S.N	Features	Minimum Requirements
		Engineering Unit
7	Input	Ohm input from Pt-100 RTD/ mV signal from thermocouples
8	Stability	± 0.1 % of reading or 0.1^{0} C, whichever is greater, for 24 months for RTDs. ± 0.1 % of reading or 0.1 ^{0}C, whichever is greater, for 12 months for thermocouples
9	Output	4-20 mA DC, linear
10	Load	600 Ohms (minimum) at 24 Volts DC
11	Power Supply	24 VDC, 2- Wire Loop Power
12	MOC of Electrical Housing	Aluminum Alloy or better
13	Enclosure Class	Weather proof as per IP 67 with corrosion resistance coating. For hazardous area explosion proof enclosure as described in NEC article 500

1. The temperature transmitter of following types (2-wire Loop Powered temperature transmitter) compatible with thermocouples shall be provided. Cold junction temperature compensation of the thermocouples shall be performed in the temperature transmitter itself. The Contractor shall use multiplexer philosophy to connect thermocouples to plant DCS. Metal thermocouples shall be terminated in Local JB and from there copper cables shall be connected upto the separate panel in the control room. For linking this panel to Plant DCS, the required communication protocol like TCP/IP, Modbus, OPC, Profibus shall be provided. The Contractor shall provide the complete system excluding the cabling between Local JBs and Control Panel and communication cable to Plant DCS.

   a. **Single/multiple Input DIN-rail mounted Temperature Transmitter (Only for Metal Temperature measurement)**

      These shall be suitable for mounting on DIN-rails in Panels/JBs. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

   b. **Field mounted Temperature Transmitter With Indicator**

      These shall be suitable for mounting on pipes/ supports. Indicator shall be provided with these transmitters. These transmitters shall have bump-less change over facility to second sensor in case first sensor fails .This changeover is to be alarmed. Protection class shall be IP67 minimum.

      The exact applications for which this type of transmitter is to be provided shall be finalized during detailed engineering.

2. Transmitters shall be provided with following features:

   - Sensor drifts alarm for sensor failure prediction

- Differential & average temperature measurement if required.
- Automatic switch-over to back-up sensor on primary sensor failure.
- Accepts any combination of two sensor types (RTDs, T/Cs, mV or ohms)
- Ambient temperature compensation
- Fault detection for electronics & sensors with fail-safe alarming.
- Provision of built-in CJC

3. Transmitters to be used for RTD sensors shall be provided with RTD EMF correction features so that it shall detect and eliminate EMF errors which are the result of small voltage produced by RTD sensing elements.

4. The product and make shall be selected so that with one make of transmitter all applications with respect to measuring range, temperature sensor (resistance thermometer / thermocouple) and connection type (2/3/4) wire connection of resistance thermometers) shall be covered.

5. Field mounted Transmitters shall be capable of communication with HART (Highway Addressable Remote Transducer) communicator. HART communicator shall be provided with transmitters for tuning / configuring / diagnosing / maintenance of the transmitters. It shall meet the intrinsic safety requirement if required depending upon the application.

6. All transmitters' cases shall be dust-tight and rugged. Weather-proof and explosion-proof cases shall be used in outer and hazardous areas respectively

9.4 Thermocouple

Table 9.3

Specifications for Thermocouple

S.N	Features	Minimum Requirements
1	Wire Gauge	16 AWG (for K type 24 AWG (for R type)
2	Protective tube	O.D. 8 mm Material SS 316 seamless Filling – Compacted Magnesium Oxide (Purity above 99.4)
3	Loading	Shall be spring loaded to ensure positive contact with the well. Prevention of rotation of the insert with respect to head and resultant twisting of leads shall be ensured.
4	Accuracy	As per ANSI MC 96.1 / IEC 751 / IS-2054 / 2055, 1974.
5	Characteristic	Linear with respect to temperature within +/- ½ per cent of top range value.

S.N	Features		Minimum Requirements	
6	Reference		For temperature vs. mV characteristics, following IS shall be applicable : Type K IS – 2054, 1974 Type R IS - 2055, 1974	
7	Head	Type	IP-65 universal screwed type (Explosion proof for NEC class-1, division-1 area)	
		Material	Die-cast aluminium or better material painted with black enamel paint.	
		Terminal Block	Brass screw type / silver plated on ceramic head.	
		Cable Connection	½ " NPT gland & grommet	
		Cover	Screwed cover with suitable gasket & SS Chain	
8	Instrument connection to Well		½" NPT	
9	Accessories		a)	Adjustable nipple-union-nipple {1/2" Sch. 80 X1/2" NPT (M)} with thermowell connection
			b)	Compression fittings/union
			c)	Flanges etc. (For flanged connection only)
			d)	SS 316 forged/barstock thermowell as per ASME PTC code. Process connection M33X2 (M)in general or 1½" Flanged for Flue gas/ Furnace air etc. application

1. The following types of sensors shall be used for the different temperature ranges:
   - For measurement of temperatures of up to max. 1100 °C, rapid-responded sheathed thermocouples with insulated tip, 16 AWG wire, as Chromel-Alumel (NiCr-NiAl, ISA type K) measuring element, with admissible deviation of thermo voltage of half the values stated in IS-2054, 1974 or DIN 43710.
   - For measurement of temperature between 1100°C and 1300°C, 24 AWG, Platinum Rhodium (13%) – Platinum (ISA type R) measuring elements, with admissible deviation of thermo voltage of half the values stated in IS-2055, 1974 or DIN-43710.
2. All thermocouples shall be duplex type with tip grounded. Thermoelectric properties and accuracy shall be as per ANSI MC 96.1 / IS-2054 / 2055: 1974.

3. The design of thermocouple assemblies shall be such that replacement on line is possible.

4. Gas-tight ceramic sheaths partially reinforced with stainless steel sheath shall be used as protective tube for Pt Rh – Pt thermocouples. For other type of thermocouple stainless steel tubes shall be used as protective sheaths. For measuring temperature of high pressure process fluid, tapered protection sheath made from solid bar stock shall be used.

5. The time-constant of thermocouples shall suit the process requirement and shall be subject to approval of Owner / Consultant.

6. The thermocouples shall be supplied with factory tested and calibrated assemblies. The assemblies shall be complete with thermo well, sensing element, connection lead, duplex terminal block, extension nipple, compression fittings / unions /flanges etc. to meet all functional requirements as per Owner's / Consultant's approved drawings. The thermocouples equipped with thermo well shall be spring loaded for positive contact with the well.

7. The duplex terminal block shall be constructed with high temperature ceramic base with brass screw type terminals.

8. Thermocouple shall be suitable for steam, water or any other liquid application. For air & flue gas service, suitable protection tubes shall be provided for the thermocouples.

9. All thermocouples (except metal thermocouples) shall be terminated to the nearest junction boxes. The cold junction compensation shall be implemented within the measuring module level, no local/ field cold junction compensation box is allowed.

9.5 Resistance Temperature Detector (RTD)

Table 9.4

Specifications for RTD

S.N	Features	Minimum Requirements
1	Type	3 / 4 wire , Pt-100 (100 ohm at 0 deg C) (as per DIN 43760)
2	No. of Element	Duplex
3	Housing/Head	IP-65/Diecast Aluminium. Plug in connectors are to be provided for external signal cable connection
4	Sheathing of RTD	Metal sheathed , mineral insulated, Compacted MgO packed
5	Calibration and accuracy	As per DIN-43670 Class-A for RTD
6	Stability	Zero & span drift within 0.1% of span for a 6 month period.
7	Characteristic	Linear with respect to temp, within ±1/2percent of top range value
8	Standard	As per DIN-43670 for RTD & ASME PTC-19.3 for

S.N	Features	Minimum Requirements	
		Thermowell	
9	Accessories	a)	Adjustable Nipple-Union-Nipple with thermo well connection / plug in connectors
		b)	Compression fittings / unions
		c)	Flanges etc.
		d)	Thermowell as per requirement

1. RTDs shall be of duplex, platinum three / four wire type with a nominal resistance of 100 ohms at 0°C and conform to DIN 43760 / BS 1904.

   Stability of RTD over full range shall be better than 0.05 ohms and the repeatability figure shall be better than 0.02 ohms. Accuracy shall be of the order of 0.15% or better and response time shall be less than 20 seconds with thermo well.

2. The protective-sheath material shall be SS 316, seamless tubes using compacted magnesium oxide packing for insulation. The insulation resistance at 540°C shall not be less than 5 mega-ohms.

3. The time constant of the RTD shall suit the process requirements and shall be subject to approval of Owner / Consultant.

9.6 Metal Temperature Thermocouple

Table 9.5

Specifications for Metal Temperature Thermocouple

S.N	Features	Minimum Requirements
1	Measuring medium	Metal Temperature
2	Type	K-Type
3	Wire Gauge	16 AWG
4	No. of Element	Duplex with separate hot junctions, ungrounded type
5	Sheathing/Insulation/Dia.	Metal sheathed (SS 321) , mineral insulated (Magnesium oxide), ceramic packed, 8 mm Dia.
6	Bending Radius	30 mm (minimum)
7	Cold End Sealing	SS pot seal with color coded PTFE headed sleeve insulated flexible tails. Sealing compound – Epoxy Resin
8	Standard	ANSI MC 96.01.1975
9	Thermocouple Length	30 Mtrs. (minimum)
10	Accessories	1/2" NPT SS sliding end connector, weld pad, weld on clamps of heat resistant steel SS310.

1. For metal temperature measurement, care shall be taken for proper contact with metal surface. The thermocouples sheath for metal temperature measurement shall have to be thermally insulated to avoid radiation /

conduction / convection loss. Thermocouple assembly for metal temperature measurement shall suit the functional requirement.

2. The thermocouple shall be attached to the heater tube surface by being furnished with stainless steel welding pads or by the use of thermocouple attachment blocks. The multiple holes in these blocks shall allow for spare thermocouple element for quick replacement.
3. For boiler metal temperature measurement, the lead wires shall have to be brought into nearest Junction Boxes which are located in accessible safe zones, using suitable protection pipes.
4. For measurement of wall temperatures at boiler tubes, sheathed thermocouples, dia 3.0 mm NiCr-Ni single thermocouples shall be used. The thermocouple line shall be designed as Teflon-insulated stranded conductor, provided with glass filament insulation and stainless steel wire braiding. The thermocouple shall be welded to the compensation line outside of the boiler insulation, with the welding point spilled hermetically in a coupling element. The area of the boiler penetration shall be designed with an anti-kink spring of stainless steel and a line-fixing sleeve of stainless steel, encapsulated in synthetic resin.
5. The differential temperature "inside / centre" of the wall shall be measured by means of sheathed thermocouples NiCr-Ni, dia 3.2 mm. For this special protective sleeve shall be used. Particular emphasis shall be put on compliance with the stipulated depth of the bores in the tube wall material.
6. For SH, RH, metal temperature measurement thermocouples shall be provided as per the specification in Table 9.5.

9.7 Thermowell for Temperature Elements

1. The design of the thermo well shall take into consideration the temperature, pressure, medium and fluid velocity specified in the process in accordance with ASME Standard PTC 19.3, 1974.

2. Thermo wells shall, in general, be of SS 316 and shall be drilled from bar stock except for air and flue gas services. However, selection of thermo well material shall be as per following guideline.

Table 9.6A

Thermowell MOC Selection

S.N	Medium	MOC
1	Lignite-Air mixtures	SS 304
2	Flue gases	Black steel, SS 446
3	Preheater	Black steel, SS 446
4	Steam lines	SS 316 and pipe material compatible for high temperature steam
5	Water lines	Low carbon steel/ SS316
6	Boiler tubes	SS 304 / SS 309 / SS 310

3. Welded type thermo wells with 38 mm O.D. for welding & ½" NPT internal threads shall be used for pressure above 100 kg / sq cm cm or temperature above 400 deg C. Socket weld type thermo well with 34 mm O.D. for welding & ½" NPT internal thread, shall be used for pressure between 40-100 kg/cm2 and temperature up to 400°C. Screwed type thermo wells with ½" NPT internal threads & M33X2 (M) outer threads shall be used for pressure below 40 kg/cm2 and temperature below 400°C. For pipes having probability of prolonged vibration, seal welding may be done all around after tightening the thermo well within the base.

4. Thermocouples / RTD used in air / flue gas path shall be supported by suitable protection tube of adequate strength with welded cap at the end. The connection size of the temperature detector with the protection pipe shall be adjustable flange type, the ratings of which shall have to be approved by Owner / Consultant. The length of the protection pipe shall be such that it supports at a distance nearly 2/3rd length of the immersed temperature detector inside the duct using a heat insulated ring support in between. The protection pipe details shall have to be approved by Owner / Consultant during detailed engineering stage. If any support is necessary for protection pipe the Contractor shall have to arrange the same.

5. Thermo wells used in Mill classifier Outlet area shall be made of suitable material of sufficient abrasion resistance such as alloy cast iron / `Ni-hard' /Tungsten Carbide of hardness approx. 400 BHN. The connection shall be flanged type, the details to be approved by Owner / Consultant. Protection rod in front of thermo wells for mill classifier if required shall be provided.

6. Thermo well manufacturing drawing covering material specification, dimensional details, details of special treatment, finish etc. as well as test procedure shall be subject to Owner's / Consultant's approval. Material certificate shall have to be furnished for each thermo well.

7. Wherever any approval is necessary from any recognized body / authority during manufacturing of high pressure wells, the same shall have to be arranged by the Contractor.

8. The thermo well immersion depth (U) shall be sufficient to eliminate conduction error. A general rule which may be followed is to use an immersion length equalling a minimum of 10 times the diameter of the protective tube or well. In general, immersion length of thermo wells for different line sizes shall be as follows:

Table 9.6B

Thermowell Immersion Length

S.N	Line Size	Immersion Length
1	From 4" to 6"	65 mm
2	From 8" & onwards	140 mm

S.N	Line Size	Immersion Length
3	Vessels	400 mm

9.8 Pressure Gauge/ Differential Pressure Gauge/Draft Gauge

Table 9.7

Specification for Pressure Gauge/ DP Gauge/ Draft Gauge

S.N	Feature	Minimum Requirement
1	Type	Bourdon / Bellows / Diaphragm
2	Sensing Element Material	AISI 316 SS
3	Movement Material	AISI 304 SS
4	Case Material / Protection Class	AISI 304 SS / IP 65
5	Dial Size	150 mm For Special application like drum pressure, Main Steam pressure etc. 250 mm shall be used
6	Scale	Black lettering on white background in 270 °C arc
7	Range Selection	Normally operate at 75% of its maximum pressure range. Instruments measuring varying pressures shall operate in a band of 60% of its maximum pressure range.
8	Over range Protection	130% of maximum range by internal stop. External stop below zero.
9	Adjustment	External Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
10	Stop at Max. Reading	Shall be provided
11	Element Connection	Argon welding
12	Process Connection	½" NPT(M) bottom connection for local mounting, back connection for flush panel mounting
13	Accuracy	+/- 1.0 % of full scale or better
14	Operating Ambient Temperature	50 °C (Max. continuous)
15	Safety Feature	Neoprene Safety Diaphragm (Blowout disc) at the back
16	Window	Shatter-proof glass
17	Chemical Seal Unit	SS 316 Flange and Diaphragm, PTFE coated / block, Silicon Oil filling fluid
18	Accessories	Snubbers for pulsating fluid applications / 3-way gauge cock / 2-valve manifold / Pigtail / Siphon for steam service / Gauge Saver, if maximum or Design Pressure is very high than the Operating Pressure / Counter Flanges / Bolts, Nuts, Gaskets / SS Tag Plate

1. Directly connected pressure measuring instruments shall be diaphragm, bourdon or bellow type elements depending upon the services conditions. In

general, diaphragm elements shall be used in the range of 0 to 1000 mm water column pressure, bellow type element for ranges of 0 to1 Kg/cm2 and bourdon type element for ranges greater than 1 Kg/cm2.

2. Primary element material shall be corrosion resistant to process fluid or diaphragm seals shall be provided for protection.

3. For draft measurement Teflon coated beryllium copper diaphragm shall be used.

4. Snubbers shall be floating pin type, externally mounted and externally adjustable. It shall be used for all pulsating services.

5. Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be the clean out type with flushing connection.

6. Over-range protection shall be provided to at least 130 % of range. For vacuum service, the element shall have under-range protection to full vacuum

7. Ranges of the gauges shall be so selected that the gauge normally operates in the middle third of the scale and conform to IS 3624 standard dials, wherever necessary.

8. The sensing elements for all gauges shall be properly aged and factory tested to remove all residual stresses and shall be SS 316 with forged socket and tip of the same material. Elements above 70 Kg/sq. cm range shall be bored instead of drawn.

9.9 Temperature Gauge

Table 9.8

Specification for Temperature Gauge

S.N	Feature	Minimum Requirement
1	Type	Mercury filled
2	Sensing Element material	Bourdon AISI 316 SS
3	Movement Materials	AISI 304 SS
4	Case Material/Protection class	SS 304/ IP65
5	Capillary Armouring	SS Flexible
6	Capillary	SS 316 (5 mtr. Length for Local & 15 metre for panel Mounting)
7	Bulb/Stem Diameter	12 mm or 6 mm uniform
8	Dial Size	150 mm
9	Window	Shatterproof glass
10	Scale	Black lettering on white background in 270 °C arc
11	Adjustment	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
12	Pointer	Externally Adjustable

S.N	Feature	Minimum Requirement
13	Range Selection	Normal Process Temperature – approximately two third of Temperature range.
14	Stop at Max. Reading	Shall be provided
15	Over range Protection	130% of FSD
16	Instrument Connection	Bottom connection for local mounting, back connection for flush panel mounting.
17	Process Connection	½" NPT with Thermowell
18	Performance :-	
a	Accuracy	+/-1.0% of full scale or better
b	Repeatability	Less than 0.5% of full range
c	Response Time	30 seconds (max.) with Thermowell and 15 seconds Bare.
15	Operating Ambient Temperature	50 °C (Max. continuous)
16	Accessories	Mounting brackets, Bolts, Nuts, Gaskets / SS Tag plate, SS Thermowell etc.

1. Temperature gauges shall be dial thermometers (liquid spring / steam pressure spring / metal expansion thermometer), either rigid stem or capillary tube depending upon application; if this is not possible for design reasons, industry type liquid – in – glass thermometers shall be used.
2. Case shall have back or bottom connection with adjustable gland to permit adjustment of thermometer into the thermo well.
3. Thermometer stem adjustable gland with union connection and bushing shall be suitable for ½ inch NPT connection.
4. Bi-metallic type dial thermometer, if used, shall be hermetically sealed, back or bottom connection type, with 150 mm dial.
5. The gauges shall be provided with automatic ambient temperature compensation.
6. Scale ranges shall be selected so that normal process temperature is in middle two – third of full scale range

9.10 Level Gauge

Table 9.9A

Specification for Gauge Glass Type Level Gauge for vessels

S.N	Feature	Minimum Requirement
1	Sensing Element & material	Tempered toughened Borosilicate gauge glass steel Armored reflex or transparent type
2	Body Material	Forged carbon steel / 304 SS
3	End Connection	Process connection as per ASME PTC and drain / vent 15 NB

S.N	Feature	Minimum Requirement
4	Accuracy	+/- 2 % of full scale
5	Scale	Linear vertical
6	Range Selection	Cover 125 % of max. of scale
7	Over Range Test	Test pressure for the assembly shall be 1.5 time of the Maximum design pressure at 38 degree C
8	Housing	CS / 304 SS leak - proof
9	Identification	Engraved with service legend or or laminated phenolic Name plate
10	Packing	PTFE Teflon
11	Illumination	220 V, 50 Hz, 25 / 40 Watts either with deflector or diffuser (for transparent type level gauge) / 220V , 50 Hz, 25 /40 Watts with red and green filter for bicolor gauge
12	Accessories	Gasket for all KEL – F shield for transparent type vent and drain valves of CS / SS as per requirement
13	Others	Anti – Frost extension for low temperature service. Heating / cooling arrangement

1. Level gauges shall be steel armoured reflex or transparent or bi –colour type, top and bottom connection as per pressure vessel standard of ASME PTC code and 15 mm NB (1/2 inch NPT) Drain and Vent connection.
2. Body material and cover material shall normally be forged carbon steel, 304 stainless steel or other superior material.
3. Reflex type gauges shall be used for clean and colorless liquids and transparent type for other liquids. For boiler and condensate services, treated water, the transparent type with KEL – F shields shall be used to avoid their attack on the glands.
4. The gauge glass must have a rating equal to or more than the vessel design pressure and temperature. The test pressure for the complete design gauge assembly shall be as per Owner's / Consultant's recommendation.
5. The maximum length of a single gauge glass shall not exceed 1400 mm. Where large range is required, multiple gauges of preferably equal lengths shall be used with 50 mm over – lapping in visibility.
6. The visibility shall cover the operating level range and the maximum and minimum ranges expected considering start – up conditions as well as alarm and shut down points. Internal heating shall be provided for viscous liquids. Integral illuminators shall be used for transparent gauges, if necessary.
7. Stand – pipes shall be used for multi – gauge glass and level controller installation and on horizontal drum or exchanger with top and bottom connections to have visibility of the complete span. The stand pipe shall not be used with block valves.
8. Primary isolation valves shall be used In addition to the gauge glass valves unless otherwise specified. When the process fluid may create lugging or

leakage problem, gauge valves may be omitted. For low temperature liquid having high vapour pressure at ambient temperature, isolation and gauge valves shall not be permissible. Safety valve shall be provided at the vent connection of the gauge glass where isolation is required.

9. For high pressure service such as boiler water etc., the gauge glass shall be multi – port illuminated type (Bi – colour type). Indication of water space shall be `green' and indication of steam space shall be `red'.

10. Bi – colour level gauges shall have following features:

- Temperature equalizing column expansion bend and chain patterned hand – wheel
- Certification by Inspectorate of Boiler

Table 9.9B

Specification for Float & Tape Type Level Gauge for Tanks

S.N	Feature	Minimum Requirement
1	Type	Float & Tape type
2	MOC of Float & Tape	SS 316
3	MOC of Pulley	Aluminium
4	Guide Wire	SS 316
5	Accuracy	+/- 5 mm
6	Indication	Arrow on Circular or Vertical scale Board

9.11 Pressure/ Differential Pressure Switch

Table 9.10

Specification for Pressure/DP Switch

S.N	Feature	Minimum Requirement
1	Type	Piston for high pressure application Bellow/Diaphragm for low pressure application
2	Sensing Element material	AISI 316 SS
3	Wetted Parts material	AISI 316 SS
4	Case Material	Epoxy coated Die Cast Aluminium
5	Setter Scale	Black graduation on white linear scale. Graduation 0 – 100% with red pointer for set points.
6	Over range for Pressure / Vacuum Switch	130% of maximum pressure
7	Set Point	Adjustable throughout switch operating range.
8	Static Pressure for Differential Pressure Switch	Maximum Line Pressure or Static Pressure on either side without permanent deformation or loss of accuracy.
9	Adjustments	Internal – set point

S.N	Feature	Minimum Requirement
		Differential adjustable feature
10	Process Connection	½" NPT(M) bottom connected
11	Switch Configuration	2 SPDT / 1 DPDT
12	Switch Rating	230 V, 5A AC / 220 V, 0.25 A DC/24 V, 2A DC
13	Switch Type	Snap acting, shock and vibration-proof
14	Cable Connection	½ " ET conduit connections or compression gland
15	Enclosure Class	Weather proof as per IP 65 with corrosion resistance coating.
16	Accuracy	1% of span up to 3Kg/cm2 0.5% of span for more than 3 Kg/cm2.
17	Repeatability	0.5% of span
18	Accessories	
a)		Snubbers for pulsating fluid application.
b)		Tag Number, service engraved in SS tag plate
c)		Teflon back-up sheath protection, as required.
d)		i) Remote diaphragm seal with SS 316 armored capillary for typical application. MOC of seal material shall be as per process fluid requirement. ii) Silver coated diaphragm for corrosive services like chlorinated water.
e)		Retention ring and screws for surface mounting.
f)		3-way Gauge Cock (SS 316) for PS / 5-Valve Manifold (SS 316) for DPS.
g)		Mounting bracket / Clamp for 2 '' pipe, bolt & nut.

1. The pressure switches shall have sensing elements made of copper alloy or stainless steel sealed diaphragm and piston actuated for high pressure service and bellows for low pressure / vacuum service.
2. Low differential pressure switches for low static pressure ranges shall be diaphragm type with snap action switch elements.
3. Low differential pressure switches for high static pressure shall be elbows and torque tube type and snap – action switch elements and metric scale dial indicators.
4. For corrosive, viscous process fluids diaphragm sealed with completely filled inert liquid shall be provided. Material of diaphragm and wetted parts shall be selected considering the nature of process fluid.
5. The sensing elements shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand at least 130 % the full scale pressure without any damage or permanent deformation.
6. Actuation set point, dead band shall be internally adjustable throughout the range with tamper proof facilities.
7. Electrical connection for the switch devices shall be suitable for plug in type connection.

8. Process connection shall be ½ inch NPT. Process piping connections shall include necessary union, nut, nipple, tail pipe, isolation valve and test connection to permit servicing, testing, calibration and removal of the instrument device.

9. Instrument for steam & hot water service, shall be connected through siphon, of stainless steel or suitable material. Pulsation dampeners shall be provided for all pulsating fluids.

10. Pressure switches shall be tested as per BS – 6134.

9.12 Conductivity Type Level Switch

Table 9.11

Specification for Conductivity Type Level Switch

S.N	Feature	Minimum Requirement
1	Sensing elements	Conductivity type
2	Material	SS 316
3	Repeatability	± 0.5 % of full range or better
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
6	Probe length	As per requirement
7	Mounting	Flanged- on external cage
8	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
9	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
10	Enclosure	IP 65
11	Housing	Cast aluminum epoxy coated weather proof
12	Ambient Temperature	60*C (max.)
13	Electrical Connection	Plug-in type
14	Cable connection	½ " NPT with cable gland
15	Set point	Adjustable
16	Accessories	All mounting accessories

9.13 Capacitance Type Level Switch

Table 9.12

Specification for Capacitance Type Level Switch

S.N	Feature	Minimum Requirement
1	Type	Capacitance type
2	Probe	Rod or Suspended Electrode
3	Material	SS 316
4	Insulation	PTFE/PP/Kynar part/full as required
5	Repeatability	± 0.5 % of full range or better
6	Accuracy	± 0.5 % of full scale or better

S.N	Feature	Minimum Requirement
7	Working temperature	As per process requirement
8	Probe length	As per requirement
9	Probe Mounting	1 ½" Flanged
10	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
11	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
12	Enclosure	IP 65
13	Housing	Cast aluminum epoxy coated weather proof
14	Cable connection	½ " NPT with Cable gland
15	Ambient Temperature	60*C (max.)
16	Electrical Connection	Plug-in type
17	Accessories	Counter flange, Cable gland, Prefab cable etc.
14	Set point	Adjustable
15	Accessories	All mounting accessories

9.14 Float/Displacer Type Level Switch

Table 9.13

Specification for Float/Displacer Type Level Switch

S.N	Feature	Minimum Requirement
1	Type	Float/Displacer type
2	Float/Stem/Displacer Material	SS 316
3	Repeatability	± 0.5 % of full range or better
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
7	Process connection	As per requirement
8	Over-range proof	150% of max. design pressure
9	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
10	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
11	Enclosure	IP 65
12	Hydro Test	Chamber – 100% at 1.5 times rated pressure or as per ANSI flange rating Float – 1.1 times of operating pressure
13	Electrical Connection	Plug-in socket
14	Accessories	All mounting accessories

1. Level Switch shall work on gland less magnetically coupled float or displacer operated mechanism having separate float chamber.
2. Float, stem and displacer shall be 316 stainless steel.

3. Level switch body, cage and process connections shall be designed to withstand the maximum pressure and temperature of the operating fluid.

4. A setting adjustment on the level set point of + / - 25 mm shall be provided. The adjustment shall be made externally to the switch.

5. The accuracy & repeatability of the switch shall be within +/- 0.5 % of full-scale range. On – Off differential shall be adjustable.

6. Process connections of the cage shall be 25 NB male plain nipples connected through socket / welded isolation valves of adequate rating.

7. Level switch connections shall also include 15 NB test and drain connections to permit servicing, testing, calibration of the instrument.

8. The switching elements shall be snap-acting, shock-proof and vibration-proof. All switches shall have two electrically isolated SPDT contacts with provision of external adjustment of set points and dead bands. The contact ratings shall be 5 amps at 230 V AC 50 Hz or 0.25 amps at 220 V DC.

9. Switch enclosures shall be cast aluminium, weather-proof, NEMA -4X type with cable entry through compression type cable glands / ¾ "NPT conduit connections. Switches located in hazardous areas shall have dust-ignition-proof enclosure as per NEC article 500 provisions.

9.15 Ultrasonic Level Transmitter

Table 9.14

Specification for Ultrasonic Transmitter

S.N	Feature	Minimum Requirement
1	Application	Level measurement in silos, sump water level etc.
2	Medium	Coarse, hard solid materials like ash etc. Materials may be slowly falling through the detection range.
3	Type	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic Transmitter. Transmitter shall be remote type or shall be configurable from remote controller/Configurator.
4	Principle	Time of flight
4	Sensor Material	Corrosion resistant material to suit individual application requirement.
5	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank / sumps obstructions such as pipes, heating coils or agitator blades. Also transmitters shall have adjustable damping circuitry.
7	Range	Capable of covering the complete level span of tank/vessel taking care of blocking distance, frequency, attenuation due to surface, obstructions, vapours etc.

S.N	Feature	Minimum Requirement	
8	Output	4 – 20 mA DC with 600 ohms load with HART compatibility.	
9	Display	Minimum 4 characters display with Integral keypad, access protected by user code.	
10	Diagnostics	Loss of echo alarm etc.	
11	Resolution	+/- 0.1 % of range or better	
12	Accuracy	+/- 2 mm or 0.2% of span	
13	Repeatability	3 mm or better	
14	Operating temperature	0 to 60^0 C	
15	Power supply	24 V DC + / - 10 %	
16	Mounting	Flanged connection at top of covers / side walls as per requirement.	
17	Accessories	a)	All weather canopies for protection from direct sunlight and direct rain.
		b)	For hazardous areas, explosion proof enclosure as per NEC article 500 shall be provided.
		c)	All mounting hardware and accessories required for erection and commissioning. Mounting fittings material shall be SS 316.

