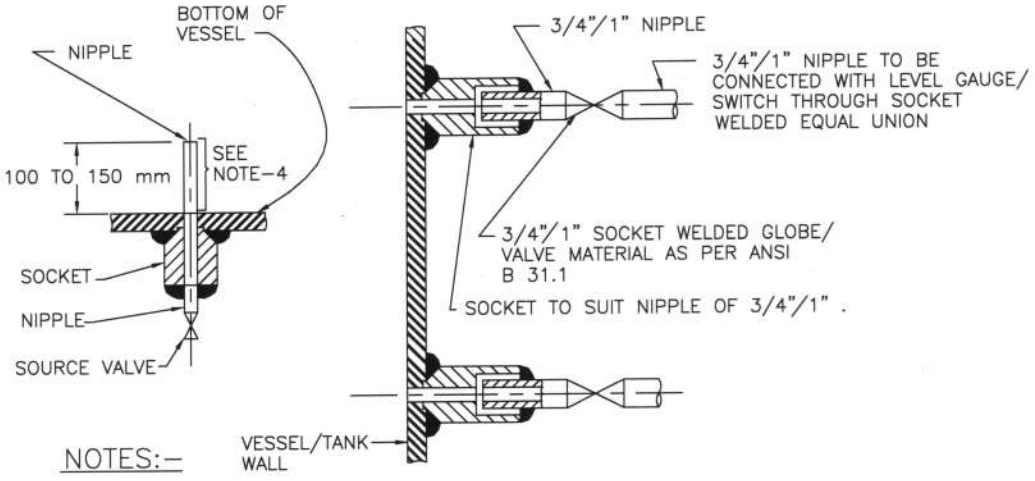
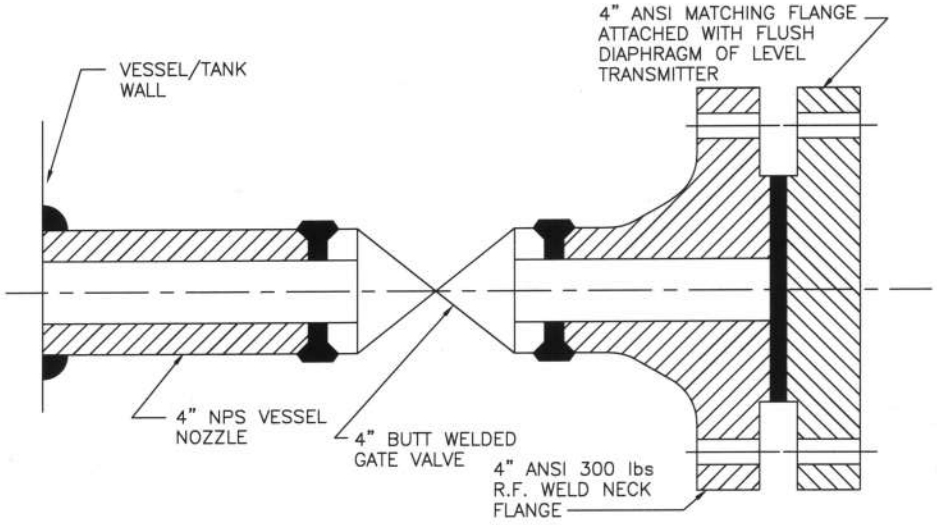
LEVEL MEASUREMENT



NOTES:-

1. THIS TYPE OF PROCESS CONNECTION SHALL BE USED FOR LEVEL GAUGE AND EXTERNAL CAGE TYPE FLOAT OR DISPLACER OPERATED LEVEL SWITCH.
2. FOR GAUGES 3/4" NIPPLE ALONG WITH 3/4" SW SOURCE VALVE AND FOR SWITCHES 1" NIPPLE ALONG WITH 1" SW SOURCE VALVE SHALL BE PROVIDED AS PROCESS CONNECTION.
3. SOURCE CONNECTION ON VESSEL SHOULD NOT BE LOCATED AT PLACES SUBJECTED TO INTERFACE AND TURBULENCE FROM INLETS AND OUTLETS.
4. IF LOWER CONNECTION IS TAKEN FROM BOTTOM OF THE VESSEL THEN THE NIPPLE MUST BE 100 mm TO 150 mm ABOVE THE BOTTOM OF THE VESSEL.



NOTES:-

1. THIS TYPE OF PROCESS CONNECTION SHALL BE PROVIDED FOR TANK LEVEL MEASUREMENT OF VISCOUS OR CORROSIVE LIQUID USING FLUSH DIAPHRAGM/WAFER TYPE LEVEL TRANSMITTER.
2. WELDING OF MATCHING FLANGE TO GATE VALVE SHALL BE DONE BY BIDDER.

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1

INSTRUCTION MANUALS

The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in specification . The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

A) ERECTION MANUALS

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of a particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tools, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection and General Safety procedures to followed during erection/installation.

h) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

j) Procedure / Check list for pre-commissioning activities.

k) Procedure / Check list for commissioning of the system.

l) Safety precautions to be followed in electrical supply distribution during erection.

B) OPERATION & MAINTENANCE MANUALS

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows:

1) Chapter 1 - Plant Description: To contain the following sections specific to the equipment/system supplied

(a) Description of operating principle of equipment / system with schematic drawing / layouts.

(b) Functional description of associated accessories / controls. Control interlock protection write up.

(c) Integrated operation of the equipment alongwith the intended system. (This to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

(e) Design data against which the plant performance will be compared.

(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.

(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement.

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

2 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in specification. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

3 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

3.1 **PLANT HANDBOOK**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

3.2 **PROJECT COMPLETION REPORT**

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

4 **DRAWINGS**

a) i) All the plant layouts shall be made in computerized 3D modelling system. 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.

ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per **Annexure-VI** of Part-C. The soft copies shall be uploaded by the vendors in C-folders, a Web-based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.

Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per specification.

iv) Contractor shall prepare the model of all the facilities located within plant boundary covering facilities in Main Plant Block area and Balance of plant (BOP) area in an integrated & intelligent 3D software solution. Main Plant Block area shall include Transformer Yard, TG building (including all facilities), Boiler area, ESP area, chimney area, FGD area and any other facility located in main plant block. BOP area shall include all facilities pertaining to AHP, CHP, LHP, GHP, DM PT plant, pipe & cable racks and any other facility located within plant boundary.

All piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings and RCC layout of major buildings and structural arrangement

drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.

Contractor shall prepare and provide 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 and shall make a presentation of the same every 3 months from LOA to enable NTPC to review the progress of engineering or as & when required by employer.

The complete 3D data (editable model) which shall be utilised for all future detailed engineering related to maintenance, operation, R&M, efficiency improvement of the project etc. Complete 3D model along with as built GADs, layout, isometrics, reports extracted and 3D models for all disciplines , with any other document generated from 3D model and naming conventions with as-built updates along with complete reference databases, component catalogues for all the size range shall be handed over to owner. Apart from the 3D Model, all drawings like GADs, Isometrics etc. extracted from the model shall also be submitted by the Contractor in Electronic form. 3D model along with complete Project databases shall be submitted at each model review stage and as final as-built. The contractor shall also submit all the configuration files, customization files, templates and all referenced databases.

All input files of software used for design of Equipments / Piping like CAESAR2 files, input files for Pressure vessel design, datasheets etc., shall be handed over to NTPC as per NTPC specifications for handover of Engineering Information.

Further, two Licenses of the used 3D Modelling Software (One for Engineering View and One for Site View) shall be provided along with compatible Hardware for possible review and study of the Model Files being submitted by the Bidder Time to time.

All software provided shall necessarily include cost for perpetual license(s) for use on all the machines and an Annual maintenance contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three years after warranty/guarantee period .

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 NTPC shall be at 30%, 60% and 90 % of 3D

model stage.

Database backup shall be taken every month and handed over to NTPC.

b) All documents/text information shall be in latest version of MS Office/MS Excel/PDF format as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission **in line with suggestive MDL.**

Further, space shall be identified on each drawing for Approval stamp and electronic signature.

f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or

approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

j) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to “as built” conditions and submit no. of copies

k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout

completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

l) The Contractor shall submit adequate prints of drawing / data / document as per Annexure-VI. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

1.0 OPERATION AND MAINTENANCE SERVICES

The bidder scope also covers the Operation and Maintenance (O&M) services for Preventive and Breakdown maintenance from the date of successful commissioning till handing over to end customer. However, actual date of start of O&M services shall be communicated to successful bidder by BHEL site personnel.

Bidder to note that the spares and consumables required for maintenance of the equipment during this O&M period shall be in bidder's scope of supply. Bidder shall use only genuine parts as mentioned in O&M Manual. Any damage or malfunction caused by the use of unauthentic parts or unqualified personnel shall be responsibility of bidder and as a consequence of above bidder is required to replenish the unauthorised part and abridge the qualified person without any commercial implication to BHEL.

O&M Services scope also covers all regular maintenance by trained service engineers and supply of genuine parts and lubricants as per the original equipment manufacturer's recommendations.