1. The power and frequency of transmission for the transmitter shall be selected to assure a sufficient signal / noise ratio.

2. The transmitter shall be designed with an electronic circuit having the features such as temperature compensation, rejection of unnecessary echoes and noises and adjusting 'zero' and 'span'. It shall consist of sensors, electronic unit and accessories.

9.16 Radar Type Level Transmitter

Table 9.15

Specification for Radar Type Transmitter

S.N	Feature	Minimum Requirement
1	Application	Level measurement of vessel under vacuum or low pressure application/ Fuel oil storage tanks
3	Type	Guided wave radar for vessel under vacuum or low pressure and Radar type for Fuel oil storage tanks
4	Principle	TDR (Time domain reflectrometry)
5	Probe Material	SS 316

S.N	Feature	Minimum Requirement	
6	Accuracy	5 mm or better	
7	Resolution	+/- 0.1 % of range or better	
8	Signal Output	4 – 20 mA DC with 600 ohms load with HART compatibility	
9	Power Supply	24 V DC + / - 10 %	
10	Display	Integral	
11	Mounting	External cage type	
12	Transmitter housing Protection Class	IP-65 with corrosion resistance coating	
13	Accessories	a)	All weather canopies for protection from direct sunlight and direct rain.
		b)	For hazardous areas, explosion proof enclosure as per NEC article 500 shall be provided.
		c)	All mounting hardware and accessories required for erection and commissioning. Mounting fittings material shall be SS 316.

9.17 RF Type Level Switch

Table 9.16

Specification for RF Type Level Switch

S.N	Feature	Minimum Requirement
1	Application	Solids
2	Particle size	Fine dust to 400 mm
3	Process Temperature	0 – 100^{0}C
4	Vessel pressure	up to 60 bar
5	Insertion length	As required
7	Mounting	Side or top or top vertical at ± 15^0
8	Process connection	40 NB thread or flanged
9	Protection Class	IP 67
10	Electronics	Remote
11	Cable connection	½ "NPT cable gland Plug-in cable connector

9.18 Flow Switch

Table 9.17

Specification for Flow Switch

S.N	Feature	Minimum Requirement
1	Type	Vane actuated/Differential bellow type
2	Vane/bellow Material	SS 316
3	Repeatability	± 0.5 % of full range or better
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
7	Process connection	As per requirement
8	Over-range proof	150% of max. design pressure
9	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact, shock & vibration proof
10	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
11	Enclosure	Cast Aluminium/IP 65
12	Cable connection	Compression type cable gland/ ½" NPT Conduit connection
13	Electrical Connection	Plug-in socket
14	Accessories	All mounting accessories

9.19 Rotameter

Table 9.18

Specification for Rotameter

S.N	Feature	Minimum Requirement
1	Type	Variable area Linear scale
2	Fluid media	Water/Oil
3	Float Material	SS 316
4	Accuracy	± 2 % of full scale or better
5	Working temperature	0 to 70*C
6	Process connection	As per requirement
7	Over-range proof	150% of max. design pressure
8	Enclosure	Transparent toughened glass/IP 65
9	Accessories	Flange, orifice in case of bypass Rotameter

Rotameter shall be used for low flow & low viscosity applications of liquid.

9.20 Coriolis Flow meter

Table 9.19

Specification for Coriolis Flow meter

S.N	Feature	Minimum Requirement
1	Service	Fuel Oil (LDO/HFO) flow measurement

S.N	Feature	Minimum Requirement
2	Primary Element	Flow tube of SS316 or better
3	Heating arrangement	Integral with flow element
4	Temperature control	To be provided
5	Allowable pressure drop	<0.5 Kg/Sq. cm.
6	End Connection type /size	Flanged WMRF to ANSI 300
7	Cable entry	½" NPT (F)
8	Accuracy	+/- 0.2% of Flow rate or better
9	Power supply	230 V 50 Hz
10	Drain	Self draining facility
11	Enclosure	SS 316
12	Display	LCD display
13	Output	2 nos. isolated output of 4-20 mA.
14	Load	<750 ohms
15	Turn down Ratio	100:1
16	Housing	IP 65 or better
17	Hazardous duty Version	FM standard
18	Accessories	Counter flanges, Nuts, Bolts, Gaskets, U clamps, prefab cables etc.

9.21 Sight Glass Indicator (Flow Glass)

Table 9.20

Specification for Flow Glass

S.N	Feature	Minimum Requirement
1	Application	Online observation of fluid flow in Pipeline
2	Type	Double window for pressurized pipe with rotary wheel for installation in horizontal or vertical pipeline. Full view for non-pressurized pipeline.
3	Size	Double window up to 12" and 600 lbs rating. Full view up to 6" and 150 lbs rating.
3	Body Material	SS 316
4	Glass	Pyrex tempered glass
	Others	Rotor & wetted parts shall be bronze All accessories shall be SS316
5	Protection class	IP-65
6	Connection	Screwed up to 50 NB size Flanged ANSI 150 RF – above 50 NB size
7	Accessories	Name plates, mating flanges with gasket, bolts & nuts etc.

9.22 Flow Elements

a) Orifice Plate

Table 9.21 A

Specification for Orifice Plate

S.N	Feature	Minimum Requirement
1	Type	Concentric as per ASME PTC – 19.5 (Part III); ISA RP – 3.2, 960; BS – 1042; ISO 5167
2	Material	SS 316
3	Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe dia above 300 mm.
3	Beta ratio	0.34 to 0.7
4	Tapping's	Flanged weld neck 3 pairs of tappings.
5	Material of Branch Pipe	Same as main pipe
6	Root Valve type	Globe
7	Root Valve material	SS 316
8	Root Valve size	1"
9	Accessories	Root valves, flanges, vent / drain hole (as required)

1. Contractor to provide Beta ratio calculation, Assembly drawings & flow vs DP curves.
2. Each orifice plate shall be provided with a handle on which the orifice diameter, pipe diameter and pressure tap distances are stamped. This information shall be so located that it can be read without removing the orifice plate from pipe line.
3. The standard primary element shall be thin plate, square-edge concentric orifice plate mounted between a pair of weld-neck type orifice flanges with flange taps. The minimum pressure rating of flanges shall be 300 pounds ANSI. The material of the orifice plates shall be SS 316 in general. Orifice plates shall be not less than 3 mm thick for nominal pipe diameters up to and including 300 mm, and not less than 6 mm thick above 300 mm NB pipe.
4. Quadrant edge or quarter circle orifice plates shall be used for highly viscous liquids and for pipe Reynolds Number below 10,000. Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids up to Reynolds Number below 250. Vent and drain holes shall be provided wherever necessary.
5. Orifice diameter shall be selected, so that d/D ratio is between 0.20 to 0.70 for gas and steam and up to 0.75 for liquids.
6. Metering orifices shall not be installed in lines less than 1 ½" (40 mm) the lines shall be blown to the 1 ½ " (40 mm) size for the meter run, keeping the d/D ratio within limits.
7. Restriction orifices and integral orifice transmitters do not require upstream or downstream straight pipe runs.

8. The orifice plate shall be supplied and fitted in conformity with ISO. When the pipe diameter is larger than the value specified in ISO, the restriction ratio shall be decided by extending the specific curve externally.

9. The length of straight pipe run required for metering accuracy shall be in conformity with ISO. When it is extremely difficult to comply with the standard, a minimum straight length of 10D (D = pipe inner diameter) on the upper stream and a minimum length of 5D on the downstream shall be considered.

10. All orifice plates shall be supplied with matching flanges of material and pressure rating not less than the rating of the associated pipe system.

11. For pipeline sizes of 500 mm and less, the orifice plates shall be an integral unit comprising of carrier ring assembly, tapping arrangement on both upstream as well down stream side. For line sizes more than 500 mm, the orifice plate shall be disc type. For disc type orifice plate, suitable corner tapping arrangement on both upstream as well as down stream side shall be provided. All tapping arrangements shall be complete with a piece of impulse pipe line and a shut – off valve suitable for specified line pressure.

12. For steam applications, orifice plate shall be supplied with a pair of steam condensation chambers suitable for specified line pressure.

13. Data sheets, sizing calculation, fabrication & sheets for the elements shall be submitted for approval and finalization.

b) Flow Nozzle

Table 9.21 B

Specification for Flow Nozzle

S.N	Feature	Minimum Requirement
1	Type	Long Radius welded type ASME PTC 19.5 (Part III) or BS – 1042
2	Material	Same as Pipe material
3	Thickness	Suitable for intended application
3	Beta ratio	Around 0.7
4	Tapping's	D and D/2 (3 nos. tappings)
5	Material of Branch Pipe	Same as main pipe
6	Root Valve type	Globe
7	Root Valve material	SS 316
8	Root Valve size	1"
9	Accessories	Root Valves, Vent & Drain Hole

1. Contractor to provide Beta ratio calculation, Assembly drawings & flow vs DP curves.

2. The branch pipes for holding the flow nozzle shall also be furnished along with the flow nozzle. All nipples, welding adaptors and root valves shall also be in the scope of supply.

3. Flow nozzles in high pressure pipes shall be subject to a test according to DIN 50049, 3.1C, considering the technical guideline. The test of flow nozzles shall contain:

   - Check of drawings
   - X-ray testing of the circular bead or colour soaking or ultra-sonic testing
   - Test of sizes.

4. Flow nozzle shall be provided with a permanent mark indicating:

   - Measuring point number
   - Direction of flow
   - Plus and minus tapping
   - Material

   Moreover, the actual inside pipe diameter "D" and the diameter of the flow nozzle shall be stated on the identification plate.

5. The Contractor shall provide the following documents:

   - Design drawings of the flow nozzle
   - Calculation documents
   - Fabrication, assembly and installation drawings
   - Test reports.

6. For measurements of steam, balancing vessels shall be provided. Balancing vessels shall be used for flow measurement in steam system based on the differential pressure method to ensure a defined water column. The balance vessels shall be arranged on the same geodetic level. If this is not possible for design reasons, the level difference shall be taken into account during calibration

c) Aerofoil

Table 9.21C

Specification for Aerofoil

S.N	Feature	Minimum Requirement
1	Type	Flanged
2	Material	SS 316
3	Tapping's	3 nos. tappings of ½" NPT
4	Material of Branch Pipe	SS 316
5	Root Valve type	Ball
6	Root Valve material	SS 316

S.N	Feature	Minimum Requirement
7	Root Valve size	1/2″
8	Accessories	All required mounting accessories

d) Venturi

Table 9.21D

Specification for Venturi

S.N	Feature	Minimum Requirement
1	Design standard	BS 1042/ISO5167
2	Material	SS 316
3	Type	Fabricated Machine Cast
4	Mounting	Flanged
5	Root Valve type	Ball
6	Root Valve material	SS 316
7	Root Valve size	1/2″
8	Accessories	All required mounting accessories & piezometric ring with 4 nos. tapping's for choke removal & screwed cap/plug on the ring

9.23 Oxygen Analyzer

Table 9.22

Specification for Oxygen Analyzer

S.N	Feature	Minimum Requirement
1	Type	In-situ Heated type
2	Principle	Partial pressure using Zirconium oxide cell
3	Sensor Type	Zirconium Oxide cell
4	Measurement Range	0.01 to 10 % O2
5	Accuracy	+/- 0.2 % of full scale
6	Linearity	+/- 1% of full scale
7	Response time	3 seconds or less (Up to 90% of full scale)
8	Drift	+/- 0.005% per 2 Deg. Centigrade temp. change
9	Operating Temperature Range	0-1600 *C
10	Temperature compensation	Automatic
11	Sample filter	Ceramic 3.5 micron
12	Zero & Span Adjustment	Required
13	Ambient Temperature	60*C
14	Indication	Digital
15	Enclosure Type/Material	Weather & Dust proof IP-65/ SS 316

S.N	Feature	Minimum Requirement
16	Type of Electronics	Microprocessor based with self diagnostic facility
17	Calibration	Auto & manual
18	Output signals	Analog: 4-20 mA DC Binary: 2 NO + 2 NC for Alarms
19	Digital Signal transmission	RS-232 or RS-485 OR as per requirement to suit connection protocol of Plant DCS
20	Other requirement	HART Communication protocol compatibility & suitable for connection to Smart Transmitter Maintenance system. Purging System

9.24 Carbon Monoxide Analyzer

Table 9.23

Specification for Carbon Monoxide Analyzer

S.N	Feature	Minimum Requirement
1	Type	In-situ type
2	Principle	IR Double beam absorption
3	Sensor Type	IR
4	Measurement Range	0-999 ppm selectable
5	Accuracy	+/- 0.2 % of full scale
6	Linearity	+/- 1% of full scale
7	Response time	3 seconds or less (Up to 90% of full scale)
8	Drift	+/- 0.005% per 2 Deg. Centigrade temp. change
9	Operating Temperature Range	0-1600 *C
10	Temperature Compensation	Automatic
11	Sample filter	Ceramic 3.5 micron
12	Zero & Span Adjustment	Required
13	Ambient Temperature	60*C
14	Indication	Digital
15	Enclosure Type/Material	Weather & Dust proof IP-65/ SS 316
16	Type of Electronics	Microprocessor based with self diagnostic facility
17	Calibration	Auto & manual
18	Output signals	Analog: 4-20 mA DC Binary: 2 NO + 2 NC for Alarms
19	Digital Signal transmission	RS-232 or RS-485 OR as per requirement to suit connection protocol of Plant DCS
20	Other requirement	HART Communication protocol compatibility & suitable for connection to Smart Transmitter Maintenance system. Purging System.

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9.25 Control Valves

A. Introduction

The control valves and accessories equipment furnished by the Contractor shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & Pressure Vessel code, Indian Boiler Regulation (IBR) & ISA or acceptable equal standards.

B. Control Valve Design & Sizing

1. The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI for dimensions, material thickness and material specification for their respective pressure classes.
2. The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA Handbook on control valves. While deciding the size of valves, Contractor shall ensure that valves outlet velocity does not exceed 8 m / sec. for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Contractor shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which shall be subject to Consultant's / Owner's approval during detailed engineering.
3. Control valves for steam and water applications shall be designed to prevent cavitations, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitations / flashing service, only valve with anti-cavitations trim shall be provided. Detailed calculations to establish whether cavitations shall occur or not for any given application shall be furnished.
4. Trim shall be multistage type having sufficient number of discrete pressure drop turns (stages) to ensure elimination of vibration, erosive – action, cavitations. Contractor shall identity the number of pressure drop turns in proposed equipment and shall also provide calculation demonstrating compliance to the trim exit velocity.
5. To prevent flow induced vibration and to protect the valve internals from foreign particles such as weld slag flow, direction shall be a flow to close (over the plug) configuration for liquid applications. To maximize noise attenuating benefits and to allow for constant fluid expansion, flow direction shall be under the plug for steam and gas applications.

6. Control valves for application such as SH spray control, RH spray control, Heavy oil pressuring & control system shall have permissible leakage rate as per leakage class V. All other control valves such as low and high range feed control valves etc shall have leakage rate as per leakage class IV.
7. The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.
8. The characteristic of the control valves shall be determined based on the application / service.
9. On supply air or electrical failure for pneumatic / electrical drive, the valve shall remain full closed, open or stay – put position as per process safety requirement.

C. Valve Construction

1. Proper selection of valve type and material of construction to meet operating requirement.
2. All valves shall be of globe body design and straightaway pattern with single or double port unless otherwise recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure or pressure drops permit.
3. Valves with high lift cage guided plugs & quick charge trims shall be supplied.
4. Cast iron valves are not acceptable.
5. Bonnet joints for all control valves shall be of the flanged and bolted type for easy dis – assembly. Bonnet joints of internal threaded or union type shall not be acceptable.
6. Plug shall be of one – piece construction either cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.
7. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing).
8. Valve characteristic shall match with the process characteristics.
9. Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 *C.
10. Flanged valves shall be rated at not less than ANSI pressure class of 300 lbs.
11. Teflon shall be used for valve gland packing to suit process requirement.

12. The valve body shall be marked to show direction of flow.

D. **Valve Materials**

1. The control valve body material shall be

- Carbon steel as per ASTM – A216 GR WCB for non – corrosive, non – flashing and non – cavitations services below 275 deg c temperature like Auxiliary Steam flow to Deaerator, CRH flow to Deaerator, Condensate flow to Deaerator etc.
- Alloy steel as per ASTM – A217 GR WC 9 for severe flashing / cavitations services like low load and full load feed water control, HP and LP heaters emergency drains, Deaerator overflow drain to Hotwell etc.
- Alloy steel as per ASTM A – 217 GR WC 6 for low flashing / cavitations services like HP heaters & LP heaters normal drain control, drain cooler normal level control, gland steam cooler minimum flow etc.
- 316 SS for condensate service below 300 deg C like condensate normal and emergency make – up controls etc.

2. The control valve trim material shall be

- 17 – 4 PH SS for severe services listed under item D.1, 2nd point & 3rd point above
- 316 SS for services listed at D.1, 4th point above and
- 316 SS with stellite faced guide parts and bushings for remaining applications.

3. However, Contractor may offer valves with body and trim materials better than specified materials and in such cases Contractor shall furnish the comparison of properties including cavitations resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis – a – vis the specified material for Owner's / Consultant's consideration and approval.

E. **End Preparation**

Valve body ends shall be either butt welded / socket welded, flanged or screwed as finalized during detailed engineering and as per Owner's / Consultant's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves sizes 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure – temperature class equal to or greater than that of the control valve body.

F. **Valve Actuator**

1. The regulating control valves shall be furnished with pneumatic actuators. The Contractor shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut

off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 *C continuously.

2. Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 kg / cm^2 per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.
3. The travel time of the pneumatic actuators shall not exceed 10 seconds.
4. For quick opening / closing services (such as fuel oil shut – off valve), the actuator shall be pilot solenoid operated pneumatic drive; the rating of solenoid shall be 24 V DC.
5. Selection of actuator shall be such that it meets the requirements of thrust / torque, stroke length, angular movement, full scale travel time, repeatability & accurate positioning for successful operation of final control element.
6. All the actuators shall have also provision for manual operation during emergency / maintenance along with graduated local position indicator.

G. Control Valve Accessory Devices

All control valve accessories such as air locks, hand wheels / hand-jacks, limit switches, SMART positioners, diffusers, external volume chambers, reversible pilot for positioners, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

Table 9.24(i)

Specification for E-to-P converter

S.N	Feature	Minimum Requirement
1	Air Supply	1.5 Kg/Sq. cm
2	Input Signal	4-20 mA DC
3	Output Signal	0.2 to 1.0 Kg/ Sq. cm
4	Linearity	0.5 % of span or better
5	Hysteresis	0.1 % of span or better
6	Ambient Temperature Effect (-20 to +60 *C)	<0.2 % of span per Degree centigrade
7	Mounting	Close to Actuator
8	Protection class	IP-65
9	Enclosure	Die cast Aluminium
10	Drift	+/- 2% of set point per hour

Table 9.24(ii)

Specification for Smart Positioners

S.N	Feature	Minimum Requirement	
1	Input	4-20 mA DC	
2	Power Supply	24 V DC Loop powered	
3	Type of Electronics	Microprocessor based with self diagnostic facility & digital communication by means of HART Protocol	
4	Valve position sensing	Non-Contact type with 4-20 mA DC Output	
5	Enclosure Type/Material	Weather & Dust proof to IP-65/ Die cast Aluminium	
6	Ambient conditions	Suitable for - 30 to +80 *C temperature & 0-95% Humidity	
7	Operating Range	Suitable for Full range & Split Range operation	
8	Modes of operation	Suitable for Direct & reverse valve action	
9	Flow characteristics	Suitable for Linear & Equal percentage Characteristics	
10	Fail safe/Freeze feature	Required	
11	Air Capacity	Sufficient to handle the Valves Selected/Boosters to be supplied if required.	
12	Air supply pressure	To suite the Air Supply Pressure / Quality available	
13	Process Connection	1/4" NPT	
14	Characteristic Deviation	< =0.5% of span	
15	Ambient Temperature effect	< =0.01%/Deg C or better	
16	Configuration	Remote Calibration, Auto & Manual Calibration shall be possible	
17	Cable Entry	½" NPT, Side or Bottom Entry to avoid water ingress	
18	Accessories	a)	Display with push buttons for configuration and Display on the positioner itself (Password Protected / Hardware Lock).
		b)	For Supply & Output Pressure, Filter Regulator and other accessories shall be provided as on required basis for making system complete
		c)	Valves Mounting Assembly For Sliding Stem / Rotary / Single Acting / Double Acting on required basis

1. SMART positioner shall be a Double stage positioner. The first stage of the positioner shall be typically a flapper-nozzle that serves as a high-gain pre-amplifier. This sensitivity shall be maintained over a wide range of dynamic conditions. Second stage shall be a power amplifier that provides power to drive the actuator. Preferably this shall be a pneumatic relay. Spool Driven type SMART positioners are not preferred due to Higher Dead Band and Poor responsiveness. The SMART positioner shall have pressure sensors to measure the pneumatic outputs to the actuator.

2. The control algorithm for the positioner shall use feedback signal from the motion of the pneumatic relay beam instead of pressure feedback to minimize pneumatic related effects and for stable and smooth response of the control valve. The SMART positioner shall have user adjustable tuning sets to identify the optimum tuning for the total valve assembly. SMART Positioner with HART Communication facility shall communicate all the valve diagnostics to Plant DCS.

Table 9.24(iii)

Specification for Air Filter Regulator (AFR)

S.N	Feature	Minimum Requirement
1	Type	Constant Bleed type
2	Inlet Pressure	10 Kg/Sq. cm (maximum)
3	Output	Adjustable from 0-2 Kg/Sq. cm or 0-7 Kg/Sq. cm (Continuous) as required
4	Filter Element	5 microns
5	Filter Element Material	Phosphor Bronze
6	Bowl Material	Metallic
7	Enclosure Protection class/ Material	IP-65/ Die cast Aluminium
8	Process connection	¼ " NPT
9	Accessories	All mounting accessories. 2" dial size Pressure gauge.

Table 9.24(iv)

Specification for Position Transmitter

S.N	Feature	Minimum Requirement
1	Power Supply	24 V DC Loop powered
2	Type	Non-Contact/ LVDT type
3	Output	4-20 mA DC/ Linear
4	Accuracy	+/- 1%
5	Enclosure Protection class/ Material	IP-65/ Die cast Aluminium
6	Cable Entry	½" NPT, Side or Bottom Entry to avoid water ingress.
7	Accessories	All mounting accessories

Table 9.24(v)

Specification for Limit Switch (Non Contact Type)

S.N	Feature	Minimum Requirement
1	Type	Non-contact type inductive Proximity
2	Sensing distance	10 mm minimum
3	Hysteresis	Maximum 10% of sensing distance
4	Indicator	LED indication

S.N	Feature	Minimum Requirement
5	Protection class	IP 67
6	Integral Cable	1 mtr.
7	Power supply	24 V DC/ 8 V DC
8	Mounting	Flush mounting with check nut
9	Other Feature	Explosion proof enclosures shall be provided wherever required by the application. Shock & Vibration proof.

G. **Test & Examination**

1. All valves shall be tested in accordance with the quality assurance programme agreed between the Owner / consultant and the Contractor which shall meet the requirement of IBR and other applicable codes.

2. The tests shall include but not but limited to the following:

   - Non-destructive test as per ANSI B – 16.34.
   - Hydrostatic shell test in accordance with ANSI B16.34 prior to seal leakage test.
   - Valve closure test and seal leakage test in accordance with ANSI B16.34 and as per the leakage class indicated under clause no. B.6.
   - Functional test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.
   - All control valves shall be tested with the positioners for accuracy of positioning and reproducibility over the full range of travel.
   - CV Test : CV test shall be carried out as type test on each size, type and design of the valves as per AISA 75.02 standard and test report shall be furnished for Owner's / consultant's approval.
   - Magnetic particle inspection shall be performed on all machined surfaces of valves having ASA rating of 1500 lbs ASA or greater. All carbon steel valves with 1500 lbs ASA or greater shall receive 100% radio graphic examination in accordance with ASTM – E71.

3. Contractor shall submit test certificates for the tests mentioned in above paragraphs in accordance with ASME and ASTM requirements. In addition Contractor shall also submit for the above equipment, certificate of manufacture and test as required by the Indian Boiler Regulations. The certificate shall be in the prescribed forms III A & III C and shall be endorsed by an Inspection Authority recognized by the Indian Boiler Regulations.

H. **General Requirements**

1. Contractor shall furnish all the control valves as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements.
2. Following documents to be furnished by the Contractor after the award of contract.
   a. Final data sheet for all control valves.
   b. Detailed dimensional and cross-sectional drawing of control valves, indicating end to end dimensions, various clearances required, weight etc.
   c. Test certificate for the following :
      - Hydrostatic test for all control valves
      - Magnetic particle inspection for all control valves.
      - Radiographic examination of control valves.
      - Seal tightness test for control valves
      - Materials test certificate for control valves.

9.26 Pneumatic Power Cylinder

Table 9.25

Specification for Pneumatic Power Cylinder

S.N	Feature		Minimum Requirement
1	Applicable standard		ISO 6431
2	Mounting Type		Fixed Position mounting/ Trunion mounting
3	Material	Cylinder	Seamless Steel Tube
		Piston rod	Hard Chrome Plated Steel
		Tie rod	Stainless steel
		End Cover	Cast Iron
		Sealing	Polyurathane
4	Control Signal		4-20 mA DC signal to Smart positioner with HART protocol for modulating purpose. Solenoid valve operating on pneumatic line for open & closing purpose of ON-OFF Damper.
5	Supply Air		0-7 Kg/cm2
6	Accuracy		Better than +/- 1%
7	Repeatability		Better than 0.5 % of full travel
8	Hysteresis		Less than +/- 0.2% of full travel
9	Dead Band		+/- 0.1%
10	Selection		Based upon thrust/torque, stroke length, angular movement, full scale travel time, repeatability, space factor etc. Provision for air-to-open or air-to-close operation

S.N	Feature	Minimum Requirement
11	Accessories	Air lock relay, hand wheel, AFR, Volume booster, Limit switch, Positioner, Solenoid valve, position transmitter & all required mounting accessories etc.
12	Fail safe operation	Stay put for regulating duty

9.27 Lignite Feeder Instruments

Table 9.26

Specification for Speed Switch

S.N	Feature	Minimum Requirement
1	Type	Microprocessor based
2	Power supply	230 VAC/110 VAC/ 24 VDC
3	Input	Pulses from Sensor Probe
4	Sensor Probe	Inductive/Capacitive type proximity sensor
5	Speed Range	Programmable
6	Output	Potential free contact output
7	Contact Rating	5A, 240 V AC, 0.5A, 220 VDC
8	Time Delay	Selectable for start up & Trip
9	Enclosure	SS 316, IP-67(for outdoor mounting)/IP-55 (for mounting inside JB/panel)
10	Accessories	All required mounting accessories

Table 9.27

Specification for Speed Probe

S.N	Feature	Minimum Requirement
1	Type	Proximity type (inductive / NAMUR)
2	Frequency Response	0-10 KHz
3	Housing	SS 316/ Polyurethane tip
4	Sensing distance	10 mm minimum (2mm for embedded type)
5	Enclosure class	IP67
6	Power supply	24 V DC/8 V DC (for NAMUR)
7	Cable	Integral Cable 6 mtr.
8	Mounting	Flush with check nut
9	Accessories	Flexible conduit, Non-conductive mounting plates etc.

Table 9.28

Specification for Speed Transmitter

S.N	Feature	Minimum Requirement
1	Type	Microprocessor based Programmable
2	Enclosure Protection	IP-67
3	Accuracy	+/- 1 RPM
4	Power Supply	24 V DC
5	Range	Programmable
6	Resolution	0.1 RPM
7	Output	4-20 mA
8	Input signal	Pulse Input from Proximity Probe
9	Display	LCD display

Table 9.29

Specification for Flow/No Flow detector switch

S.N	Feature	Minimum Requirement
1	Operating Principle	Microwave
2	Detection Range	Adjustable
3	Power Supply	230 V AC, 50 Hz
4	Housing	SS 316
5	Protection Class	IP 67
6	Output	Potential free contact output
7	Contact Rating	5A, 240 V AC; 0.5A, 220 VDC
8	Time delay for contact Changeover	Adjustable
9	Accessories	All required mounting accessories

9.28 Solenoid Valves

Table 9.30

Specification for Solenoid Valves

S.N	Feature	Minimum Requirement
1	Operating Principle	Electromagnetic (noiseless), Pilot operated
2	Coil Voltage Rating	24 V DC (in general)/220 V DC/230 V AC/ 110 V AC as required
3	Ways	3 ways in general others as required
4	Port size	¼ " NPT all ports
5	Body	SS Bar stock/Brass

S.N	Feature	Minimum Requirement
6	Trim	AISI 316 SS
7	Manual Operation	In built
8	Duty	Suitable for continuous Energisation
9	Sealing	Airtight & leak proof
10	Coil Enclosure	SS 316/Moulded type
11	Insulation class	Class H
12	Coil Casing	IP-67
13	Mounting	Suitable for mounting On pipe or in panel
14	Cable connection	½" NPT Cable gland
15	Accessories	Mounting Bracket, nuts, bolts etc.
16	Other Features	LED Indication

9.29 Dew Point Meter

Table 9.31

Specification for Dew Point Meter

S.N	Feature	Minimum Requirement
1	Type	Sensor- Hyper Thin Film high capacitance Al2O3, Transmitter- Microprocessor based 2-wire loop powered
2	Accuracy	±5.5°F (±3°C)
3	Repeatability	±0.9°F(±0.5°C
4	Storage temperature	-40°F to +176°F (-40°C to +80°C)
5	Local Indication	To be provided
6	Input Resolution	0.1°C dew point
7	Power Supply	24 VDC
8	Output	4 - 20mA
9	Enclosure material	Die – cast Aluminium
10	Enclosure protection	Weatherproof IP 65
11	Electrical connections	½ " NPT
12	Process connection	As per requirement
13	Accessories	All required mounting accessories.

5. DESIGN CRITERIA

This section covers the general design criteria to be adopted in designing the Control & Instrumentation system for the SG Package.

5.1 General Requirements

5.1.1 Ambient Conditions

Instruments, devices and equipment for location in outdoor / indoor / air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment of a Lignite fired Power plant and also during periods of air conditioning failure without any loss of function, or departure from the specification requirements covered under this specification.