For the purpose of Operation of AC System, One-day shall be considered as 24 hours i.e. 3 shifts of 8 hours each. The AC System (along with related accessories) shall be operated on Round-the-clock basis on all the days of the year including Sundays and Public Holidays

O & M Personnel should be acquainted with local language. Governmental / Statutory approval w.r.t. O&M service as applicable shall be in bidder's scope.

Total duration of the Operation and Maintenance services has been envisaged for six (06) months for individual AC plants/control buildings identified in price format/specification. The duration of operation & maintenance services can be increased or decreased as per requirement and payment in such case shall be made on pro-rata basis.

The operation and maintenance services can be continuous or intermittent as per site requirement for individual AC plants/control buildings identified in price format/specification.

Bidder has to compulsorily maintain log book for the O & M staff engaged for O&M jobs and submit to Engineer in charge for certification for realization of the bills. After certification of the bill by Engineer in charge of BHEL, bidder shall claim the amount after completion of minimum 30 days.

Depending on start of O&M services, there is a possibility that some period of O&M services and Warranty period may overlap. **However, it is clarified that any maintenance required or any spare of AC System required to be replaced during Warranty period (as part of warranty clause requirement) shall not be made part of O&M Services. Bidder may take care of this fact while working out the prices of O&M services**

Wherever AC system has been written in O&M Service Specification, the same shall be deemed as complete AC System.

The vendor shall deploy following minimum manpower for Operation of AC System.

i. Two qualified and experienced AC operator per shift on "Round the Clock" basis throughout the year for all days of the year including Sundays & Public Holidays. There must be minimum 30 minutes overlapping between two shift operators to get familiarize with the status of AC System.

ii. Two Helper per shift on " Round the Clock" basis throughout the year for all the days of the year including Sundays and Public Holidays. The helper shall assist the AC System Operator in day to day operation of AC System and accessories and shall assist him for keeping AC System equipment's in neat and tidy condition.

1.1 Responsibility of AC System Operator

i. AC System operator shall be responsible for proper sequential operation of AC System including operation of standby equipment in a predefined sequence and stopping the same (when necessary) as per the procedural practice. In case of any abnormality (like non availability of power supply at incomer of AC System), he shall immediately report the matter to BHEL site Engineer for further action. Similarly, any malfunctioning in the system shall be immediately reported by him to BHEL site Engineer for suitable corrective action irrespective of time of occurrence of malfunctioning / abnormality in the system. A log book of all such outrages shall be maintained by AC system operator, which shall be shared with BHEL site engineer on periodic basis.

ii. AC System operator shall take hourly readings of all the parameters of AC System / Equipment's including reading on main electrical panel of AC System. Temperature & RH readings inside all AC areas shall be taken at least once in a day. All the readings shall be recorded in a logbook register.

1.2 Responsibility of Helper.

i. The AC System helper shall assist AC System operator for day to day smooth operation of AC System, like Checking of water levels of cooling tower, cleaning of Tanks, cleaning of strainers, checking water parameters of softening plant cleaning of AHU filters and other filters etc. as and when required. He shall be responsible for keeping all the equipment's of AC System as applicable in clean and tidy condition. He shall also carry out general cleaning of all AC equipment's including Electrical Panels (Part of AC System), AHU's etc. on regular basis.

ii. The helper shall work under the control of AC System operator and shall always ensure that unusable junk materials are not allowed to be kept in AC System room or AHU rooms.

iii. Under such eventuality, he will report the matter to Plant Operator, who in turn will take suitable action including reporting the matter to BHEL site Engineer.

1.2.1 All the log book registers shall be arranged by vendor. Log book register duly paged and bounded will be maintained in good condition by vendor.

1.2.2 All the necessary tools & tackles and other materials, required for operation of AC System shall be kept by vendor under the control of AC System operator. These tools & tackles shall be separate from tools & tackles (as per price format) which shall be handed over to customer in new condition. Required testing instruments like refrigerant leak detector, Multi Meter (for Electrical portion of AC System), Sling pshycrometer, Line Tester, Tool Kit, Torch, vacuum pump, oil charging pump, Pressure testing kit etc. should also be always available with Plant Operator.

1.2.3 In case of any operator / helper being on leave, vendor shall immediately take advance action and provide substitution so that minimum manpower as indicated above is not reduced on any day. In case a particular shift duty A/C Operator or helper does not turn up due to any reasons, the earlier duty person shall continue to make sure that AC System never remains unattended.

2.0 Maintenance of AC System

i. Maintenance work under scope of the vendor shall broadly include but in no way limited to the following:

a) Preventive maintenance of the plant.

b) Servicing of the AC plants and associated equipment's at regular interval

c) Attending to complaints.

d) Replacement of worn out or defective components

e) Replacing of consumables like refrigerant gas, oil, chemicals and salt for softening plant as and when required.

No consumable or any other items of AC system shall be arranged by Customer and no extra payment shall be made by customer in this regard.

ii. Vendor shall be responsible at all time, during the entire period of contract for satisfactory performance of AC system (including accessories) with zero down time. During emergency or breakdown, vendor's Engineer along with related technicians shall be available immediately even though it may be beyond normal working hours or on public holidays till the AC System is restored back into normal satisfactory condition. Response time for attending breakdown complaints shall not exceed 2 hours.

iii. Defective / worn out components shall be replaced only by genuine and original parts. OEM or its authorized dealer's invoice shall be submitted as proof of using genuine parts. All common spares required for AC system shall normally be kept available in the plant by the vendor. However, for critical spares, the same shall be made available in not more than 72 hours from the time of break-down requiring such spare.

iv. Preventive Maintenance, servicing of AC System equipment's and accessories etc. shall be done by vendor in a planned manner in consultation with concerned customer's engineer. Preventive maintenance and service should be done as per the recommendations / guidelines of various OEMs

v. Major servicing & over handling of equipment's like compressors, evaporators, condensers, pumps, AHU's, piping / ducting works, valves etc. shall be done by vendor once in a year.

vi. In case any repair/services of particular equipment of system like chiller unit is to be carried out by vendor through OEM (or their authorized dealer), all the arrangements including tools, O&M spares etc. shall be the total responsibility of vendor.

vii. Vendor shall arrange and maintain separate logbook register for services / maintenance of AC System. Record of work done for services/maintenance repairs etc. shall be recorded by vendor's engineer in this register. This register shall always be with updated records & shall be produced to customer's engineer on weekly basis or as & when required by him.

viii. Vendor shall arrange and maintain sufficient stock of spares and consumable at site (AC room). Similarly, all necessary tools & instruments required for the purpose of servicing / maintenance / routine testing etc. shall also be arranged by vendor and should be available at site at all times.

ix. Repairs / servicing works shall normally be done by vendor at site up to maximum possible extent. However, in case any equipment or accessories is essentially required to be taken by vendor out of the plant premises for repairing / servicing, all necessary arrangements including to and fro transportation shall be the responsibility of vendor. Vendor shall also inform concerned customer's engineer for doing procedural formalities (like issue of gate pass etc.), prior to taking out the materials out of Plant premises.

x. In case bidder fails to supply the spares required for maintenance of the equipment, same shall be provided by BHEL at Bidders risk and cost.

xi. Vendor shall be fully responsible for safety of his personal at all times. Vendor shall also be responsible for taking all safety precautions at all the times, especially during servicing / preventive maintenance and repairs of AC System equipment's etc.

xii. All the safety controls of AC Plant such as HP, LP, OP, Water pressure switch, inter locking etc. shall be positively checked at least once a month and same shall be recorded by vendor engineer

xiii. Technicians & helpers engaged by the vendor shall wear uniform with nameplate for easy identification, while being within plant premises

xiv. Vendor's engineer shall be focal point for customer. He shall report to customer engineer on daily basis, for taking necessary instructions and to update the status of AC system

xv. If any damage to the equipment and its accessories has happened due to improper maintenance by bidder shall be recovered from the bidder.

xvi. Bidder is to arrange all the safety gears like helmets, air plugs, safety shoes etc. during the maintenance for the O&M Staff.

xvii. Bidder shall have to maintain storage shed along with site office during O & M contract also

xviii. Fabrication and erection of platform/extra support for AC areas if felt necessary during operation and maintenance of the system has to be done by the bidder.

Notes:

1. The bidder shall take approval from Engineer-in charge of BHEL by submitting organization Chart of O&M staff for this site clearly indicating man power deployment with their educational background & experience with supporting documents.

2. The bidder shall be solely and wholly responsible for safety and security of workers engaged in the job and the BHEL property. In case of any accident the contractor shall pay proper compensation to the workers as per workmen's compensation act and repair/replace BHEL property at their own cost & arrangement. The bidder shall also make adequate provision of insurance for their workers at their own cost to cover them against the risk of accident.

3. The bidder and their workers engaged in the job shall follow all safety rules at the time of execution of work. It shall be responsibility of the bidder to supply all safety equipment as necessary to its O&M staff.

4. Beyond general shift if any trouble/breakdown occurs in the plant, Maintenance team must reach the plant without any delay along with Engineer/Site In-charge.

5. No Person from the list of manpower shall leave the plant site without prior permission from the Engineer in charge of BHEL.