Table 5.1

Protection Class Requirement

Ambient Temperature (outside temperature)	Pressure	Relative Humidity	Atmosphere	Required Protection class of panels /cabinets /desks to be provided by Contractor
Outdoor Location				
55 *C max	Atmosphere	100%Max	Air (dirty)	IP 65
4 *C min	Atmosphere	5% Min	Air (dirty)	IP 65
Indoor Location				
55 *C max	Atmosphere	95% Max	Air	IP 54^^
4 *C min.	Atmosphere	5% Min	Air	IP 54^^
Air-conditioned Area				
24 +/- 2 *C normal	Atmosphere	95% Max	Air	IP 42
50 *C Max. ^	Atmosphere	5 % Min	Air	IP 42

^ During Air Conditioning failure
^^ For non-ventilated enclosures. For Ventilated enclosures, protection class shall be IP 42.
1. For hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.
2. For PCs, OWS, EWS, Servers, Printers and other peripherals, maximum temperature limit shall be 35 *C. For LVS the same shall be 25 *C & for UPS the same shall be 40 *C

12. SYSTEM CABINETS, PANELS & JUNCTION BOX

12.1 General Requirements

1. All control panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads and accessories as per IS:5039-1969 as required for completeness of the system.
2. All panels & cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire. The Cabinets shall be designed for front & back access to components, terminals and wiring
3. The cabinets shall be provided with bottom two/three piece glanding plate which shall be removable from inside and shall be provided with sufficient no. of knockouts. The details of knockouts shall be provided during detail engineering. All knockouts shall be provided with pluggable grommets.
4. The cabinets shall be of max. 2200 mm height including base channel. The base channel shall be of 100 ISMC. All cabinets shall be of same height. Construction shall be modular..
5. System & non-system cabinets shall have "look alike" appearance.
6. All electronic system cabinets shall be designed for 50 deg C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10 deg. C above ambient temperature under all operating conditions. Necessary louvers, fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.
7. Panels, cabinets enclosures wiring shall be arranged to enable the removal of modules/instruments and devices without unduly disturbing them.
8. All panels, cabinets, enclosures interiors shall be illuminated with rapid start fluorescent strip fixtures with door actuated switches. Door switch terminals shall be shrouded. All illumination lights shall be provided with isolation switch in addition to door switch for maintenance & switching Off when not required. Illumination light shall be provided on both front & back sides if both sides are provided with equipments/instruments/terminal blocks requiring maintenance.
9. Sufficient number of power receptacles with disconnect switches shall be installed within panels, enclosure and racks.
10. The local instrument enclosures/racks shall be provided locally for mounting of electronic transmitters and switches, etc.

11. All panels, cabinets shall be properly grounded. The grounding scheme shall be as approved by the Owner.

12. Exterior steel surface shall be sand blasted, ground smooth, filed, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish colour shall be applied to all surfaces.

13. The colour of the panel's interior shall be brilliant white. External colour of the panels shall be as RAL 7032 for LIE/ LIR and RAL 7035 for control room system cabinets.

14. All panels, enclosures, system cabinets, marshalling cabinets shall be provided with a minimum of 20% spare terminations and system cabinets shall be provided with spare space for 20% additional modules fully wired with connectors etc. in excess of the total requirement of the system design when the cabinets are delivered. The spare space capacity shall be distributed evenly throughout the cabinets.

12.2 System Cabinets

Table 12.1

Specifications for System Cabinets

S.N	Features	Minimum Requirements
1	Application	For housing Signal conditioning cards, input/output cards, processor cards, power supply units etc.
2	Location	Indoor
3	Type	Free standing Vertical type
4	Protection class	IP-42
5	Material & Thickness	CRCA steel/ min. 2mm for panel sides & 3mm for gland plates
6	Doors	Double door with neoprene gasket, Lockable,
7	Cable entry	Bottom with fire proof compound thickness 50 mm for sealing
8	Anti vibration pad	Required, 15mm
9	Painting	Interior- Brilliant White Exterior- RAL 7035
10	Cabinet Dimension	To be decided during detail engineering
11	Grounding	M6 earthing stud shall be provided
12	Ventilation	Fans & louvers with brass mesh required
13	Lighting	rapid start fluorescent strip fixtures with door actuated switches required
14	Lifting arrangement	Removable lifting eyebolts shall be provided

1. The racks in system cabinets shall have provision along with plug in sockets/back plane to house accommodate the spare slots/modules as specified elsewhere.

2. The system cabinets, racks in system cabinets, slots in the racks & the terminals shall have identification numbers. A stainless steel metal tag (plate) shall be fixed to the inside of the door & the layout of the racks, slots & details of the card type/service shall be inscribed on this metal tag.

3. Each cabinet shall be provided with one each 3 pin receptacles for 230 V, 1P, 50 Hz and receptacles for 24V DC.

4. One of the doors shall be provided with folder to keep the relevant engineering document of the cabinet.

5. All cabinets shall have common key for locks.

6. Door shall have concealed type of hinges with 120 degree swing.

7. Door latches shall be of the three-point type to ensure tight closing.

8. Separate Power & shield earthing bus shall be provided at the front & rear side of the cabinets. The earthing bus shall be isolated from panel body by suitable insulation material.

12.3 Marshalling Cabinets

Table 12.2

Specifications for Marshalling Cabinets

S.N	Features	Minimum Requirements
1	Application	For termination of all cables originating from field.
2	Location	Indoor
3	Type	Free standing Vertical type
4	Protection class	IP-42
5	Material & Thickness	CRCA steel/ min. 2mm for panel sides & 3mm for gland plates
6	Doors	Double door with neoprene gasket, Lockable,
7	Cable entry	Bottom with fire proof compound thickness 50 mm for sealing
8	Terminal Blocks	Rail mounted cage-clamp suitable for conductor size up to 2.5 mm^2 & fused type with LED indication for power supply (24 VDC, 230 V AC, 110 V AC etc.) for instruments & equipments.
9	Anti vibration pad	Required, 15mm
10	Painting	Interior- Brilliant White Exterior- RAL 7035
11	Cabinet Dimension	To be decided during detail engineering
12	Grounding	M6 earthing stud shall be provided
13	Ventilation	Fans & louvers with brass mesh required
14	Lighting	rapid start fluorescent strip fixtures with door actuated switches required
15	Lifting arrangement	Removable lifting eyebolts shall be provided

1. Separate Marshalling cabinets for the system shall be supplied for terminating all cables originating from the field and for distributing the signals to different functional panels and cubicles.
2. The terminal blocks shall be cage clamp type. Fused terminal blocks hinged at one end to facilitate easy isolation shall be provided wherever necessary. All cabinets shall be provided with spare terminals for the spare inputs/outputs as specified elsewhere in the specification. The type of terminals for terminations from cabinets/panels shall match with the pre fabricated cables and pins supplied.
3. The terminals for field cables shall be arranged in a logical order of equipment/system wise and shall be worked out by Contractor, subject to approval by Owner / Consultant.
4. The marshalling cabinets, the terminal blocks, the terminals and the electronic hardware if any, shall have identification numbers.
5. Each cabinet shall be provided with one each 3 pin receptacles for 230 V, 1P, 50 Hz and receptacles for 24V DC.
6. One of the doors shall be provided with folder to keep the relevant engineering document of the cabinet.
7. All cabinets shall have common key for locks.
8. Door shall have concealed type of hinges with 120 degree swing.
9. Door latches shall be of the three-point type to ensure tight closing.
10. Separate Power & shield earthing bus shall be provided at the front & rear side of the cabinets. The earthing bus shall be isolated from panel body by suitable insulation material

12.4 Local Instrument Enclosure & Racks

1. Transmitters and switches, devices, etc. mounted in the field shall be suitably grouped together and mounted in local instruments enclosures in case of open areas of the plant and in local instrument racks in case of covered areas. These local instrument enclosures and racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalised during detailed engineering stage subject to the Owner's approval.
2. The local instrument enclosures shall be constructed of 2 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Vibration dampeners shall be installed for supporting each enclosure. The internal layout shall be such that the impulse piping/ blow down lines are accessible from back doors of the enclosure and the transmitters etc. are accessible from front side for easy maintenance. Gaskets shall be used between all mating sections to achieve protection class of IP-65.

3. The local instrument racks shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel, and extended beyond the ends of the rack. Bulk heads, especially designed to provide isolation from process line vibration shall be provided. Exact fabrication details shall be as finalized during detailed engineering stage. The junction box for racks also shall conform to IP 65 protection class.

4. Provision for continuous purging arrangement is to be made for all air and flue gas applications.

5. Each transmitter enclosure housing instruments i.e. for air and flue gas applications, requiring purge air for continuous air purging shall be provided with common purge air header, air filter regulators of sufficient capacity, required pressure gauges, valves, fittings, SS tubing and individual purge meters for each purge line etc. as required.

6. As soon as the panel's fabrication is over, Owner shall inspect the panels and further work on the panels, namely assembly, wiring and assembly of components shall be carried out only after the inspection.

7. The junction box of Local Instrument Enclosure & Racks shall be provided with hinged type door, latch for locking & gland plates for cable entry. All terminals in junction box shall be of rail mounted cage clamp type suitable for conductor size up to 2.5 Sq. mm.

12.5 Local Junction Box

Table 12.3

Specifications for Junction Box

S.N	Features	Minimum Requirements
1	No. of Ways	32 (2X16) with 20% spares terminals
2	Material & Thickness	2 mm thick Stainless steel
3	Protection class	IP-65 for outdoor/ IP 55 for Indoor
4	Cable entry	Bottom
5	Mounting	Suitable for Wall/column/structures mounting
6	Terminal Blocks	Rail mounted cage-clamp type suitable for conductor size up to 2.5 mm^2
7	Grounding	M6 earthing stud shall be provided
8	Gland plate	Removable type
9	Door	Single Lockable door with gasket, able to open sideways, turnable hinge based, latch type lock without handle with common key.
10	Accessories	Tag plate, clamps, fixtures, bolts (SS), nuts (SS), Gasket (Neoprene), cable glands (SS), Lugs (Brass), Fire proof compound for sealing.

1. All JB's for outdoor application shall be provided with individual canopies to prevent ingress of water.
2. All JB' shall have provision to add 10% additional TB's.
3. The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams.
4. Separate Terminal blocks shall be used for Analog & Digital Signals & also for signals with different voltage levels.
5. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
6. Separate shield bus shall be provided with screw connection for terminating cable shields.
7. All spare cable entries shall be provided with plugs.
8. All wires in JB shall be neatly dressed & ferruled.
9. Double deck type terminal block shall not be used.

Table 12.4

Specifications for Cable Glands

S.N	Features	Minimum Requirements
1	Type	Double compression
2	Entry Thread	½" NPT
3	Material	Brass
4	Finish	Cadmium Plated
5	Protection	IP-54 or better
6	Accessories	Neoprene gasket, Locknut, Reducer etc.

10. PROCESS CONNECTION PIPING

The Contractor shall provide, install and test all required material for completeness of impulse piping system, sample piping system and air piping system as per the requirements of this clause on as required basis for the connection of instruments and control equipment to the process and make the system complete . However, the Contractor shall furnish during detailed engineering all relevant drawings, material and technical specifications of various items service wise for Owner/Consultants approval.

Control and instrument piping & connections shall generally be designed in accordance with the following criteria and these criteria shall be closely co-ordinated with Mechanical Piping Contractor / Erector to fulfill the Mechanical Design Criteria also. This is a guideline for Piping design & selection. OEM standard proven practice in these regard are also acceptable if it is complying with applicable international standard.

1. Pressure connections and piping up to the root valves for all pressure indicators, pressure switches, pressure transmitters, etc., shall be as indicated for miscellaneous piping.

2. Temperature indicators, temperature controllers, temperature switches, temperature detectors, and test well connections shall be as follows:

   - Main steam -- 40 mm NPT.
   - Extraction steam -- 40 mm NPT.
   - Boiler feed water -- 32 mm NPT.
   - Reheat steam -- 40 mm NPT.
   - Duct temperatures -- 25 mm NPT.
   - All others -- 19 mm NPT.

3. Draft pressure connections on steam generator walls and ducts shall be 50 mm pipe couplings.

4. Flow transmitter connections and piping up to the root valves shall be 25 mm for all piping except orifice flanges, where 15 mm piping and valves shall be used.

5. Level switch connections and piping up to root valves shall be 25mm.

6. Level controllers and level transmitters of the displacement type shall have connections and piping up to root valves of 50 mm.

7. Level controllers and level transmitters of the differential pressure type shall have connections and piping up to root valves of 25 mm.

8. Instrument columns at tanks and pressure vessels shall generally be 65 mm minimum.

10.1 Design Pressure and Temperature

Instrument primary piping design pressure and temperature shall be selected consistent with the requirements discussed in Mechanical Design Criteria of this specification, for the process pipe to which the instrument primary piping is connected. The following general criteria shall also apply:

Instrument primary piping for steam and other systems shall be designed for 1-½ times the maximum sustained process pressure and temperature (plus 20°C).

10.2 Sizes of Instrument Primary Piping

Instrument primary piping shall not be smaller than the connection at the process pipe root valve and/or the following (metric sizes are nominal):-

1. 20 mm for pressure measurement piping with a design pressure equal to or less than 42.0 bar and a design temperature equal to or less than 400°C.
2. 25 mm for pressure measurement piping with a design pressure greater than 42.0 bars or a design temperature greater than 400°C.
3. Flow and level measurement by differential pressure shall also use primary piping conforming to the above requirements; however, flange tap connections may be of 13 mm size.
4. Float actuated level switch devices shall be supported on connecting piping not smaller than 25 mm.
5. Level controllers and transmitters of the displacement float type shall be supported on connecting piping not smaller than 50 mm.
6. Instrument columns for float actuated level switches and displacement float devices shall be piping of not less than 65 mm.
7. Primary piping internal diameter shall not be less than 8 mm between the process connection and instrument blow down valve.

10.3 Materials for Instrument Primary Piping

Material for instrument primary piping connecting to the root valve shall preferably be the same as that used in the process system to which it is connected. Higher strength materials may be substituted in the interest of standardization; however, welding procedures at the point of joining the instrument primary piping to the process piping must be appropriate to the combination of materials involved. Copper may be used only for compressed air services that use copper process piping.

10.4 Insulation of Instrument Primary Piping

Instrument primary piping connecting to high temperature systems, which might become hot enough to injure personnel during blow down of the

instrument line, shall be insulated where such hazard exists. Insulation materials, exterior finish, and metal lagging shall conform to the standards adopted for the process piping.

All materials supplied shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The material offered by the Contractor shall be from reputed, proven manufacturer.

10.5 Process Connection Size

Size of tapping point, Stub No. and size of Root valves for different type of measurements.

These shall be as follows:

Table 10.1

Process Connection Stub & Root valve

S. N.	Quantity of root valves (Nos.)	Size of stub and root valves	Service condition
A. Pressure and Differential pressure measurement			
1	2	25NB	> =62 bar or 425degree C
2	1	15NB	<62 bar and 425 degree C
B. Level Gauge and Switch			
1	2	25 NB	> = 62 bar or 425 degree C
2	1	25NB	<62 bar and 425 degree C
C. Level Transmitter (Displacement Type)			
1	2	40NB	> =62 bar or 425degree C
2	1	40NB	<62 bar and 425 degree C
D. Stand pipe for Level measuring instrument			
1	2	80 NB	> =62 bar or 425degree C
2	1	80 NB	<62 bar and 425 degree C
E. Flow measurement			
1	2	25NB	> =62 bar or 425degree C
F. Level measurement			
1	1	25NB	<62 bar and 425 degree C

S. N.	Quantity of root valves (Nos.)	Size of stub and root valves	Service condition
G. Sampling system measurement (system and water service)			
1	2	25 NB	> =62 bar or 425degree C
2	1	25 NB	<62 bar and 425 degree C
H. Air and Flue gas Tapping points			
The Air and Flue Gas Tapping points shall be 40 NB. These tappings shall be of "Y" type to have access for removing the choke. One arm of the "Y" piece shall be closed with leak proof threaded cap with chain. The other arm shall be with reduced diameter suitable to connect to 25 NB impulse pipes.			

10.6 Impulse Piping, Tubing, Fittings, Valves & Valve Manifolds

All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. For various applications specification of impulse pipe materials and associated fittings and valves shall be as given in Table –10.2 (Process Connection Piping).

Table 10.2

Process Connection piping

S. N	Service	Size		Impulse tube material	Impulse tube material	Impulse line fitting material	valves material
		Pipe	Tube			ANSI rating	ANSI Rating
1	Main steam / Saturated steam	SCH.XXS 21.34mm OD	1.7 mm ODX 1.65HK	SS 316	ASTM-A-335-Gr-P-22 (alloy steel)	ASTM-A-182-Gr-F-22	ASTM-A-182-Gr-F-22
						9000 LBS	2500 SPL. Class
2	Hot reheat / extraction to HPH	SCH.80 21.34mm OD	12.7 mm ODX 1.65mm THK	SS 316	ASTM-A-335-Gr-P-22 (alloy steel)	ASTM-A-182-Gr-F-22	ASTM-A-182-Gr-F-22
						9000 LBS	2500 SPL. Class

S. N	Service	Size		Impulse tube material	Impulse tube material	Impulse line fitting material	valves material
		Pipe	Tube			ANSI rating	ANSI Rating
3	Cold reheat / extraction / heater drains / condensate system; aux. steam	SCH.80 21.34mm OD	12.7 mm ODX 1.65mm THK	SS 316	ASTM-A-106-Gr-B (carbon steel)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	400LBS
4	Water system	SCH.80 21.34mm OD	12.7 mm ODX 1.65mm THK	SS316	ASTM-A-106-Gr-B (carbon steel)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	400LBS
5	LDO system; lube oil system	SCH.80 21.34mm OD	- -	SS316	ASTM-A-106-Gr-B (carbon steel)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	150LBS
6.	Instrument air system	SCH.40 21.34mm OD(pipe through out)	12.7 mm ODX 1.65mm THK	SS316	IS 1239 Heavy Class (Galvanisied)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	150LBS
7.	Service air system	SCH.40 21.34mm OD	12.7 mm ODX 1.65mm THK	SS 316	IS 1239 Heavy Class (Black)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	150LBS
8.	Boiler fuel gas / air system	SCH.8021 .3 mm OD (pipe through out)		SS 316	ASTM-A-106-Gr-B (carbon steel)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	150LBS

S. N	Service	Size		Impulse tube material	Impulse tube material	Impulse line fitting material	valves material
		Pipe	Tube			ANSI rating	ANSI Rating
9.	Vacuum	SCH.40 21.34mm OD	7 mm ODX1.6 5mm THK	SS 316	ASTM-A-106-Gr-B (carbon steel)	ASTM-A-105-Gr-II	ASTM-A-105-Gr-II
						3000LBS	150LBS
10.	Make up water system	SCH.40 21.34mm OD	12.7 mm ODX1.6 5 mm THK	SS 316	ASTM-A-312-TP-316 (SS)	ASTM-A-182-Gr-IF6a	ASTM-A-182-Gr-IF6a
						3000LBS	150LBS

Notes:-

1. Impulse pipe thickness shall be selected as per ANSI B 36.10. based on the schedule indicated against each service.
2. Wherever impulse tubes are provided, all the fittings required for these shall be SS316.

The following guidelines shall also be considered along with the Table 9.1 for size, material and rating for impulse line/tube fittings and accessories:

a. Impulse line / tube fittings and accessories

1. Nipple shall be provided for root valve size more then ½ inch and the nipple size shall be same as the root valve size. Reducer / adepter shall be provided to suit instrument connection, where nipple, root valve size is more then ½ inch.
2. Bulk head fitting socket welded type to be provided at instrument rack / enclosure.

b. Fittings

1. All fittings except the last fitting connecting to the instrument shall be socket welded. The size of the fittings shall be same as the impulse line size.
2. The fitting connecting to the instrument shall have a size and thread to suit the instrument connection.

c. Drain

Drain shall be provided for all water / steam and non-inflammable / non-corrosive fluids only.

d. Drain Valve

1. Two numbers of globe drain valves shall be provided for process conditions of 425 degree C or 62 bar and higher.
2. One number globe drain valve shall be provided for process conditions of less than 425 degree C and 62 bar.
3. The valve size shall be same as impulse piping / tubing size.

e. Funnel with drain header

1. This shall be provided in the racks for blowing / draining out the process fluid in the impulse tubings.
2. The size of drain header shall be 1"
3. When instruments are mounted local to the tapping point and are not mounted in rack, or panel or enclosure. The drains shall be connected to the nearest floor level or plant drain.

f. Instrument Valves

1. Type of the valve shall be needle valve with built in drain valve.
2. Sizing of the valve shall be ½".

g. Right / left threaded fittings

This shall be provided for installation / removal of instruments without disturbing the tubing / piping.

h. A suitable adapter shall be provided to install the instruments on ½" right-left threaded fittings.

i. A ½" vent line with a ½" isolation valve shall be provided in the instrument rack for air and compressible fluids or otherwise if the installation call for eg. for liquid service where the transmitter is located at a higher elevation than the tapping point.

j. For air / flue gas measurement a drain pot with plug shall be provided in place of drain valves.

10.6.1 Stainless steel tube shall be provided inside enclosures and racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A,B,C &D of the Table 9.1) the

material shall be ASTM A 213 TP 316H and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard.

10.6.2 All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. tee, elbow etc.) shall be ASTM A182 Gr. 316 H for high pressure/ temperature applications (as defined above) and ASTM A182 Gr. 316L for other applications. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.

10.6.3 The source shut-off (primary process root valve) and blow down valve shall be as per Table 10.2. The disc and seat ring materials of carbon steel and alloy steel valves shall be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be re-conditioned and stem and disc may be replaced without removing the valve body from the line.

10.6.4 The valve manifolds shall be of 316 s Furnishing Recommended protection interlock logics stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3 valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and differential pressure transmitters/ switches respectively. 5 valve manifold shall be used for remaining applications like DP, flow and level measurements.

10.6.5 For Pressure/D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three way gauge cock provided along with the pressure/D.P gauges.

Table 10.3

Specification for Seamless SS Pipe

S.N	Property	Requirement
1	Reference	ASTM A-312 TP-316
2	Material Grade	TP-316
3	Type	Seamless/Plain end
4	Size	½" NB
5	Schedule	40/60/80
6	Standard Length	5 metre

Table 10.4

Specification for Seamless SS Pipe Fittings

S.N	Property	Requirement
1	Reference	ASTM A-182 F-316
2	End Connection	Socket welded
3	Type	Forged conforming to ANSI B16.11
4	Size	½" NB
5	Rating	3000/6000/9000 lbs
6	Type of Fittings	Reducing coupling, Male-Female reducer, Straight coupling, Equal Tee, Three Piece Union, Elbow, Cap etc.

Table 10.5A

Specification for Seamless SS Tube (1/2")

S.N	Property	Requirement
1	Reference	ASTM A-213 TP-316
2	Material Grade	TP-316
3	Type	Cold Drawn annealed, pickled, passivated, descaled, hydraulically cleaned seamless tube.
4	Size	½" OD X 2.1 mm thick
5	Properties	Tube shall be free from scratches & suitable for bending & capable of being flared by hardened & tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80
6	Test Pressure	400 Kg/Sq mm minimum
7	Tolerance	+/- 0.13 mm for outside dia. +/- 15% for wall thickness
8	Test	Flare, Hardness, Ball & Bubble test
9	Standard Length	5 metre

Table 10.5B

Specification for Seamless SS Tube (1/4")

S.N	Property	Requirement
1	Reference	ASTM A-269 TP-316
2	Material Grade	TP-316
3	Type	Cold Drawn annealed, pickled, passivated, descaled, hydraulically cleaned seamless tube.
4	Size	1/4" OD X 1.2 mm thick
5	Properties	Tube shall be free from scratches & suitable for bending & capable of being flared by hardened & tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80
6	Test Pressure	400 Kg/Sq mm minimum
7	Tolerance	+/- 0.13 mm for outside dia. +/- 15% for wall thickness

S.N	Property	Requirement
8	Test	Flare, Hardness, Ball & Bubble test
9	Standard Length	5 metre

Table 10.6

Specification for Seamless SS Tube Fittings

S.N	Property	Requirement
1	Reference	ASTM A-182
2	Material Grade	SS 316 forged
3	Type	Double ferrule double compression
4	Ferrule	SS 316
5	Size	To suit SS tubing & NPT end connection
6	Type of fittings	Male/Female connectors, elbow, Equal & Unequal Tee, Cross, Straight connector, bulk head unions, etc. as required to suit the installation.

Table 10.7

Specification for Instrument Valve Manifolds

S.N	Property	Requirement
1	Type	Two valve manifold/Three Valve Manifold Five valve manifold
2	Mounting	Remote 2" pipe mounting
3	Construction	Single Block (Bar Stock)
4	Material	Forged body & bonnet AISI 316 SS
5	Ports	½" NPT
6	Rating	420 Kg/ cm2 at ambient
7	Packing	PTFE Wafer
8	Seat & Stem	AISI 316 SS
9	Plug	AISI 316 SS free to turn on stem/ 17-4 PH
10	Handle	AISI 316 SS
11	Connection	Straight
12	Accessories	Plug for all ports Mounting Bracket, nut, bolts etc.

Table 10.8

Specification for Condensate Pot

S.N	Property	Requirement
1	Reference	ASTM A 182 F22/ ASTM A105
2	Material	Alloy Steel/Carbon Steel as per application
3	Construction	Drilled Bar stock
4	End Connection	3 nos. ½" SW

S.N	Property	Requirement
5	Accessories	Vent Valve

10.7 Air Supply Piping

1. All pneumatic piping, fittings, valves, air filter cum regulator and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.

   This shall include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements of Local Instrument Enclosures (LIE) etc.

2. For individual supply line and control signal line to control valve, 1/4 inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of copper tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.

3. All other air supply lines of 1/2 inch to 2 inch shall be of carbon steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.

4. For air supply to various devices mentioned above, the Contractor shall provide 2 nos., 2 inch size GI pipe header with isolation valve, one for boiler area and one for turbine area. In the boiler area the 2 inch head shall be provided up to top most elevation of boiler floor and from this 2 inch header, 1 inch sub-header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of 1/2 inch, with isolation valve shall be provided up to various devices. Similar air supply piping shall be done in the turbine area also. Similar system is to be followed for service air required for intermittent purging in the Local Instrument Enclosures (LIEs) etc.

5. Instrument air filter cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10 kg/ sq.cm max. inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2 inch size pressure gauge and built in filter housing blow down valve. The end connection shall be as per the requirement to be finalised during detailed engineering.

6. All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be 1/2 inch to 2 inch.

7. **Purge Air Connection for Air and Flue Gas Applications**

a) The continuous purging with instrument air shall be done, for all air and flue gas measurements excepting instrument air and service air instruments, at the process source connection end. Necessary arrangements required for continuous purging shall be provided inside all the air and flue gas local instrument enclosures.

b) For intermittent purging with service air, necessary arrangements inside all the air and flue gas Local Instrument enclosures/racks shall be provided. The SS three way valve provided in the SS tubing shall be used for isolating the transmitter and connecting the service air quick disconnect line.

c) One air filter regulator, purge Rotameter and blow down device per instrument shall be provided in the transmitter rack/enclosure.

Table 10.9

Specification for Instrument Air Header

S.N	Property	Requirement	
		For Panel	For Field
1	Material	SS 316	SS 316
2	Inter Connection	2″ NPT (M)	1″ NPT (M)
3	Header Take-Off	SS 316	SS 316
4	Take-Off Connection	½″ NPT (M)	½″ NPT (M)
5	Take-Off Valve	½″ Ball Valve SS 316	½″ Ball Valve SS 316
6	Drain	½″ Ball Valve SS 316 at the lowest point	½″ Ball Valve SS 316 at the lowest point

Table 10.10

Specification for CS Pipe

S.N	Property	Requirement
1	Reference	ASTM A-106 Gr. C
2	Material	Cold Drawn Seamless CS
3	Type	Seamless/ threaded ends as per ASA B2.1/ Hot dip Galvanised from Inside & outside as per IS-1239
4	Size	½″ to 2″ NB
5	Schedule	80/160
6	Standard Length	5 metre

Table 10.11

Specification for CS Pipe Fittings

S.N	Property	Requirement
1	Reference	ASTM A-234/ ASA B16.11
2	Type	Forged/ hot dip galvanised from inside & outside

S.N	Property	Requirement
3	Size	½" to 2" (as required)
4	Rating	3000/6000/9000 lbs.
5	End Connection	Threaded as per ASA B2.1
6	Type of Fittings	Reducing Coupling, Male-Female reducer/ Straight Coupling/ Equal Tee/ Three piece Union/ Elbow/ Cap etc.

Table 10.12

Specification for CS Globe Valve

S.N	Property	Requirement
1	Reference	ASTM A-105/ASTM B62
2	Type	Globe
3	Construction	Forged body cadmium plated
4	Rating	PN 40/PN 160/ PN 320/ PN 400
5	End Connection	Screwed Female ends as per ASA B2.1
6	Material	Body- Carbon steel Stem- Hardened Steel Plug- AISI 316 SS Seat- SS Stellited
7	Size	½" to 2 " as required
8	Packing	Teflon/Grafoil as required
9	Hand wheel	CS
10	Yoke	ASTM A105
11	Design Standard	As per ANSI B16.34

S.N	Test Requirement	Standard
2	Core Concentricity	IEC 793-1-A3
3	Macro Bending	EIA/TIA-455-62A (IEC 793-1-C11)
4	Micro Bending	IEC-793-1-C3
C	Proof Test	IEC-793-1-B1
D	Strippability	IEC 793-1-B6
E	Visual Examination	EIA/TIA-455-13 (IEC 793-1-B5)

11.4 Instrumentation Cable Interconnection & Termination Philosophy

The cable interconnection philosophy to be adopted shall be such that expensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations. (where large concentrations of signals are available, e.g. valves limit and torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the following Table:

Table 11.5

Instrumentation Cable Interconnection & Termination Philosophy

S.N	Application		Type of Termination		Type of Cables
	From (A)	To (B)	End A	End B	
1.	Limit, Torque switches of valves / dampers / drives (integral junction box)	Marshalling cubicle / Marshalling cum Termination Cubicle / Local group JB	Plug-in connector	Posts mount cage clamp type	G
2.	Transmitters, E/P converters, process actuated switches mounted in LIE / LIR	Integral junction box of LIE / LIR	Plug-in connector	Cage clamp (rail mount)	F, G
3.	RTD heads	Local junction Box	Plug-in connector	Cage clamp (Rail mount) type	F
4.	Thermocouples	Junction Box	Plug in connector	Cage clamp (Rail mount) type	A, B, C*
5.	Other Field Mounted Instrument	Local JB / Group JB	Plug in connector	Screwed, Cage clamp (Rail mount) type	F (For analog signals) G (For Binary Signals)
6.	Junction Box (For	Marshalling Cubicle /	Cage clamp (Rail mount)	Screwed, Cage clamp (Rail	A, C*. These

S.N	Application		Type of Termination		Type of Cables
	From (A)	To (B)	End A	End B	
	Thermocouples for interlock and protection	Marshalling cum Termination Cabinet	type	mount) type	signals shall preferably through 6 pair cable
7.	Local junction box, Instrument Junction box of LIE / LIR / Group JB / MCC / SWGR	Group JB	Cage clamp (Rail mount) type	Cage clamp (Rail mount) type	F, G
8.	Local junction box, Instrument Junction box of LIE / LIR / Group JB / MCC / SWGR	Marshalling Cubical / Marshalling cum termination Cabinet	Cage clamp (Rail mount) type	Posts mount cage clamp type	F, G
9.	Marshalling Cubical / Termination Cabinet	Electronic system cabinet	Cage clamp post mounted type	Plug-in connector / Other System as per manufacturer's Standard	Internal Wiring

Notes:

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs.
2. For analog signals, individual pair shielding & overall shielding & for binary signals only overall shielding of instrumentation cables shall be provided.
3. * For high temperature applications only.
4. Instrument Cabling for instruments / equipment of specialized / proprietary Control System shall be as per manufacturer's standard.

11.4.1 Terminal Blocks

1. All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic / termination / marshalling cubicles shall be suitable for the post mounted cage clamp connection at the field input end. The terminal blocks for

5.8 Flow Element Selection

Table 5.5

Flow Element Selection

S. N	Type of Flow meter	Fluid medium	Process Parameter	Pipe sizes suitable for FE	Application	Type of connection
1	Orifice Plate	Water (DM Water)	As per process requirement	For all sizes Except very large diameter pipe	DM Water Flow To CST	Flange
2	Orifice Plate	Steam	For any condition	< 3″	Soot blowing steam flow	BW
3	Flow nozzle(AISI Type316L)	Water	As per process requirement	For all pipe sizes except very large diameter Pipe	(i) FW Flow to boiler drum (ii) SH/RH Spray water flow	BW
4	Flow nozzle(AISI Type316L)	Steam	As per process requirement		AUX. Steam flow	BW
5	Air foil	Air		All duct sizes	(i) Primary air flow (ii)secondary air flow	BW BW
6	Any Other Services required.	Subject to Owner / Consultant's approval during Detail Engineering.				

5.9 Drive Control Philosophy

The Drive control & measurement philosophy for the project is detailed in this section.

5.9.1 Bi-directional drives (inching or open/close)

1. All bi-directional drives shall be operable from Remote i.e. from CCR.
2. Remote manual operation of all drives shall be carried out from OWS.
3. Remote Open/Close commands, generated in control system shall be issued to MCC module through interposing relays located in respective MCC module in the MCC room. Latching of commands shall be provided in control system

logic which shall be reset by Limit/Torque switch feedback. The Limit/Torque switch feedback from drive shall be directly wired to Control System.

4. Necessary Electrical protections shall be realized at MCC module whereas process interlocks & protections shall be realized in Control system.

5. Following hardwired signal exchange shall be envisaged between Drive & Control system:

   - Open Limit Switch (Both NO & NC contacts)
   - Close Limit Switch (Both NO & NC contacts)
   - Open Torque Actuation
   - Close Torque Actuation
   - Position feedback (4-20 mA, two wire electronic type) for inching drive

6. Following hardwired signal exchange shall be envisaged between MCC & Control system(Remote I/O cabinet of control system located in/near MCC room):

   - Switchgear available
   - Switchgear disturbance
   - Open Command
   - Close Command

7. All Numerical relays/Intelligent controllers shall be interfaced to Control System through IEC 61850 protocol

The block diagram of the bidirectional drive (On-Off type & Inching type) controls is shown in drawing no. **LII-GEOE11019-G-00172-727 & LII-GEOE11019-G-00172-728**.

5.9.2 Unidirectional LT drives

1. Unidirectional LT drives shall be operable only from Remote i.e. from CCR. In addition, Local pushbutton shall be provided only for emergency stopping of drive. Local start operation of the drive is not envisaged.

2. Remote manual operation of all drives shall be carried out from OWS.

3. Remote Start/Stop commands shall be generated in Control system & shall be issued to MCC module through interposing relays located in respective MCC modules.

4. Emergency stop of the drive shall be envisaged from the local pushbutton provided near the drive. The stop push button (Stay put type) shall be provided with a press to lock & turn to release type keyless mechanism. Under locked position the drive operation is inhibited from remote. The local emergency stop push button shall be wired directly to MCC.

5. Necessary Electrical protections shall be realized at MCC module whereas process interlocks & protections shall be realized in Control system.

6. Current transducer with 4-20 mA type outputs shall be provided in the MCC for monitoring the current in Control System for all Drives greater than 90 KW. Auxiliary power supply to these transducers shall be from the control supply of the respective MCC modules.

7. Following hardwired signal exchange shall be envisaged between MCC & Control system(Remote I/O cabinet of control system located in MCC room):

   - Switchgear available
   - Switchgear disturbance
   - On Feedback
   - Off Feedback
   - Start Command
   - Stop Command

8. All Numerical relays/Intelligent controllers for LT drives shall be interfaced to Control System through IEC 61850 protocol.

The block diagram of the Unidirectional LT drive controls is shown in drawing no. **LII-GEOE11019-G-00172-729.**

5.9.3 Solenoid Operated drives

1. Solenoid operated drives shall be operable only from Remote i.e. from CCR.
2. Remote manual operation of all drives shall be carried out from OWS.
3. Remote Open/Close commands shall be generated in Control system & shall be issued to the Solenoid through interposing relays, located in Relay Panel.
4. Necessary process interlocks shall be realized in Control system.
5. Following hardwired signal exchange shall be envisaged between solenoid drive & Control system:

   - Open Limit Position
   - Close Limit Position
   - Open Command
   - Close Command

The block diagram of the Solenoid drive controls is shown in drawing no. **LII-GEOE11019-G-00172-731**

5.9.4 HT drives

1. HT drives shall be operable only from Remote i.e. from CCR. In addition, Local pushbutton shall be provided only for emergency stopping of drive. Local start operation of the drive is not envisaged.
2. Remote manual operation of all drives shall be carried out from OWS.

3. Remote Start/Stop commands shall be generated in Control system & shall be issued to MCC module through interposing relays located in respective MCC modules.

4. Emergency stop of the drive shall be envisaged from the local pushbutton provided near the drive. The stop push button (Stay put type) shall be provided with a press to lock & turn to release type keyless mechanism. Under locked position the drive operation is inhibited from remote. The local emergency stop push button shall be wired directly to MCC.

5. Necessary Electrical protections shall be realized at MCC module whereas process interlocks & protections shall be realized in Control system.

6. Current transducer with 4-20 mA type outputs shall be provided in the MCC for monitoring the current in Control System for all Drives. Auxiliary power supply to these transducers shall be from the control supply of the respective MCC modules

7. Following hardwired signal exchange shall be envisaged between MCC & Control system(Remote I/O cabinet of control system located in MCC room):

   - Switchgear available
   - Switchgear disturbance
   - Master Trip relay Operated
   - On Feedback
   - Off Feedback
   - Trip Feedback
   - Emergency stop feedback
   - Start Command
   - Stop Command
   - Current Feedback

8. All Numerical relays/Intelligent Controllers for HT drives shall be interfaced to Control System through IEC 61850 protocol.

The block diagram of the HT drive controls is shown in drawing no. **LII-GEOE11019-G-00172-730**

5.9.5 Variable Frequency Drives (VFD)

1. VFD shall be operable from Remote i.e. from CCR & from VFD Local Display unit. In addition, Local pushbutton shall be provided only for emergency stopping of drive.

2. Remote manual operation of VFD shall be carried out from OWS.

3. Remote Start/Stop commands shall be generated in Control system & shall be issued to VFD Panel through interposing relays located in VFD Panel.

4. Emergency stop of the drive shall be envisaged from the local pushbutton provided in the field. The stop push button (Stay put type) shall be provided with a press to lock & turn to release type keyless mechanism. Under locked position the drive operation is inhibited from remote. The local emergency stop push button shall be wired directly to VFD panel.

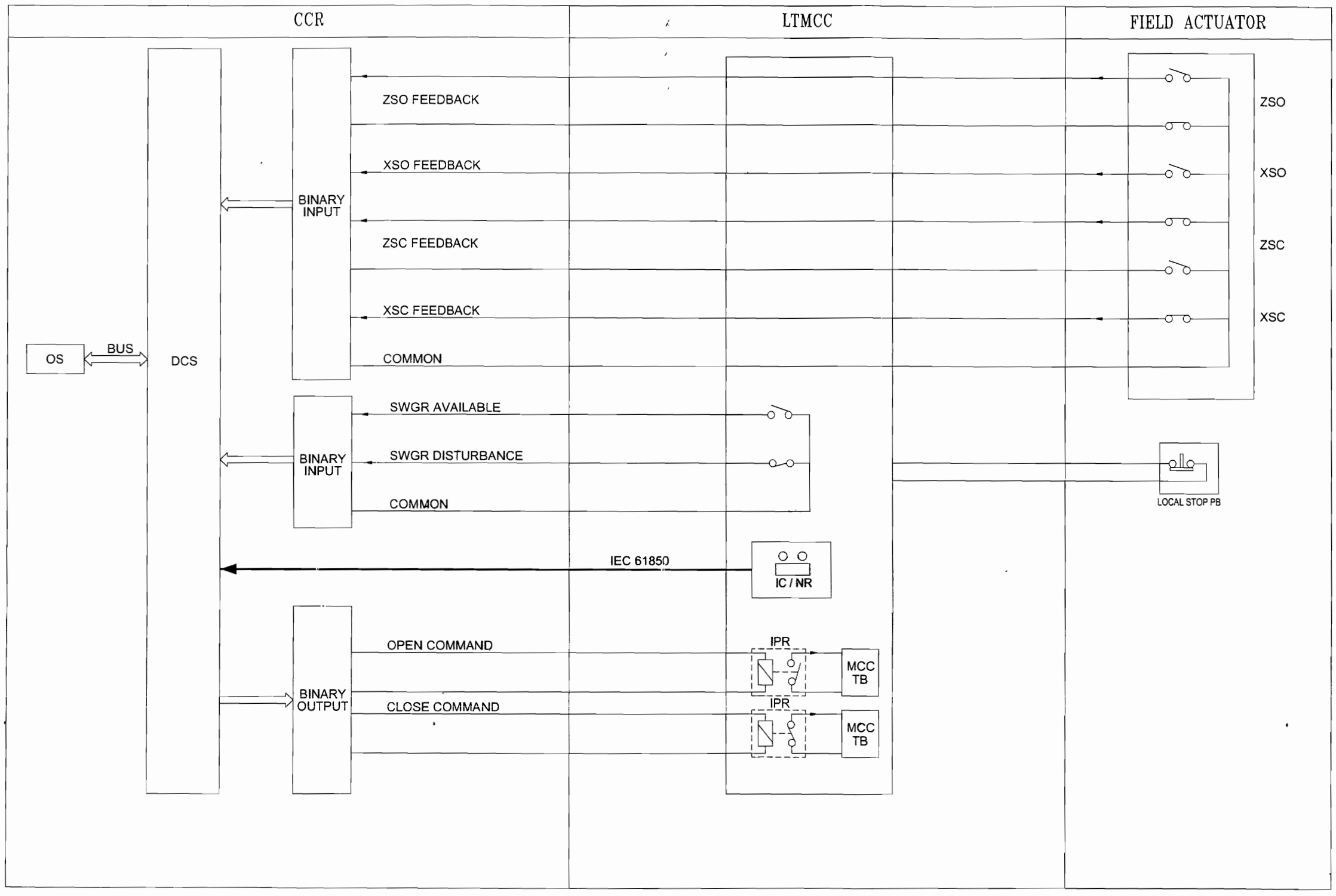
5. Necessary Electrical protections shall be realized at VFD module whereas process interlocks & protections shall be realized in Control system.

6. Following hardwired signal exchange shall be envisaged between VFD & Control system:

   - Switchgear available
   - Switchgear disturbance
   - On Feedback
   - Off Feedback
   - Trip Feedback
   - Emergency stop feedback
   - Start Command
   - Stop Command
   - Current Feedback
   - Speed feedback
   - Speed Setpoint

7. The VFD shall also be interfaced with control system via Modbus soft link.

The block diagram of the Variable Frequency drive controls is shown in drawing no. **LII-GEOE11019-G-00172-733**



NOTE:-

1. FOR LIMIT SWITCH BOTH NO & NC CONTACT SHOULD BE WIRED UPTO DCS.

ABBREVIATIONS

CCR	-	CENTRAL CONTROL ROOM
DCS	-	DISTRIBUTED CONTROL SYSTEM
MCC	-	MOTOR CONTROL CENTRE
SWGR	-	SWITCH GEAR
OS	-	OPERATOR STATION
IPR	-	INTERPOSING RELAY
ZSO	-	LIMIT SWITCH OPEN
XSO	-	TORQUE SWITCH OPEN
ZSC	-	LIMIT SWITCH CLOSE
XSC	-	TORQUE SWITCH CLOSE
PB	-	PUSH BUTTON
TB	-	TERMINAL BOX
IC	-	INTELLIGENT CONTROLLER
NR	-	NUMERICAL RELAY

Praveen Kottoni

K. Keshav

S.A.Khan

Varun Jain

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REV. No.	DATE	CHECKED				DESCRIPTION
		DEM	DEC	DEE	DEI	
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

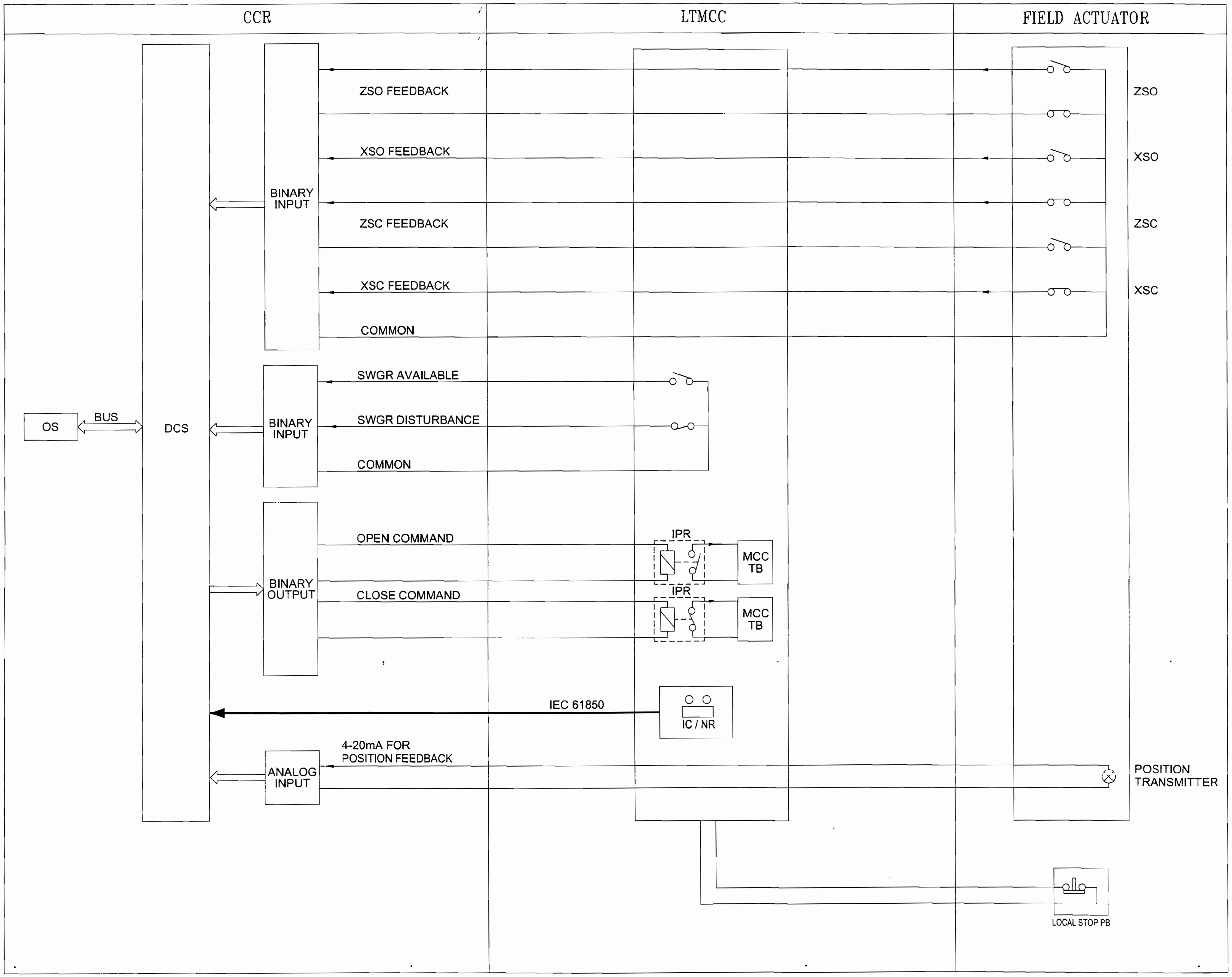
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : DRIVE CONTROL PHILOSOPHY BI-DIRECTIONAL DRIVES (MOV-ON/OFF TYPE)

DRAWING NO : LII-GEOE11019-G-00172-727 | REV. 00 | SHEET 1 OF 1



NOTE:-

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ABBREVIATIONS

CCR	-	CENTRAL CONTROL ROOM
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XSC	-	TORQUE SWITCH CLOSE
PB	-	PUSH BUTTON
TB	-	TERMINAL BOX
IC	-	INTELLIGENT CONTROLLER
NR	-	NUMERICAL RELAY

Praveen Kishore
K. Keshav
S A Khan
Varun Jain

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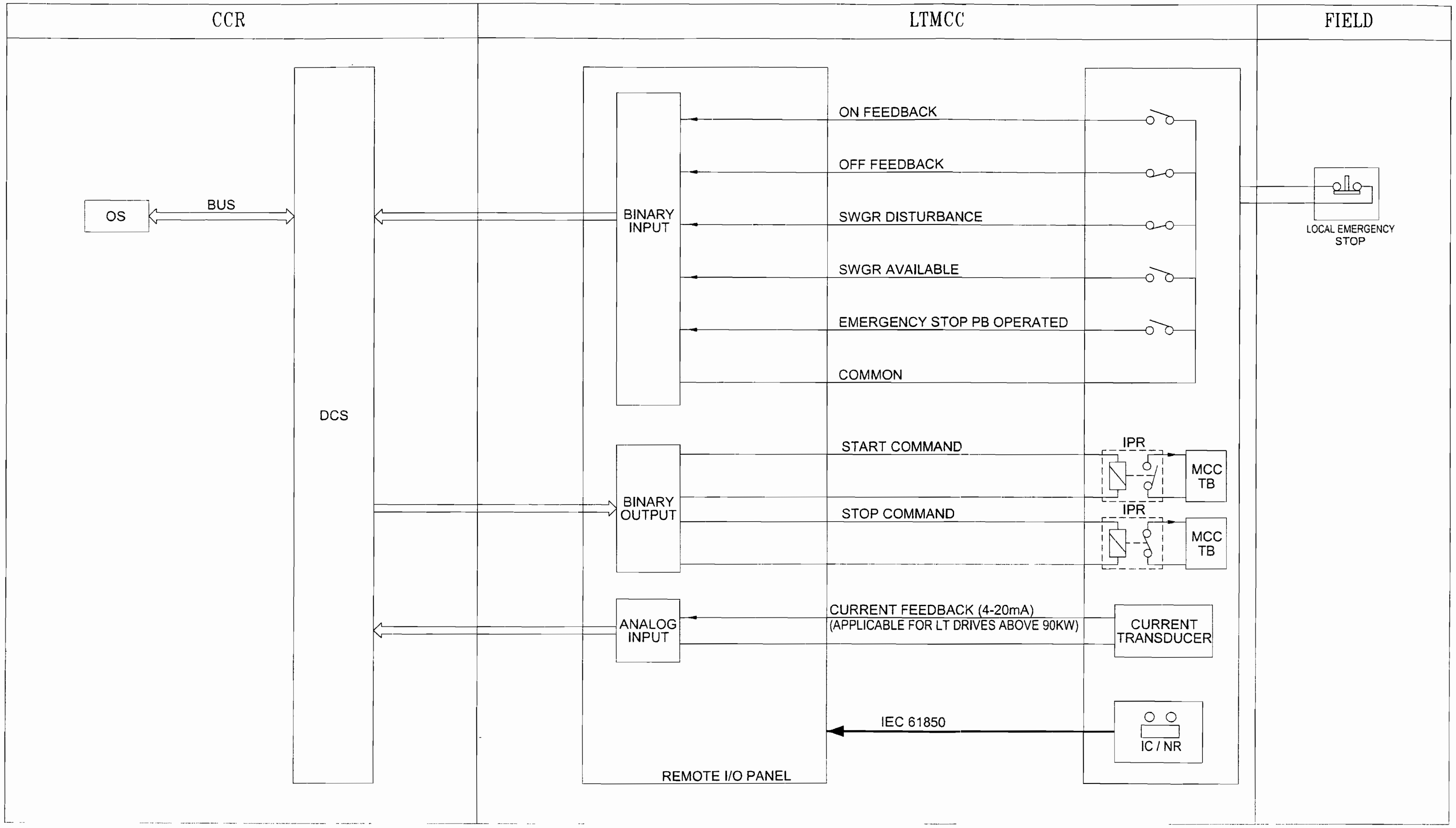
REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
		CHECKED				

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO .			PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT
PREPARED	NAME	DATE	
DRAWN BY	PS	16-DEC-13	
DESIGNED BY	NHR	16-DEC-13	DRAWING TITLE : DRIVE CONTROL PHILOSOPHY BI-DIRECTIONAL DRIVES (MOV-INCHING TYPE)
CHECKED BY	SKM	16-DEC-13	
APPROVED BY	AJV	16-DEC-13	
SHEET SIZE	A3		DRAWING NO : LII-GEOE11019-G-00172-728 — REV. 00 — SHEET 1 OF 1
SCALE	NTS		



ABBREVIATIONS

CCR - CENTRAL CONTROL ROOM
DCS - DISTRIBUTED CONTROL SYSTEM
MCC - MOTOR CONTROL CENTRE
SWGR - SWITCH GEAR
OS - OPERATOR STATION
IPR - INTERPOSING RELAY
I/O - INPUT/OUTPUT
TB - TERMINAL BOX
IC - INTELLIGENT CONTROLLER
NR - NUMERICAL RELAY

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Varun Jain

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REV No	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS GURGAON, INDIA

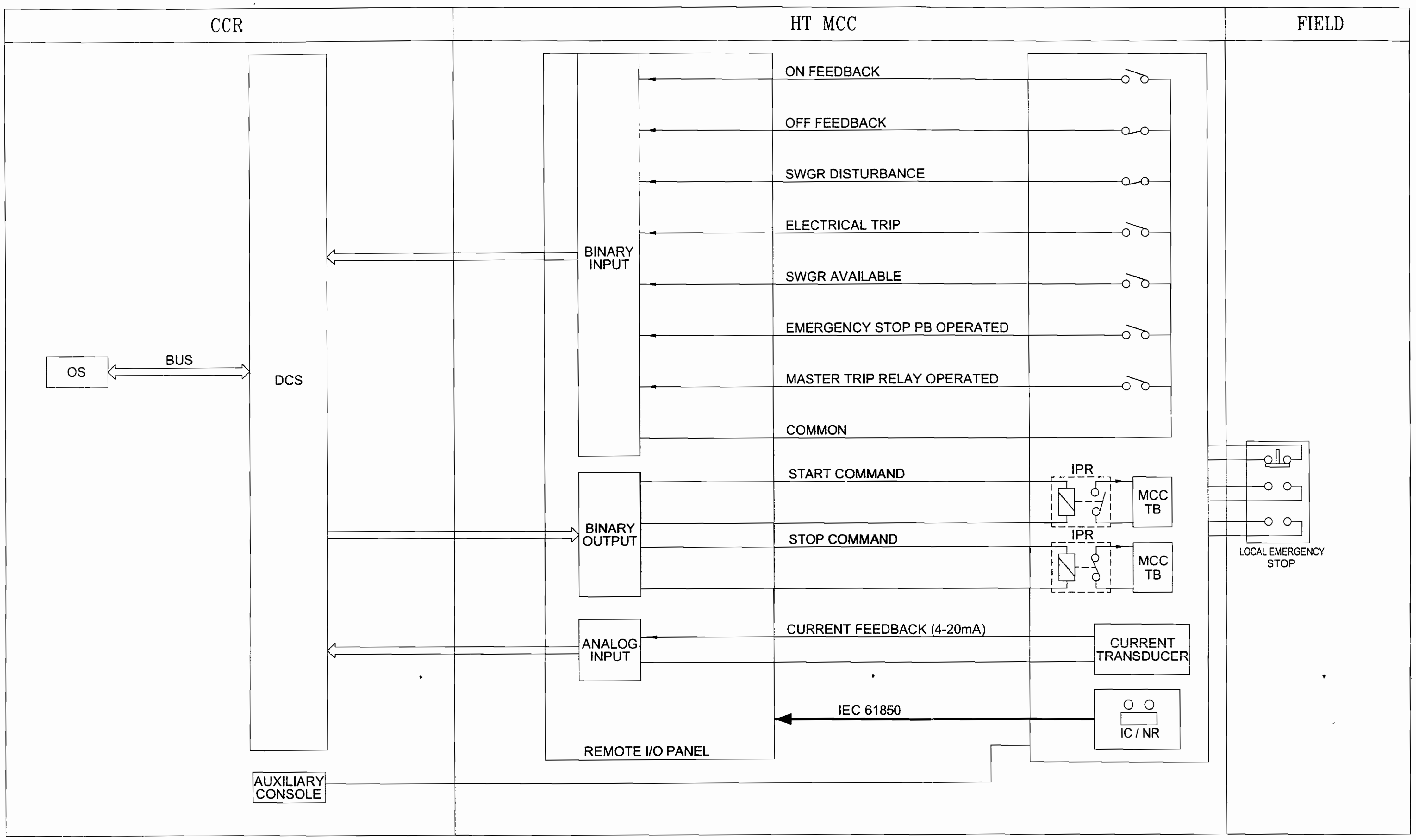
CONTRACT NO :

PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT: 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE: DRIVE CONTROL PHILOSOPHY UNI-DIRECTIONAL LT DRIVE

DRAWING NO: LII-GEOE11019-G-00172-729 | REV. 00 | SHEET 1 OF 1



ABBREVIATIONS

CCR - CENTRAL CONTROL ROOM
DCS - DISTRIBUTED CONTROL SYSTEM
MCC - MOTOR CONTROL CENTRE
SWGR - SWITCH GEAR
OS - OPERATOR STATION
IPR - INTERPOSING RELAY
I/O - INPUT/OUTPUT
TB - TERMINAL BOX
IC - INTELLIGENT CONTROLLER
NR - NUMERICAL RELAY

Praveen Kishore K. Keshav S A Khan Varun Jain

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
		CHECKED				

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

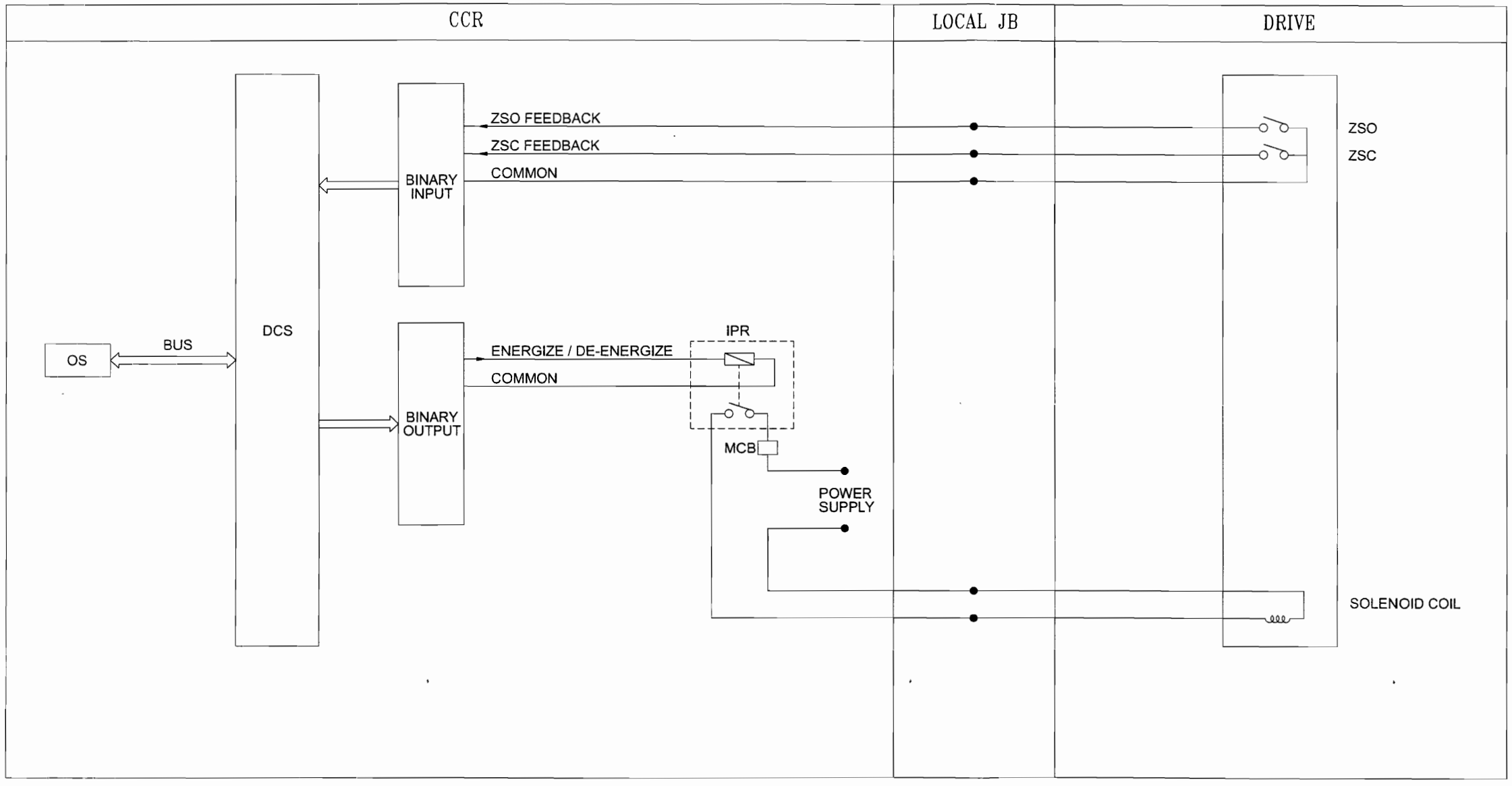
CONTRACT NO :