6. However, in operation part, if any person is absent, substitute must be given immediately otherwise proportionate deduction will be made

7. The replacement / substitute personnel for maintenance, manpower shall have the same educational qualification and experience.
8. If any additional manpower is required during O&M whatsoever under the scope of contract the same shall be made available by bidder in time within the cost. To cater the need of time bound maintenance jobs, the bidder shall depute additional manpower without any cost implication to BHEL
9. During execution of work if any personnel is found not suitable for the job or his presence inside powerhouse premises is felt undesirable, the personnel has to be replaced within 15 days.
10. BHEL will not be responsible for payment towards idle labour charges

Statutory Compliance by the bidder:

All Statutory compliances related to Labour, Health & Safety, Quality & Environment protection and insurance shall be as GCC Rev-07.

Sub : Sub-Qualifying Requirements for the Air Conditioning System

(A) In line with the Sub-Qualifying Requirements stipulated in Clause No. 4.5 of Sub-Section-IA, Part-A of Section-VI, we/our sub-vendor hereby confirm that we/our sub-vendor have designed, supplied, erected and commissioned atleast One (1) number of Air Conditioning systems having a total installed capacity of 300TR or more including stand-by chiller unit (if any), which included atleast one chilling unit with a minimum capacity of 60 TR. The system have been in successful operation for atleast One (1) year. The details are given below:

Sl.No.	Item Description	Plant No. 1
1.	Name of the Client with full address, contact person(s), fax and tele no.	
2.	Name and address of the Plant	
3.	Purchase Order no. and date	
4.	Copy of purchase order enclosed	Yes/No
5.	Date of Commissioning	
6.	No. of years of successful operation	
7.	Whether clients certificate is enclosed to prove that "the Air Conditioning system is in successful operation for atleast one (01) year.	Yes/No
8.	Total installed capacity of air conditioning system (should be atleast 300 TR)	..... TR
9.	Capacity of largest chilling unit in above air conditioning system (should be atleast 60 TR)	..... TR
10.	Type of installation	Industrial/ Commercial Installation
11.	The scope of Contract included	
	(a) Design	Yes/No
	(b) Supply	Yes/No

Signature of authorized signatory.....

Sl.No.	Item Description	Plant No.1
	(c) Erection	Yes/No
	(d) Commissioning	Yes/No
12.	Documentary evidence in support of above enclosed	Yes/No

(B) We further declare that the chillers to be suppplied under the package shall be sourced from manufacturer M/s..... who has manufactured and supplied atleast One (1) no. of similar type of chiller unit having a capacity of not less than 150 TR and have been in successful operation for atleast One (1) year.

Chillers proposed to be supplied under this package would be sourced from following manufacturers. Experience details of the manufacturers are given below:

(a)	Type of vapor compression type chilling unit offered	Screw compressor
(b)	Name and Address of Manufacturer from whom the above equipment is sourced	
(c)	For the above type of chiller Experience details of the Manufacturer is as follows :	

Sl.No.	Item Description	Plant No.1
1.	Name of the Client with address, name of contact person(s), tel. no. & fax no.	
2.	Purchase Order no. and date	
3.	Date of Commissioning	
4.	No. of years of successful operation	
5.	Capacity of chiller unit	..... TR

Sl.No.	Item Description	Plant No.1
6.	Clients certificate to demonstrate successful operation of machine for at least one (01) year.	Yes/No
7.	Documentary evidence in support of above enclosed	Yes/No

Date :

Place :

(Signature).....

(Printed Name).....

(Designation).....

(Common Seal).....

Signature of authorized signatory.....

PERFORMANCE GUARANTEES TO BE DEMOSTRATED

PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SITE	
S.N.	**DESCRIPTION OF TESTS TO BE PERFORMED**
1	Capacity (TR) of water cooled chillers for A/C system of Main Plant Area (TG Building) and A/C system of ESP/AHP/FGD control rooms
2	Capacity (TR) of Air cooled condensing (D-X) unit for A/C system of water system control building and office area in control tower.
3	Guaranteed room conditions during summer for all the Air conditioned areas.
4	Parallel operation of chilled water and condenser water pumps.
5	Vibration level of chillers, condensing units, centrifugal fans of AHUs and all pumps.
PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SHOP	
S.N.	**DESCRIPTION OF TESTS TO BE PERFORMED**
1	Capacity and discharge pressure of chilled water pumps, condenser water pumps at its rated duty point.
2	Capacity and static pressure of AHU fans at its rated duty point.

1.0.0 INTRODUCTION

In accordance with the condition of contract /letter of award on successful completion of system trial operation at site and liquidation of all defects, the system/ individual equipments shall be subjected to performance and Guarantee Tests at site.

2.0.0 SCOPE

The test procedure shall cover the Performance and Guarantee Tests to be conducted at site for the entire system / subsystems and individual equipments covered in the A.C. Package. The test procedure shall cover the testing method for parameters covered as — Guaranteed Parameters in LOA and checking of ratings and performance requirements stipulated for various equipments covered in the specifications.

3.0.0 OBJECTIVE O F THE TEST

3.1.0 To check healthy working of all the equipments forming the total air conditioning system.

3.2.0 To check the power consumption of the motors for which power consumption limits are guaranteed at specified capacity of equipments.

3.3.0 To verify the total capacity of the plant including stand-by equipments. The tonnage rating obtained from all AHUS/Chillers is to be cross checked from the heat rejection across the condensers. However, capacity of plant shall be verified during summer (May-August) but room temperature verification for 24 hours shall be done in both summer and monsoon.

3.4.0 Capacity rating and guaranteed power consumption to be established during summer only during May to August when the ambient temperature (DBT) is generally high (Additional heating load if required shall be provided by NTPC / Vendor).

3.5.0 To check the temperature and relative humidity conditions during summer and monsoon in the air-conditioned space with those incorporated in the contract.

However Relative Humidity shall not be guaranteed for areas catered by High wall/Cassette/Ductable split air conditioners

3.6.0 Operating parameters of the system to be logged for complete cycle with calibrated instruments at the time of capacity test during summer.

3.7.0 Operating parameters of the system to be logged with online instruments except calibrated psychrometer for Room condition test during Monsoon test.

3.8.0 To check satisfactory operation of all safety switches and electrical interlocks for each individual equipment and for the complete system.

3.9.0 Vibration and noise level to be measured for all rotating equipments.

4.0.0 CONDTIONS OF TEST

4.1.0 Conductance of test

Performance and Guarantee Test at site shall be conducted by accredited representatives of the CONTRACTOR/ Vendor and NTPC Limited. The contractor shall be given permission to inspect the entire system in advance and make it ready for test. Contractor representatives shall witness and associate with all phases of test and record the data jointly with NTPC representatives.

4.1.1 The responsibility for conducting the test rests with the contractor.

4.2.0 TEST INSTRUMENTS

4.2.1 All instruments required for the PG test will be provided by the contractor at their cost.

4.2.2 Calibration of test instruments shall be responsibility of the contractor.

4.2.3 Calibration of instruments (to be used in the test) shall be carried out at a Govt. /NTPC approved test laboratory.

4.2.4 Calibration of the instruments should be carried out prior to, but not more than six months before the commencement of the test. The calibration certificate of the instruments should be valid for the period of the test.

4.2.5 Calibration certificates (in original) of all instruments from Govt. /NTPC approved Test Laboratory shall be submitted by the contractor for NTPC approval prior to start of the test. Original Calibration certificate will be returned to Contractor after review & acceptance of the certificate.

4.2.6 All the calibrated instruments preferably shall be sealed after calibration at Test Lab & intactness of the seal shall be checked by NTPC before start of the test. If sealed, NTPC shall issue a certificate confirming the breakage of the seal after verification of instruments.

4.2.7 All on line instruments, which will be used during the test, shall be calibrated at Govt. /NTPC Test Laboratory.

4.2.8 On line pressure gauges shall be used for recording the parameters of compressor cycle.

4.2.9 Calibrated gauges of± 0.5% accuracy shall be used on water circuit for pressure and temperature measurement.

4.2.10 Airflow of AHU shall be measured by using calibrated anemometer / velometer.

4.2.11 Bearing temperature is to be measured with thermometer of ±1degree C accuracy with Least count LC of 0.5 degree C.

4.2.12 Dry and wet bulb temperatures shall be measured using sling psychrometers. The thermometers of sling psychrometer shall be of±0.5% accuracy with LC of 0.5 degree C.

4.2.13 All power consumption measurements shall be done by2-wattmeter method OR Clamp-ON power analyser/tong tester method of accuracy class ±1% duly calibrated shall be used.

4.2.14 Tachometer for RPM measurement shall be of ±1.0% accuracy.

4.2.15 Calibrated instruments shall be used for vibration and noise level measurement.

4.3.0 PRE-REQUISITES TO THE PG TESTS.

4.3.1 The contractor should furnish a written statement to the effect that work covered in the contract has been completed for the system for which PG test will be carried out.

4.3.2 All the erection /commissioning protocols in respect of hydro test of pipe lines headers, alarm /annunciation /control system, vibration and noise level data of AHU, condenser and chiller pump etc. During commissioning shall be made available during PG test by the Contractor.