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

DRAWING TITLE : DRIVE CONTROL PHILOSOPHY UNI-DIRECTIONAL HT DRIVE

DRAWING NO : LII-GEOE11019-G-00172-730 — REV. 00 — SHEET 1 OF 1



ABBREVIATIONS

CCR	-	CENTRAL CONTROL ROOM
DCS	-	DISTRIBUTED CONTROL SYSTEM
MCC	-	MOTOR CONTROL CENTRE
MCB	-	MINIATURE CIRCUIT BREAKER
OS	-	OPERATOR STATION
IPR	-	INTERPOSING RELAY
I/O	-	INPUT/OUTPUT
ZSO	-	LIMIT SWITCH OPEN
ZSC	-	LIMIT SWITCH CLOSE
JB	-	JUNCTION BOX

Praveen Kolloru

K. Keshav

S.V.Rao

Varun Jain

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
		CHECKED				

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

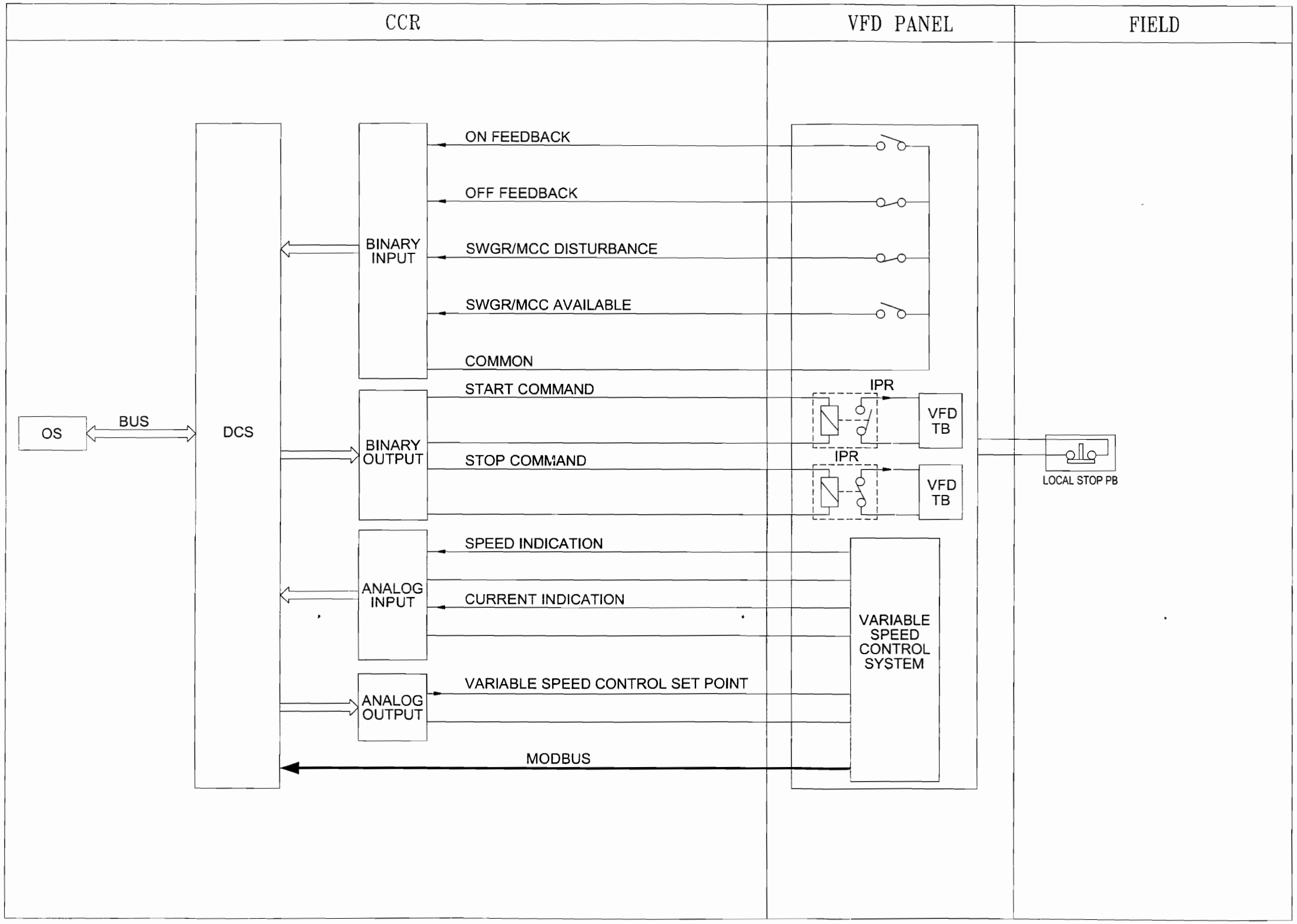
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : DRIVE CONTROL PHILOSOPHY SOLENOID VALVE-SINGLE COIL

DRAWING NO : LII-GEOE11019-G-00172-731 | REV. 00 | SHEET 1 OF 1



ABBREVIATIONS

CCR	-	CENTRAL CONTROL ROOM
DCS	-	DISTRIBUTED CONTROL SYSTEM
MCC	-	MOTOR CONTROL CENTRE
OS	-	OPERATOR STATION
IPR	-	INTERPOSING RELAY
PB	-	PUSH BUTTON
SWGR	-	SWITCHGEAR
TB	-	TERMINAL BOX
VFD	-	VARIABLE FREQUENCY DRIVE

Praveen Kalkora

K. Keshav

S.K.Rao

Varun Jain

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
01	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

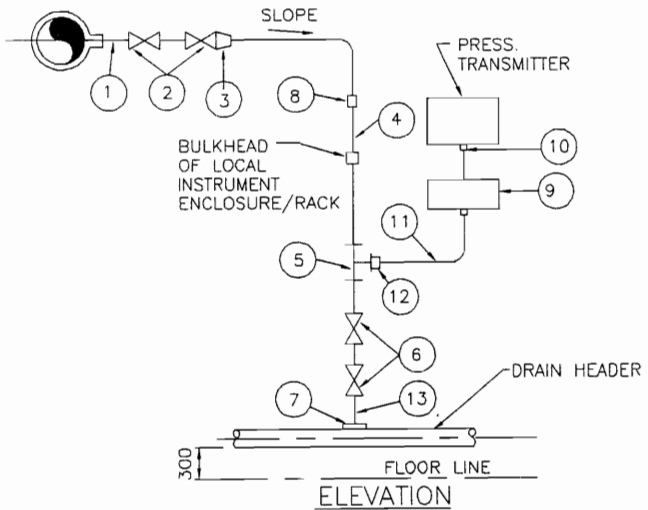
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO .		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT . 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

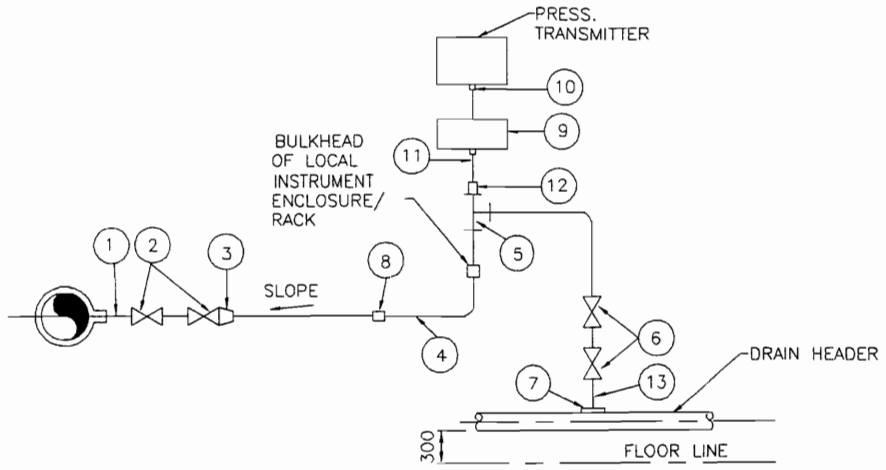
DRAWING TITLE : DRIVE CONTROL PHILOSOPHY VFD CONTROL

DRAWING NO : LII-GEOE11019-G-00172-733 | REV. 00 | SHEET 1 OF 1



ELEVATION

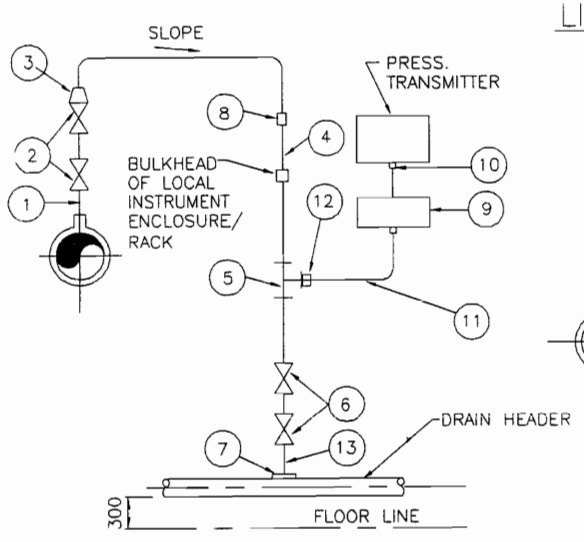
TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT



ELEVATION

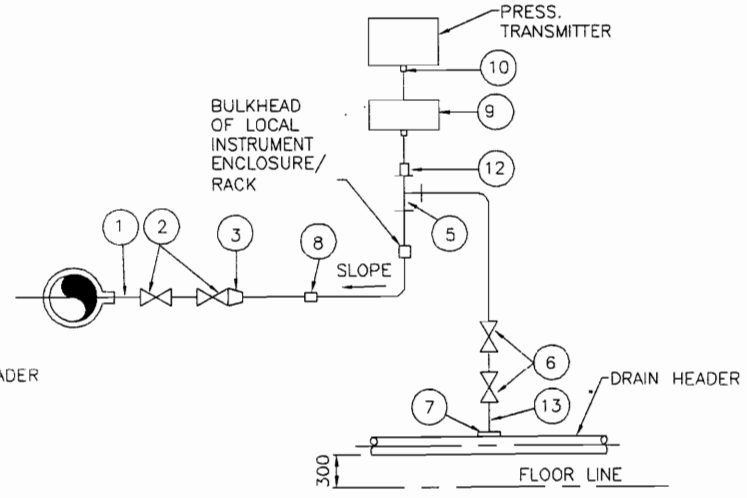
TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

LIQUID PRESSURE MEASUREMENT



ELEVATION

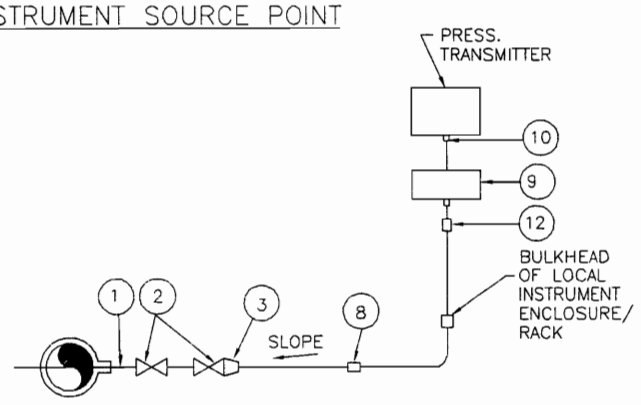
TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT



ELEVATION

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

STEAM PRESSURE MEASUREMENT



ELEVATION

VACCUM PRESSURE MEASUREMENT

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	1/2" / 3/4" / 1" NPS SCH. 40/80/160/XXS/P91 NIPPLE OF MATERIAL AS THAT OF MAIN PIPE
2	3/4" / 1" SW GLOBE VALVE
3	3/4" / 1" TO 1/2" REDUCING INSERT
4	1/2" NPS PIPE
5	1/2" SW EQUAL TEE
6	1/2" SW GLOBE VALVE
7	1/2" NPS SCH. 80/160 SW x 1/2" CS/AS COUPLER
8	1/2" PIPE UNION
9	2/3 VALVE MANIFOLD
10	SUITABLE ADAPTER
11	SS TUBE
12	1/2" PIPE x 1/2" PIPE UNION
13	1/2" NPS SCH. 80/160 SW x 1/2" NPT (M) CS/AS NIPPLE

NOTES:-

1. FOR VACCUM APPLICATION OTHER PORT OF TRANSMITTER SHALL BE KEPT OPEN TO ATMOSPHERE.

Praveen Kolluru

K.Keshav

S.V.Khan

Varun Jain

Bharat Heavy Electricals Limited Power Sector Marketing NOIDA

NLC LTD. NEYVELI

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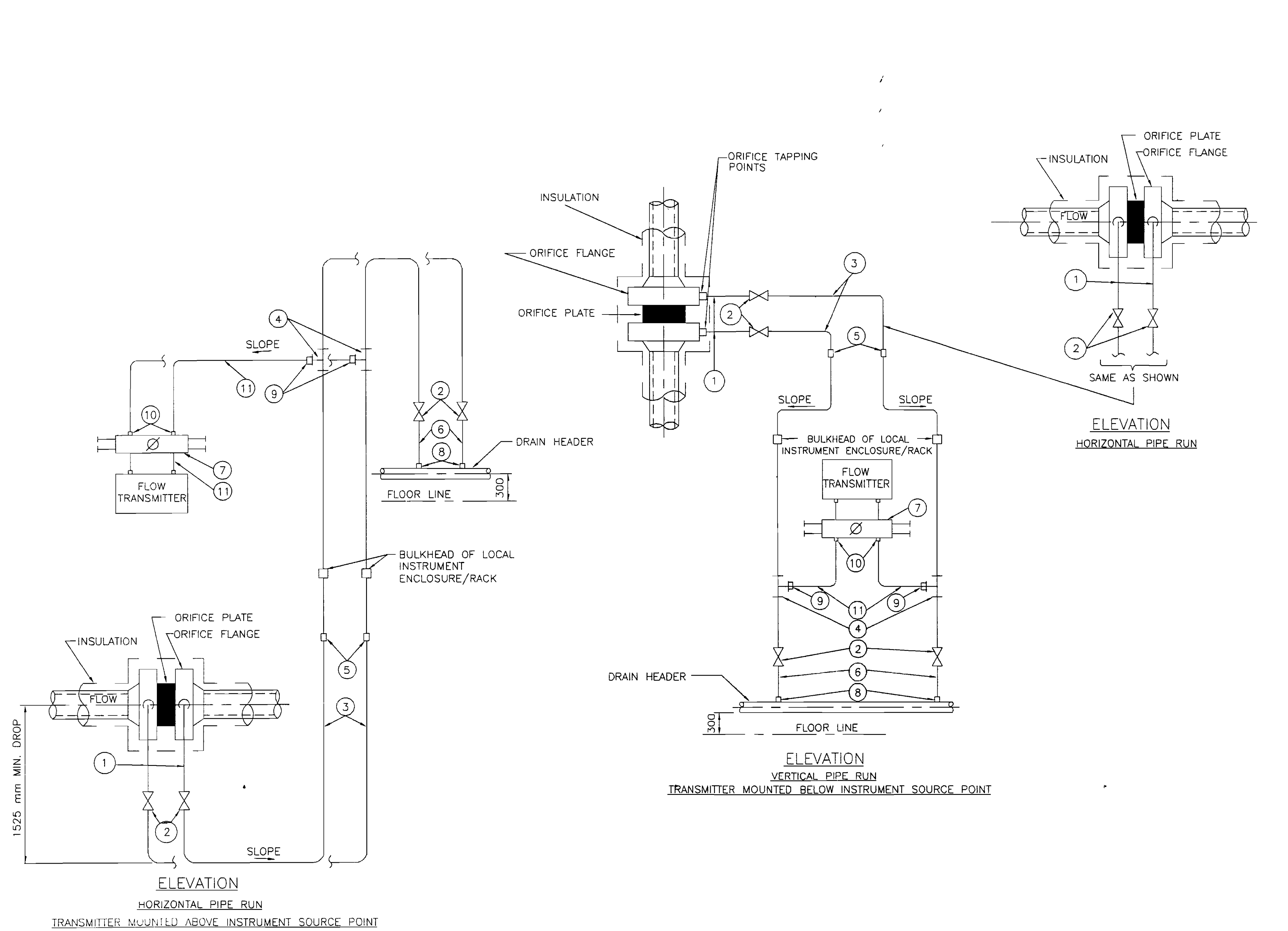
REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT
PREPARED	NAME / DATE	
DRAWN BY	PS / 16-DEC-13	
DESIGNED BY	NHR / 16-DEC-13	DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM (PRESSURE MEASUREMENT USING PRESS./DP TRANSMITTER STEAM/LIQUID VACCUM)
CHECKED BY	SKM / 16-DEC-13	
APPROVED BY	AJV / 16-DEC-13	
SHEET SIZE	A3	DRAWING NO : LII-GE0E11019-G-00172-703 / REV. 00 / SHEET 1 OF 1
SCALE	NTS	



LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	1/2" NPS SCH. 80 NIPPLE OF MATERIAL SAME AS THAT OF MAIN PIPE WITH NECESSARY ATTACHMENT TO FLANGE OF ORIFICE
2	1/2" SW GLOBE VALVE
3	1/2" NPS PIPE
4	1/2" SW EQUAL TEE
5	1/2" PIPE UNION
6	1/2" NPS SCH. 80 SW x 1/2" NPT (M) S.S. NIPPLE
7	5 VALVE MANIFOLD
8	1/2" T SW HALF COUPLET CS
9	1/2" PIPE x 1/2" TUBE UNION
10	SUITABLE ADAPTER
11	SS TUBE

Praveen Kishore

K. Keshav

S A Khan

Varun Jain

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
		CHECKED				

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

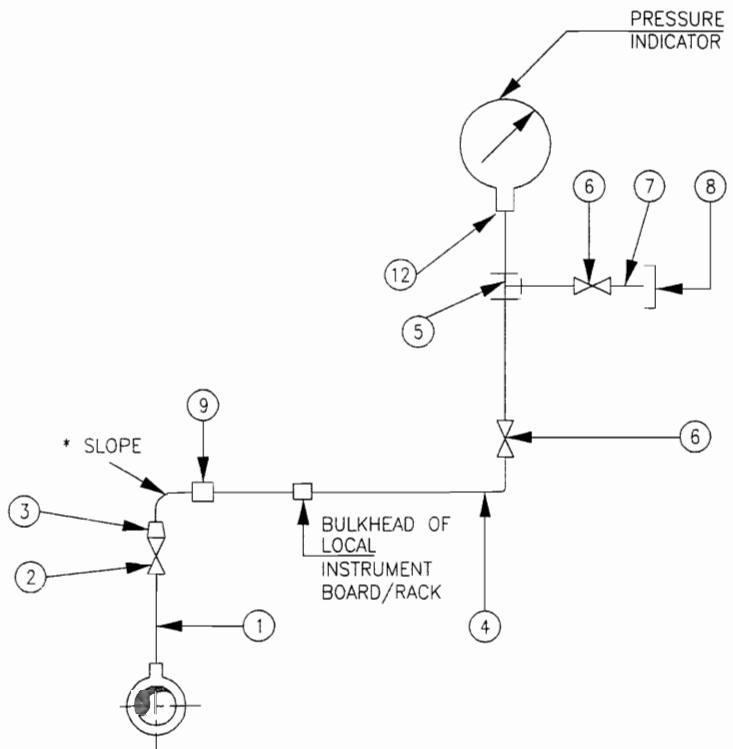
CONTRACT NO :

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

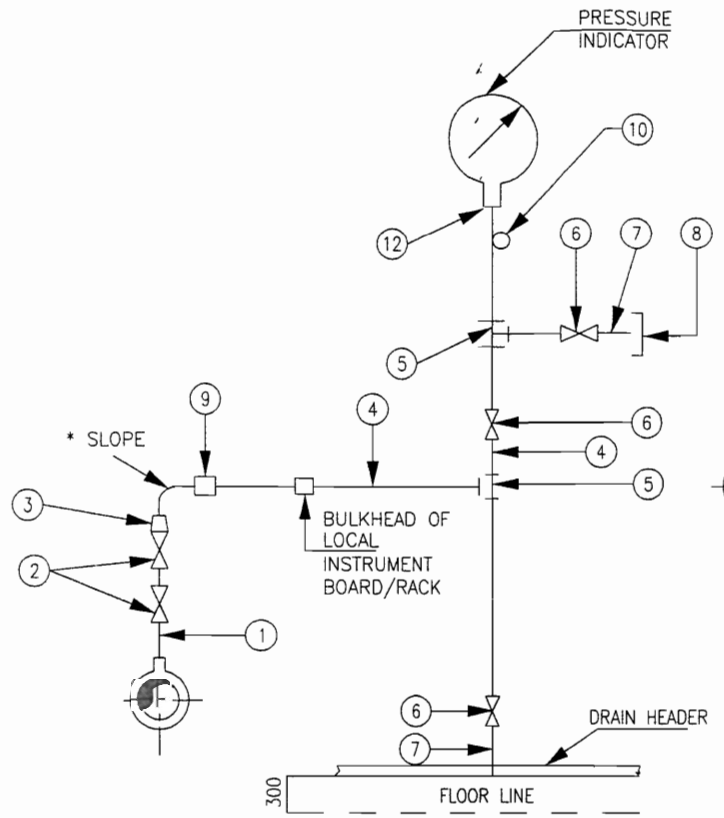
DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM
FLOW MEASUREMENT (USING ORIFICE PLATES)
CONDENSATE & SERVICE WATER

DRAWING NO : LII-GEOE11019-G-00172-704 | REV. 00 | SHEET 1 OF 1



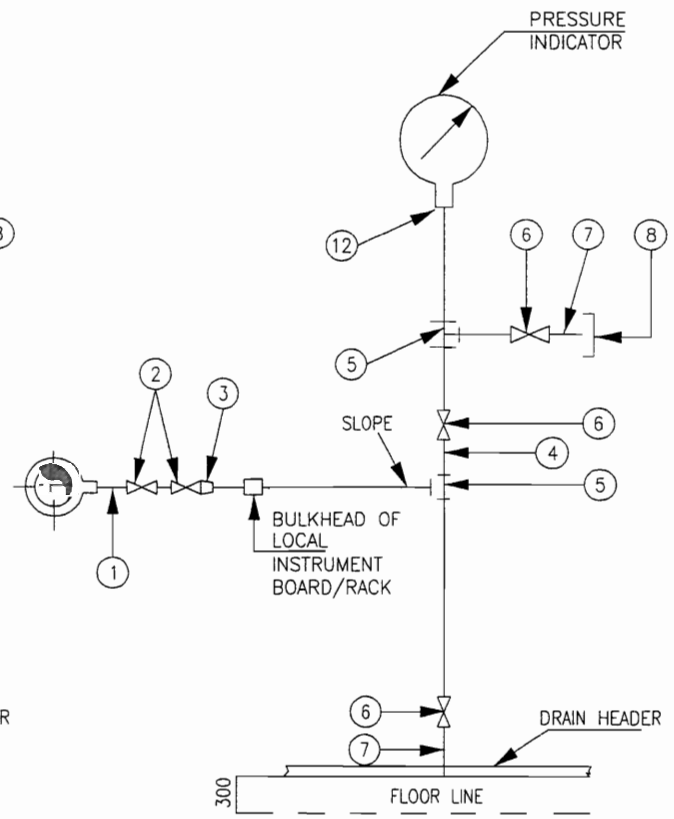
ELEVATION INST./SERVICE AIR

(PRESSURE INDICATORS MOUNTED REMOTE FROM INSTRUMENT SOURCE POINT)



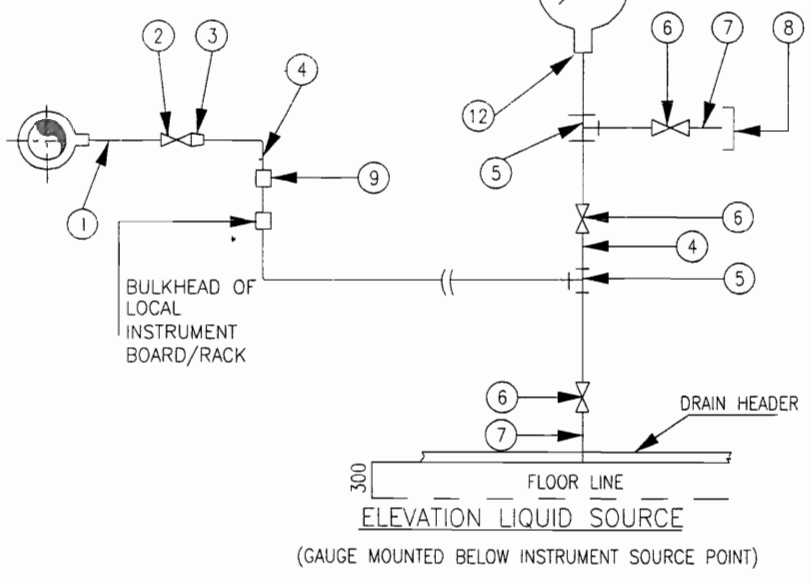
ELEVATION STEAM SERVICE

(PRESSURE INDICATORS MOUNTED REMOTE FROM INSTRUMENT SOURCE POINT)



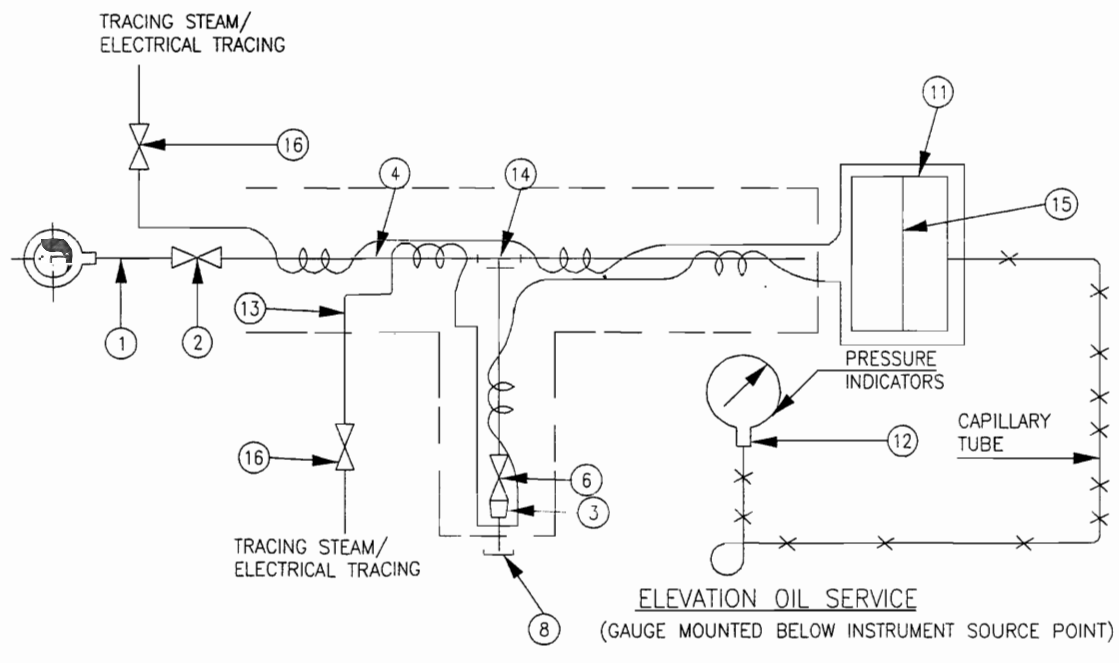
ELEVATION LIQUID SOURCE

(GAUGE MOUNTED ABOVE INSTRUMENT SOURCE POINT)



ELEVATION LIQUID SOURCE

(GAUGE MOUNTED BELOW INSTRUMENT SOURCE POINT)



ELEVATION OIL SERVICE

(GAUGE MOUNTED BELOW INSTRUMENT SOURCE POINT)

NOTES:-

1. THE MATERIAL SPECIFICATION AND SCHEDULE NO. OF IMPULSE PIPE AND NIPPLE AS LISTED HEREIN SHALL BE AS PER TECHNICAL SPECIFICATIONS.
2. THE MATERIAL SPECIFICATION AND RATING OF FITTINGS AS LISTED SHALL BE AS PER SPECIFICATION. WELDED /THREDED FITTING SHALL CONFIRM TO ANSI-B.16-11
3. INSTRUMENTS VALVES BODY STEM MATERIAL AND PRESSURE CLASS SHALL BE AS PER TECHNICAL SPECIFICATIONS.
4. FOR BOILER AIR/FLUE GAS SERVICES SOURCE CONNECTIONS IMPULSE PIPING AND ALL FITTING SHALL BE OF 3/4" NB SIZE.
5. GAUGES SHALL NOT BE MOUNTED ON THE PIPE. IT WILL BE MOUNTED ON CHANNEL, FRAME OR RACK.
6. *SLOPE APPROX 40MM/METRE.

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	1/2",3/4", 1"NPS SCH 40/80/160/XXS/P91(AS PER PROCESS REQUIREMENT) NIPPLE OF MATRIAL SAME AS THAT OF MAIN PIPE
2	1/2"/3/4"/1" SW GLOBE VALVE/GATE VALVE
3	3/4"/1"X1/2" SW REDUCING INSERT
4	1/2"/3/4" PIPE
5	1/2"/3/4" SW EQUAL TEE
6	1/2"/3/4" SW GLOBE VALVE
7	1/2"/3/4" NPS SW X 1/2"/3/4"NPT (M) CARBON/ALLOY STEEL NIPPLE
8	1/2" 3/4" NPT (F) CS CAP
9	1/2" 3/4" PIPE UNION
10	6" SS SYPHON
11	1/2" BLIND 300lbs RF ANSI FLANGE DRILLED AND TAPED FOR 1" NPT PIPE
12	SUITABLE ADAPTER
13	1/4" CHROME MOLY STEEL TUBE
14	1"/3/4" SW EQUAL TEE
15	DIAPHRAGM (WATER ELEMENT)
16	ISOLATION VALVE 316 SS. 1/4"SW

Bharat Heavy Electricals Limited Power Sector Manufacturing Unit New Delhi

NLC LTD NEYVELI 082

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

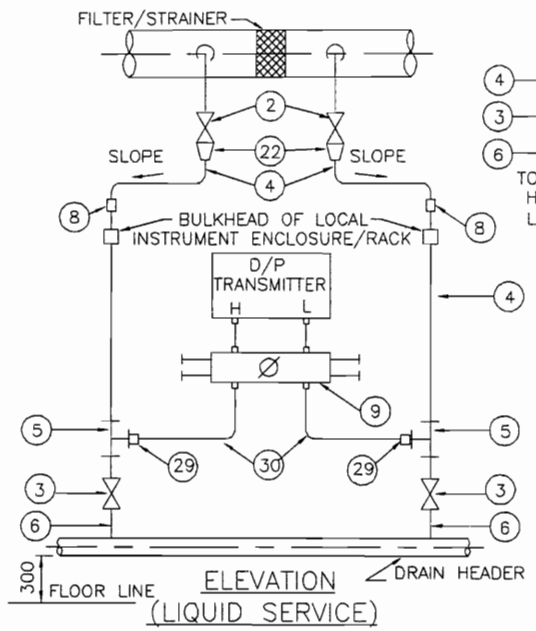
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM (FOR PRESSURE GAUGE)

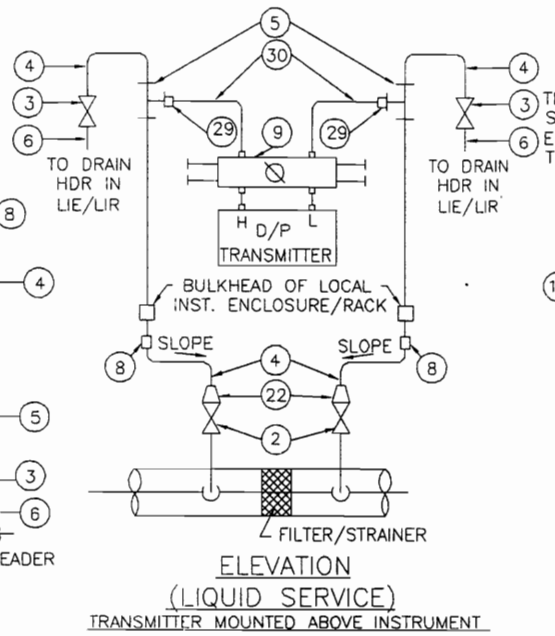
DRAWING NO : LII-GE0E11019-G-00172-705 | REV. 00 | SHEET 1 OF 1

Varun Jain | S A Khan | K. Keshav | Praveen Kishore



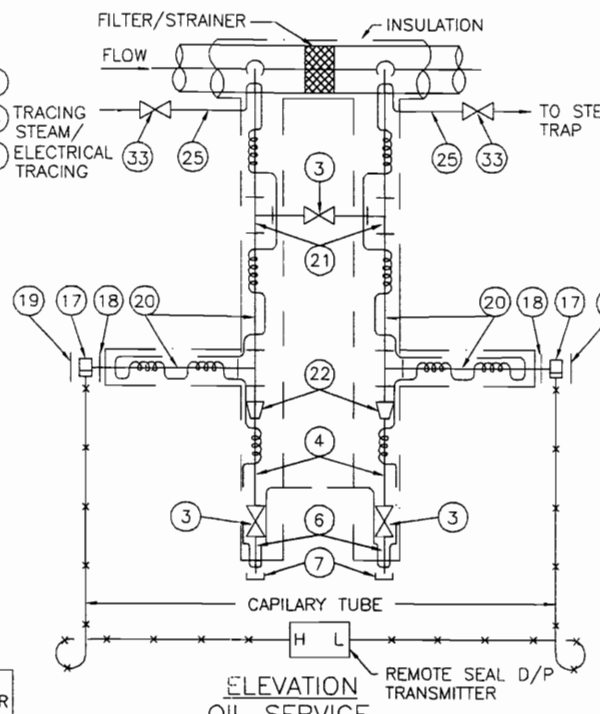
ELEVATION
(LIQUID SERVICE)

TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT

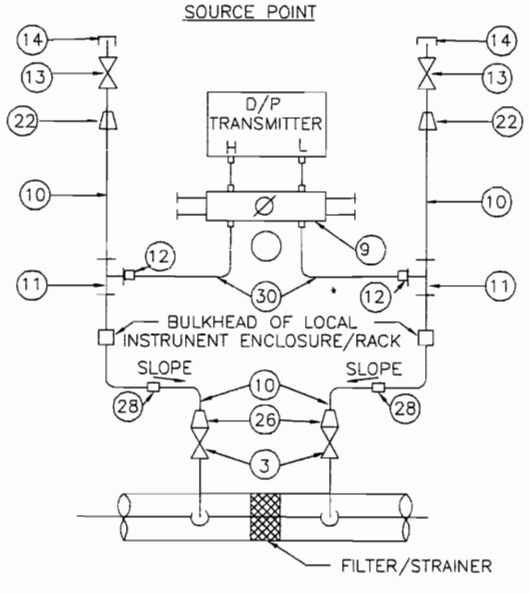


ELEVATION
(LIQUID SERVICE)

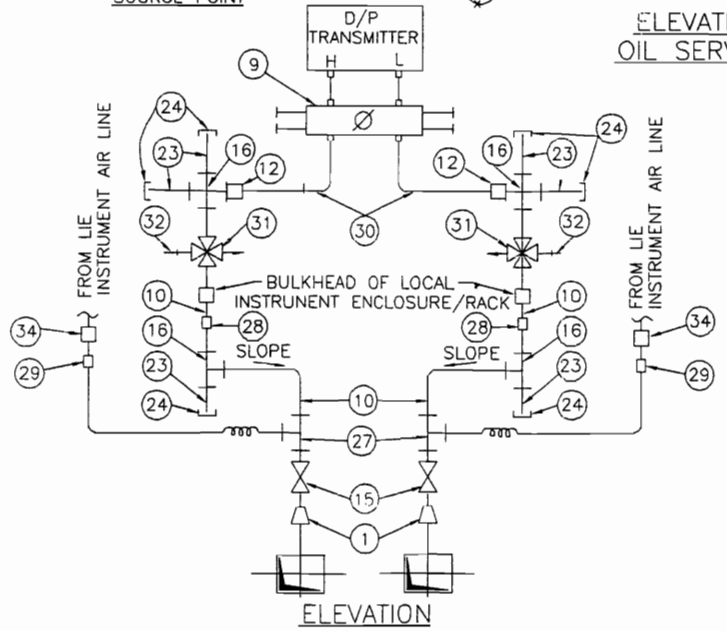
TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT



ELEVATION
OIL SERVICE



ELEVATION
CLEAN GAS/AIR SERVICE



ELEVATION
FLUE GAS SERVICE/DIRTY AIR SERVICE

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT
DIFFERENTIAL PRESSURE MEASUREMENT

Varun Jain S A Khan K. Keshav Praveen Kishore

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	42x2 TO 3/4" SW REDUCING AGENT
2	3/4" SW GLOBE VALVE
3	1/2" SW GLOBE VALVE FOR LIQUID APPLICATION & 3/4" / 1" IN GAS / AIR APPLICATION
4	1/2" NPS 40/80/160 (AS PER PROCESS REQUIREMENT) CARBON / ALLOY STEEL PIPE
5	1/2" SW EQUAL TEE
6	1/2" NPS SW x 1/2" NPT(M) CS NIPPLE
7	1/2" NPT (F) CS CAP
8	1/2" PIPE x 1/2" PIPE UNION
9	5 VALVE MANIFOLD
10	3/4" SCH 80 CARBON / ALLOY STEEL PIPE
11	3/4" / 1/2" SW EQUAL TEE
12	3/4" x 1/2" TUBE UNION
13	1/2" SCREWED GLOBE VALVE
14	1/2" NPT (M) PLUG
15	3/4" SW GATE VALVE
16	3/4" SW EQUAL CROSS
17	WAFER ELEMENT FOR USE WITH 3" ANSI R.F VALVE
18	3" BLIND 300lbs R.F. WELD NECK FLANGE DRILLED FOR 1" SCH. 40/80 PIPE
19	3/4" BLIND FLANGE
20	1" NPS SCH. 40/80 (AS PER PROCESS REQUIREMENT) CS PIPE
21	1" SW EQUAL TEE
22	3/4" X 1/2" SW REDUCING INSERT
23	3/4" SW x 3/4" NPT (M) CS/AS NIPPLE
24	3/4" NPT (F) CS/AS CAP
25	1/4" NPS ALLOY STEEL PIPE
26	1" x 3/4" REDUCING AGENT
27	3/4" SW x 1/2" PSW BRANCH TEE
28	3/4" PIPE UNION
29	1/2" CLAMP UNION (THREADED) SUITABLE FOR FLEXIBLE CONNECTION OF NYLON REINFORCED PVC TUBE
30	SS TUBE
31	3/4" SW 4 WAY VALVE
32	QUICK DISCONNECT FITTINGS
33	1/4" SW ISOLATION VALVE 316SS
34	1/2" x 1/2" SS PIPE UNION

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

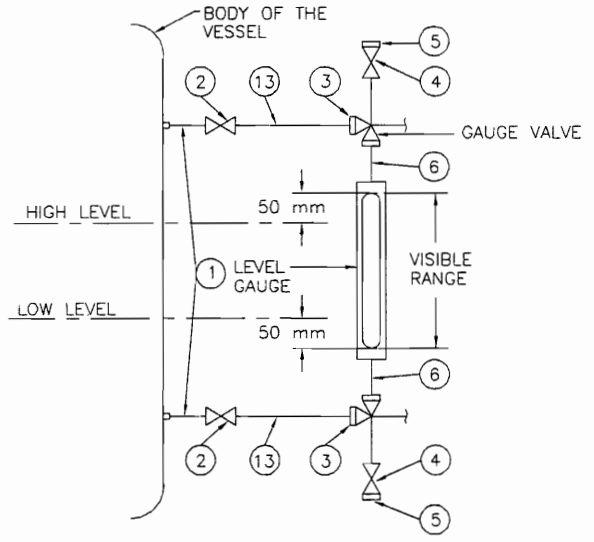
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

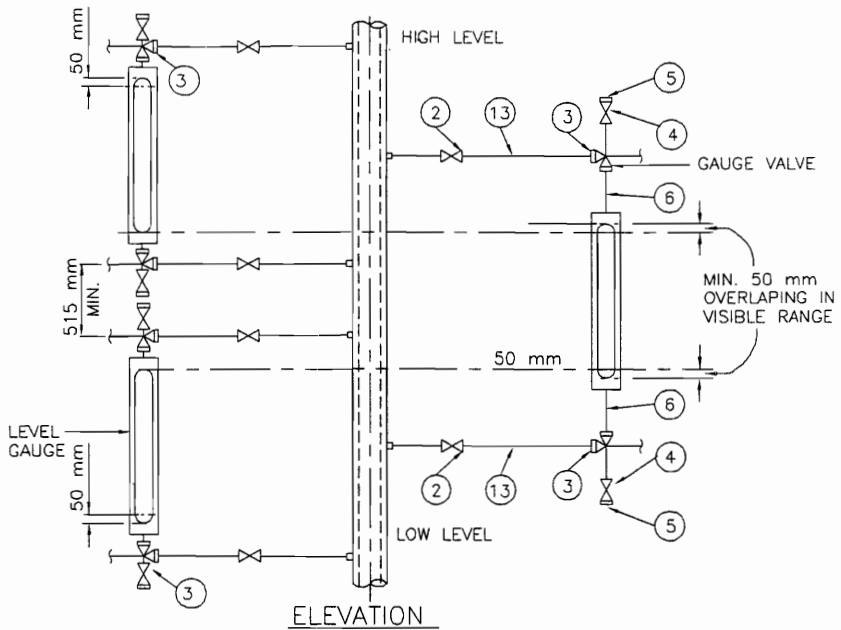
DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM DIFF. PRESS. MEASUREMENT (LIQUID,OIL,AIR/GAS SERVICE)

DRAWING NO : LII-GE0E11019-G-00172-706 | REV. 00 | SHEET 1 OF 1



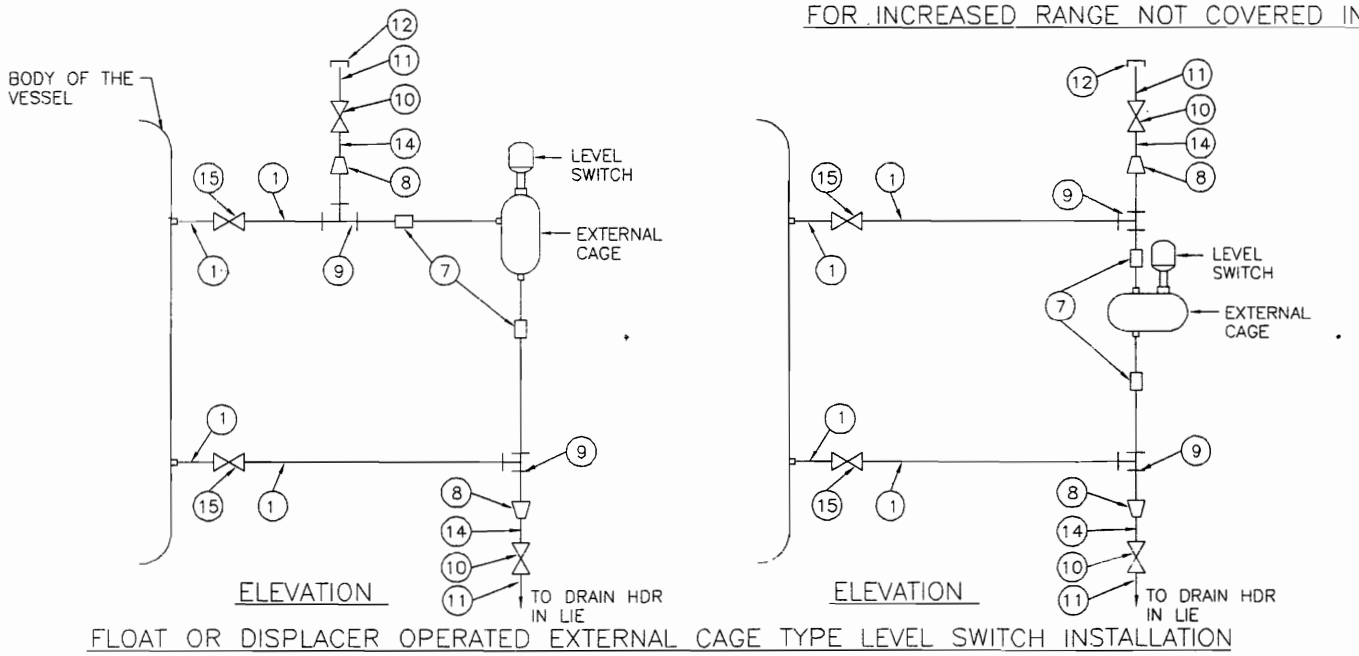
ELEVATION

LOCAL LEVEL INDICATION USING GAUGE GLASS



ELEVATION

LOCAL LEVEL INDICATION USING MULTIPLE GAUGES
FOR INCREASED RANGE NOT COVERED IN A SINGLE UNIT



FLOAT OR DISPLACER OPERATED EXTERNAL CAGE TYPE LEVEL SWITCH INSTALLATION

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	3/4" / 1" NPS SCH. 40/80/160/XXS/P91(AS PER PROCESS REQUIREMENT) CARBON/ALLOY STEEL PIPE.
2	3/4" SW GLOBE VALVE
3	3/4" SW UNION
4	3/4" NPT GLOBE VALVE
5	3/4" NPT (M) CAP
6	3/4" NPT (F) UNION CONNECTION
7	1" SW EQUAL UNION
8	1" X 1/2" SW REDUCING INSERT
9	1" SW EQUAL TEE
10	1/2" SW GLOBE VALVE
11	1/2" NPS SW X 1/2" NPT(M) CS/AS NIPPLE
12	1/2" NPT (F) CS CAP
13	3/4" X 1/2" NPS SCH. 40/80 CS/AS PIPE
14	1/2" NPS SCH. 80/160 CS/AS NIPPLE
15	1" SW GLOBE VALVE

NOTES:-

1. FOR LEVEL GAUGE 3/4" AND FOR LEVEL SWITCH 1" PROCESS CONNECTION SHALL BE PROVIDED.

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
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NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

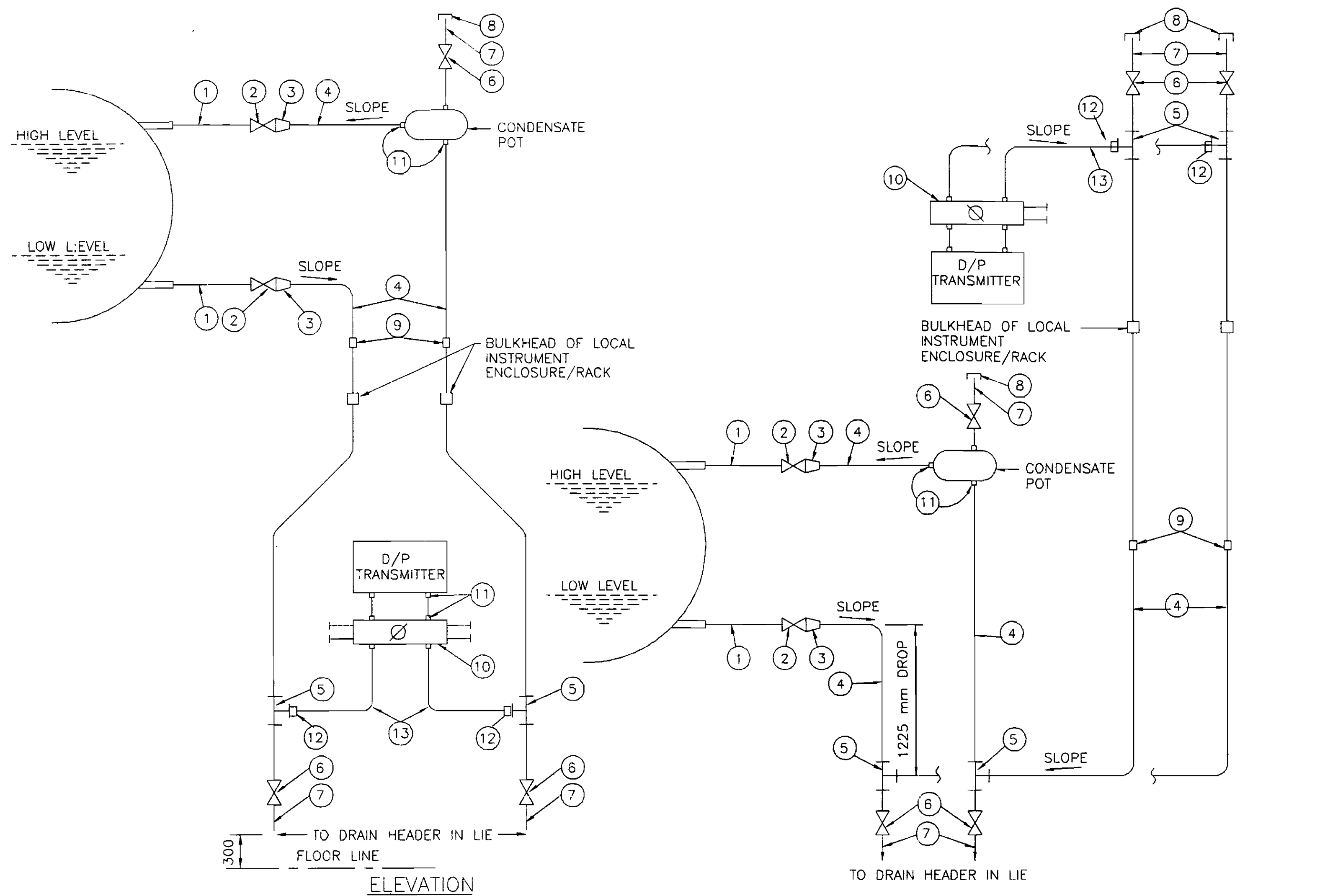
LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM (LEVEL GAUGE AND SWITCHES)

DRAWING NO : LII-GE0E11019-G-00172-707 | REV. 00 | SHEET 1 OF 1



ELEVATION
TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT

ELEVATION
TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

LEVEL MEASUREMENT OF CLEAR NON-VISCOUS OR NON-CORROSIVE LIQUID IN CLOSED VESSEL WITH CONDENSABLE ATMOSPHERE USING D/P TRANSMITTER

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	1/2",3/4", 1"NPS SCH 40/80/160/XXS/P91(AS PER PROCESS REQUIREMENT) CARBON/ALLOY STEEL PIPE
2	1" SW GLOBE VALVE
3	3/4"/1" TO 1/2" REDUCING INSERT
4	1/2" NPS SCH.80/160/XXS(AS PER PROCESS REQ.)CS/AS PIPE
5	1/2" SW EQUAL TEE
6	1/2" SW GLOBE VALVE
7	1/2" NPS SW X 1/2" NPT(M) CS/AS NIPPLE
8	1/2" NPT (F) CS CAP
9	1/2" PIPE UNION
10	5-VALVE MANIFOLD
11	SUITABLE ADAPTER
12	1/2" PIPE X 1/2" TUBE UNION
13	S.S. TUBE

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

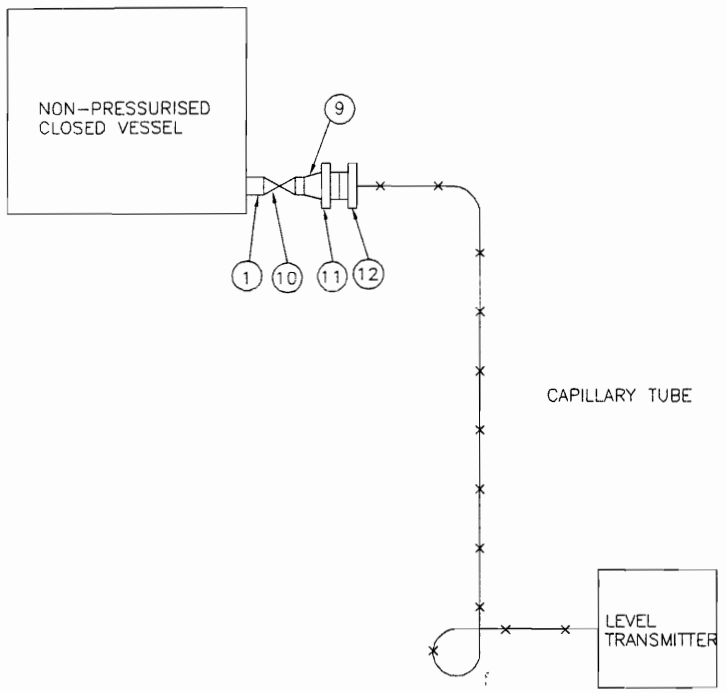
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM (LEVEL MEASUREMENT USING D/P TRANSMITTER)

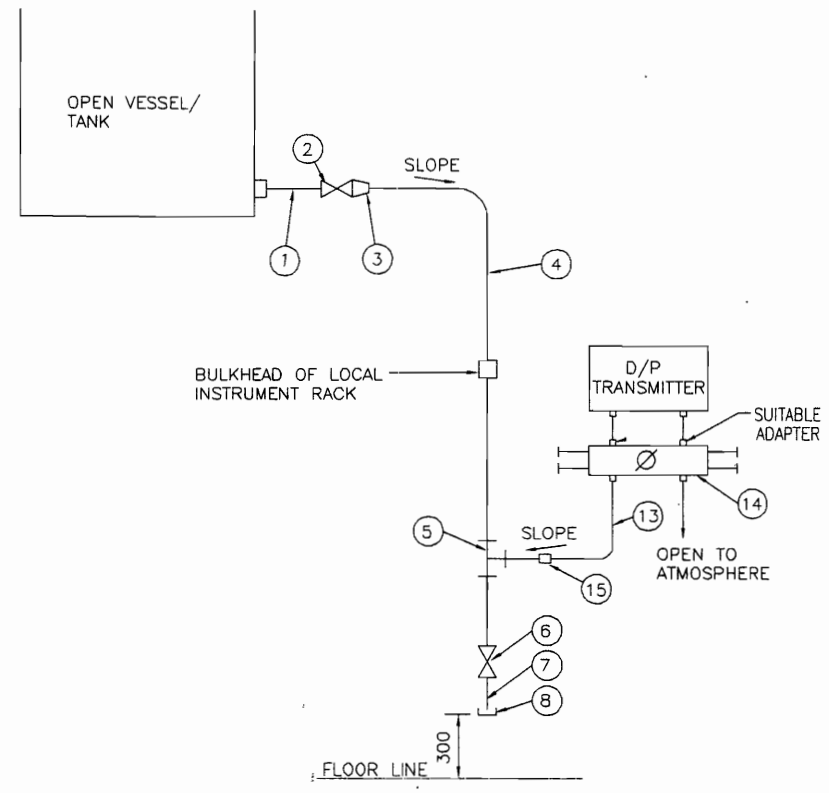
DRAWING NO : LII-GEOE11019-G-00172-708 REV 00 SHEET 1 OF 2

Varun Jain
S A Khan
K. Keshav
Praveen Kishore



ELEVATION

LEVEL MEASUREMENT OF VISCOUS OR CORROSIVE LIQUID IN CLOSED VESSEL USING FLUSH DIAPHRAGM/WAFER TYPE LEVEL TRANSMITTER WITH REMOTE SEAL



ELEVATION

LEVEL MEASUREMENT OF CLEAN LIQUID IN AN OPEN VESSEL USING D/P TRANSMITTER

LIST OF MATRERIALS

ITEM NO	DESCRIPTION
1	3/4" / 1" NPS 40/80 CARBON STEEL PIPE
2	3/4" SW GLOBE VALVE
3	3/4" / 1/2" SW REDUCING INSERT
4	1/2" NPS SCH 40/80 CS PIPE
5	1/2" SW EQUAL TEE
6	1/2" SW GLOBE VALVE
7	1/2" NPS SW X 1/2" NPT(M) CS NIPPLE
8	1/2" NPT (F) CS CAP
9	3/4" TO 4" EXPANDER
10	3/4" BUTT WELDED GATE VALVE
11	4" ANSI 300lbs RF WELDED NECK FLANGE
12	4" ANSI MATCHING FLANGE WITH FLUSH DIAGRAM OF LEVEL TRANSMITTER
13	SS TUBE
14	3-VALVE MANIFOLD
15	1/2" PIPE X 1/2" TUBE UNION

NOTES:-

1. FOR VACCUM APPLICATION OTHER PORT OF TRANSMITTER SHALL BE KEPT OPEN TO ATMOSPHERE.

Bharat Heavy Electricals Limited Power Sector Marketing New Delhi

NLC LTD. NEYVELI

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
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00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD. CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

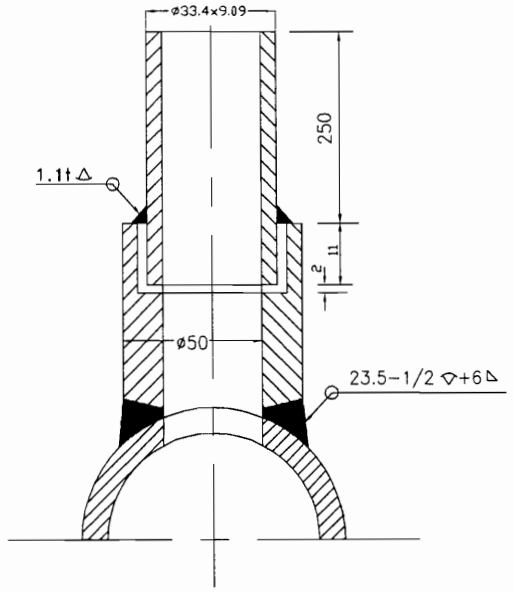
DRAWING TITLE : INSTRUMENT INSTALLATION DIAGRAM (LEVEL MEASUREMENT- CLOSED/OPEN VESSEL)

DRAWING NO : LII-GE0E11019-G-00172-709 | REV. 00 | SHEET 1 OF 1

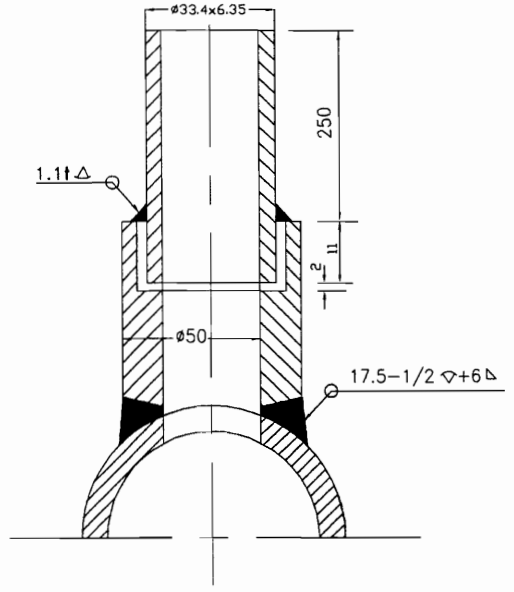
Varun Jain | S A Khan | K. Keshav | Praveen Kishore

PRESSURE MEASUREMENT

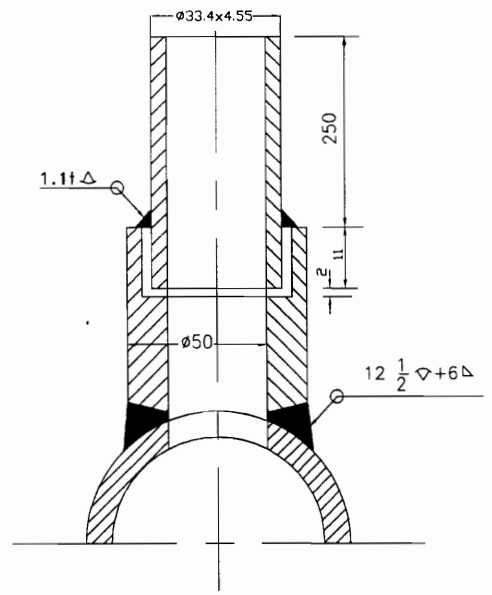
(SYSTEM PR.>40Kg/Sq cm CL 9000)



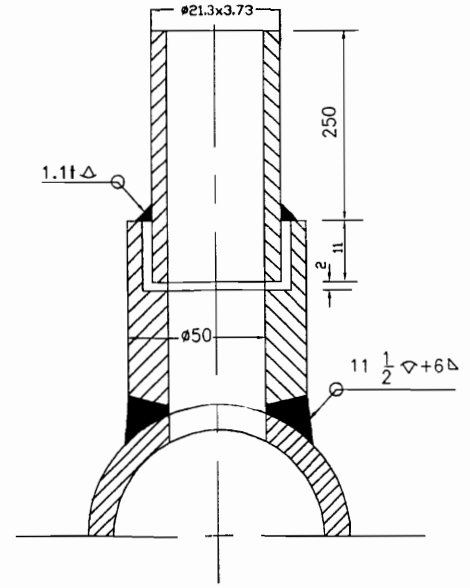
(SYSTEM PR.>40Kg/Sq cm CL 6000)



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



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



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NOTES:−

1. MATERIAL OF THE BOSS AND NIPPLE BE THE SAME AS 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 SOCKETWELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B16.1.
4. TWO ISOLATED VALVES ARE TO BE USED FOR PRESSURE=>62KgMCm2 & TEMP.=>425°C
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 VARY WITH TYPE OF PROCESS FLUID AND NATURE OF RUN OF THE PIPE.
7. ACTIVITES 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 AND OTHERWISE STATED.