4.3.3 All NTPC approved data sheets for the plant /system for which PG test is to be carried out to be made available during PG test.

4.3.4 Uninterrupted power supply within specified parameters for the duration of the Test to be ensured by other agencies

4.3.5 Proper lubrication and oil level of all equipments to be ensured.

4.3. 6 Cleanliness of plant /system

4.3.7 Protection relays of switchgears and all motor feeders shall be checked by other agencies.

4.3.8 Readiness of all protections, interlocks and safety switches to be ensured. Joint protocol in this respect shall be signed

4.3.9 Availability of suitable fire protection systems /fire fighting equipments to be ensured by other agencies during PG test.

4.3.10 Deputation of team to site to associate with the P&G test to be ensured by the contractor.

4.3.11 Arrangement of all calibrated test instruments as per cl 4.2.0 to be ensured by the contractor.

4.3.12 The plant /system shall be jointly inspected by NTPC and the contractor and a joint protocol shall be signed that the plant is fit for P&G Test.

4.3.13 All the power measurement shall be done by 2 watt meter method. The watt meters of accuracy +/- 1% duly calibrated shall be used.

4.4.0 GUARANTEED PARAMETERS DECLARATION

4.4.1 The contractor should furnish a declaration in the manner as per Appendix -I for the guaranteed parameters which attract levy of liquidated damages for Shortfall in performance. Also declaration shall be given by contractor for other parameter covered as guaranteed parameter (Without liquidity damages).

4.4.2 TEST METHODOLOGY

The test can be classified into four following groups:

1) Equipment performance

2) Capacity Assessment - Verify the plant capacity (tonnage rating) during summer (May to August) when ambient temperature (DBT) is generally high.

3) Power consumption -At specified capacity of the equipment

4) Room condition test- During summer and monsoon.

5.0.0 Equipment performance

The plant should run continuously for 2 to 3 hours for stabilization of the system before measurements. After stabilization of the system, various parameters of the major equipment will be recorded in hourly log sheet. Four sets of such readings are to be recorded under stable conditions.

Following are the parameters to be recorded during equipment performance check

5.1.1 Current rating and voltage of all motors with on line panel meter or calibrated tong tester to be logged.

5.1.2 Bearing temperature of all motors with calibrated thermometer.

5.1.3 Pressure of water at condenser water pump inlet and outlet with calibrated gauges (To be done preferably with differential pressure gauge in order to avoid inaccuracy).

5.1.4 Pressure of water at chilled water pump inlet and outlet with calibrated gauges (To be done preferably with differential pressure gauge in order to avoid inaccuracy).

5.1.5 Temperature of water at condenser inlet and outlet with calibrated gauges.

5.1.6 Temperature of water at chiller inlet and outlet with calibrated gauges.

5.1.7 Dry and wet bulb temperature of entering air to AHU and of leaving air from cooling coil with calibrated psychrometer. DBT and WBT measurement of leaving air from Cooling coil of AHU shall be done at plenum or canvas connection of AHU.

5.1.8 Velocity of air shall be measured on the filters at the suction area the AHUs with calibrated anemometer /velometer.

5.1.9 After completion of capacity tests, working of heaters and humidifiers shall be demonstrated by adjusting the set points. The instruments controlling these equipments are to be kept in their set points during PG test and shall operate automatically only, if the inside conditions demand for.

5.1.10 Following shall be checked for cooling tower

a. Correct direction of fan with proper orientation of leading and trailing edges shall be checked.
b. Free &clear flow of all nozzles shall be checked.
c. Inlet & outlet temperature of cooling tower shall be recorded.

5.1.11 Speed of rotating equipment, wherever possible, shall be checked with calibrated Tachometer.

5.1.12 Proper working of modulating type mixing valves to be demonstrated by adjusting set points.

5.1.13 Noise and vibration level measurement

Vibration and noise level of compressor, condenser water pump, chilled water pump, AHU fan, cooling tower motor shall be measured during PG test. Permissible limit of vibration for pumps shall be ___ microns peak to peak and for AHU, shall be in line with VDI-2056 class IV machines (good zone). Vibration level of compressor shall not exceed ___ mm/sec RMS velocity. Vibration level of Cooling Tower and other equipments shall be as per manufacturer recommendation shall be made available during testing. However acceptance vibration limit of all the equipments shall be made available at the time of testing.

The maximum noise level shall be ____dbA at 1.5 meter elevation and at a horizontal distance of 1.0 meter from the equipment.

5.1.14 Parallel operation of chilled water pumps and condenser water pumps to be demonstrated at site.

5.2.0 CAPACITYASSESSMENT:

i) CHILLED WATER SYSTEM:

The capacity of the plant shall be assessed by chiller method as detailed in 5.2.2. The same will however, be cross checked also by condenser and AHU method as detailed at 5.2.3. and 5.2.1 respectively.

In centralised chiller plant cumulative tonnage capacity (by chiller method) of all running equipment shall match with all running AHU's chiller system

ii) PAC /AIR-COOL CONDENSING UNIT

PAC/Air Cooled condensing units is -Direct Expansion type of AC Plant and hence the capacity of these units shall be assessed based on AHU method as detailed below in 5.2.1

(iii) AIR COOLED CHILLING SYSTEM:

The capacity of the plant shall be assessed by chiller method as detailed in 5.2.2. The same will however, be cross checked also by AHU method as detailed at 5.2.1.
In centralised chiller plant cumulative tonnage capacity (by chiller method) of all running equipment shall match with all running AHU's chiller system

5.2.1 Plant capacity from AHU method

For verifying the plant capacity by AHU method the total air quantity handled by individual AHU shall be measured as mentioned below:

Air quantity measurement will be taken on filters in front of AHU suction area. The air velocity shall be measured with calibrated anemometer / velometer. While taking this measurement, the following conditions are to be maintained:

a. All the AHUs except the standby unit should be in running condition.

b. Doors leading to AHU room should be kept closed and all other openings in AHU room as well as in the air-conditioned space and the areas in the return air path are to be sealed.

c. Air quantity of fresh air should be measured and damper is to be adjusted to allow the required quantity of fresh air only.

d. Air velocity should be measured using calibrated Anemometer /velometer. Velocity shall be taken at 9 traverse in the direction perpendicular to AHU suction area on the each filter. Measurements shall be carried out to compute average air flow.

AHU being the ultimate equipment for heat transfer, capacity of the system shall be arrived at by calculations based on various recorded data of AHU.

It is to be ensured that while recording different parameters of AHU, the compressor shall run at full load.

METHOD OF CALCULATIONS:

AHU capacity (TR) = Qa x (E1-E2) x D/3024

Where, Qa = Quantity of air in M3/hr
D = Density of air at AHU inlet in kg/m3
E1 = Enthalpy of entering air at AHU in Kcal/kg
E2 = Enthalpy of leaving air from AHU in Kcal/kg

Q is to be calculated by multiplying mean velocity of air by inlet suction area of AHU.

i.e. Q (in M3/hr)= Effective Filter size x No of Filters x Average Velocity x 3600

E1 & E2 are to be found out by plotting dry and wet bulb temperatures of entering and leaving air on psychometric chart.

5.2.2 PLANT CAPACITY FROM CHILLER:

Capacity of plant shall be assessed by chiller method. Same however will be cross checked by AHU method as detailed in 5.2.1

$$TR = \frac{Q_w \times (T1 - T2) \times 1000}{3024}$$

Where
TR = Capacity in TR
Qw = Water flow rate through chiller (M^3/Hr) = Quantity of water circulated by chilled water pump in M3/Hr
T1 = Water temperature at chiller inlet (°C)
T2 = Water temperature at chiller outlet (°C)
1000 = Multiplying factor
Qw is to be obtained from the characteristic curve of the chiller water pump and pressure differential across the pump. Necessary correction for actual speed with respect to design speed shall be made. Original Characteristic curves of the chiller water pump shall be submitted by vender along with test results.

5.2.3 PLANT CAPACITY FROM CONDENSER/ HEAT REJECTION FROM CONDENSER

Heat rejection across the condenser should be equal to the sum of the heat absorbed by the evaporator (cooling coil) and the equivalent heat of the compressor shaft K.W.

Heat absorbed by the evaporator maybe calculated from the corresponding data of the AHU recorded simultaneously by the formula in 5.2.1 above

Heat rejection across the condenser (Kcal/hr)

=Qw x (T1 - T2) x 1000 k-Cal/Hr .....A

Where,

Qw = Water flow rate thru condenser (M^3/Hr) = Qty of water circulated by cond. water pump in M^3/hr

T1 = Water temp. at condenser outlet (degC)

T2 = Water temp. at condenser inlet (degC).

1000 = Multiplying factor

Q_w is to be obtained from the original characteristic curve of the pump and pressure differential across the pump. Necessary correction for actual speed with respect to design speed shall be made.

Characteristic curves of the condenser water pump shall be submitted by the vendor along with test result.

Heat equivalent of compressor shaft KW (Kcal/hr) = Input KW of compressor motor x motor efficiency x 860..... B

1KW = 860 Kcal

Tonnage Capacity= (A-B)/3024

Since 1Ton = 3024Kcal/hr.

5.3.0 POWER CONSUMPTION TEST:

Measurement of power for all motors shall be done by Power Analyzer or Two wattmeter method only. Power measurements shall be done at rated capacity during capacity test of equipments.

5.4.0 ROOM CONDITION TEST:

Room condition test shall consist of taking the readings of dry and wet bulb temperatures at different location points to be mutually decided at site in the areas which are air-conditioned by the respective system /plant. Room Condition test shall be done after stabilization of system.

The dry and wet bulb temperature shall be measured by sling psychrometer which will have accuracy of ±0.5% with a least count of 0.5 °C.

This will be carried out for 24 hours continuously and readings will be taken every two hours. Standby equipment should be changed over during this 24 hours. This test hall be carried out during summer when the maximum ambient temperature is at least 40°C and during monsoon when relative humidity prevalent is not less than (-)10% of design value.

6.0.0 AIR COOLED CONDENSOR SYSTEM

6.1.1 PLANT CAPACITY FROM AHU METHOD

For verifying the plant capacity by AHU method total air quantity handled by individual AHU shall be measured as mentioned below.

Air quantity measurement will be taken in AHU suction in a direction perpendicular to AHU suction area. The air velocity shall be measured with calibrated anemometer/Velometer. While taking this measurement, following conditions are to be maintained:

I. All the AHUs except the standby should be in running condition.
II. Doors leading to AHU room should be kept closed and all other openings in AHU room as well in the air conditioned space and areas in return path are to be sealed.
III. Air quantity of fresh air should be measured and damper to be adjusted to allow the required quantity of fresh air only.
IV. Air velocity shall be measured using calibrated Anemometer / velometer. Velocity shall be taken at 9 traverse points in a direction perpendicular to AHU suction area. Measurements shall be carried out to compute average air flow.

AHU being the ultimate equipment for heat transfer, capacity of the system shall be arrived at by calculations based on various recorded data of AHU.
It is to be ensured that while recording different parameters of AHU the compressor shall be at full load.

METHOD OF CALCULATION

$T = Q \times d \times (E1-E2)$
Where
T= Capacity in TR
Q= Quantity of air in m3/hr

d= density of air at AHU inlet in Kg/m3 (At AHU inlet temperature and pressure to be measured and density to be calculated)

E1= Enthalpy of entering air at AHU in Kcal/kg

E2 = Enthalpy of leaving air from AHU in Kcal/kg
Q is to be calculated by multiplying mean velocity of air by inlet suction area of AHU.

i.e. Q (in M3/hr)= Effective Filter size x No of Filters x Average Velocity x 3600

E1 & E2 are to be found out by plotting dry and wet bulb temperatures of entering and leaving air on psychometric chart.

6.1.2 PLANT CAPACITY FROM CONDENSOR

Heat rejection across the condenser should be equal to sum of the heat absorbed by the evaporator (cooling coil) and the equivalent heat of compressor shaft KCal/Hr.

Heat absorbed by the evaporator may be calculated from corresponding data of AHU recorded simultaneously by the formula of 6.1.1 above.

Heat rejection across the condenser (K Cal/Hr)

Qa= ma x Cp x ΔT (T1-T2)……A

Where Qa = Heat rejection capacity of compressor (KW)

ma= mass flow rate of air (Vax Da) Kg/sec
Va = Volume flow rate per fan M3/sec
Da= Density of Ambient Air 1.0933 Kg/sec
Cpa = Specific heat of air 1.006 KJ/KgK
T1 = Outlet air temp in ° C at condenser
T2 = Inlet temperature in ° C at condenser

Qa is to be obtained from condenser approved data sheet/selection sheet

Original Characteristics curves of the condenser fan shall be submitted by the vendor along with test results

Heat equivalent of compressor shaft (Kcal/hr)

= Input KW of compressor motor x motor efficiency X 860 …….. B

(As 1KWh =860 KCal)
Tonnage Capacity= (A-B)/3024

Since 1TR= 3024 KCal / Hr

ANNEXURE – I

TECHNICAL PARAMETERS OF AC SYSTEM

Design Ambient Temperature (summer) i) DB – …..°C
ii) WB – ……..°C

Design Ambient Temperature (monsoon) i) DB – ……..°C
ii) WB – ……°C

Design Ambient Temperature (winter) i) DB – ……°C
ii) WB –……°C

Design Indoor Conditions DB RH

i) All Building 24°C±1°C 50%±5%

Selected AC plant capacity as per NTPC Technical specification/Heat load calculation.

Sl. No.	Item	Capacity (each)	Quantity
1.0	**Centralized AC system for Main plant Control Rooms**		
1.1	Water cooled Chiller	…….. TR	(…..Working + ….Standby)
1.2	Chilled water pumps & motor	…….. m^3/hr at …… MWC	(…..Working + ….Standby)
1.3	Condenser cooling water pump & motor.	(…..Working + ….Standby)	(…..Working + ….Standby)
1.4	Cooling tower with fan & drive.	…… m^3/hr	(…..Working + ….Standby)
1.5	Air Handling Units	…… m^3/hr	(…..Working + ….Standby)
2.0	**A/C system for ESP Control Room of Unit #1 & #2**		
2.1	Air cooled condensing units.	…… TR	(…..Working + ….Standby)
2.2	Air Handling Units	…… m^3/hr	(…..Working + ….Standby)
3.0	**A/C system for Water System Control Building.**		
3.1	Air cooled condensing units.	…… TR	(…..Working + ….Standby)
3.2	Air Handling Units	…… m^3/hr	(…..Working + ….Standby)

Appendix – I

GUARANTEED PARAMETERS WITH LIQUIDATED DAMAGES

Main Power House (TG Building)				
SL NO	EQUIPMENT DESCRIPTION	DUTY	Absorbed power (Guaranteed) at motor input terminal.	Value Tested During PG test
1	Water cooled Chiller - 1	(Continous/Standby)	….	…..
2	Water cooled Chiller - 2		….	…..
3	Water cooled Chiller - 3		….	…..
4	Chilled water pumps – 1		….	…..
5	Chilled water pumps – 2		….	…..
6	Chilled water pumps – 3		….	…..
7	Condenser water pumps – 1		….	…..
8	Condenser water pumps – 2		….	…..
9	Condenser water pumps – 3		….	…..
10	AHU - 1		….	…..
11	AHU - 2		….	…..
12	AHU - 3		….	…..

FGD control room, ESP control room of each units, AHP control room				
SL NO	EQUIPMENT DESCRIPTION	DUTY	Absorbed power (Guaranteed) at motor input terminal.	Value Tested During PG test
1	Water cooled Chiller - 1	(Continous/Standby)	….	…..
2	Water cooled Chiller - 2		….	…..
3	Water cooled Chiller - 3		….	…..
4	Chilled water pumps – 1		….	…..
5	Chilled water pumps – 2		….	…..
6	Chilled water pumps – 3		….	…..
7	Condenser water pumps – 1		….	…..
8	Condenser water pumps – 2		….	…..
9	Condenser water pumps – 3		….	…..
10	AHU - 1		….	…..
11	AHU - 2		….	…..
12	AHU - 3		….	…..

Water System Control Building				
SL NO	EQUIPMENT DESCRIPTION	DUTY	Absorbed power (Guaranteed) at motor input terminal.	Value Tested During PG test
1	Air Cooled	(Continous/St	….	…..

	Condensing Unit - 1	andby)		
2	Air Cooled Condensing Unit - 2		….	…..
3	AHU - 1		….	…..
4	AHU - 2		….	…..

Total cumulative power consumption of AC system package is …… KW as per bidding documents. (Bidder to attach relevant page of bidding document)

Note: The above list is indicative only. Bidder to furnish the guaranteed power consumption of all equipment which attract Liquidated damages as per specification/contract.

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited
STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE
AIR CONDITIONING SYSTEM

Equipment		Description of Parameter	Guaranteed Value as per LOA	Quantity (Working quantity as per Tech. Spec.)	Value Noted during PG Test
AC Plant for Main Plant Area: TG BUILDING					
1	Chilling Unit Plant .	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	…. KW	….Nos	
2	Chilled Water Pump for main AC Plant ……. M³/hr at ….M total Head	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	….KW	….Nos	
AC Plant for ESP Building & WSCB					
3	CONDENSING UNITS: …. TR	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drivedrive	….KW	….Nos.	
4	CONDENSING UNITS: …. TR .	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	…. KW	…. Nos.	
5	Condenser Water Pump for main AC Plant ….M³/hr at ….M total Head	Auxiliary Power consumption in KW at motor input terminal at rated duty point for each drive	…..KW	….Nos.	
AHU Fans for Various Areas					
6	i) AHU - 1 to 6 - M³/hr at …..mmWC	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	….KW	Nos	
	ii) AHU -7 to 8 -.... M³/hr at ….mmWC	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	….KW	….Nos	

	iii) AHU - 9 to …No.s - ….M³/hr at .mmWC	Auxiliary Power consumption in KW at motor terminal at rated duty point for each drive	….KW	….Nos	

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AIR CONDITIONING SYSTEM

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE
AIR CONDITIONING SYSTEM

GUARANTEED PARAMETERS (Parameter covered under liquidity damages)

SL No	Equipment	Description of Parameter	Guaranteed value as per LOA	Quantity (Working quantity as per Tech. Spec.)	Value noted During PG Test

Contractor :

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

OTHER GUARANTEED PARAMETERS (Without liquidity damages)

SL No	Equipment / System	Description of Parameter	Guaranteed value
1	Design Indoor Condition	Dry Bulb Temperature in deg. C	24°C ± 1°C
		Relative Humidity	50% ± 5%

Contractor :

Appendix I

FORMAT FOR RECORDING AIR QUANTITY ACROSS AHU

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited
STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM
Date :

Reading Set : Unit of Operation No. of Filters : Effecting Filter Size (L x W) m² :

Filter No	No of Reading in each Filter / Point (m/s)				
	1	2	3	4	5

Average Velocity (m/s) :

NTPC **CONTRACTOR**

Appendix - II

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Date :

FORMAT OF CHECKING POWER CONSUMPTION OF MOTORS - AIR CONDITIONING PACKAGE

SL No	Time in hr	Current in amps	Voltage in volts	Wattmeter reading	Actual power	Power factor	Remarks
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			

NTPC CONTRACTOR

Appendix -III

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Date :

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

FORMAT OF CHECKING POWER CONSUMPTION OF MOTORS - AIR CONDITIONING PACKAGE

SL No	Time in hr	Current in amps	Voltage in volts	Wattmeter reading	Actual power	Power factor	Remarks
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		RR - Y - B	RY RY - YB - RB	RR - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			

NTPC **CONTRACTOR**

Appendix – V

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Motor make :

Location & application :

Guaranteed power cons. (as per LOA/Contract)

Dated of calibration of instrument and name of test :

Reading Set No :

Date :

FORMAT OF CHECKING POWER CONSUMPTION OF MOTORS - AIR CONDITIONING PACKAGE

SL No	Time in hr	Current in amps	Voltage in volts	Wattmeter reading	Actual power	Power factor	Remarks
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		RR - Y - B	RY RY - YB - RB	RR - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			

NTPC **CONTRACTOR**

Appendix -III

Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Motor make :
Location & application :
Guaranteed power cons. (as per LOA/Contract)
Dated of calibration of instrument and name of test :

Reading Set No :

Date :

FORMAT OF CHECKING POWER CONSUMPTION OF MOTORS - AIR CONDITIONING PACKAGE

SL No	Time in hr	Current in amps	Voltage in volts	Wattmeter reading	Actual power	Power factor	Remarks
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - YY - B	RY - YB YB - RB	R - YY - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			
		R - Y - B	RY - YB - RB	R - Y - B			

NTPC CONTRACTOR

FORMAT FOR RECORDING OF EQUIPMENT PARAMETERS

Appendix-IV
Project :……., STAGE-…. (…x….. MW)
Package: Air condition System COA No. :……..
Contractor: …….. Owner :NTPC Limited
STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Date :

Area : MAIN POWER HOUSE
Instrument Used & SL No : .
Reading set no :

SL No	EQUIPMENT	Parameters	Reading 1 Time :	Reading 2 Time :	Reading 3 Time :	Reading 4 Time :
1	CHILLER No :	Water temp. at inlet (°C)				
		Water temp. at outlet (°C)				
2	CHILLER No :	Water temp. at inlet (°C)				
		Water temp. at outlet (°C)				
3	CONDENSER No :	Water temp. at inlet (°C)				
		Water temp. at outlet (°C)				
4	CONDENSER No :	Water temp. at inlet (°C)				
		Water temp. at outlet (°C)				
5	CHILLED WATER PUMP No :	Pressure at suction (kg/cm²)				
		Pressure at discharge (kg/cm²)				
		Bearing temp. of motor (°C)				
		Rotating speed (RPM)				
		Full Load Current				
6	CHILLED WATER PUMP No :	Pressure at suction (kg/cm²)				
		Pressure at discharge (kg/cm²)				
		Bearing temp. of motor (°C)				
		Rotating speed (RPM)				
		Full Load Current				
		Pressure at discharge (kg/cm²)				
		Bearing temp. of motor (°C)				
		Rotating speed (RPM)				
		Full Load Current				
7	COOLING TOWER & FAN MOTOR No : COOLING TOWER & FAN MOTOR No :	Inlet Temperature (°C)				
		Outlet Temperature (°C)				
		Flow through nozzle				
		Inlet Temperature (°C)				
		Outlet Temperature (°C)				

		Flow through nozzle				

NTPC CONTRACTOR

FORMAT FOR RECORDING VIBRATION LEVEL & NOISE LEVEL OF EQUIPMENT

Appendix - V

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited Date :

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Instrument Used & SL No :

Reading set no : Area : MAIN POWER HOUSE

SL No	EQUIPMENT	READING No	TIME	DISPLACEMENT IN MICRON (Acceptable value ----- microns)			NOISE LEVEL IN dBA (acceptable value ---- dBA)	RPM	REMARKS
				V	A	H			
1	AHU No :	1							
		2							
		3							
		4							
2	AHU No :	1							
		2							
		3							
		4							
3	AHU No :	1							
		2							
		3							
		4							
4	AHU No :	1							
		2							
		3							
		4							
5	AHU No :	1							
		2							
		3							
		4							
6	AHU No :	1							
		2							
		3							
		4							
7	AHU No :	1							
		2							
		3							
		4							
		2							
		3							
		4							

NTPC CONTRACTOR

FORMAT FOR RECORDING VIBRATION LEVEL & NOISE LEVEL OF EQUIPMENT

Appendix - V

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited **Date :**

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Instrument Used & SL No :

Reading set no : Area : ESP CONTROL ROOM

SL No	EQUIPMENT	READING No	TIME	DISPLACEMENT IN MICRON (Acceptable value ----- microns)			NOISE LEVEL IN dBA (acceptable value ---- dBA)	RPM	REMARKS
				V	A	H			
1	AHU No :	1							
		2							
		3							
		4							
2	AHU No :	1							
		2							
		3							
		4							
3	AHU No :	1							
		2							
		3							
		4							
4	AHU No :	1							
		2							
		3							
		4							
5	AHU No :	1							
		2							
		3							
		4							
6	AHU No :	1							
		2							
		3							
		4							
7	AHU No :	1							
		2							
		3							
		4							

NTPC **CONTRACTOR**

Appendix - VI

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited **Date :**

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Instrument Used & SL No :

Reading set no : Area : ESP CONTROL ROOM

SL No	EQUIPMENT	READING No	TIME	Entering Air Parameters			Leaving air parameters		
				DB (C)	WB(C)	Enthalpy Kcal/Kg	DB (C)	WB(C)	Enthalpy Kcal/Kg
1	AHU No :	1							
		2							
		3							
		4							
2	AHU No :	1							
		2							
		3							
		4							
3	AHU No :	1							
		2							
		3							
		4							
4	AHU No :	1							
		2							
		3							
		4							
5	AHU No :	1							
		2							
		3							
		4							
6	AHU No :	1							
		2							
		3							
		4							
7	AHU No :	1							
		2							
		3							
		4							

NTPC **CONTRACTOR**

FORMAT FOR RECORDING VIBRATION LEVEL & NOISE LEVEL OF EQUIPMENT

Appendix -VII

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Instrument Used & SL No :

Date :

Reading set no : Area : MAIN POWER HOUSE

SL No	EQUIPMENT	READING No	TIME	DISPLACEMENT IN MICRON (Acceptable value ---- microns)			NOISE LEVEL IN dBA (acceptable value ---- dBA)	REMARKS
				V				
1	CHILLING UNIT No :	1						
		2						
		3						
		4						
2	CHILLING UNIT No :	1						
		2						
		3						
		4						
3	CHW PUMP No :	1						
		2						
		3						
		4						
4	CHW PUMP No :	1						
		2						
		3						
		4						
5	CHW PUMP No :	1						
		2						
		3						
		4						
6	CCW PUMP No :	1						
		2						
		3						
		4						

NTPC **CONTRACTOR**

Area : FORMAT FOR RECORDING VIBRATION LEVEL & NOISE LEVEL OF EQUIPMENT

Appendix-VIII

Project :……., STAGE-…. (…x….. MW)

Package: Air condition System COA No. :……..

Contractor: …….. Owner :NTPC Limited

STANDARD GUARANTEE AND ACCEPTANCE TEST PROCEDURE FOR AC SYSTEM

Instrument Used & SL No :

Date :

Reading set no : Area ESP & WSC BUILDING

SL No	EQUIPMENT	READING No	TIME	DISPLACEMENT IN MICRON (Acceptable value ----- microns)			NOISE LEVEL IN dBA (acceptable value ---- dBA)	REMARKS
				V				
1	COND. UNITS	1						
		2						
		3						
		4						
2	COND. UNITS	1						
		2						
		3						
		4						

NTPC CONTRACTOR

Note:

1. Vendor to sign /digitally sign and stamp on all pages of PG procedure.
2. Attachment 10 giving guaranteed parameters to be enclosed.
3. Relevant pages of Functional Guarantee & LD to be enclosed.
4. Relevant pages of Tech Specs to be enclosed.

STANDARD MANUFACTURING QUALITY PLAN

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT:
		Doc. No.:	Rev.: 00	PACKAGE:
		ITEM / EQUIPMENT: STANDARD QUALITY PLAN FOR WATER COOLED SCREW CHILLER UNIT		CUSTOMER:
				MAIN CONTRACTOR :
				SUB CONTRACTOR :

S. No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE OF CHECK	QUANTAM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE DOCUMENT	FORMAT OF RECORD	D*	AGENCY**			REMARKS
					M	C / N					M	C	N	
1	2	3	4	5	6		7	8	9	10	11	12	13	14
1	**RAW MATERIAL / BOUGHT OUT ITEMS**													
1.1	Compressor	Make:	Major	Visual	100%		As per approved TDS / Mfg. Stnd.	As per approved TDS / Mfg. Stnd	Mfr. Test Certificate	√	P	V	V	Mfg. TC shall be provided
		HV/IR Tests	Major	Measurement	100%		Mfg. standard	Mfg. test certificate	Mfr. Test Certificate	√	P	V	V	Mfg. TC shall be provided
		Motor Rotor Balancing	Major	Measurement	100%		Mfg. standard	Mfg. test certificate	Mfr. Test Certificate	√	P	V	V	Mfg. TC shall be provided
1.2	Compressor Assembly	Visual	Major	Visual	100%		As per spec / TDS / OEM stnd	As per spec / TDS / OEM stnd	Insp. report	√	P	V	V	
1.3	Compressor Assembly	Pneumatic Test	Major	Pneumatic Test	100%		As per spec / TDS / OEM stnd	As per spec / TDS / OEM stnd	Insp. report	√	P	V	V	
1.2	**Evaporator**													
1.2.1	Shell for Evaporator	Material conformation	Major	Chemical & Physical test	One per lot		As per approved TDS / IS 2062 Gr B / SA516 / IS3589	Test Certificate	Test Certificate	√	V	V	V	Mfg. TC shall be provided
		Dimensional	Major	Measurement	100%		As per approved TDS / Mfg. Stnd	Inspection Report	Inspection. Report		P	V		
		Visual Inspection	Major	Visual	100%		No defect	No defect	Inspection. Report		P	V		
1.2.2	Tube sheet for Evaporator	Material conformation	Major	Chemical & Physical test	One per lot		As per approved TDS / IS 2062 Gr B / SA516 / IS3589	Test Certificate	Test Certificate	√	V	V	V	Mfg. TC shall be provided
		Dimensional	Major	Measurement	100%		As per approved TDS / Mfg. Stnd	Inspection Report	Inspection. Report		P	V		
		Visual Inspection	Major	Visual	100%		No defect	No defect	Inspection. Report		P	V		

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT:
		Doc. No.:	Rev.: 00	PACKAGE:
		ITEM / EQUIPMENT: STANDARD QUALITY PLAN FOR WATER COOLED SCREW CHILLER UNIT		CUSTOMER:
				MAIN CONTRACTOR :
				SUB CONTRACTOR :

1.2.3	Tubes	Material conformation	Major	Chemical & Physical test n	One per lot	C12200 / Approved TDS / ASME SB-359	C12200 / Approved TDS / ASME SB-359	Test Certificate	√	V	V	V	Performed by Overseas supplier. Mfrs. TC shall be furnished
		Internal defects	Major	Eddy Current testing	100%	Approved Specs / TDS / OEM Std	No defects	Inspection. Report	√	P	V	V	
		Visual Inspection	Major	Visual	100%	No defects	No defects	Inspection. Report		P	V		
1.3	**Condenser**												
1.3.1	Shell for Condenser	Material conformation	Major	Chemical & Physical test	One per lot	As per approved TDS / IS 2062 Gr B / SA516 / IS3589	Test Certificate	Test Certificate	√	V	V	V	Mfg. TC shall be provided
		Dimensional	Major	Measurement	100%	As per approved TDS / Mfg. Stnd	Inspection Report	Inspection. Report		P	V		
		Visual Inspection	Major	Visual	100%	No defect	No defect	Inspection. Report		P	V		
1.3.2	Tube sheet for Condenser	Material conformation	Major	Chemical & Physical test	One per lot	As per approved TDS / IS 2062 Gr B / SA516 / IS3589	Test Certificate	Test Certificate	√	V	V	V	Mfg. TC shall be provided
		Dimensional	Major	Measurement	100%	As per approved TDS / Mfg. Stnd	Inspection Report	Inspection. Report		P	V		
		Visual Inspection	Major	Visual	100%	No defect	No defect	Inspection. Report		P	V		
1.3.3	Tubes	Material conformation	Major	Chemical & Physical test n	One per lot	C12200 / Approved TDS / ASME SB-359	C12200 / Approved TDS / ASME SB-359	Test Certificate	√	V	V	V	Performed by Overseas supplier. Mfrs. TC shall be furnished
		Internal defects	Major	Eddy Current testing	100%	Approved Specs / TDS / OEM Std	No defects	Inspection. Report	√	V	V	V	
		Visual Inspection	Major	Visual	100%	No defects	No defects	Inspection. Report		P	V		
2	**Process Inspection**												

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT:
		Doc. No.:	Rev.: 00	PACKAGE:
		ITEM / EQUIPMENT: STANDARD QUALITY PLAN FOR WATER COOLED SCREW CHILLER UNIT		CUSTOMER:
				MAIN CONTRACTOR :
				SUB CONTRACTOR :

2.1	Welding Procedure Qualification	WPS & PQR	Major	Welding Parameters	100%	ASME Sec IX	ASME Sec IX	WPS & PQR	√	P	V	V	Refer Note-1
2.2	For both condenser & evaporator												
2.2.1	Shell Butt Joints	Surface defects	Major	LPE Test	100% on weld joints	ASME Sec. V ARTICLE 6	ASME SEC.VIII Div.1-No linear indication	Insp. Report	√	P	V	V	NA for round ERW / seamless pipe
2.2.2	Shell joint	Internal defects	Major	Radiographic examination	10% spot of weld joint	ASME Sec. V ARTICLE 2	ASME SEC.VIII Div.1-CLAUSE UW52	Inspection. Report	√	P	V	V	
2.2.3	Shell to tube sheet joint	Surface defects	Major	LPE Test	100% on weld joints	ASME Sec. V ARTICLE 6	ASME SEC.VIII Div.1-No linear indication	Insp. Report	√	P	V	V	
2.3.4	Tube expansion	Dimensional	Major	Dimensional	10%	As per OEM procedure	As per OEM procedure	Insp. Report	√	P	V	V	
2.3.5	Control Panel	Color DFT, Electrical parts / Layout	Major	Visual	100%	OEM DRG. / Approved data sheet / appd drawing	As per Col.7	Mfg. TC	√	P	V	V	
3	**IN PROCESS INSPECTION FOR BOTH COOLER & CONDENSER**												
3.1	Condenser Assembly	i. Pressure Test (Shell side)	Critical	Pneumatic check Underwater	1 / size	No leakage at 220 psi (g) for 10 minutes.	No Leakage	Insp. report	√	P	W	V	
		ii. Pressure Test (Tube side)	Critical	Hydraulic check	1 / size	No leakage at 195 psi (g) for 10 minutes.	No Leakage	Insp. report	√	P	W	V	
3.2	Evaporator assembly	i. Pressure Test (Shell side)	Critical	Pneumatic check Underwater	1 / size	No leakage at 220 psi (g) for 10 minutes.	No Leakage	Insp. report	√	P	w	V	
		ii. Pressure Test (Tube side)	Critical	Hydraulic check	1 / size	No leakage at 195 psi (g) for 10 minutes.	No Leakage	Insp. report	√	P	W	V	

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT:
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				MAIN CONTRACTOR :
				SUB CONTRACTOR :

4	**FINAL INSPECTION**													
4.1	CHILLER UNIT Assembly	i. Dimension Overall	Major	Measurement	100%	Approved Dwg / TDS	Approved Dwg / TDS	Inspection. Report	√	P	W	W	
		ii. Functional test of Control Panel	Major	Measurement/ Visual	100%	OEM DRG. / Approved TDS	OEM DRG. / Approved TDS	Inspection. Report	√	P	W	W	Simulation of safety trips shall be witnessed during Run test of performance test
		iii. Pressure Test of Refrigerant System	Critical	Pneumatic	100%	Soap Leak Test at 220 Psi (g). For 10 minutes	No Leakage	Inspection. Report	√	P	W	W	
		iv. Evacuation	Critical	Measurement	100%	Pull vacuum below 500micron & after 1Hr Hold should not raise above 1000 micron	Pull vacuum below 500 micron & after 1Hr Hold should not raise above 1000 micron	Inspection. Report	√	P	W	W	
		v. Capacity Test of chiller	Critical	Measurement	100%	ARI 550 / 590 stand.	As per approved TDS	Inspection. Report	√	P	W	W	Performance Test at 100% load to be witnessed.
		vi. Noise & Vibration	Major	Measurement	100%	OEM DRG. / Approved TDS	OEM DRG. / Approved TDS	Inspection. Report	√	P	W	W	
		vii. Insulation	Major	Insulation material check	100%	OEM DRG. / Approved TDS	OEM DRG. / Approved TDS	Inspection. Report	√	P	W	W	

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT:
		Doc. No.:	Rev.: 00	PACKAGE:
		ITEM / EQUIPMENT: STANDARD QUALITY PLAN FOR WATER COOLED SCREW CHILLER UNIT		CUSTOMER:
				MAIN CONTRACTOR :
				SUB CONTRACTOR :

		viii. Painting (Paint Shade & DFT)	Major	Visual, measurement	100%	OEM DRG. / Approved TDS	OEM DRG. / Approved TDS	Inspection. Report	√	P	W	W	
4.2	Packing & dispatch	Completeness	Major	Verify with packing list	100%	OEM Spec/ Packing list	OEM Spec/ Packing list	Inspection. Report	√	P	-	-	

NOTE-1: WPS approval and PQR, WPQ qualifications from reputed agencies like TUV, Lloyds, BVI, SGS, Intertek, NTPC, BHEL, etc.'

LEGEND: -

D* RECORDS IDENTIFIED WITH TICK (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.

M: MANUFACTURER/VENDOR, C: BHEL, N: CUSTOMER, P: PERFORM, V: VERFICATION, W: WITNESS

SIGNATURE				Page no.	
NAME				M: MANUFACTURER / VENDOR	P: PERFORM
PARTY	VENDOR / MANUFACTURER	BHEL	CUSTOMER	C: BHEL	W: WITNESSING
				N: CUSTOMER	V: VERIFICATION

	MANUFACTURE'S NAME & ADDRES	STANDARD QUALITY PLAN	PROJECT :
		QP. NO. :	
		ITEM : CENTRIFUGAL PUMP	PACKAGE :
		REV. : 0	
		SYSTEM : DATE :	CONTRACT NO. :
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			SUB CONTRACTOR :

SL No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**MATERIAL.CONTROLS**											
1.1	CASING(UPPER&LOWER/VOLUTE)/BOWLS DIFFUSER,STAGE BODIES,DISCHARGE HEAD (IF CAST) ETC.	Physical & Chemical Props.	Critical	Physical & Chemical Analysis.	ONE/HEAT /BATCH	Apprd. Data Sht/ Apprd G.A. Drg.	Apprd. Data Sht/ Apprd G.A. Drg.	LAB. REPORT	3, 2			
1.2	IMPELLERS	Physical & Chemical Props.	Critical	Physical & Chemical Analysis.	ONE/HEAT /BATCH	Apprd. Data Sht/ Apprd G.A. Drg.	Apprd. Data Sht/ Apprd G.A. Drg.	LAB. REPORT	3, 2	2, 1		
1.3	STUFFING BOX,SUCTION HOUSING,SUCTION BELL,WEARING RINGS,NECK RINGS,SHAFT	Physical & Chemical Props.	MA	Physical & Chemical Analysis.	ONE/HEAT /BATCH	Apprd. Data Sht/ Apprd G.A. Drg.	Apprd. Data Sht/ Apprd G.A. Drg.	LAB. REPORT	3, 2		2,1	
	STRESS RELIEVING/HEAT TREATMENT OF CASTING, AS ABOVE(IF APPLICABLE)	HEAT CYCLE	MA	VARIFICATION OF SR/HT CHARTS	ALL BATCHES	Apprd. Data sht / Apprd G.A. Drg.	Apprd. Data sht / Apprd G.A. Drg.	SR/HT CHARTS	3, 2		2,1	
1.4												
1.5	BARS/FORGINGS FOR SHAFTS,LINE SHAFTS	1.Physical & Chemical Props. 2.DIMENSIONS 3.SUB-SURFACE DEFECTS FROM 50 MM AND ABOVE DIA SHAFTS	Critical	1.Physical & Chemical Analysis. 2.Measurement 3. ULTRASONIC TEST	1/CAST OR 1/BAR 100%	MFR DRAWING ASTMA:388,BACK WALL ECHOE 100%	MFR DRAWING DEFECT ECHOE MAX.20% OF B.W.E.LOSS OF BACK WALL ECHOE 20% MAX.	MILL T.C. OR LAB. REPORT INSPN. REPORT	3, 2		2,1	
1.3	Shaft (Above 50 mm dia)	Ultrasonic Testing	Critical	Non Destructive Testing	1005	ASTM-E-114	OEM Procedure	NDT Certificate	3		2,1	

	Q.P No :		DESIGNATION		DATE		DATE			DATE
	REV. No / DATE		NAME							
	PAGE No	1 OF 3	PARTY	CUSTOMER/ CONSULTANT		BHEL		VENDOR		

	MANUFACTURE'S NAME & ADDRES	MANUFACTURING QUALITY PLAN	PROJECT :
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		ITEM : CENTRIFUGAL PUMP	PACKAGE :
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		SYSTEM : DATE :	MAIN CONTRACTOR :
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SL No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	**INPROCESS INSPECTION**											
2.1	Various Components Mentioned in 1.0	Dimensional Inspection	Major	Dimensional Check	100% for Critical & 10% for others	Approvd. Drawing	Approvd. Drawing		3			
2.2	Impeller	Cleaning & de burning	Major	Visual	100%	Approvd. Drawing	Approvd. Drawing	Assm report	3			
2.3	Rotating Unit	Balancing	Major	Balancing	100%	ISO 1940 Gr.6.3 at reduced speed	ISO 1940 Gr.6.3 at reduced speed	Balancing Certificate	3		2,1	
2.4	Impeller	D.P. Testing	Critical	D.P. Test on Machined surface and Accessible	100%	ASTM-E-165	OEM Procedure	NDT Certificate	3		2,1	
2.5	Shaft & Shaft sleeve	D.P. Testing	Critical	D.P. test	100%	ASTM-E-165	OEM Procedure	NDT Certificate	3		2,1	
3.0	**ASSEMBLY & TESTING**											
3.1	Hydro Test	Leak Tightness	Major	Visual	100%	Appd. Data sheet	No leak for test duration of 30 min.	Hydrostatic Pressure Test Certificate	3	2, 1		Refer Note 4
	Dimension	Overall dimension	Major	Measurement	100%	Appd drawing	Appd drawing	IR	3	2, 1		

	Q.P No :		DESIGNATION		DATE		DATE			DATE
	REV. No / DATE		NAME							
	PAGE No	2 OF 3	PARTY	CUSTOMER/ CONSULTANT		BHEL		VENDOR		

	MANUFACTURE'S NAME & ADDRES	MANUFACTURING QUALITY PLAN	PROJECT :
		QP. NO. :	
		ITEM : CENTRIFUGAL PUMP	PACKAGE :
		REV. : 0	
		SYSTEM : DATE :	CONTRACT NO. :
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			SUB CONTRACTOR :

SL No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.2	Performance test with calibrated shop motor / Job Motor	Q Vs H,Q Vs n, Q Vs P, Vibration, noise level and	Critical	Performance test	100%	Appd. Data sheet & HIS	Appd. Data sheet & HIS	Test Report	3	2, 1		CHP refer note 5
3.3	Strip test	Check for wear and rubbing	Major	Visual	100%	No undue wear & rubbing	No undue wear & rubbing	I.R.	3	2, 1		CHP refer note 6
4.0	**FINAL INSPECTION**											
4.1	Pump	Record checking and crediting / review of QA documentation	Major	Record Checking / Verification	100%	All assembly record & test certificates as per appd. QAP	Appd. QAP	Crediting Slip	3		2,1	
		Painting, Packing & Despatch	Major	Visual	100%	Relevant Spec.	OEM Procedure.	Crditing slip	3			

NOTES :

A) Chemical composition of grey cast iron, Ni = as applicable, S = 0.1% Max, P = 0.15% Max., As cast heat mark shall be provided on CI castings.

B) In case of co-relation TC's are not available then quantum of check will be each bar.

1. **This QAP is also applicable for spares if ordered.**
2. **No weld repairs permissible on CI castings.**
3. **Materials shall be as per approved C.S. Drawings.**
4. **Test Pressure shall be 1.5 times the Shut off Head or twice the Duty Point Head whichever is higher.**
5. **Vibration level shall be recorded during shop test but shall not form acceptance criteria, However values as per HIS are quaranteed at site only.**
6. **Strip Test : - Only in case of abnormal performance, pump shall be dismantled followed by re-assembly & testing. Otherwise it is limited to bearing inspection only by removing bearing cover. Bearing shall not be removed from shaft.**

Q.P No :		DESIGNATION		DATE		DATE		DATE
REV. No / DATE		NAME						
PAGE No	3 OF 3	PARTY	CUSTOMER/ CONSULTANT		BHEL		VENDOR	

LEGEND : P- PERFORMANCE, W - WITNESS, V- VERIFICATION
3 - OEM/VENDOR, 2- BHEL, 1 - CUSTOMER