Bharat Heavy Electricals Limited ★ Power Sector ★ New Delhi - 110049

NLC LTD. NEYVELI

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
			CHECKED			
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

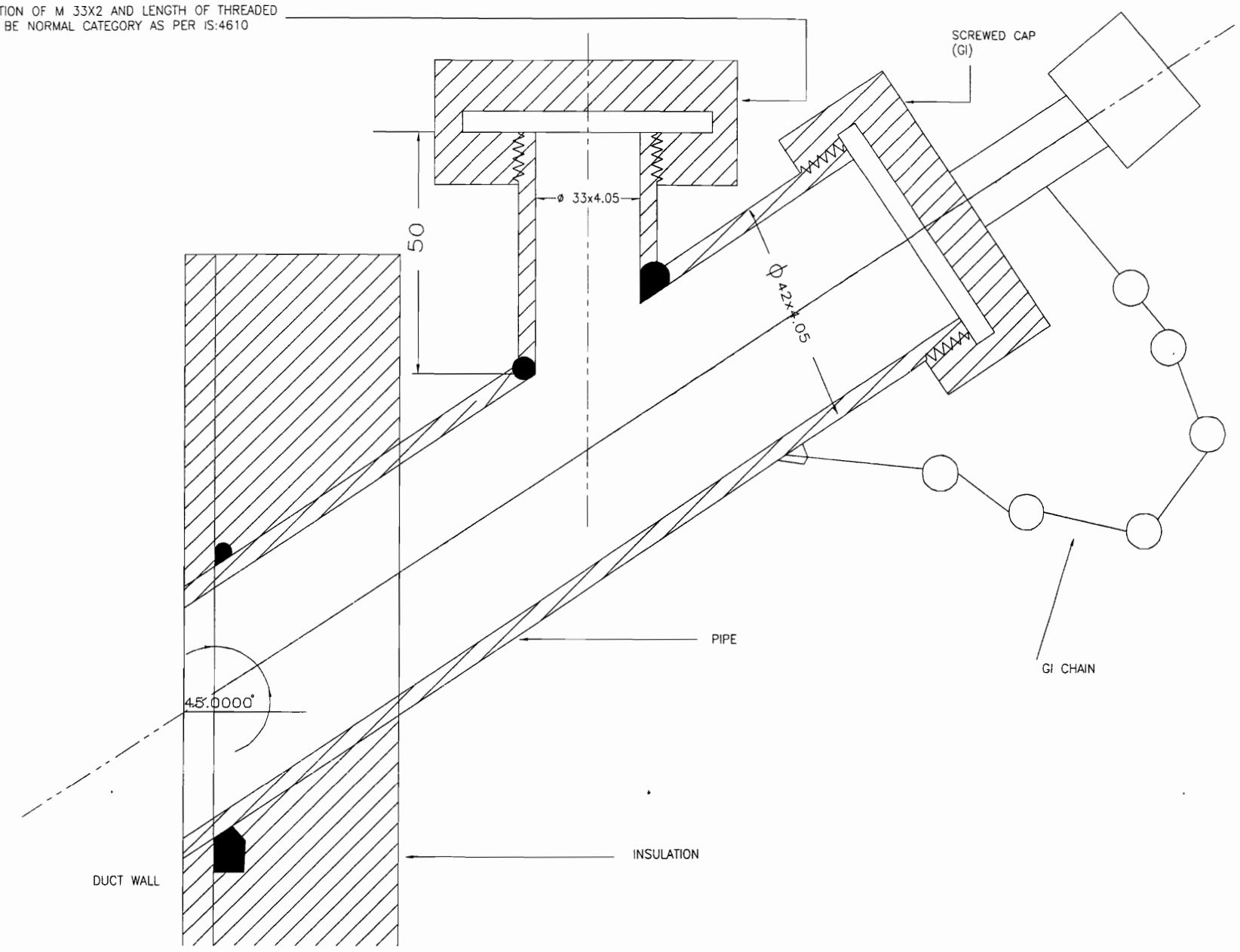
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - PRESSURE MEASUREMENT

DRAWING NO : LII-GE0E11019-G-00172-710 | REV. 00 | SHEET 1 OF 1

PRESSURE MEASUREMENT



NOTES:-

1 THIS TYPE OF PRESSURE CONNECTION SHALL BE PROVIDED FOR PRESSURE MEASUREMENTS IN AIR AND FLUE GAS DUCT/FURNACE

2. DIMENSION ARE INDICATIVE ONLY.

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD. CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
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CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

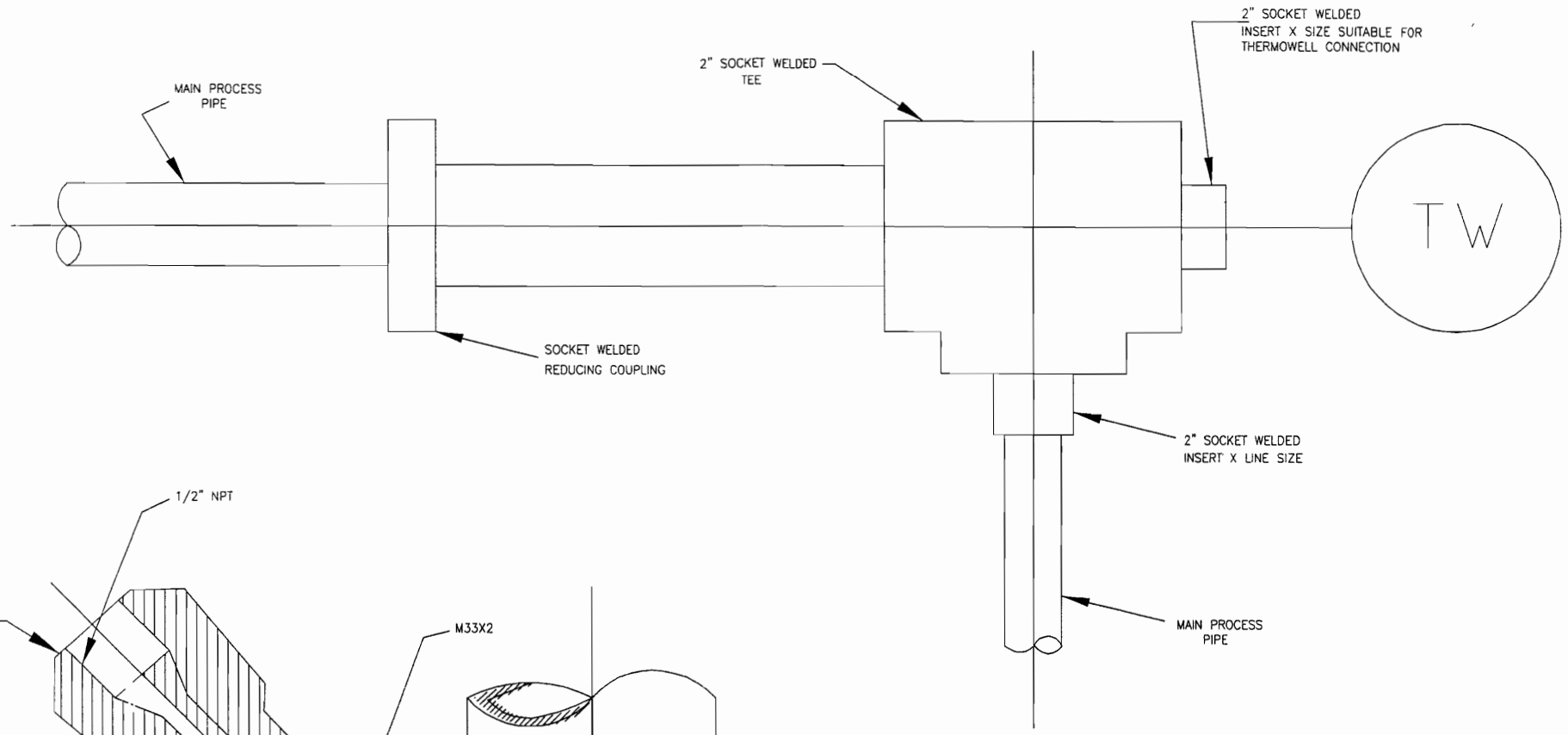
PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

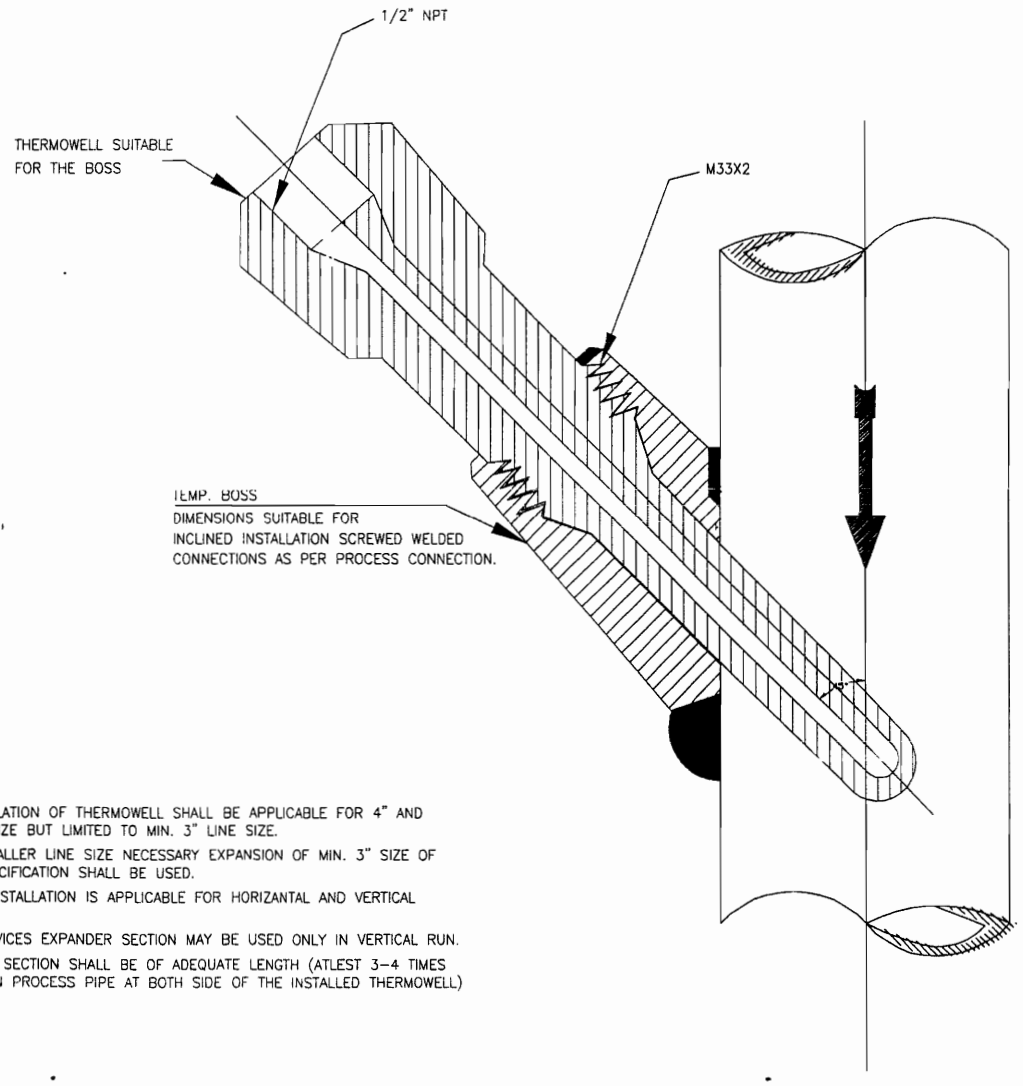
DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - PRESSURE MESUREMENT

DRAWING NO : LII-GE0E11019-G-00172-711 | REV. : 00 | SHEET : 1 OF 1

Varun Jain | S A Khan | K. Keshav | Praveen Kishore

TEMP. MEASUREMENT





ELEVATION LIQUID SOURCE

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 EXPANSION OF MIN. 3" SIZE OF MAN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZANTAL 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 (ATLEST 3-4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF THE INSTALLED THERMOWELL)

NOTES:-

1. THIS TYPE OF THERMOWELL INSTALLATION IS SUITABLE FOR 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 150 mm (IT MUST BE GREATER THAN THERMOWELL LENGTH)

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
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NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
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DRAWN BY	PS	16-DEC-13
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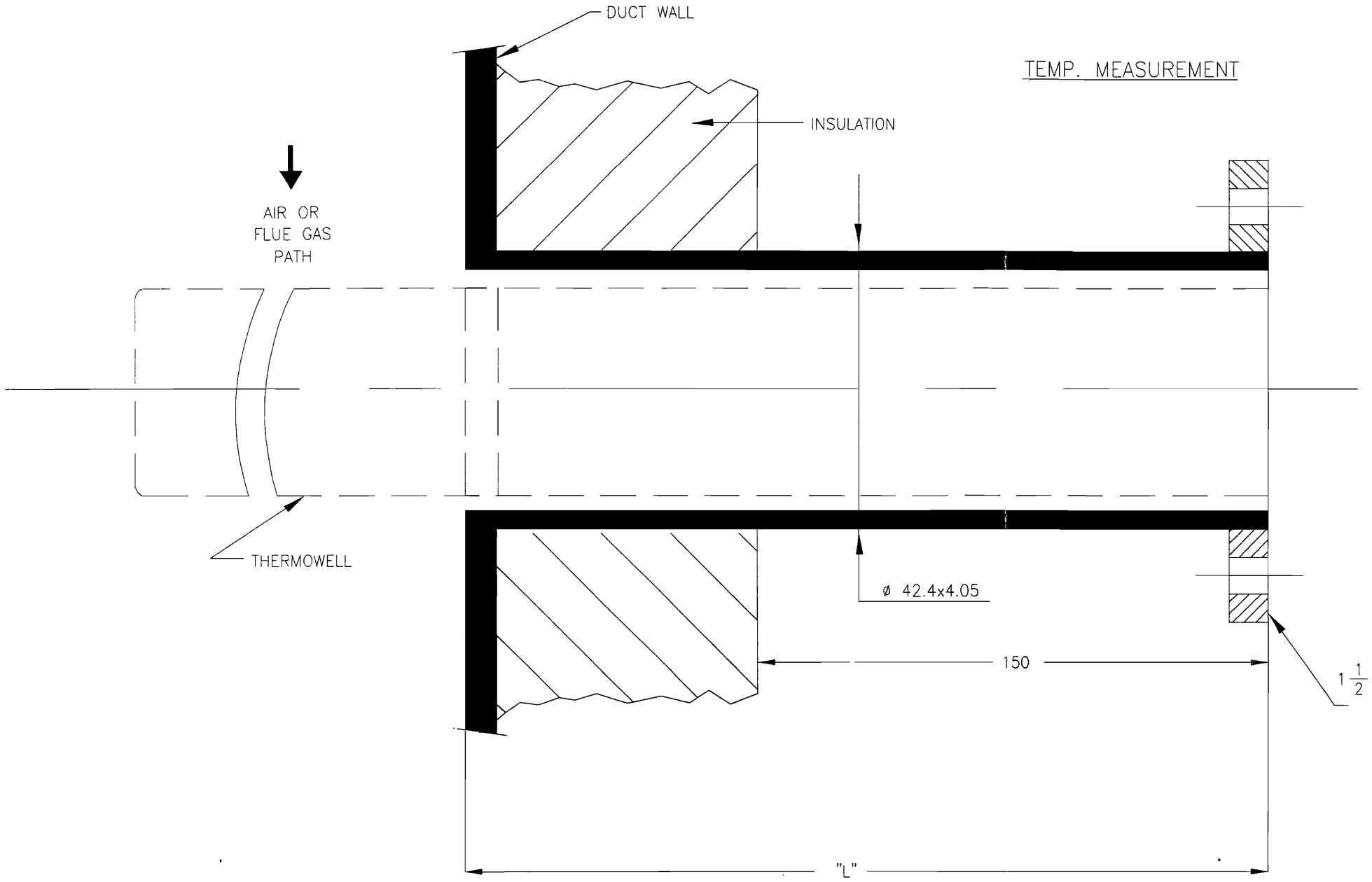
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : - 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - TEMP. MESUREMENT

DRAWING NO : LII-GE0E11019-G-00172-712 | REV. 00 | SHEET 1 OF 1

Varun Jain | S A Khan | K. Keshav | Praveen Kishore



TEMP. MEASUREMENT

$1\frac{1}{2}$" 300 lbs
FLANGE AS PER
ANSI B 16.5

NOTES:–

1. THIS TYPE OF THERMOWELL CONNECTION SHALL BE PROVIDED FOR TEMPERATURE MEASUREMENT IN AIR AND FLUE GAS DUCT
2. MATERIAL OF THERMOWELL SHALL BE OF 316SS.
3. EXTERNAL CONNECTION SHALL BE OF SLIP ON FLANGED TYPE AND THERMOWELL DESIGN SHALL BE AS PER ASME. PTC--19.3
4. CONTRACTOR TO SUPPLY AND INSTALL THE COUNTER FLANGED AND THERMOWELL (ALONG WITH TEMP. ELEMENT)
5. ALL DIMENSIONS ARE INDICATIVE ONLY

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS. GURGAON, INDIA

CONTRACT NO :		
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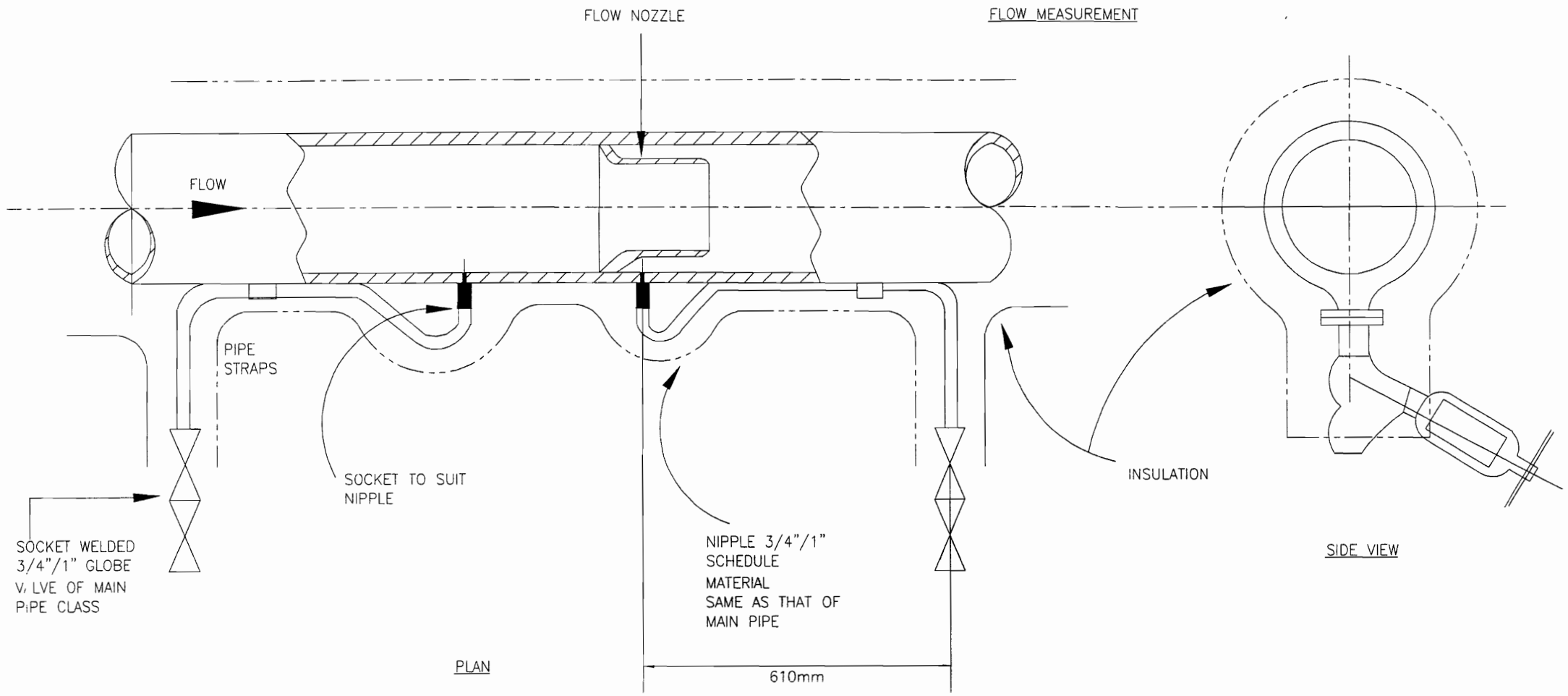
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - TEMP. MESUREMENT

DRAWING NO : LII-GE0E11019-G-00172-713 | REV. 00 | SHEET 1 OF 1

Varun Jain S A Khan K. Keshav Praveen Kishore



PLAN

FLOW MEASUREMENT

SIDE VIEW

NOTES:–

1. THIS METHOD OF CONNECTING NIPPLES AND VALVES ON THE HORIZONTAL PIPE IS APPLICABLE FOR MEASUREMENT OF STEAM TEMP ABOVE 425°C.
2. FOR STEAM SERVICE IN HORIZONTAL PIPE THE PRESSURE HOLES AND CONNECTING NIPPLES SHOULD BE IN THE HORIZONTAL PLANE OF THE PIPE CENTRE LINE.
3. THE ENTIRE LENGTH OF THESE NIPPLES AS WELL AS SHUT OFF VALVES SHOULD BE LAGGED IN WITH STEAM LINE AS SHOWN IN THE DRAWING.
4. FLOW ELEMENTS SHALL BE PROVIDED WITH 3 PAIRS OF TAPPING POINTS.

Bharat Heavy Electricals Limited Power Sector Marketing New Delhi

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REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
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00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
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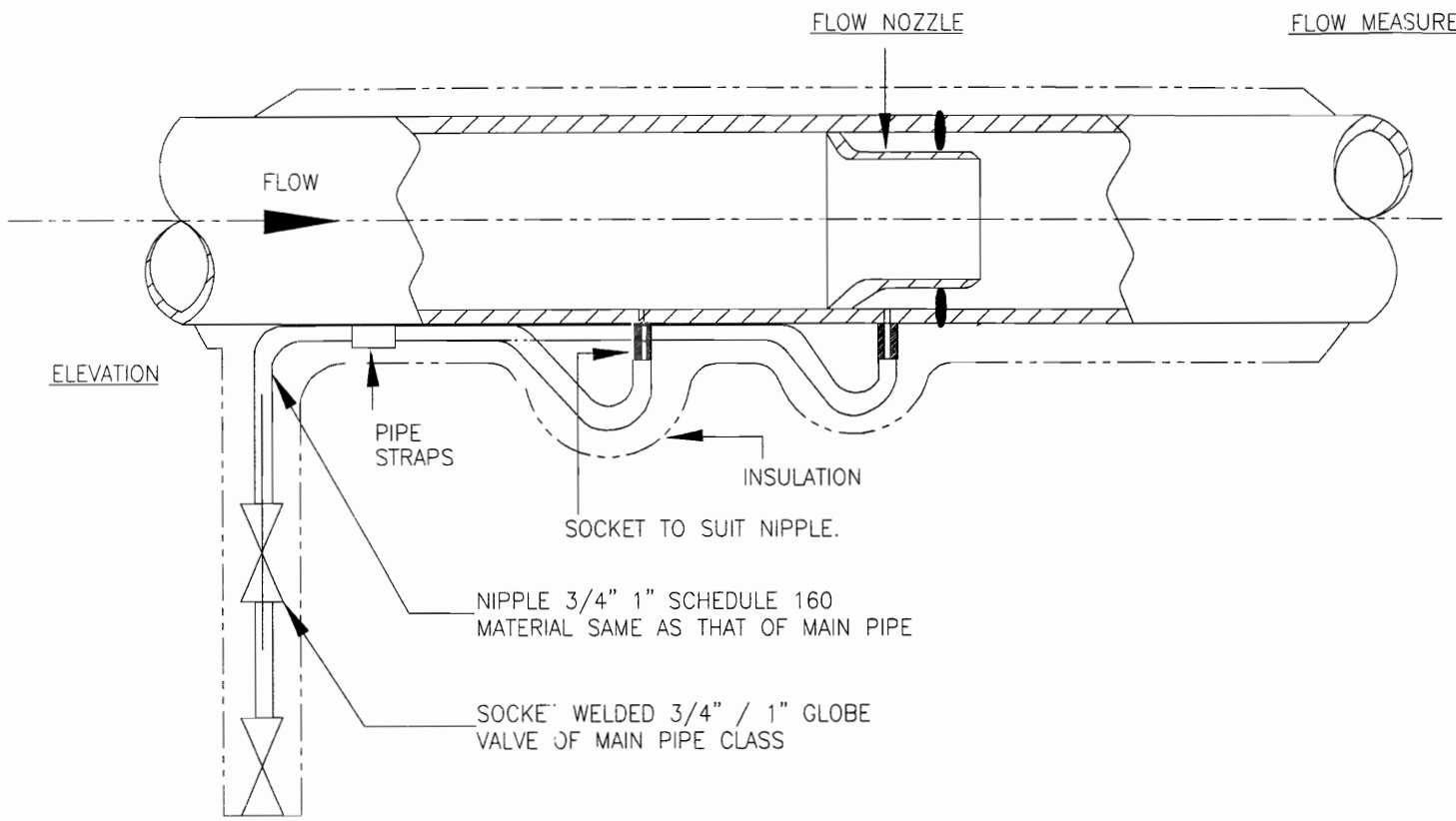
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

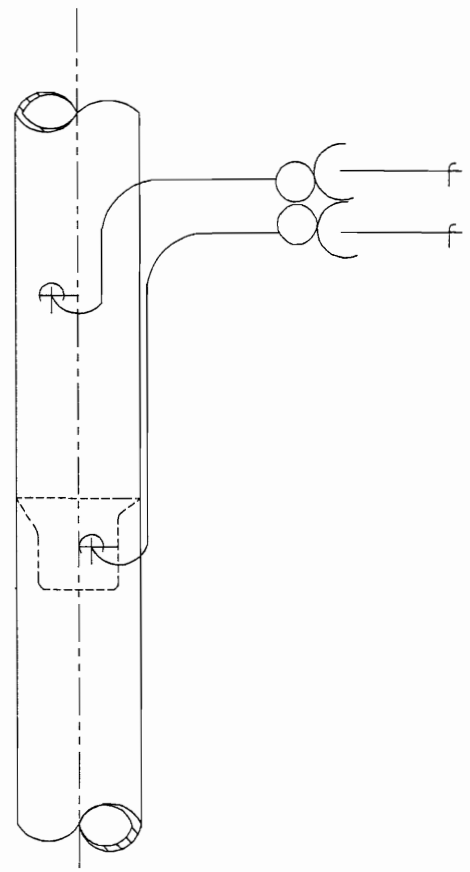
PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - FLOW MEASUREMENT

DRAWING NO : LII-GEOE11019-G-00172-714 | REV. 00 | SHEET 1 OF 1

Varun Jain | S A Khan | K. Keshav | Praveen Kishore





NOTES:–

1. THIS METHOD OF CONNECTING NIPPLES AND VALVES ON THE VERTICAL STEAM PIPE IS APPLICABLE FOR MEASUREMENT OF STEAM AT TEMP. ABOVE 425°C
2. THE ENTIRE LENGTH OF THESE NIPPLES AS WELL AS SHUT OFF VALVES SHOULD BE LAGGED IN WITH STEAM LINE AS SHOWN IN THE DRAWING.
3. ON VERTICAL STEAM PIPE BOTH HIGH TEMPERATURE (SPECIAL VENTS) NIPPLES WILL BE LONG ENOUGH SO THAT HIGH AND LOW PRESSURE CONNECTION NIPPLES WILL BE AT SAME LEVEL.
4. UP STREAM AND DOWN STREAM PRESSURE CONNECTIONS MUST BE INSTALLED IN DIFFERENT PLANES PASSING THROUGH THE CENTRE OF THE PIPE.
5. FLOW ELEMENTS SHALL BE PROVIDED WITH 3 PAIRS OF TAPPING POINTS.

Varun Jain | S A Khan | K. Keshav | Praveen Kishore

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FOR CONTRACT PURPOSE ONLY

REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

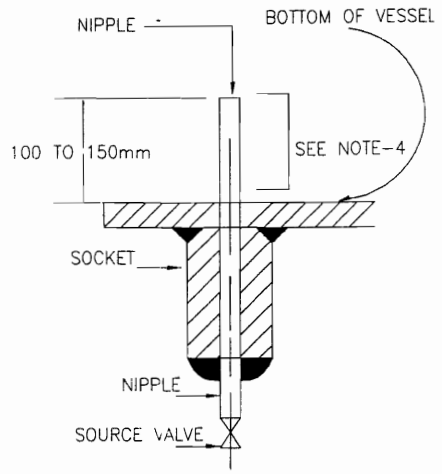
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

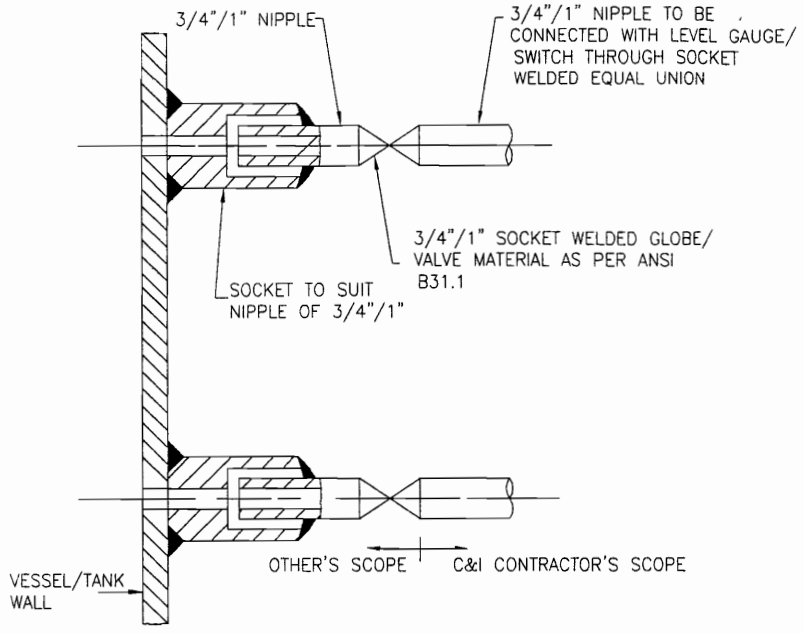
PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - FLOW MEASUREMENT

DRAWING NO : LII-GE0E11019-G-00172-715 | REV. 00 | SHEET 1 OF 1

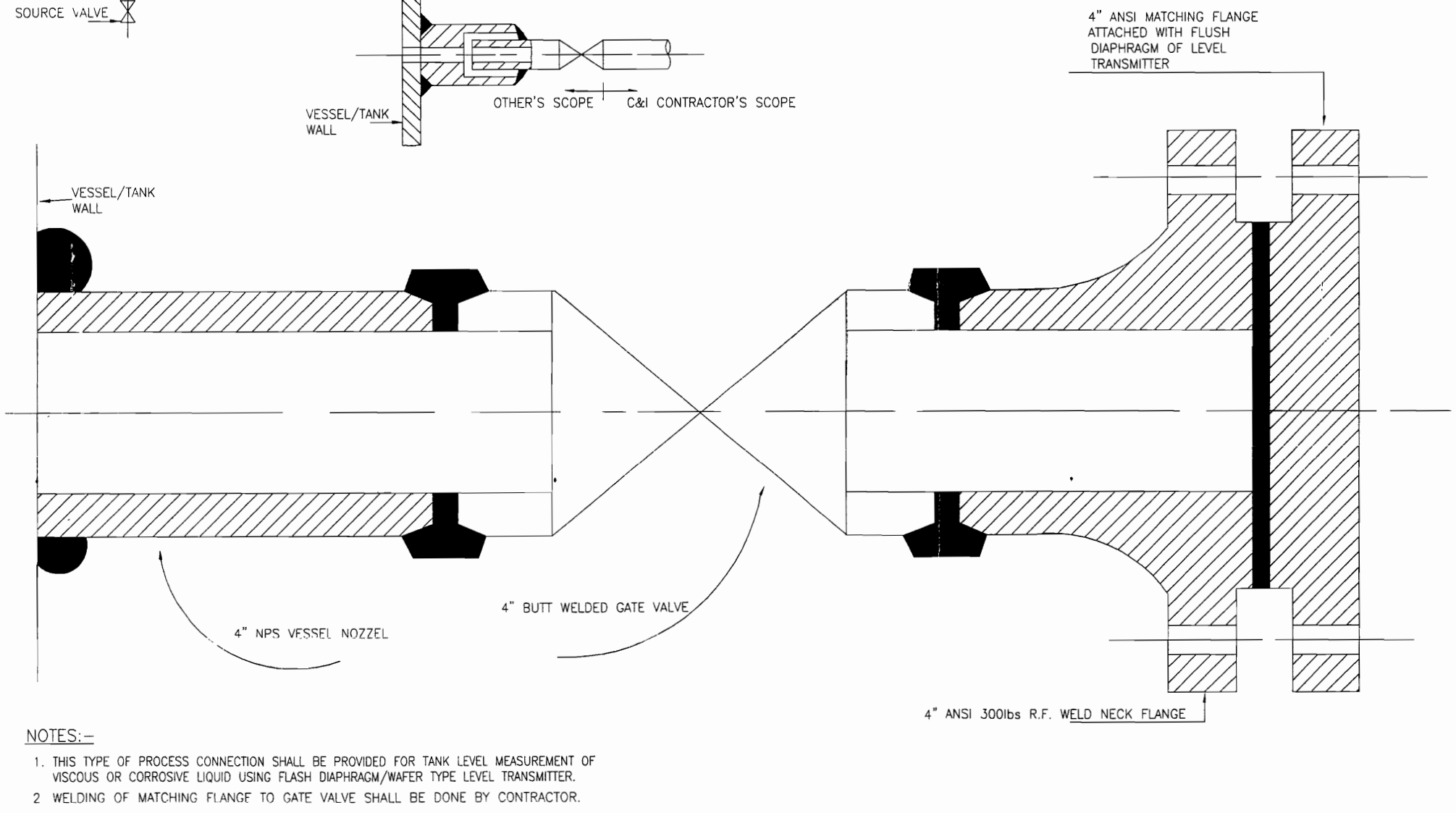
LEVEL MEASUREMENT





NOTES:-

1. THIS TYPE OF PROCESS CONNECTION SHALL BE USED FOR LEVEL GAUGE AND EXTERNAL GAGE 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 TURBULANCE FROM INLETS AND OUTLETS.
4. IF LOWER CONNECTION IS TAKEN FROM BOTTOM OF THE VESSEL THEN THE NIPPLE MUST BE 100mm TO 150mm 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 FLASH DIAPHRAGM/WAFER TYPE LEVEL TRANSMITTER.
2. WELDING OF MATCHING FLANGE TO GATE VALVE SHALL BE DONE BY CONTRACTOR.

Varun Jain | S A Khan | K. Keshav | Praveen Kishore

Bharat Heavy Electricals Limited Power Sector Marketing New Delhi

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FOR CONTRACT PURPOSE ONLY

REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
00	16.12.13				SKM	
		CHECKED				

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

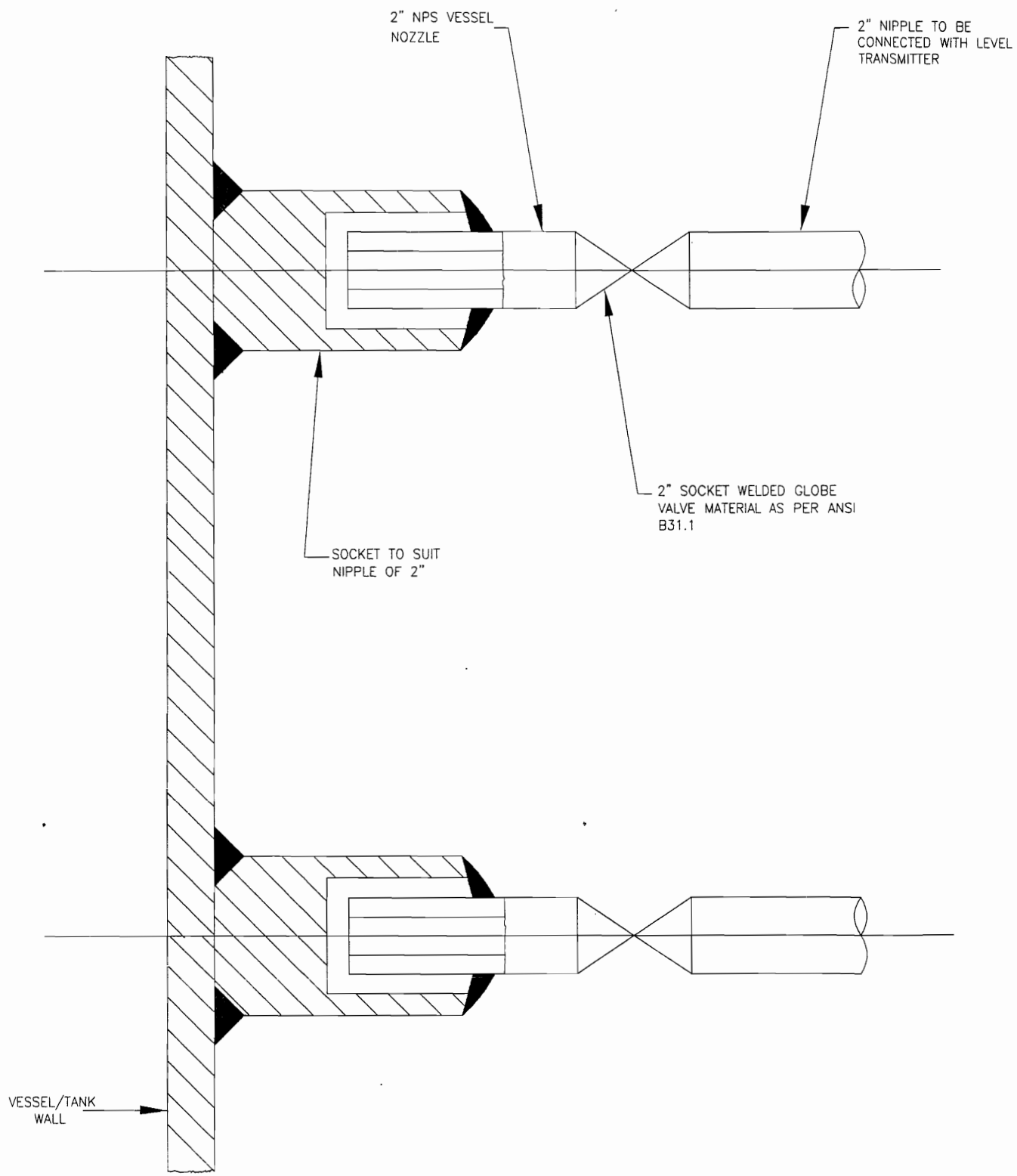
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT: 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE: INSTRUMENT SOURCE CONNECTION DETAILS - LEVEL MEASUREMENT

DRAWING NO: LII-GE0E11019-G-00172-716 | REV. 00 | SHEET 1 OF 1

LEVEL MEASUREMENT



NOTES:-

1. THIS TYPE OF PROCESS CONNECTION SHALL BE USED FOR DISPLACER TYPE LEVEL TRANSMITTER.
2. SOURCE CONNECTION ON VESSEL SHOULD NOT BE LOCATED AT PLACES SUBJECTED TO INTERFACE
3. IF LOWER CONNECTION IS TAKEN FROM BOTTOM OF THE VESSEL THEN THE NIPPLE MUST BE 100mm TO 150mm ABOVE THE BOTTOM OF THE VESSEL.

094

FOR CONTRACT PURPOSE ONLY

REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
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00	16.12.13				SKM	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO		
PREPARED	NAME	DATE
DRAWN BY	PS	16-DEC-13
DESIGNED BY	NHR	16-DEC-13
CHECKED BY	SKM	16-DEC-13
APPROVED BY	AJV	16-DEC-13
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER PROJECT

DRAWING TITLE : INSTRUMENT SOURCE CONNECTION DETAILS - LEVEL MEASUREMENT

DRAWING NO : LII-GE0E11019-G-00172-717 | REV. 00 | SHEET 1 OF 1

Varun Jain | S A Khan | K. Keshav | Praveen Kishore

SECTION: D
STANDARD TECHNICAL SPECIFICATIONS

STANDARD TECHNICAL SPECIFICATION FOR CENTRAL AIR-CONDITIONING PLANT

1. GENERAL

1.1 This specification covers the design, manufacture, testing at Manufacturer's works, delivery to site, handling at site, installation, commissioning and carrying out acceptance tests and final painting at site of various equipment of the central air conditioning plant, as specified hereinafter.

2. CODES & STANDARDS

2.1 The design, manufacture and performance of air conditioning equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment are to be installed. The equipment shall also conform to the latest applicable Indian/British/American standards. Nothing in this specification shall be construed to relieve the tenderer of this responsibility. In particular the equipment shall conform to the latest editions of the following standards.

2.1.1	IS-660	:	Safety code for Mechanical Refrigeration.
2.1.2	ARI 520-90	:	Standard for Positive Displacement Refrigerant compressors and condensing units.
2.1.3	IS-5111	:	Code of Practice of Measurement for Testing Refrigeration compressors.
2.1.4	ASHRAE/23-93	:	Method of Testing for Rating Positive Displacement Refrigerant compressors and condensing units.
2.1.5	ARI-450:		Standard for water-cooled Refrigerant condensers, Remote Type.
2.1.6	ASME (Section VIII)	:	Unfired pressure Vessels Code.
2.1.7	IS-2825	:	-do-
2.1.8	IS-4503	:	Shell and tube type heat exchangers.
2.1.9	ASHRAE/22-92	:	Method of Testing for rating of Water Cooled refrigerant condensers.
2.1.10	IS-659	:	Safety code for Air conditioning.
2.1.11	IS-2379	:	Color Code for Identification of pipe lines.
2.1.12	TEMA	:	Standards of Tubular Exchanger manufacturers Association.
2.1.13	IS-1239 (Part-I)	:	Seamless steel tubes (Up to & including 168.2 mm OD.).
2.1.14	IS-3589	:	For piping above 168.2mm to 2032mm Outside Diameter.
2.1.15	IS-778	:	Valves up to 50 MM.
2.1.16	IS-780	:	Valves 50 MM to 300 MM.
2.1.17	ASHRAE 24	:	Method of Testing for Rating liquid coolers.

2.1.18 ARI-480: Standard for refrigerant cooled liquid coolers-Remote type.

3. DESIGN & CONSTRUCTION REQUIREMENTS

3.1 The components of Central air conditioning plant comprising compressor, chiller refrigerant piping, valves and fittings etc. Shall be as given in Data sheet A. The type of all accessories, controls and instrumentation shall also be as indicated in data sheet A.

3.2 The various equipments supplied under this specification shall be fully compatible with each other & capable of operating as fully balanced integrated system to deliver the specified output under design conditions.

4. TESTING AND INSPECTION

(Refer standard quality plan)

4.1 Hydrostatic, Volumetric and refrigerant leak tests etc. shall be carried out at manufacturers works before dispatch of equipment in accordance with the applicable codes and standards.

Following minimum tests amongst others shall be conducted.

4.1.1 Material analysis, testing and identification (Data sheet/ Drg. Shall clearly indicate the specification, grade, class and Heat treatment condition of material for which TC will be furnished)

4.1.2 Hydrostatic pressure test of all pressure parts.(Testing pressure shall be clearly indicated for each component/ subassembly/ assembly)

4.1.3 Static and Dynamic balancing test of rotating parts at rated and over speed and to determine vibration & noise level.(Grade of balancing, type- whether dynamic or single plane balancing for components/ subassembly/ assembly shall be clearly indicated in data sheet/ approved drg.. Permissible vibration (velocity and displacement –peak to peak and noise level in dB(A) to be indicated in Data Sheet/Approved Drg.)

4.1.4 Radiography & magna-flux examination of materials & welds.(Components to be subjected to NDT with applicable, procedures and acceptance norms to be clearly indicated in Data sheet/ approved drg. If in a component only certain areas are to be subjected to NDT same shall be clearly brought out else it will be understood that the entire component is subject to NDT)

4.1.5 Ultrasonic test of castings & forgings.(Procedure and acceptance norms with areas subject to NDT to be clearly indicated in Quality Plan).

4.1.6 Performance test including determination of capacity, efficiency & characteristics etc.(Applicable standard, Acceptance norms, Procedure for test (if not covered in applicable standard),performance characteristics with applicable tolerances and drive to be used during shop test to be clearly indicated in Quality Plan). Performance data to be indicated in Approved Drg./ Data Sheet)

4.1.7 Functional checks and adjustments of controls & instrumentation. (Functional checks required to be clearly indicated with extent of check and applicable standard in approved check list / Quality plan. Class of instruments / tolerances and performance data to be incorporated in Approved Data Sheet / Drg.)

4.1.8 Checking of working clearances.(desired working clearances to be indicated in approved Drg.)

4.1.9 Examination after selective opening up after testing.(basis/ reasons for selective opening up, areas to be examined and parameters to be checked to be brought out in Quality Plan)

4.2 TESTS AT SITE

Tests to prove guaranteed performance of the air conditioning plant, shall also be carried out at site after proper installation. The site test shall include performance testing (as per FQP) of equipment for 72 continuous hours each in all three seasons i.e. Summer, Winter and Monsoon. Unless specified elsewhere. All instruments, tools etc. as may be required to carry out site tests shall be arranged by the tenderer.

5. PERFORMANCE GUARANTEE

5.1 Each equipment of air conditioning system shall be guaranteed for its rated capacity under the specified site conditions.

5.2 If the shop/site performance tests indicate failure of equipment to meet specified requirement, it would be tenderer's responsibility to carry out required alterations at no extra cost to purchaser. Tests shall be repeated after carrying out the modifications to demonstrate the performance.

5.3 The air conditioning plant before being taken over by purchaser shall be subjected to running test for a minimum period of one week during which all readings shall be recorded. Any deficiencies noted during this period, shall be rectified by the tenderer /at no extra cost to purchaser. These running tests shall be in addition to the seasonal performance test specified under clause 4.2. The inside design conditions shall be guaranteed throughout the year**.**

6. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

6.1 Final version of all drawings & data submitted with the along with technical schedules enclosed in Volume III.

6.2 Drawings including equipment layout, foundation & loading details etc. for civil works for the entire plant. These drawings must cover sufficient details so that design of civil works can be completed.

6.3 Inspection, operation & Maintenance Manuals.

6.4 Manuals for method of testing & calibration of all instruments.

6.5 Equipment description giving complete design calculations, basis of design, selection criteria etc.

6.6 Schematic piping diagrams.

6.7 Layout of piping.

6.8 Electrical drawings.

6.9 Test Certificates.

6.10 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

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DESCRIPTION		DATA
1.	**GENERAL**	
1.1	Type of AC plant	: Chilled Water Type.
1.2	Plant configuration/capacity.	: Refer to Section-C of Specific Technical Requirements.
1.3	Location of AC plant rooms	: As per Tender drawings.
1.4	Type of lifting facility provided.	: Chain Pulley block with monorail (by BHEL)
1.5	Electrical work scope: -	
	i) MCC for AC plant	: By Others
	ii) Power cables / Control cables.	: By Others
	iii) Drives	: By Bidder.
	iv) Whether separate alarm/annunciation Panel/control panels required	: Yes (By bidder), Refer to Section-C of Specific Technical Requirements.
	v) Termination of cabling & earthling at Equipment end.	: By Bidder for bidder supplied equipment.
2.	**REFRIGERATION COMPRESSOR**	
2.1.	Type	: SCREW CHILLE
2.2.	Nos. (working + standby)	: Refer to Section-C of Specific Technical Requirements.
2.3.	Type of capacity control	: Automatic.
2.4.	Type of drive	: Direct driven.
2.5.	Restart after tripping	: Manual.
2.6.	Type of start	: As per manufacturing standard.
2.7.	Shaft Seal	: Mechanical shaft seal.
2.8.	Purge Recovery unit	: As per manufacturing standard.
2.9.	Type of lubrication	: As per manufacturing standard.
2.10.	Refrigerant used	: Environment friendly HCFC, (CFC is not acceptable)

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3. DESIGN REQUIREMENTS

3.1.	Minimum capacity at Design conditions	: Refer to Section-C of Specific Technical Requirements.
3.2.	Capacity control	: Microprocessor based Control Panel sheet metal panel, located on each Compressor/chiller unit including protection devices
3.3.	Vibration isolator	:Neoprene rubber pads/Equivalent approved to suit chiller package.
3.4.	Type of foundation	: Floating / As per manufacturing standard

4.0 CONDENSER

4.1	Type	: Horizontal shell & tube type water-cooled
4.2	Number required	: One no. for each machine.
4.3	Design requirements	
4.3.1	Fluid	: Refrigerant (Shell side) Water (tube side)
4.3.2	Cooling Water Quantity	: To suit requirement.
4.3.3	Capacity of condensers	: To match compressor & to provide at least 2°C sub cooling.
4.3.4	Cooling water inlet temp.	: Refer to Section-C of Specific Technical Requirements.
4.3.5	Leaving Water Differential.	: Refer to Section-C of Specific Technical Requirements.
4.3.6	Max. flow velocity through tubes.	: 2.5 m/sec.
4.3.7	Design fouling factor	: 0.0002 (MKS Unit)
4.3.8	Maximum pressure drop.	: 0.6 Kg/cm2 (g)
4.3.9	Tube wall Thickness	: Not less than 18 SWG
4.4	Materials of construction	
	i/ Shell	: M.S. Plate fusion welded.
	ii/ Tube	: Integrally bonded Seamless copper

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iii/ Head ends : Cast Iron.

iv/ Tube sheet material : Steel

v/ Baffle plate : Steel.

4.5 Accessories required

i/ Purge & drain connections with valves. : Yes

ii/ Relief valves : Yes

iii/ Liquid line shut off valve. : Yes

iv/ Isolating valves on water side. : Yes

v/ Flow switch : Yes (interlocked with control of individual refrigeration system)

vi/ Pressure/temperature gauges at inlet/outlet : Yes

vii/ Descaling tee : Yes

viii/Charging valve : Yes

ix/ MS supporting frame work : Yes

viii/Cooling thermostat : Yes

ix/ MS supporting frame work. : Yes

5.0 **CHILLER** (Applicable for chilled water type plant only.)

5.1 Type : Horizontal shell & tube flooded type

5.2 Number required/standby : One no. for each chiller package.

5.3 Design requirements

5.3.1 Fluid to be cooled : Water

5.3.2 Water flow rate (Inside tube) : To suit requirement.

5.3.3 Water inlet temperature : 12 ^{o}C approx.

5.3.4 Water outlet temperature : 7 ^{o}C approx.

5.3.5 Super heating of refrigerant material : By at least 3 deg. C.

5.3.6 Insulation /thickness/finish : As per the manufacture standard.

5.3.7 Design fouling factor : 0.00010(MKS Unit)

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5.3.8 Maximum pressure drop. : 0.6 Kg/cm2 (g)

5.3.9 Tube wall Thickness : Not less than 22 SWG.

5.4 Materials of construction

i/ Shell : M.S. Plate fusion welded.

ii/ Tube : Integrally Seamless copper (internally Corrugated)

iii/ Head ends : Cast Iron.

iv/ Tube sheet material : Steel.

v/ Baffle plate : Steel.

5.5 Accessories required

i/ Purge & drain : Yes

ii/ Gate valves at water inlet/outlet. : Yes

iii/ Flow switch : Yes

iv/ Pressure/temperature gauges at inlet/outlet : Yes

v/ Anti-freeze thermostat : Yes

vi/ Thermostatic expansion valves : Yes

vii/ Pilot solenoid valve : Yes

viii/ Cooling thermostat : Yes

ix/ MS supporting frame work. : Yes

Note :-

The system shall also incorporate:

1) Auto operation of chilling plant for operation of the whole AC system.

2) A Central Control Panel with fault annunciators with provision for remote extension besides local control kiosks.

3) Water Chiller package shall be skid-mounted unit with microprocessor based control panel complete with all accessories and controls are assembled at manufacturing works on single unit.

4) Screw chiller shall be suitable for 415V $\pm$ 10 %/50 Hz $\pm$ 3%/3 phase operation with voltage & frequency variation as specified with built in starter etc.

5) Only supply feeders shall be provided for chillers.

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STANDARD TECHNICAL SPECIFICATION
FOR
AIR HANDLING UNITS

1. GENERAL

1.1 This specification covers the design, manufacture, Construction features, installation, commissioning, inspection and performance testing at site of AHUs.

2. CODES AND STANDARDS

2.1 The design manufacture and performance of AHU shall comply with all currently applicable statutes, regulations and safety codes in the locality where the AHU is to be installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this spec. shall be construed to relieve vendor of this responsibility. In particular the equipment shall conform to the latest editions of the following standards:

2.1.1 IS-659 : Safety code for air conditioning

2.1.2 IS-660 : Safety code for mechanical refrigeration

2.1.3 ASHRAE: Method of testing forced circulation air-cooling and air heating coils. standard 33

2.1.4 ARI 41 : Standard for forced circulation air cooling and air heating coils.

2.1.5 ARI 430/435 : Air-cooling and air heating coils Central Station AHU / Application of Central Station AHU.

2.1.6 AMCA : 211 and 311

In case of any conflict in the standards and this specification the decision of PEM,BHEL shall be final and binding.

3. CONSTRUCTION FEATURES

3.1 The casing of AHU shall be made of insulated double wall construction of min. 24 gauge galvanized sheet steel - IS 277 Gr. 120 (parent sheet: D/DD-IS-513) ribbed and reinforced for structural strength and rigidity with 25 mm thick polyurethane insulation of minimum 40 kg/m^3 density in between. The external wall will be pre-plasticised over GI coating on the outside. Angle irons or channel sections made of 16 gauge galvanized sheet steel shall be used for reinforcing. The casing shall be of sectionalized construction with proper sealing at the joints to make them air tight. Fan section and panels with bearing support shall be reinforced with heavy gauge channels (min. 5 mm thick). Suitable number of forged hot dip galvanized (610 gm/sq.m) U brackets shall be provided for AHU suspended from ceiling/roof.

Necessary arrangement shall be provided on the casing for measuring temperature and pressure in cooling/heating coil. Class of instruments shall be min. 2.

3.2 Fan impeller shall be forwardly/backwardly inclined curved blade centrifugal type. Impeller shall be double width double inlet type. Fans shall be preferably low rpm (<=1500) to minimize vibration and noise. Noise shall be within 85 dB(A) at 1 metre distance from AHU casing. Max. Vibration level shall be acceptance and norms to be specified. Two to three wheels (impellers) shall be provided for each AHU. Impeller blades shall be fabricated from (min. 1.0 mm) galvanized/ epoxy powder coated sheet steel. Fan shall be of epoxy powder coated / galvanized sheet steel (min. 1.6

mm) scroll with die formed inlets for uniform air flow. Fan shafts shall be solid cold rolled carbon steel (EN8 normalised), ground and polished. Fan shaft bearings shall be of heavy duty type selected for average operating life of 100,00 hours. Bearings shall be self-aligning, permanently lubricated type. Make of Brgs(SKF/FAG/NORMA/TATA) to be specified. Bearing Housing shall be of casting of min. IS Gr. 210, split type and suitably supported. The V-belt drive with belt guard shall be provided. Motors shall have minimum 15% margin over maximum BHP in working range.

3.3 DX or chilled water cooling coils and steam/hot water coils shall be internally corrugated copper/ cupronickel tubes (as per manufacturer's standard) with smooth non corrugated external fins of aluminium (thickness 0.14 mm and grade 1100 as per spec) unless specified otherwise in specification. At least 5 fins /per cm. shall be provided. The chilled water/hot water coils shall have suitable (standardize class, size, threading) drain and vent connections.

3.4 The filters in the filter section shall be provided as detailed in data sheet A.

3.5 Humidifier shall be Pan type/as specified in the specification.

Pan type Humidifier consisting of SS304/316 tank, heater, geyserstat with piping connection to supply air duct shall be provided unless specified otherwise in data sheet A.

Heaters and branch line shall be of galvanized steel and nozzles shall be of brass (matl. grade) /SS 304.

3.6 Condenser water from coil or surplus water from spray humidifier shall be collected in 16 gauge SS-304 pan. Minimum 50mm dia GI pipe nipple shall be provided on each end for drain connection. The drains for these points shall be extended to the main drain in AHU room.Condensate drain pipe (GI) of required length with sealing loop shall be provided and insulated as specified in the specification for insulation. Minimum requirement For GI Pipes and fittings shall be ERW/Seamless of medium thickness as per IS-1239/3589 and Hot dip galvanized

3.7 Suitable number of Spring type vibration isolators shall be provided for fan and motor assembly. Neoprene rubber pads shall be provided below the AHU.

The AHU shall be provided with 18 G SS drain pan.

4. **TESTING AND INSPECTION AT MANUFACTURERS WORKS:**

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection.

4.1 Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.

4.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating. For pipes and fittings compliance report shall be furnished by Manufacturer for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

4.3 Shaft: Mechanical and chemical.

4.4 Motors (of approved make): Routine TC.

4.5 Workmanship and dimensional check as per manufacturing drg. and approved Drgs.

4.6 Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked to avoid loosening. Balancing weights and fasteners used shall be galvanized.

4.7 Performance test of one Centrifugal fan/per type/per size as per AMCA standard (for indigenous make).

4.8 Centrifugal fans for AHUs will be 100% run tested by main contractor of BHEL. One centrifugal fan/per type/per size will be run tested. Vibration shall be within good zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.

4.9 Complete assembly of one AHU/per type/ per size (excluding cooling coil and filter) shall be witnessed.

4.10 Run test of one complete assembly/per type/per size (excluding cooling coil and filter). Vibration shall be within satisfactory zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient.