

RFQ NO. : SM/B861-701-EA-MR-6002/08
Item : Air fin Cooler (cs)

Addition / Deletion Rates

Sr. No.	Description	Unit Rate
1	Change in size of the standard flanges - SA 105	Rs. 280 /- Kg
2	Change in size of Nozzle neck - SA 106 GRB	Rs. 150 /- Kg
3	Plate for plenum chambers, side frame etc.	Rs. 120 /- Kg
4	Weight for external lugs for SA 516 Gr. 60	Rs. 230 /- Kg
5	Grating, screen etc	Rs. 4760 /- M2
6	Rolled section like I beams. channels, angles etc	Rs. 100 /- Kg

(Signature & Stamp of the Bidder)

Material Requisition (Top Sheet)

Item Description : AIR FIN COOLER (CS)	
Item Code : 01CJ	Destination : As per Commercial Documents
Item Category : II	Delivery Period : As per Commercial Documents

Requisition Number (Always quote this Number given below as reference)

B861	701	EA	MR	6002	C
Job No.	Unit/ Area	Main Cost Centre	Doc. Code	Sr. No.	Rev.

27/09/2024	80	42
Date	Divn.	Dept.
	Originator	

Notes :

1. This sheet is a record of all the Revisions of this Requisition.
2. Vendor shall note the item category and shall submit his offer in line with the requirements included in attached 'Instructions to Vendors'.
3. The nature of the Revision is briefly stated in the 'Details' column below, the Requisition in its entirety shall be considered for contractual purposes.

Rev.	Date	Prepared By	Checked By	Approved By	Details
A	13/06/2024	Patel Ronakkumar Rameshbhai	Pankaj Kumar Prasad	Tarun Kumar	ISSUED FOR BIDS
B	30/08/2024	Patel Ronakkumar Rameshbhai	Pankaj Kumar Prasad	Tarun Kumar	ISSUED FOR BIDS
C	27/09/2024	Patel Ronakkumar Rameshbhai	Pankaj Kumar Prasad	Tarun Kumar	ISSUED FOR BIDS

This is a system generated approved document and does not require signature.

Sr. No.	Tag No./Item Code/ [ID.No.]	Description	Quantity	Delivery Location
01.00		Complete equipment supply including structural design of steel parts (RCC structure design and supply by others) & residual design (including CFD analysis) and engineering, procurement of all materials and bought out components, manufacturing, fabrication, application of primer and finish paint, assembly at shop/site, inspection (Note 1), trial run, testing, supply of pallet type trolley, monorail and its structure including chain pulley block, packing & delivery of the following including supply of fans, motors, all supporting structure, platforms, staircase, handrails, gratings structurals etc, plenum chambers, all mandatory spares, commissioning spares, special tools & tackles, erection material, first fill of consumables & documentation as per the enclosed specifications, job specification, data sheets etc. and other codes and standards attached or referred.		
▶ 01.001	A1 701EA1001-28A*	ETHYLENE GLYCOL WATER AIR HEATER (*Tag No.: 701-EA-1001A TO 701-EA-1028A (28 BUNDLES))	1 UNIT	
▶ 01.002	A1 701EA1001-28B*	ETHYLENE GLYCOL WATER AIR HEATER (*Tag No.: 701-EA-1001B TO 701-EA-1028B (28 BUNDLES))	1 UNIT	
▶ 01.003	A1 701EA1001-28C*	ETHYLENE GLYCOL WATER AIR HEATER (*Tag No.: 701-EA-1001C TO 701-EA-1028C (28 BUNDLES))	1 UNIT	
▶ 01.004	A1 701EA1001-28D*	ETHYLENE GLYCOL WATER AIR HEATER (*Tag No.: 701-EA-1001D TO 701-EA-1028D (28 BUNDLES))	1 UNIT	
▶ 01.005	A1 701EA1001-28E*	ETHYLENE GLYCOL WATER AIR HEATER (*Tag No.: 701-EA-1001E TO 701-EA-1028E (28 BUNDLES))	1 UNIT	
02.00		Unloading at site, handling, transportation to store and from store to work site, storage at site, erection and assembly of airheater, bundles & accessories like motor and fan assembly, plenum chamber, supporting structure, ladder, platform etc on RCC structure at site, installation, application of touchup paint, testing, pre-commissioning, commissioning, handing over to client and supply of commissioning spares for the following, as per the enclosed EIL standard specifications, instructions to vendors, job specification, data sheets etc.		

Sr. No.	Tag No./Item Code/ [ID.No.]	Description	Quantity	Delivery Location
▶ 02.001	A1 {02}701EA1001-28A*	For Item SL. No. 01.001	1 UNIT	
▶ 02.002	A1 {02}701EA1001-28B*	For Item SL. No. 01.002	1 UNIT	
▶ 02.003	A1 {02}701EA1001-28C*	For Item SL. No. 01.003	1 UNIT	
▶ 02.004	A1 {02}701EA1001-28D*	For Item SL. No. 01.004	1 UNIT	
▶ 02.005	A1 {02}701EA1001-28E*	For Item SL. No. 01.005	1 UNIT	
03.00		Transportation from Vendors work/ shop to site for the following as per the enclosed EIL standard specifications, instructions to vendors, job specification, data sheets etc		
▶ 03.001	A1 {03}701EA1001-28A*	For Item SL. No. 01.001	1 UNIT	
▶ 03.002	A1 {03}701EA1001-28B*	For Item SL. No. 01.002	1 UNIT	
▶ 03.003	A1 {03}701EA1001-28C*	For Item SL. No. 01.003	1 UNIT	
▶ 03.004	A1 {03}701EA1001-28D*	For Item SL. No. 01.004	1 UNIT	
▶ 03.005	A1 {03}701EA1001-28E*	For Item SL. No. 01.005	1 UNIT	
04.00		Deleted		
05.00		Supply of Two Years Operation and Maintenance Spares.		
05.001		Supply of Two Years Operation and Maintenance Spares, as per enclosed job specification (seperate quote and not to be include in quoted price) with list of the same	1 Lot	
06.00		Unit Rates Indicate charges for future addition/deletion of the following components:		
06.001		Change in size of the standard flanges - SA 105	1 kg	
06.002		Change in size of Nozzle neck - SA 106 GRB	1 kg	
06.003		Plate for plenum chambers, side frame etc.	1 kg	
06.004		Weight for external lugs for SA 516 Gr. 60	1 kg	
06.005		Grating, screen etc	1 m ²	
06.006		Rolled section like I beams. channels, angles etc	1 kg	
07.00		Deleted		
08.00		Deleted		

Sr. No.	Tag No./Item Code/ [ID.No.]	Description	Quantity	Delivery Location
09.00		Drawings and documents as per attached Vendor Data requirement for all supplies and services covered above in Sr.Nos.1.00 to Sr.No.8.00	Lot	
10.00		Deleted		
11.00		Deleted		
12.00		Deleted		
13.00		Deleted		
14.00		Deleted		
15.00		Deleted		
16.00		Deleted		
17.00		Deleted		
18.00		Deleted		
19.00		Deleted		
20.00		Deleted		
21.00		Deleted		
22.00		Deleted		
23.00		Deleted		
24.00		Deleted		
25.00		Deleted		
31.00		Deleted		
32.00		Deleted		

- Bidder shall quote prices in EIL Price Schedule except for Sr.No.09.00. Price for documentation is implied to be included in the prices quoted against Sr.No. 01.00 to Sr.No. 32.00

Vendor to note that the numbers given in square '[' and curly '{}' brackets are not for their use and meant for store purpose only. Items shall be tagged as per main equipment Tag No. only.

Note:

Bidder to note that one fixed price is to be quoted for grouped items. The groups of items are identified by A1, where A1 indicates one group and so on.

Grouped items shall not be split ordered.

Clause Related

Supply

1. INSPECTION SHALL BE CARRIED OUT BY EIL AS PER APPROVED ITP/QAP.REFER OTHER SECTION OF BIDDING DOCUMENT FOR DETAILS.

Unit Rate

1. 2. REFER SL.NO.6 UNIT RATES:-
A.) QUOTED RATES SHALL BE APPLICABLE FOR COMPONENTS / PARTS / ATTACHMENTS INCLUDING THE FABRICATION & TESTING.
B.) THE UNIT RATES QUOTED SHALL BE APPLICABLE FOR ADDITION AS WELL AS FOR DELETION OF THE ITEMS.
C.) VENDOR TO NOTE THAT FINISH / FABRICATED WEIGHTS SHALL BE CONSIDERED FOR FINAL SETTLEMENT.
D.) THE WEIGHTS INDICATED ON ENGINEERING DRAWINGS DO NOT FORM THE BASIS FOR OFFER, SINCE THESE ARE APPROXIMATIONS ONLY.

List of Attachments

Sr. No.	Document Title	Document No.	Revision			
			Rev.	Rev.	Rev.	Rev.
			Date	Date	Date	Date
LIST OF ATTACHMENT						
1.	LIST OF ATTACHMENTS FOR AIR HEATER (AIR FIN COOLER)	B861-80-42-LL-6002	A	B		
			30/08/2024	27/09/2024		

LIST OF ATTACHMENTS FOR AIR HEATER (AIR FIN COOLER)

B	27/09/2024	ISSUED FOR REQUISITION/BIDS	RP	PKP	TK
A	30/08/2024	ISSUED FOR REQUISITION/BIDS	RP	PKP	TK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

S. No.	Documents Title	Documents No.	Rev.	Remarks
CHECKLIST/JOB SPECIFICATION/DATASHEET				
1.	INSTRUCTIONS TO VENDOR/ TECHNICAL REQUIREMENTS	B861-80-42-TCL-6002	A	
2.	TECHNICAL CONFIRMATION CHECK LIST (ELECTRICAL)	B861-701-16-50-LL-6002	B	
3.	SCOPE OF WORK AND SUPPLY	B861-80-42-SS-6002	B	
4.	AIR HEATERS MDS (701-EA-1001- 1028 A/B/C/D/E)	B861-701-80-42-DS-3001	A	
5.	AIR COOLED HEAT EXCHANGERS THERMAL DATA SHEET	B861-701-80-45-DS-1401	2	
6.	MR JOB SPECIFICATION	B861-80-42-SP-6002	C	
7.	JOB SPECIFICATIONS (DESIGN & FABRICATION REQ.)	B861-701-80-42-SP-0009	B	
8.	MATERIAL OF CONSTRUCTION FOR ACHE	B861-80-42-MC-6002	A	
9.	MANDATORY SPARE PARTS	B861-701-80-42-SL-6002	B	
10.	SPECIFICATION SHEET FOR FAN FOR ACHE	B861-80-42-FN-6002	B	
11.	MOTOR SUSPENSION SKETCH (For reference only)	B861-701-80-42-SK-3009	A	
12.	GUIDELINE TO VENDOR FOR BELT SELECTION	B861-80-42-BS-6002	B	
13.	JOB SPECIFICATIONS-ELECTRICAL	B861-701-16-50-SP-6002	B	
14.	JOB SPECIFICATIONS-INSTRUMENTATION	B861-701-16-51-SP-6002	B	
15.	JOB SPECIFICATION FOR SURFACE PREPARATION AND PROTECTIVE COATING	B861-000-06-42- PLS-01	1	
16.	M.V. MOTOR	B861-701-16-50-DS-6002	B	
17.	OVERALL PLOT PLAN (KLL Dhabol)	B861-000-81-45-0-0001	0	
VENDOR DATA REQUIREMENTS				
18.	VENDOR DATA REQUIREMENTS	B861-701-80-42-VDR-6002	A	
19.	VENDOR DATA REQUIREMENTS (INSTRUMENTATION)	B861-701-16-51- VDR-6002	B	
20.	VENDOR DATA REQUIREMENTS (ELECTRICAL))	B861-701-16-50-VR-6002	A	
21.	VENDOR DATA REQUIREMENTS FOR PROTECTIVE COATINGS	B861-701-6-42-VDR-PLS0002	0	
DATASHEET/P&ID				
22.	PROCESS DATA SHEET FOR ETHYLENE GLYCOL WATER AIR HEATER	B861-700-02-42-DS-1401	2	
23.	STANDARD SYMBOLS AND NOMENCLATURE (SHEET 1 OF 3)	B861-02-42-001-1191 (SHEET 1 OF 3)	0	
24.	STANDARD SYMBOLS AND NOMENCLATURE (SHEET 2 OF 3)	B861-02-42-001- 1191 (SHEET 2 OF 3)	0	
25.	STANDARD SYMBOLS AND NOMENCLATURE (SHEET 3 OF 3)	B861-02-42-001- 1191 (SHEET 3 OF 3)	0	
26.	GENERAL NOTES AND TYPICAL DETAILS	B861-02-42-001- 1192	0	
27.	INTERLOCK DESCRIPTION	B861-02-42-001- 1193	1	
28.	AMBIENT AIR HEATERS, 701-EA-1001A TO 701-EA-1014A	B861-02-42-701- 1126	1	

29.	AMBIENT AIR HEATERS, 701-EA-1015A TO 701-EA-1028A	B861-02-42-701- 1127	1	
30.	AMBIENT AIR HEATERS, 701-EA-1001B TO 701-EA-1014B	B861-02-42-701- 1128	1	
31.	AMBIENT AIR HEATERS, 701-EA-1015B TO 701-EA-1028B	B861-02-42-701- 1129	1	
32.	AMBIENT AIR HEATERS, 701-EA-1001C TO 701-EA-1014C	B861-02-42-701- 1130	1	
33.	AMBIENT AIR HEATERS, 701-EA-1015C TO 701-EA-1028C	B861-02-42-701- 1131	1	
34.	AMBIENT AIR HEATERS, 701-EA-1001D TO 701-EA-1014D	B861-02-42-701- 1132	1	
35.	AMBIENT AIR HEATERS, 701-EA-1015D TO 701-EA-1028D	B861-02-42-701- 1133	1	
36.	AMBIENT AIR HEATERS, 701-EA-1001E TO 701-EA-1014E	B861-02-42-701- 1134	1	
37.	AMBIENT AIR HEATERS, 701-EA-1015E TO 701-EA-1028E	B861-02-42-701- 1135	1	
STANDARD SPECIFICATIONS				
38.	Standard specification for welded tube to tubesheet joints.	6-15-0003	5	
39.	General specification for air cooled heat exchangers	6-15-0071	6	
40.	Specification for Documentation Requirement from Suppliers	6-15-0072	4	
41.	Standard specification for hardness requirement of static equipment (pressure vessels, heat exchanger).	6-15-0091	4	
42.	Specification for flameproof control stations.	6-51-0006	6	
43.	Specification for industrial type control stations.	6-51-0014	6	
44.	Specification for energy efficient medium voltage induction motors	6-51-0064	2	
45.	Specification for electrical equipment installation.	6-51-0081	5	
46.	Specification for field inspection, testing and commissioning of electrical installations	6-51-0087	4	
47.	Specification for electrics of package equipment	6-51-0093	6	
48.	Standard specification for erection of equipment & machinery	6-76-0001	4	
49.	Specification For Quality Management System Requirements From Bidders	6-78-0001	2	
50.	Specification for Documentation Requirement from Suppliers	6-78-0003	2	
51.	Standard specification for positive material identification (PMI) at supplier's works	6-81-0001	4	
52.	Standard specification for health, safety & environmental management at construction sites	6-82-0001	2	
STANDARD INSPECTION TEST PLAN				
53.	ITP for seamless pipes	6-81-0003	6	

54.	ITP for forged, seamless & welded fittings.	6-81-0005	8	
55.	Inspection and test plan for flanges, spectacle blinds and DRIP rings	6-81-0006	6	
56.	ITP For Bolting Material	6-81-0007	5	
57.	Inspection and test plan for gaskets	6-81-0008	5	
58.	ITP for air cooled heat exchanger	6-81-0010	4	
59.	ITP for flameproof control stations	6-81-1006	4	
60.	ITP for industrial type control stations	6-81-1014	4	
61.	Inspection and test plan for energy efficient medium voltage motors	6-81-1064	1	
STANDARDS				
62.	Tube hole preparation and roller expanding (shell & tube exchangers & air-cooled Exchangers)	7-15-0006	5	
63.	Earthing lug (shell & tube exchangers)	7-15-0016	6	
64.	Half tube supports (air cooled Exchangers)	7-15-0101	5	
65.	Frame standard stationary header fixing (air-cooled heat exchangers)	7-15-0105	5	
66.	Frame end top (air-cooled heat exchangers)	7-15-0106	5	
67.	Frame standard tube support top (air-cooled heat exchangers)	7-15-0107	5	
68.	Frame standard floating header support (air-cooled heat exchangers)	7-15-0108	5	
69.	Frame bracing detail (air-cooled heat exchangers)	7-15-0109	5	
70.	Tube support bottom beam detail (air-cooled heat exchangers)	7-15-0110	5	
71.	Tube access plug (air-cooled exchangers)	7-15-0111	5	
72.	Jack screws (cover type header)	7-15-0113	5	
73.	Lifting lug for cover plate	7-15-0114	5	
74.	Fabrication tolerances (air-cooled Exchangers)	7-15-0115	4	
75.	Frame standard lifting lug (for air coolers)	7-15-0116	5	
76.	Name plate (for air coolers)	7-15-0017	4	
77.	Tolerances and notes for gaskets (air-cooled exchangers)	7-15-0118	5	
78.	Tube bundle frame detail (equal tubes in each row) (air-cooled heat exchangers)	7-15-0121	5	
79.	Tube bundle frame detail With spacer (air-cooled heat exchangers)	7-15-0122	5	

80.	Tube bundle frame detail (unequal tubes in row) (air-cooled heat exchangers)	7-15-0123	5	
81.	Stiffening strips for nozzles	7-15-0142	5	
82.	Typical arrangement for earthing of motor	7-51-0104	6	
83.	Typical earth connection for push button station.	7-51-0106	6	
84.	Typical arrangement for earthing of overhead cable tray and electric motor.	7-51-0109	6	
85.	Handrail - Tube and Ball Type	7-68-0060	1	
86.	Steel stairs	7-68-0506	7	
87.	Details of steel ladder	7-68-0507	9	
88.	Steel ladder joint details	7-68-0509	7	
89.	Electroforged grating type-I & type-II	7-68-0697	6	
VENDOR LIST				
90.	VENDOR LIST - INSTRUMENTATION	B861-701-16-51-MD-6002	A	
91.	VENDOR LIST-ELECTRICAL	B861-701-16-50-OD-6002	B	

TECHNICAL COMPLIANCE STATEMENT

A	11/06/2024	ISSUED FOR BIDS	CSM	PKP	TK
Rev. No	Date	Purpose	Prepared By	Checked By	Approved By

TECHNICAL COMPLIANCE STATEMENT

(TO BE SIGNED BY VENDOR'S PRINCIPAL CORPORATE LEVEL SIGNATORY ON COMPANY LETTERHEAD)

I, ON BEHALF OF M/s _____ CONFIRM THAT THE PROPOSAL OF -----
-----QUOTED BY M/s _____ **FOR EPCM Services for Ambient Air
Heating System at KLL PROJECT AT KLL LNG TERMINAL , ANJANWEL OF M/S
KONKAN LNG LIMITED** AGAINST MATERIAL REQUISITION /TENDER/PACKAGE No. -----
----- IS IN TOTAL COMPLIANCE TO THE FOLLOWING

- A. SCOPE OF SUPPLY AND WORK
- B. PROCESS DATA SHEETS
- C. BATTERY LIMIT/INTERFACE REQUIREMENTS
- E. TECHNICAL AMENDMENT IF APPLICABLE
- F. ANY OTHER DOCUMENT ATTACHED AS PART OF MR

**AS WELL AS ALL THE TECHNICAL SPECIFICATION AND NO DEVIATION, VARIATION OR
RESERVATION WHATSOEVER HAS BEEN MENTIONED IN THE TECHNICAL OFFER.** IT IS
FURTHER AGREED THAT THE TECHNICAL DETAILS FURNISHED IN OUR OFFER WILL BE
REVIEWED BY EIL/KLL DURING DETAILED ENGINEERING STAGE AFTER ORDER AND ANY
CHANGE REQUIRED TO MEET THE REQUIREMENTS OF ENQUIRY SCOPE AND SPECIFICATION
INCLUDING AMENDMENT(S) (IF ANY) WILL BE INCORPORATED BY US WITHOUT ANY PRICE
AND TIME IMPLICATION.

(SIGNATURE WITH SEAL)

TECHNICAL CONFIRMATION LIST (ELECTRICAL)

AIR HEATER

PROJECT : AAH
CLIENT : M/s KLL
CONSULTANT : ENGINEERS INDIA LIMITED

Vendor's Signature and Stamp	
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Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	11.07.2024	REVISED & ISSUED WITH MR	CS	RKS	ANPS
A	28.05.2024	ISSUED WITH MR	CS	RKS	ANPS

S.NO	COMPLIANCE STATEMENT / QUERY	VENDOR'S CONFIRMATION / ANSWER
1.	Confirm that the scope of work shall be complete in all respects as specified in the MR document and all other equipment, materials and work not explicitly mentioned but nevertheless required to fulfil the functional requirements shall be deemed to be included without any deviation in the scope of Vendor with no additional cost and times implication to the Owner.	
2.	Confirm that the equipment and components supplied shall be from one of the approved vendors, as per list given in the bid document.	
3.	Vendor to furnish KW rating of Air heater fan motors.	
4.	Vendor is informed that the detailed offers from the equipment manufacturer for all equipment is not required to be furnished in the Vendor's proposal at this stage. If any such details are furnished by the Vendor in their proposal, these shall not be reviewed or taken cognisance of at this stage. These details shall be treated as preliminary and for reference and record purpose only and shall not be contractually binding. Please confirm compliance.	
5.	Duly filled in equipment data sheets shall be subject to Owner / EIL's approval to ensure compliance to bid specification during detailed engineering stage. Please confirm compliance.	
6.	Confirm that all Inspection & acceptance, type Tests as required for each equipment, as per specification and codes attached and referred to have been included by the Vendor in his proposal.	
7.	Please note that mandatory spares as per the mandatory spare list attached with MR shall be provided along with the motors being supplied and the list of these items shall be included in the offer. Please confirm compliance.	
8.	Confirm that Operation and Maintenance spares required for the two years of normal operation for all equipments along with unit prices and quantities as recommended by the equipment manufacturer have been quoted.	
9.	Confirm that commissioning spares, as required for each equipment, have been included in the proposal.	

S.NO	COMPLIANCE STATEMENT / QUERY	VENDOR'S CONFIRMATION / ANSWER
10.	Confirm that Special Tools and Tackles, as required for each equipment, have been included in the proposal.	

SCOPE OF WORK & SUPPLY FOR AIR HEATER

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	27.08.2024	REVISED & ISSUED FOR BIDS	CSM	PKP	TK
A	11.06.2024	ISSUED FOR BIDS	CSM	PKP	TK

Price shall be quoted group-wise as per requirements of requisition and its attachments which shall include but not limited to following.

1. Complete equipment supply (total bundles as specified), structural design of steel structures (RCC structure design and supply by others), residual design including CFD analysis for Cold air recirculation (refer clause 24 below) & engineering.
2. Air Heater proper assembly with Tube bundle, Supporting Structure, Fan, Motor, Drive assembly,
3. Header, Plugs & gaskets, Side frames, nozzles blind flange, gaskets & fasteners for Drain, Vent & MP (Multipurpose) connections, Lifting lugs.
4. Plenum and other necessary accessories.
5. Air heater supporting structure such as Fan & driving parts supports, Platforms/walkways/Ladders with grating, handrails for fan & driving parts maintenance and header maintenance, Ladders with safety cage/gate/working grating (as applicable over tube bundle) for Fan & motor maintenance, Bolts, nuts & washers necessary for the assembly
6. Anchor / Setting bolts, nuts, washers & Setting plates with liners, Earth lugs / boss.
7. Complete documentation including as built dossier, operating and periodic maintenance manual, QAP etc.
8. Preparation of fabrication drawings.
9. Axial fans (manual adjustable pitch), Air plenums, Fan decks, fan rings.
10. Motor with terminal boxes, cable stands, cable lugs(with required test certificate)Fan driving parts such as HTD belt & pulley drive system, Bearing block with suitable supports, Safety mesh guards for fan, motor, drive system, External rain shields to protect Motor from rain water ingress.
11. Procurement of all materials, Structural design, fabrication, inspection testing, surface preparation, primer application and finish painting, assembly, sea worthy packing and forwarding, Structural design guarantee, workmanship guarantee etc.
12. Design and Supply of handling / lowering rearrangement (Permanent) for maintenance (i.e. **Chain pulley block, Moveable Pallet type Trolley** (with anchoring arrangement) & required supporting structure/**monorail/ jib crane** etc.) for **complete fan assembly** and motor from working level to ground level. **Applicable hoist system & its structure (monorail/jib crane etc) shall be provided at both end of each Air Heater unit.**
13. Fin protection for tube bundle during transportation
14. Sliding/friction pads considering good friction fraction factor for tube bundle.
15. First fill of lubricant.
16. Supply of following mandatory spares.
 - a) 400% gaskets for nozzles with blind flanges
 - b) 200% gaskets for plugs
 - c) 20% plugs
 - d) 100% Belts
 - e) 20% bolts & nuts (min.4) for all nozzles with Blind Flange.
 - f) 100 % Bearings
 - g) 5% of Set of Hub (Drive & Driven), pulley (Drive & Driven) and lock bush
 - h) 5% of fan drive shaft with lock nut
 - i) 5% Fan Assembly
 - j) Mandatory spares (electrical) as per document no. B861-701-80-50-SL-6002.
17. Supply of all erection and commissioning spares.
18. Supply of 2-years operation and maintenance spares if any for fans, motors etc. as recommended by Suppliers if ordered by client (Furnish itemized list)
19. Necessary special tools & tackles including tools & tackles required for site erection & commissioning, Spreader beam suitable for heaviest lifting with relevant calculations & certifications, hoisting beams or hook-on bundle support beam plenum chamber for lowering/lifting motor, fan, shaft, which can carry 200 % of weight of heaviest member.
20. Lubrication system for the bearing assembly of air heaters, to be extended to the movable trolley /walkway area for accessibility.
21. Unloading at site, handling, transportation to store and from store to work site, storage at site, erection and assembly of airheater, bundles & accessories like motor and fan assembly, plenum chamber, supporting structure, ladder, platform etc on RCC structure at site, installation, application of touchup paint, testing, pre-commissioning, commissioning, performance guarantee

- run, handing over to client and supply of commissioning spares for the air heater, as per the enclosed EIL standard specifications, instructions to vendors, job specification, data sheets etc.
22. Any other requirements specified in requisition/job specifications or required for safe and smooth operation of the equipment.
 23. Bearings of fans and motors to have individual vibration probe extension or frame to have provision of taking vibration physically.
 24. Layout of the air heaters should be such that cold air does not form a closed loop affecting efficiency adversely and fog formation does not effect visibility.
 25. Air heater structure shall be provided with appropriate penetration sealers to provide barrier against the penetration of moisture and ingress of chlorides.
 26. The design of air heater shall ensure proper condensate collection & quick removal of condensed water from air heater system to reservoir.
 27. Permanent maintenance facility for air heaters shall be provided
 28. Mechanical equipment should be preferably located above tube bundle to avoid being exposed to water drops from the tube bundles.
 29. Ensure easy cleaning of the tube bundle **including supply of suitable Tube Fin Cleaning system & arrangement.**
 30. Complete air heater loop (i.e. Including piping and tube bundle shall be chemically cleaned before commissioning.
 31. **Supply & installation of Ethylene Glycol leakage detection system**
 32. Air heater fans should be of low rpm. .
 33. Start/ Stop push buttons to be provided at Air heater platform. Stop push button to be provided at Grade level also
 34. Provide vibration transmitter for each air heater unit.
 35. The configuration of this Air Heaters shall be as per plot plan available in requisition
 36. Manual adjustable 2 pitch fan blades shall be considered

Equipment Schedule

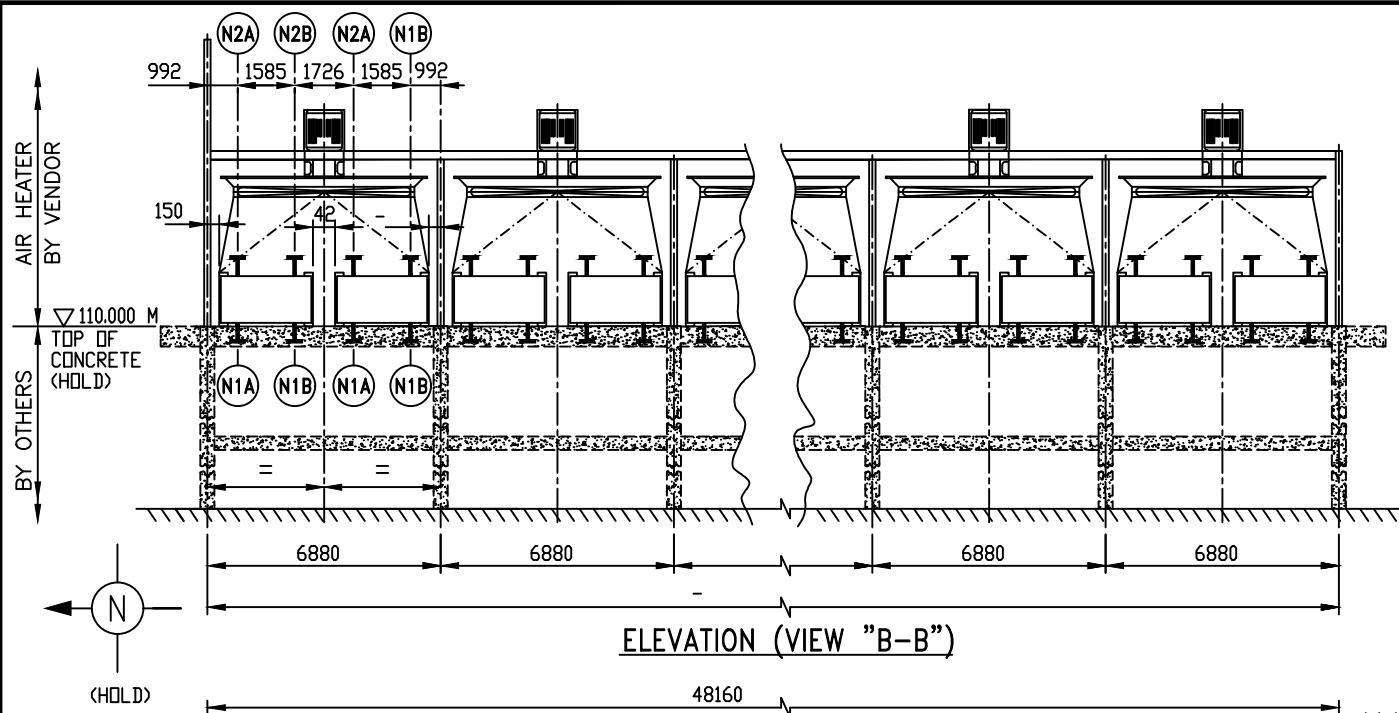
SR.NO.	ITEM NO. & NO OF BUNDLES	SERVICE	QUOTATION
1	701-EA-1001A TO 701-EA-1028A (28 BUNDLES)	ETHYLENE GLYCOL WATER AIR HEATER	
2	701-EA-1001B TO 701-EA-1028B (28 BUNDLES)	ETHYLENE GLYCOL WATER AIR HEATER	
3	701-EA-1001C TO 701-EA-1028C (28 BUNDLES)	ETHYLENE GLYCOL WATER AIR HEATER	
4	701-EA-1001D TO 701-EA-1028D (28 BUNDLES)	ETHYLENE GLYCOL WATER AIR HEATER	
5	701-EA-1001E TO 701-EA-1028E (28 BUNDLES)	ETHYLENE GLYCOL WATER AIR HEATER	

NOTE:

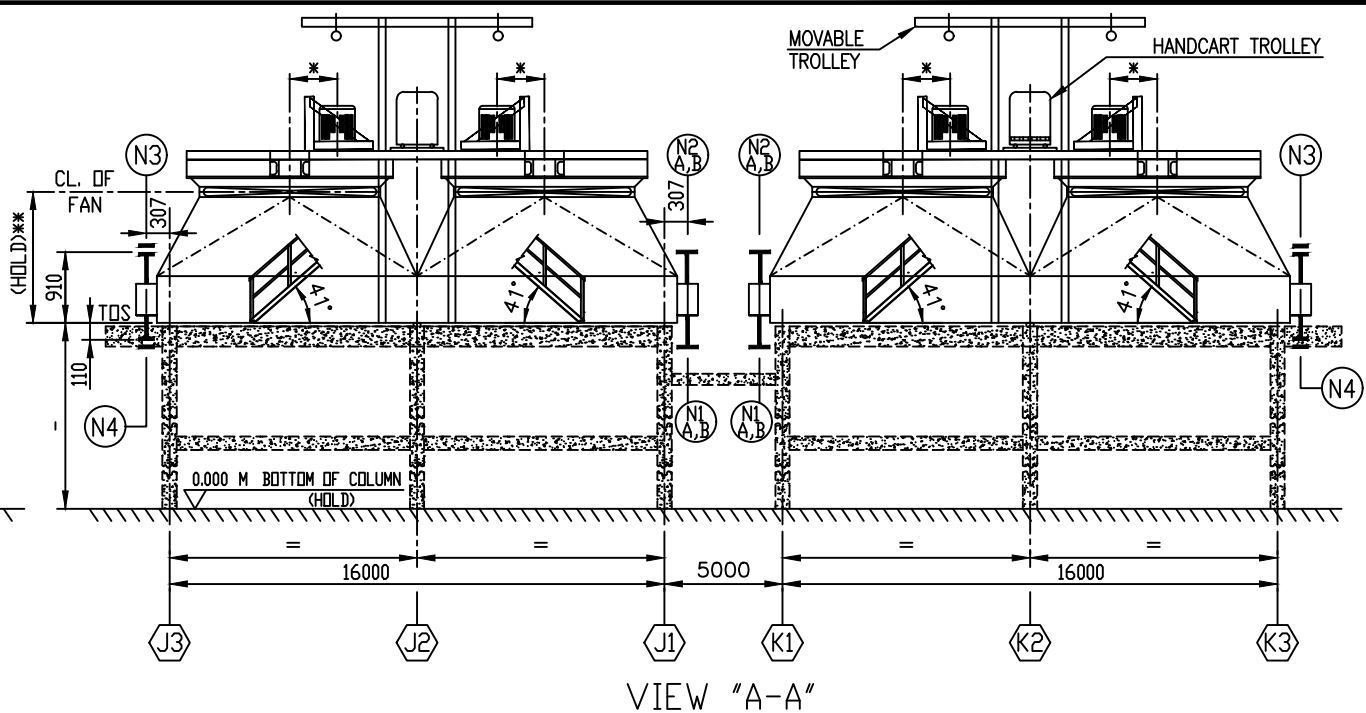
- 1) **The submission of prices by vendor shall be construed to mean that he has confirmed compliance with all technical Specification of the corresponding item (s).**
- 2) **The weights indicated on EIL engg. drawings shall not form the basis for offer, since these are approximate only.**

Vendor's Name :
Vendor's Signature with Seal/ Stamp :
Date :

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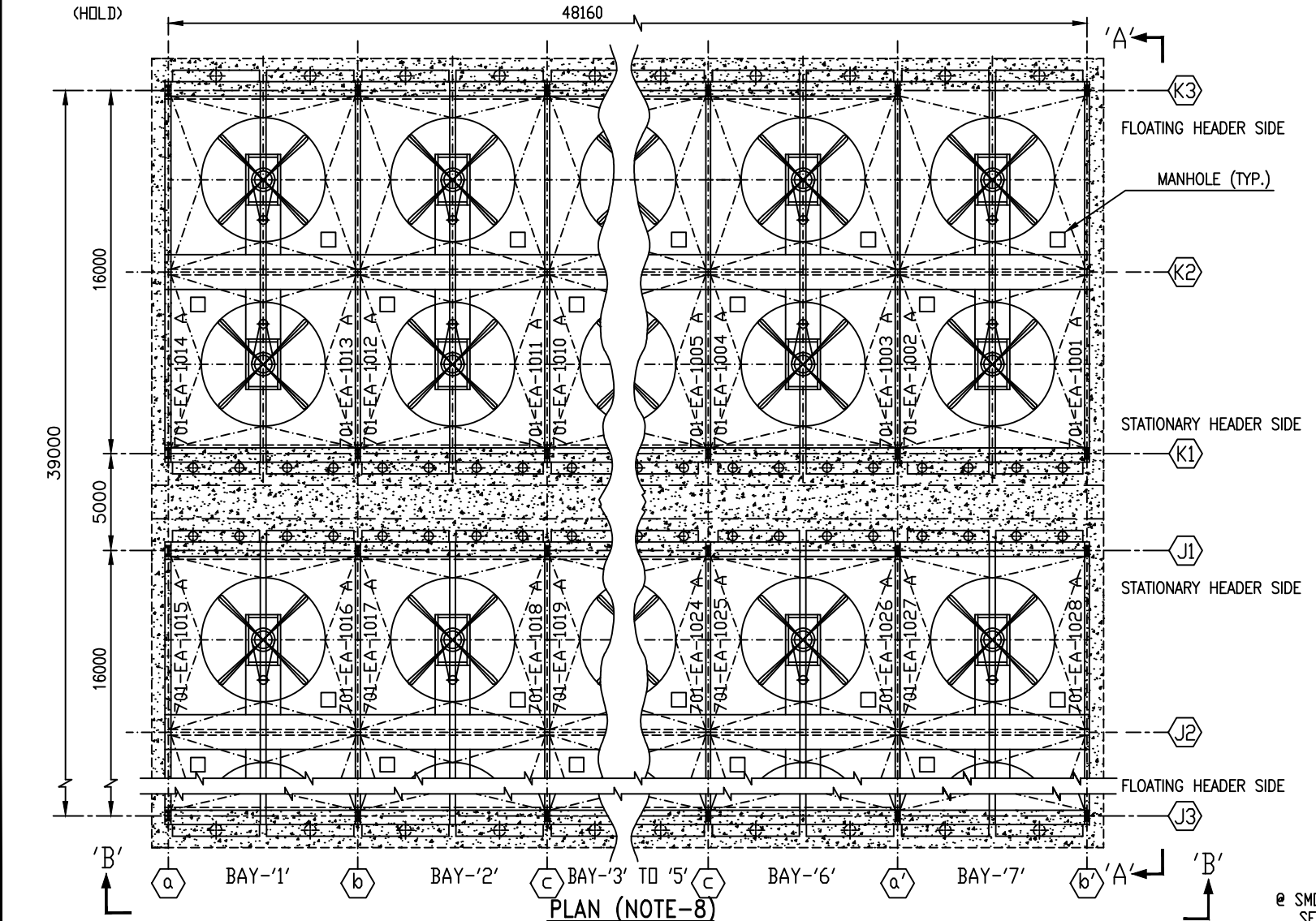
ELEVATION (VIEW "B-B")



VIEW "A-A"

NOTES:-

1. ALL DIMENSION ARE IN MM. UNLESS OTHERWISE STATED.
- *2. BY VENDOR.
- **3. TO BE CONFIRMED BY VENDOR.
4. STRUCTURALS SHALL BE DESIGNED TAKING CARE OF 2 TIMES API NOZZLE LOADS.
5. PLENUM SHALL BE OF CONICAL TYPE.
6. PROVIDE SUITABLE STRUCTURAL FILLER MATERIAL BETWEEN TWO BAYS.
7. STRUCTURAL (SUPPLIED IN LOOSE) SHALL BE ASSEMBLED AT SITE. SUITABLE DETAIL SHALL BE DESIGNED & SUPPLIED BY VENDOR FOR EASE IN ASSEMBLY (WELDING SHALL PREFERABLY BE AVOIDED). PROCEDURE FOR ASSEMBLY AT SITE SHALL BE PREPARED & FURNISHED BY VENDOR
8. 701-EA-1001A CONSISTS OF 28 BUNDLES, SIMILARLY 701-EA-1001B/C/D/E ARE IDENTICAL CONFIGURATION AS THAT OF BLOCK-A (TOTAL BUNDLES 28x5=140 NOS.).



PLAN (NOTE-8)

FAN DATA

FAN DIA	17.0 ft.
TYPE	MANUALLY ADJUSTABLE
NOS. REQD.	140 Nos.
MAKE	-

MOTOR DATA

TYPE	TEFC AC, 1440 RPM, 415V, 3 PHASE, 50 CYCLE.
HP **	40 (MIN.) EACH
NOS. REQD.	140 Nos.

DRIVE

HTD BELT	140 SETS (ONE SET CONSISTS OF DRIVER PULLEY DRIVEN PULLEY + BELT + TAPER LOCK BUSH.)
MAKE	-

LOUVRE

NOS. REQD.	-
MAKE	-

NOZZLE SCHEDULE

NOZZLE MARK	NOM SIZE	ASME CLASS	TYPE	PIPE SCH.	FLANGE FACE	SERVICE	REMARKS
N1AB	6"	150 #	WNRF	80	@	INLET	-
N2AB	6"	150 #	WNRF	80	@	OUTLET	-

@ SMOOTH FINISH TO 125 AARH
SERVICE :- AIRHEATERS FOR STV 4-E-113C



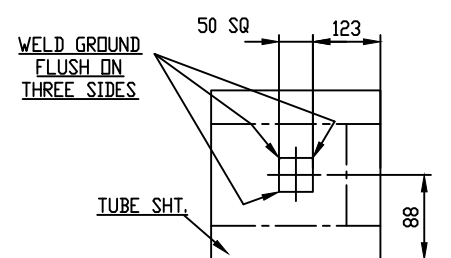
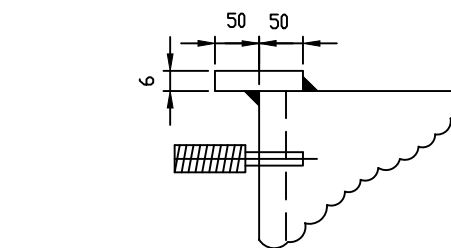
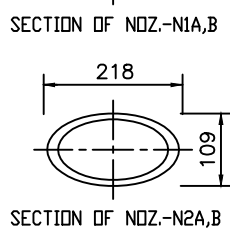
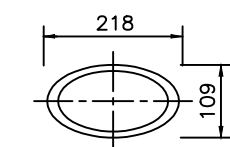
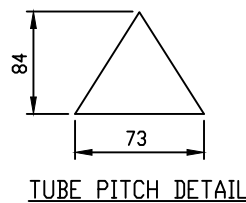
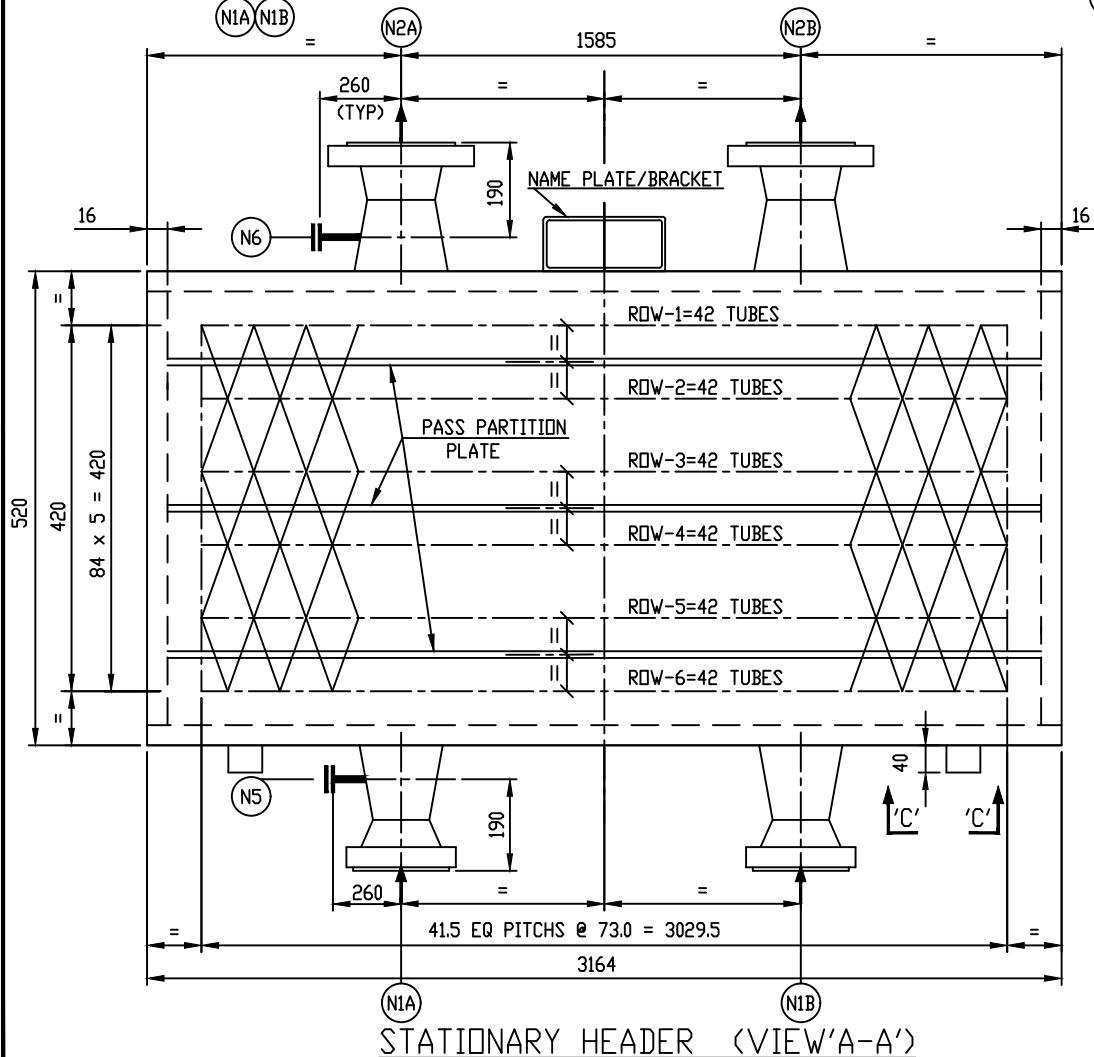
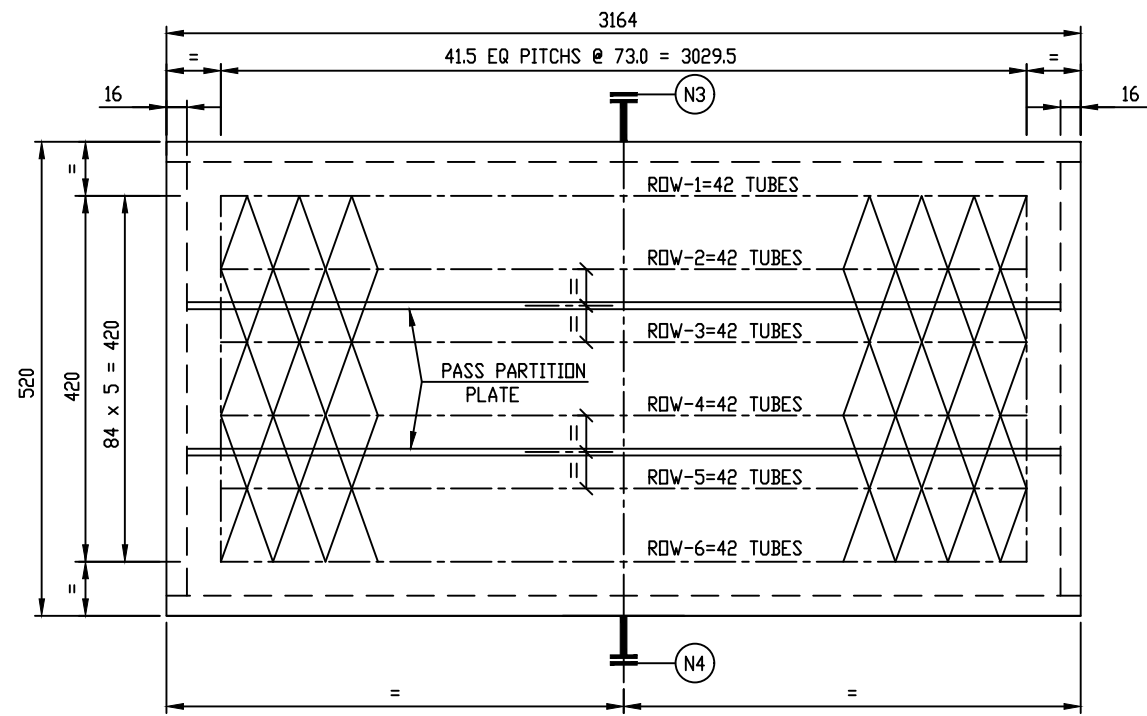
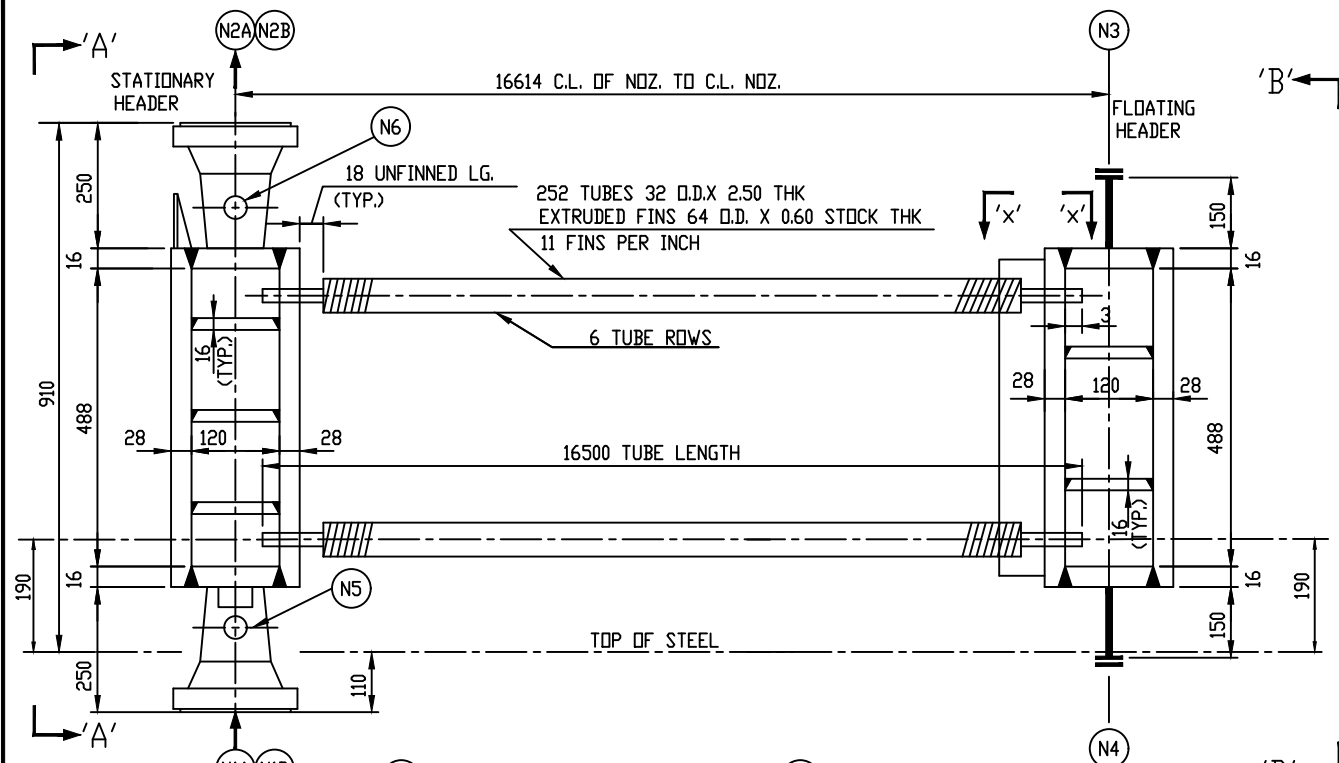
JOB NO.: B861 UNIT: 701
CLIENT: M/S KONKAN LNG LIMITED
PLANT: EPCM SERVICES FOR AMBIENT AIR HEATING SYSTEM

REV.	DATE	REVISION	BY	CHK	APPROVED	APPROVED
A	24.05.2024	ISSUED FOR BIDS/ENGG.	NS	CSP/MPK	TK	

SETTING PLAN
FOR ITEM NO.
701-EA-1001 A/B/C/D/E-1028 A/B/C/D/E

DRAWING NO.	REV.
B861-701-80-42-DS-3001	A
SHEET 1 OF 3	

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NOTES:-

1. EACH TUBE TO HAVE ONE PLUG ON OF SIZE 1-3/8" - 12 UNF ON EACH SIDE IN PLUG SHEET AS PER STD. 7-15-0111.
2. NOZZLE FLANGE FACE FINISH SHALL BE 125 AARH.
3. MDMT= (-)5°C.

NOZZLE DATA

NOZZLE MARK	SIZE (INCH)	ASME CLASS	FLANGE	SCH.	SERVICE	REMARKS
N1AB	6"	150#	WNRF	80	HEADER INLET	
N2AB	6"	150#	WNRF	80	HEADER OUTLET	
N3	2"	150#	WNRF	160	VENT+BF	
N4	2"	150#	WNRF	160	DRAIN+BF	
N5	2"	150#	WNRF	160	MP CONN + BF	
N6	2"	150#	WNRF	160	MP CONN + BF	

DESIGN DATA

APPLICABLE CODE API 661 LATEST EDITION	
ASME SEC. VIII DIV. 1 LATEST EDITION	
DESIGN PRESSURE Kg/cm ² g	19.17 / FV
HYD. TEST PRESSURE Kg/cm ² g	24.92
OPERATING PRESS. Kg/cm ² g	7.85
DESIGN TEMP. °C	(-)25/65
OPERATING TEMP. IN/OUT °C	2 / 18
CORROSION ALLOWANCE mm	3.00
RADIOGRAPHY	FULL
JOINT EFFICIENCY	0.9
POST WELD HEAT TREATMENT	NIL
NO OF PASSES	6
OPERATING FLUID	ETHYLENE GLYCOL WATER MIX (36% WT)
TUBE TO TUBE SHT. JOINT	STRENGTH WELDED
HEAT EXCHANGED MM kcal/hr.	34.85
FINNED SURFACE/BUNDLE M ²	9034
WEIGHT OF TUBE BUNDLE kg	~17000 (EACH)
WEIGHT FULL OF WATER kg	~19000 (EACH)
SERVICE :-ETHYLENE GLYCOL WATER AIR HEATER	
NO. OF BUNDLES REQD. = 140	



ENGINEERS INDIA LIMITED
NEW DELHI

JOB NO.: B861 UNIT: 701
CLIENT: M/S KONKAN LNG LIMITED
PLANT: EPCM SERVICES FOR AMBIENT AIR HEATING SYSTEM

REV.	DATE	ISSUED FOR BIDS/ENGG. REVISION	BY	CHK	TK	APPROVED
A	24.05.2024	ISSUED FOR BIDS/ENGG.	NS	CSM/PKP	TK	

TUBE BUNDLE DETAIL

FOR ITEM NO.

701-EA-1001 A/B/C/D/E-1028 A/B/C/D/E

DRAWING NO.

B861-701-80-42-DS-3001

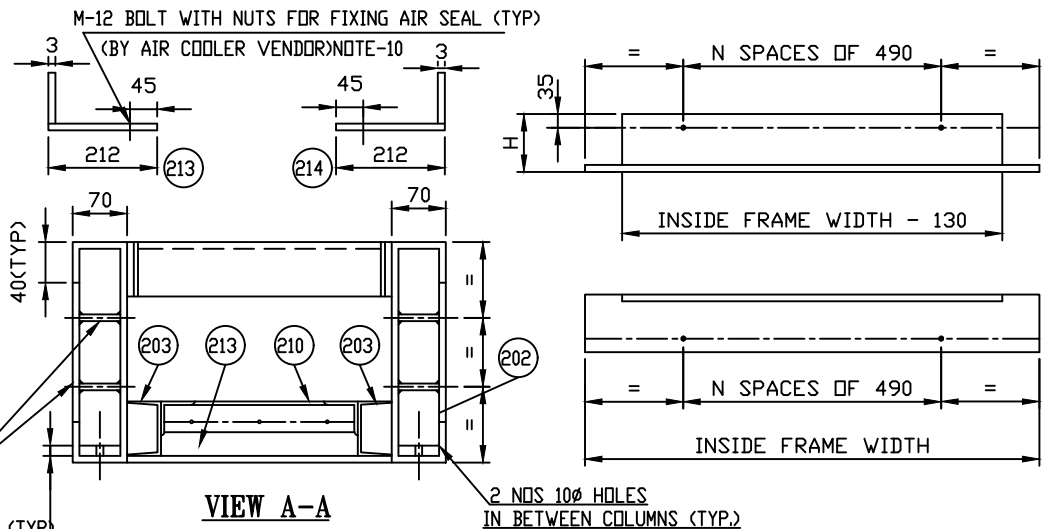
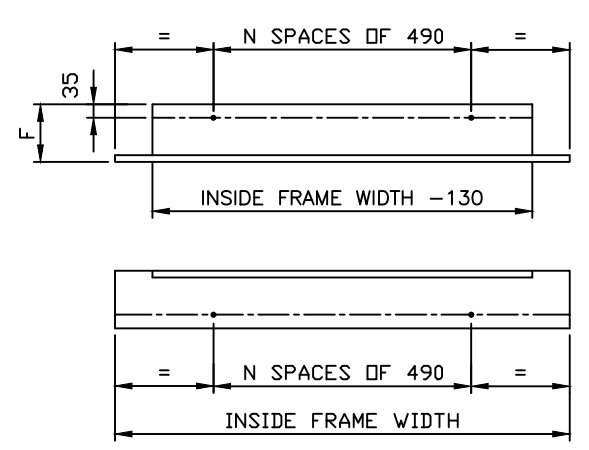
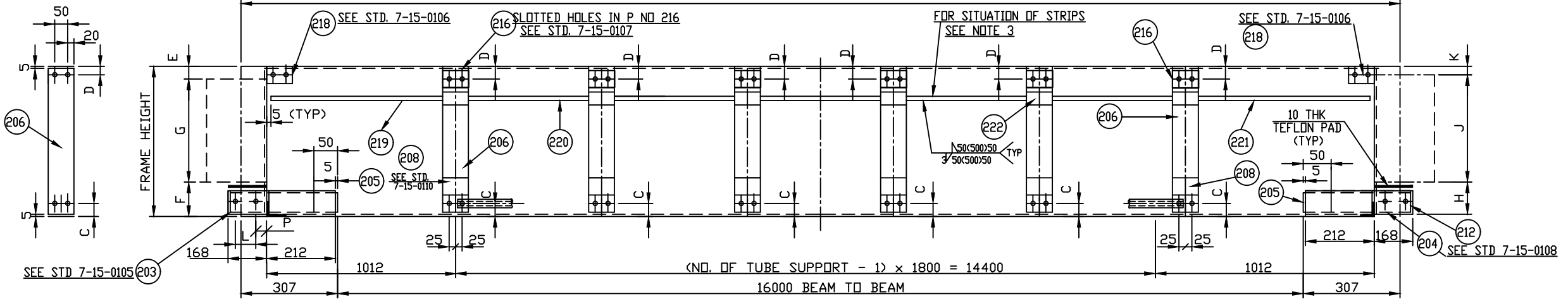
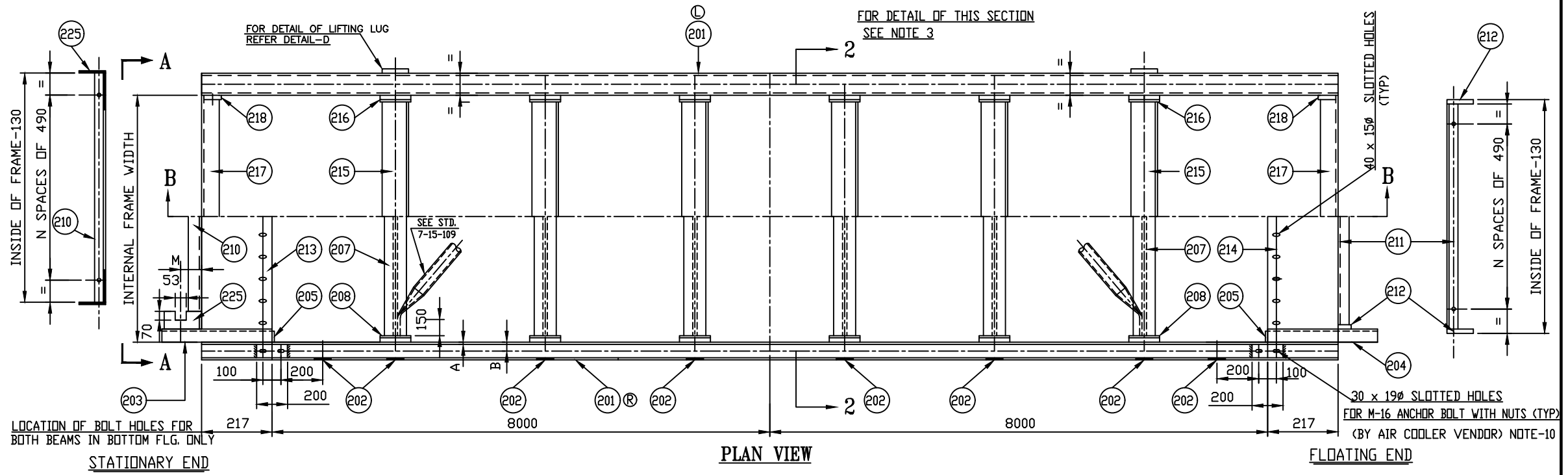
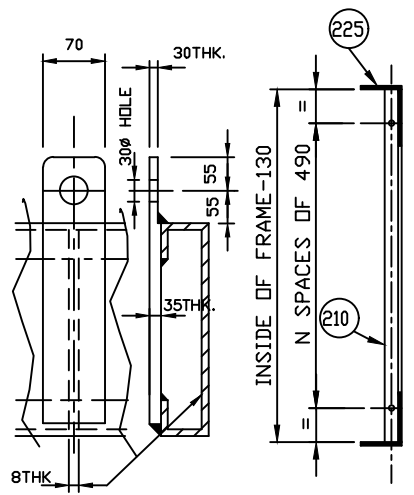
REV.

A

SHEET 2 OF 3

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**DETAIL - D
LIFTING LUG**



- NOTES:-**
- IS HOLES FOR M12 BOLTS.
 - ⊕ IS HOLES FOR M16 BOLTS.
 - FOR SEC 2-2 SEE STD. 7-15-0121/0122/0123.
 - FRAME TO BE LIFED WITH SPREADER BEAMS.
 - ANGLES P. NO. 210 & 211 SHALL BE CUT TO CLEAR NOZZLES IF THEY INTERFERE.
 - ALL PARTS SHALL BE HOT DIP GALVANISED.
 - MATL. OF CONST. CS STRUCTURAL QUALITY SA 36.
 - ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
 - AIR SEALS SHALL BE DESIGNED TO MINIMISE AIR LEAKAGE.
 - MATL. OF ANCHOR BOLTS/NUTS (STRUCTURAL BOLTING) GRADE S275JR CONFIRMING TO BS-EN10025.

INT. FRAME WIDTH	3129
FRAME HEIGHT	747
FRAME THK	A
	B
	C
	D
	E
	F
	G
	H
	J
	K
	L
	M
	N
	P
NO OF TUBE SUPP.	9
NO OF HALF PIPE SUPP.	4536
FRAME WEIGHT (KG)	~ 3600 EACH
NO OF FRAMES REQD.	28



ENGINEERS INDIA LIMITED
NEW DELHI

JOB NO.: B861 UNIT: 701
CLIENT: M/S KONKAN LNG LIMITED
PLANT: EPCM SERVICES FOR AMBIENT AIR HEATING SYSTEM

REV.	DATE	REVISION	BY	CHK	APPROVED	APPROVED
A	24.05.2024	ISSUED FOR BIDS/ENGG.	NS	CSM/PKP	TK	

TUBE BUNDLE FRAME
FOR ITEM NO.
701-EA-1001 A/B/C/D/E-1028 A/B/C/D/E

DRAWING NO.	REV.
B861-701-80-42-DS-3001	A
SHEET 3 OF 3	



REV.	1	EIL JOB NO.	B861		ITEM NO.	701-EA-1001 A/B/C/D/E -1028 A/B/C/D/E (Note3)					
	2	PROCESS D/S REF NO.	B861-701-02-42-DS-1401,REV 2 DTD 21.08.2024		CUSTOMER	M/S KONKAN LNG LIMITED					
	3	SERVICE	ETHYLENE GLYCOL WATER AIR HEATER		PROJECT	EPCM SER. FOR AMBIENT AIR HEATING SYS.					
	4	LOCATION	ANJANWEL, MAHARASHTRA		TYPE	FORCED DRAFT (Note-2)					
	5	BUNDLE SIZE	3.3 m x 16.5 m		BUNDLE/SECTION:	TWO		NO. OF UNITS	FIVE (Note-3)		
	6	BUNDLES/UNIT	TWENTY EIGHT		IN PARALEL	SECTION SIZE 6.9 m x 16.5 m					
	7	SURFACE/BUNDLE	FINNED	9034 M²	BARE TUBE	410 M²	SECTION/UNIT FOURTEEN				
	8	SURFACE/UNIT	FINNED	252952 M²	BARE TUBE	11480 M²	PLOT AREA/UNIT				
	9	PERFORMANCE DATA (DESIGN CASE: CASE 1) (22)									
	10	HEAT EXCHANGED	(MMKcal/hr)	34.85 (16)			MTD (CORRECTED)	7.5 °C			
	11	TRANSFER RATE	(Kcal/hr m ² °C)	18.4			(FINNED SURFACE)	405 (BARE SURFACE)			
	12	TUBE SIDE									
	13	FLUID CIRCULATED	EHTYLENE GLYCOL WATER MIX (36% WT)				INLET		OUTLET		
	14	TOTAL FLUID ENTERING	Kg/hr	2570000 (3,17)		DENSITY LIQ/VAP	Kg/m ³	1058	1052		
	15			INLET	OUTLET	VISCOSITY LIQ/VAP	cp	4.4	2.46		
	16	VAPOUR	kg/hr			SPECIFIC HEAT LIQ/VAP	KCal/Kg.°C	0.843	0.853		
	17	LIQUID	kg/hr	2570000	2570000	THER. CONDUCT. LIQ/VAP	KCal/hr.m.°C	0.36	0.378		
	18	STEAM	kg/hr			MOL. WT.VAP/NON-COND					
	19	WATER	kg/hr			LATENT HEAT LIQ/VAP	KCal/Kg				
	20	NONCONDENSABLES	kg/hr			VELOCITY	m/sec	1.01			
	21	OPERATING TEMPERATURE	°C	2	18	PRESSURE DROP	Bar	ALL: 0.85	CALC: 0.85		
	22	OPERATING PRESSURE	Barg	7.7		PASSES/BUNDLE		SIX (5)			
	23	FOULING RESISTANCE	hrm ² °C/KCa	0.00021							
	24	AIR SIDE									
	25	TEMPERATURE	°C	IN: 23	OUT: 13	ALTITUDE	m	112			
	26	TOTAL FLOW /UNIT	kg/hr	14,300,000		STATIC PR.	mm H2O	11.7			
	27	QUANTITY/FAN	kg/hr	510,715		POWER/FAN	HP	32 (20)			
	28	FACE VELOCITY	m/sec			POWER/UNIT	HP	896			
	29	CONSTRUCTION OF EACH BUNDLE									
	30	DESIGN PRESSURE:	18.8/FV	Barg	TEST PRESSURE	AS PER CODE	Kg/cm ² g	DESIGN TEMP.	(-)25 / 65 °C		
	31	CODE REQUIREMENT: API 661									
	32	TYPE OF TUBING	EXTRUDED FINNED		TUBE MATERIAL	KCS	FIN MATERIAL	ALUMINIUM			
	33	BARE TUBES NO.	252	NO. OF ROWS	6	OD: 32 MM	ID: 27 MM	LENGTH	16.5 M	PITCH(MM)	73 △
	34	FIN SPACING	11/INCH		OD: 64 MM	ROOT DIA. 32 MM	STOCK THICKNESS	0.60 MM			
	35	TYPE (PLUG/COVER)	PLUG		NO.OF SPLITS: -	MATL: KCS	CORROSION ALLOWANCE	3 MM			
	36	PLUG/GASKETS	SOFT IRON		SIDE FRAME:	SA 516 GR.70					
	37	NOZZLES	IN:	2 X 6" 150# WNRF			COUPLINGS	VENT:	1 X 2" 150# WNRF		
	38		OUT:	2 X 6" 150# WNRF				DRAIN:	1 X 2" 150# WNRF		
	39	CONSTRUCTION OF EACH SECTION									
	40	STRUCTURE	CS		SEC. GR. NO.			DESIGN WIND LOAD	Kgf/m		
	41	PLENUM CHAMBER	C.S. HOT DIP GALVANIZED		TYPE:	TRAPEZOIDAL					
	42	FANS	NO.:	TWO		DIAMETER	17 ft	RPM:	MFR:		
	43	BLADES	MATERIAL: ALUMINIUM		NO./FAN:	PITCH ANGLE(DESIGN):					
	44	HUBES	MATERIAL:		PITCH ADJUSTABLE/AUTOVARIABLE (NO.) 2/-						
	45	DRIVERS	NO.:	TWO		TYPE:	TEFC. MOTORS		MFR:		
	46		H.P.(MIN.):	40 (EACH) RPM		:	VOLTS: 415	CYCLES: 50	PHASE: 3		
	47	COUPLINGS	NO.:			TYPE:	MFR:				
	48	SPEED REDUCERS	NO.:	TWO		TYPE:	HTD BELTS				
	49		REDUCTION RATIO:								SERVICE RATING:
	50	LOUVRES	MATERIAL:		TYPE:						MFR:
	51	WEIGHTS	Kg	EACH SECTION: DRY				FULL OF WATER			
	52			EACH BUNDLE: DRY				FULL OF WATER			
	53	REMARKS:									
	54	(1) For additional notes refer P&ID number B861-02-42-701-1126-1135 and BEDB.									
	55	(2) Forced draft type with fan mounted on top of bundle.									
	56	(3) As per PDS, each loop of five PHE (700-EP-1001 A/B/C/D/E) will have 28 no. of Air heater units. This datasheet corresponds to total 28 number of units (one Bundle constitutes one unit). 2570000 Kg/hr is the combined GW flow for 28 units of each PHE loop.									
	57	(4) Minimum air temperature 10 deg C and maximum air temperature 40.6 deg C.									
	58	(5) Provide one tube row in each tube pass. Pass arrangement is counter current w.r.t air flow direction across the tube bundle.									
	59	(6) Bearings of fans and motors to have individual vibration probe extension or frame to have provision of taking vibration physically.									
	60	(7) The design of air heater shall ensure proper condensate collection & quick removal of condensed water from air heater system to reservoir.									
	61	(8) Layout of the air heaters should be such that cold air does not form a closed loop affecting efficiency adversely and									
	62										
	63										
	64										
	65										
	2	28.08.2024	REISSUED FOR ENGINEERING			AS	KMB	SS			
	1	03.06.2024	REISSUED FOR ENGINEERING			AS	KMB	SS			
REV		DATE	DESCRIPTION			BY	CHECK	APPROVAL			

REV	1	EIL JOB NO.	B861	ITEM NO. :	701-EA-1001 A/B/C/D/E -1028 A/B/C/D/E
	2	PROCESS D/S REF. NO.	B861-701-02-42-DS-1401 , REV 2 DTD 21.08.2024	CUSTOMER :	M/S KONKAN LNG LIMITED
	3	SERVICE OF UNIT	ETHYLENE GLYCOL WATER AIR HEATER	PROJECT :	EPCM SER. FOR AMBIENT AIR HEATING SYS.
	4			LOCATION:	ANJANWEL, MAHARASHTRA
	5	NOTES:-			
	6	fog formation does not effect visibility.			
	7	(9) Air heater structure shall be provided with appropriate penetration sealers to provide barrier against the penetration of moisture and ingress of			
	8	chlorides.			
	9	(10) Permanent maintenance facility for air heaters shall be provided.			
	10	(11) Mechanical equipment should be preferably located above tube bundle to avoid being exposed to water drops from the tube bundles.			
	11	(12) Ensure easy cleaning of the tube bundle.			
	12	(13) Complete air heater loop (i.e. Including piping and tube bundle) shall be chemically cleaned before commissioning.			
	13	(14) Air humidity minimum 0% to 100%.			
	14	(15) Air heater fans should be of low rpm.			
	15	(16) Specified heat duty is for one set of air heaters unit i.e. 701-EA-1001A-1028A of one PHE loop.			
	16	(17) Ethylene glycol water flow rate specified is for one set of air heaters unit i.e. 701-EA-1001A-1028A of one PHE loop.			
	17	(18) Tube to tubesheet joint shall be strength welded.			
	18	(19) Provide 1 x 2" 150# WNRF MP connection per Bundle			
2	19	(20) Power consumption per fan at ambient air temperature of 21 deg C must not exceed the figure specified at row 27 on Pg 1 of 2.			
	20	(21) Provide vibration transmitter for each air heater unit.			
	21	(22) Air heater is adequate for design case 2 also.			
	22	(23) Start/ Stop push buttons to be provided at Air heater platform. Stop push button to be provided at Grade level also.			
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2	28.08.2024	REISSUED FOR ENGINEERING		AS	KMB SS
1	03.06.2024	REISSUED FOR ENGINEERING		AS	KMB SS
REV	DATE	DESCRIPTION		BY	CHECK APPROVAL

JOB SPECIFICATION FOR AIR HEATERS

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

C	24.09.2024	ISSUED FOR BIDS	CSM	PKP	TK
B	27.08.2024	ISSUED FOR BIDS	CSM	PKP	TK
A	11.06.2024	ISSUED FOR BIDS	CSM	PKP	TK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. The drawings issued for bids are strictly for quotation purpose only. The drawings are being issued along with requisition for preparation of drawings and fabrication works. All relevant drawings like tube bundle, frame, setting plan etc. and typical details of motor suspension assembly are attached with the requisition. Based on these details, the guidelines attached with requisition & the fan/motor/pulley data, vendor shall perform the design & detailing of structural and detailing of drive. The minimum size and thickness shall be as given in the requisition. Vendor shall also submit details of drive for EIL review as per clause 7.2.3 to 7.2.10 of specification No 6-15-0071.
2. Vendor shall follow API 661, Seventh Edition July 2013 and shall correlate the relevant clauses of this edition of code with this specification. The pressure design and code shall be ASME Section VIII Division 1
3. All materials required for fabrication, testing and inspection shall be supplied by vendor. No material shall be supplied by owner.
4. Vendor shall furnish list of drawings/documents with schedule of submission of drawings for approval by EIL. The same shall be submitted to EIL immediately after the placement of order as per format already available with MR.
5. **Bidder to note deviations are not acceptable.**
6. Bidder to note that complete structural framework above RCC (columns, beams & bracings) as per EIL drawing, partition beams, beams for supporting fan & drive assembly, air seals, stairs, ladders, gratings, handrails, roofing, plenum chamber, fan & pulley guards etc are in their scope of work & supply. Vendor should include for the residual design and supply of the entire air heater structural framework. Vendor shall also include supply and assembly of additional supports required for transportation/shipping/ handling and installation at site. However, vendor to note that weights if any given in drawings are for guidance only and actual weight as required shall be considered in the scope and price shall be quoted accordingly. Any variation in weight/area of structure, plenum chamber, frames, gratings & screens etc. will not call for any increase in price quoted by the vendor. Variation in price is allowed only for any addition/ deletion of structure by EIL/ Client over the drawing enclosed with the requisition.
7. The noise level shall be limited to 85 dB (A) max. measured at a distance of one meter from the bundle at the header access platform walkways and one meter from the bay limit on motor maintenance platform. The noise level within the air heater bay shall be 90 dB (A) maximum, at locations defined as per API.
8. Vendor shall conduct dry run to ensure successful working of electrical/ instrumentation system as well as noise and vibration tests.
9. The fabrication drawings prepared by vendor will be reviewed by EIL for the following points only:
 - Nozzle data, orientation and location, dimensions for interfacing etc.
 - Bundle detail and interfacing of bundle & frame.
 - Design data and materials of construction.
 - Critical details like tube to tube sheet joint and air sealing arrangement details.
 - Bearing Block detail and motor suspension assembly drawings.
 - Details of motor like motor datasheets, performance curves for motors.
 - Drive selection, Fan selection performance curves, ~~Auto variable fan hook-up scheme, Louver performance curves.~~
 - Other details of fabrication drawings submitted shall only be for information/records of EIL and vendor to fabricate, supply equipment based on his responsibility of ensuring compliance to the requirements of the requisition including drawings, specifications etc., as well as for residual design/detailing performed by the vendor. Structure calculations to be submitted for information.

10. While preparing fabrication drawing it shall be endeavored to cover all fabrication details in minimum number of drawings.
11. Vendor not to furnish details which are repetition of technical requirements of requisition in his bid. If submitted, same shall be reviewed only after order and change if any shall be binding on vendor.
12. Anchor bolts and nuts shall be supplied by vendor. Vendor shall erect the bundle frames using anchor plates (& shims if necessary).

13. SITE DATA

Wind load shall be calculated on the basis of IS 875.

- a) Drag coefficient for cylindrical vessels shall be 0.7 minimum.
- b) Drag coefficient for spherical vessel shall be 0.6 minimum.
- c) Basic wind speed of 50 m/s (**HOLD**) shall be considered
- d) Other factors shall be as below

K1 = 1.0

K2 shall be based on Category 3 for units and 2 for offsite

K3 = 1.0

A contingency factor of 1.1 shall be applied to wind pressure.

The elevation of foot of the air heater bundle frame base plate is given on the respective setting plan item drawings. The elevation is with reference to the Highest Point of Pavement (HPP) EL 100.000M which corresponds to 110 m (HOLD) above mean sea level (MSL). Vendor to consider fan elevation accordingly in their design.

14. Earthquake Consideration:

Earthquake loads for equipment shall be calculated in accordance with IS 1893/site-specific seismic spectra as specified in the project specification.

15. Gratings on platforms, staircases shall be as per standard 7-68-0697.
16. Hand rail shall have top rail NB32 (m) tube (steel walkway platforms, stairs etc.).
17. Assembly of all components shall be done at site by Air Heater Vendor. Erection shall be done by Air heater Vendor.

Steel structure shall be shop assembled wherever possible and match marked before dispatch. Driving arrangement & fan shall be assembled at site and trial run to check vibrations shall be performed. All rotating parts shall be balance as per API.
18. Vendor shall provide plate motor guards in addition to fan and pulley guards. Details of the guards shall be developed by the vendor.
19. Fan cage (guard) shall be provided with access man way to access the fan. These shall be hinged type and provided below/above the fan. Further to clause 7.2.6.1 of spec 6-15-0071, the fan access door shall be hinged type and should open towards airside.
20. One pair of earthing bosses as per EIL standard 7-15-0016 shall be provided on one column of each item.
21. Fan and motor assemblies should be designed for remote lubrication from maintenance platform without shutting down the equipment. Suitable SS tubing (3/8"dia) shall be provided outside the fan/motor guards to permit lubrication of fan shaft bearing and motor shaft bearing without shutting

down of the fan/motor. These connections shall be accessible from blind floor. Vendor to develop detailed connection drawing to connect the lubrication piping to one point.

22. If radiography is being substituted by UST for the final closing seam as permitted by the Code, magnetic particle examination shall be carried out in addition to UST.
23. Wherever radiography is indicated as full all long and circumferential seams including flange to neck, pipe to pipe and pipe to fitting shall be 100% radiographed.
24. Hardness of various materials for nozzle flange & gaskets are as follows:-

FLANGES		GASKET	
MATERIAL	HARDNESS (BHN)	MATERIAL	HARDNESS (BHN)
SS304L	140 (Min)	SOFT IRON	90 (Max.)
		SS 316L	160 (Max)

However gasket hardness should be at least 20 BHN less than Flange hardness

25. Catalogues for fans, belts, pulleys, motors etc. shall be supplied along with the drive details selection and motor suspension drawings.
26. Tolerances are as under:
- | | | | |
|----|------------------------------------|-----|------------------|
| 1. | On total tube length after Finning | : - | 0, +3 mm |
| 2. | On fin OD | : - | -1.2 mm, +0.8 mm |
27. The air heater fan should have the bearing greasing points brought below/above the fan guards.
28. Hand cart trolley suitable for maintenance of fans, motors etc. shall be supplied by vendor for each unit of air heaters.
29. Refer Para 11.1.6 of specification 6-15-0071. The protective cover including heavy duty wire mesh shall be hot dip galvanized.
30. The air heater fan should have the bearing greasing points brought above outside the fan guards.
31. Fans, electrical motors etc. shall have proper item tag nos and the same shall be clearly identified in vendor's drawing.
32. For nozzles fabricated from pipe thickness specified in MDS shall be considered as minimum.
33. Tube thickness indicated in the MR drawings are overall tube thickness
34. Vendor shall ensure that all data folder documents including the "AS BUILT" drawings are updated and complete in all respect and incorporate all suggestion/corrections informed by Inspector while obtaining certificate of completeness from inspector.
35. Positive material identification (PMI), vendor shall ensure that all alloy steel and stainless steel materials are properly identified and finally check tested by a PMI analyzer before dispatch of equipment.
36. In addition to stamping, the specifications and manufacturers symbol as specified in ASME material specifications, on one of the ends the size of the studs shall be clearly punch marked. Similarly the nuts shall have the size punch marked on one of the faces. In case of tapped hole the size shall be

punch marked near the hole without disturbing the gasket seating area. Further for all alloy/SS metallurgy bolts & nuts shall also be identified by distinct color marking at the stud end/bolt side face.

37. **Subcontracting of the entire / main equipment is not acceptable.** Subcontracting of the bought outs / components should be done to EIL approved vendors only. When no list exists for sub vendors consider only reputed vendors after EIL approval.
38. List of sub-suppliers for fans, tubes, fins, motors, VFD, belts and pulleys, louvers etc., shall be as per EIL approved vendor list.
39. Bought-out items e.g. fans, belts and pulleys, gear drive, Vibration switches etc. shall be accompanied with manufacturer's test certificates.
40. Plug gasket must be soft steel gasket (dead soft annealed). Hardness of gasket shall be 20 BHN lower than that of the material of plug & plug sheet. **This shall be hold point for inspection agency.**
41. The machinery mount shown in the motor suspension drawing is indicative only and sizes are minimum to be adopted. Vendor shall provide suitable supporting arrangement based on their structural design and supplier's catalogue. All the catalogues shall be supplied along with the drive details selection and motor suspension drawing.
42. In addition to air seal indicated in the setting plan drawings, air seal (thk. same as plenum) shall be suitably provided inside the plenum of required width along the length of the bundle. Details to be developed by the vendor.
43. Minimum head room clearance of 1300mm between Tube bundle & Fan/motor shall be kept for maintenance of fan & motor.
44. Maintenance & access Platform and safety guard for the mechanical equipment shall be considered by the Vendor. Vendor's design shall ensure that it will not be a harmful obstruction to the fan performance and vibration
45. Fan & Motor lifting / lowering arrangement from operating location up to ground along with trolley, chain pulley arrangement & required supporting structure for maintenance to be provided by vendor at both ends of each Air Heater Unit.
46. Vibration Switches to be provided as per applicable specifications attached elsewhere in tender.
47. Vibration switches shall be weatherproof to IP65, and it shall be suitable for area classification as specified elsewhere in the MR.
48. Vendor to ensure the material of construction of Air heater as mentioned in Thermal data sheet/Setting plan of MDS / Material of construction (B861-80-42-MC-6002).
49. Layout of the Air heaters should be such that cold air does not form a closed loop affecting efficiency adversely & fog formation does not affect visibility. Same needs to be demonstrated by adequate study. Vendor to implement impact of the study in air heater layout.
50. Vendor shall provide motor guards on top of motor to avoid ingress of rain water into motor
51. Fan blades shall be aluminium
52. Air heater Fan shall have anti reverse rotation device to avoid reverse rotation due to wind when fan is in idle condition.

53. Air heater type shall be Forced draft with fan mounted above tube bundles. Air stream shall be from the top to the bottom of tube bundle (downward).
54. Window shall be provided to measure vibration at motor & fan bearing housing using external/portable vibration meter & appropriate measure to be provided for accessing such window.
55. All tube to tube sheet joint shall be strength welded & requirement of strength welded tube to tube sheet as specified in 6-15-0003 are minimum to be adopted.
56. FRP canopy to each motor shall be provided as per specification on top of motor to avoid ingress of rain water into motor & bearings.
57. Vendor shall ensure the easy cleaning of the tube bundle and suitable arrangement including access shall be provided.
58. All Hardwares/Fastners shall be used considering corrosive coastal area. (i.e. SS-304 material). 2 mm thick PTFE seal as a barrier between Stainless steel washer & galvanized part to avoid galvanic corrosion shall be additionally provided.
59. Air heater shall ensure quick removal of condensed water from ambient air.
60. Lubrication points to motor, drives & Anti-rotating device shall be accessible from outside guards so that lubrication shall be done in operating condition.
61. Proper Air sealing plates between two bays/bundles shall be provided by Vendor
62. All structure bolts of air heater structure should be of SS as with ageing of fans bolts gets corroded due to presence of moisture.
63. Zinc coating of HTD gratings shall be of 900 gm/m² as per EIL Electrogalvanized grating Std. No.7.68-0697.
64. Air heater shall be mounted above the RCC structure. Design and supply of RCC structure is not in Vendor's scope.
- 65. Conflict:**
In case of any conflict between any of the specification/requirement listed in the requisition the most stringent condition of these requirements shall govern. However, all such discrepancies between various documents shall be brought to the notice of EIL and EIL's decision shall be final and binding on the vendor.
66. Lifting lug for frame shall be as shown in drawings and shall be placed in staggered manner. Design for these lugs shall be carried by Vendor with minimum impact factor of 2 & the same shall be furnished to EIL for review.

67. PAINTING OF HEADER BOXES & PLENUM CHAMBERS

Surface preparation, shop primer and finish paint (final coat i.e. field / erection paint) shall be done at vendor shop only prior to dispatch and painting system shall be as per specification B861-000-06-42-PLS-01

All structural parts of tube bundle frame, plenum chamber, motor suspension assembly, shaft housing, all guards etc. shall be hot dip galvanized as per CI 11.2.6 of 6-15-0071. Bolting shall be electro galvanized.

All other structural parts including grating for platforms, handrail, staircase etc. shall be painted/ hot

dip galvanized as per specification B548-000-06-41-PLS-01.

68. Plenum chamber shall be conical. Plenum panel is of 3 thk (min) and shall be of bolted assembly type.
69. Belts shall be toothed timing belts, Oil resistant in accordance with BS 903 part A16, as well as fire resistant and anti-static "FRAS" conforming to BS3790.
70. While designing the structure vendor to consider nozzle loads as thrice the API specified nozzle loads.

71. INSPECTION

- 71.1 All materials including those used for internals shall be procured with stage-wise inspection. Stage wise and final inspection of equipment and its components shall be carried out by following:

Inspection shall be carried out by EIL as per approved ITP's/QAP. Refer other section of bidding document for details.

- a. Virtual Monitoring for critical fabricated Equipment

"EIL / OWNER would review the actual job progress at place of fabrication/Manufacturing shop as & when desired or on monthly basis.

Vendor shall have provisions for showing live feed of job status / Work in progress at place of fabrication / shop floor for the ordered equipment by use of high-resolution cameras / helmet cameras or any suitable electronic device during virtual progress review. Recording of the job status (in soft) shall be captured & submitted to EIL / Owner after each review.

Vendor shall ensure that requisite facilities to show virtual job progress/ Work in Progress are available at their manufacturing shop/place of fabrication and in case these are not available same shall be installed within one month of award".

- 71.2 The Purchaser/EIL and Licensor also reserve the right to inspect the equipment at any time during fabrication and at final stage before dispatch and witness the testing.
- 71.3 During inspection, material certificates, shop test data, certificates for bought out components and other relevant information shall be furnished and testing done as required so as to ascertain that the specifications and quality is complied with. Original mill test certificates for all raw materials for pressure parts to be submitted to the inspection agency for acceptance.
- 71.4 Positive material identification (PMI) - Vendor shall ensure that all alloy steel and stainless steel material are properly identified and finally check tested by a PMI analyzer before dispatch of equipment as per EIL Specification 6-81-0001. Any comments by EIL/Owner shall be complied-with without time & cost implication.
- 71.5 In addition to stamping, the specifications & manufactures symbol as specified in ASME material specifications, on one of the ends the size of the stud shall be clearly punch marked. Similarly the nuts shall have the size punch marked on one of the faces. In case of tapped hole the size shall be punch marked near the hole without disturbing the gasket

seating area. Further for all alloy/SS metallurgy bolts & nuts shall also be identified by distinct color marking at the stud end/bolt side face.

- 71.6 Vendor shall carry out various tests as per applicable codes/standards. Any or all test including hydro / pneumatic test shall be witnessed at Purchaser's option by its authorized representative.

The presence of the inspector shall not reduce the obligation of fabricator to carry out his own tests and controls. Should any component and / or material be found not in compliance with requirements specified, the authorized inspector shall be entitled to reject them even if such non-compliance has not been evidenced in course of inspection or tests.

72. Preparation & Submission of Document Control Index (DCI):

Vendor shall prepare Document Control Index (list of those drawings, which are to be submitted to EIL along with the submission dates for each drawing) after placement of FOI. Vendor shall strictly adhere to this drawing submission schedule. Successful Vendor to submit DCI (document control index) and all the vendor data through vendor portal (<http://edocx.eil.co.in/vportal>) only. The detail guidelines for uploading the documents on vendor portal are available on the site itself.

Vendor to note that unscheduled documents (documents which are not listed in DCI) shall not be accepted by EIL. All vendor drawings/documents shall be submitted as scheduled document only.

73. TECHNICAL DOCUMENTATION REQUIRED WITH BID

The technical part of the bid document shall contain following:

- Duly filled in, signed and stamped Technical Compliance Sheet (Doc. No. B861-80-42-TCL-6002).

DESIGN & FABRICATION REQUIREMENTS FOR AIR HEATER

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

B	29.08.2024	ISSUED AS JOB SPECIFICATION	CSM	PKP	TK
A	11.06.2024	ISSUED AS JOB SPECIFICATION	CSM	PKP	TK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

Abbreviations:

ACHE	Air-cooled heat exchangers
AI	Authorised Inspector
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing of Materials
AWS	American Welding Society
BHN	Brinell hardness number
CA	Corrosion Allowance
CAF	Compressed Aramide Fibre
CS	Carbon Steel
DFT	Dry Film Thickness
DNV	Det Norske Veritas
DP	Dye Penetrant Test
DPDT	Double pole double throw
EIL	Engineers India Limited
FM	Factory Mutual
FRP	Fibre Reinforced Plastics
HAZ	Heat Affected Zone
HIC	Hydrogen Induced Cracking
HP	Horse Power
HTRI	Heat Transfer Research Institute
IEC	International Electrochemical Commission
I/P	Current to pneumatic converter
LAS	Low Alloy Steel
LP	Liquid Penetrant Test
LTCS	Low temperature CS
MDMT	Minimum design metal temperature
MP	Magnetic Particle Test
NACE	National Association of Corrosion Engineers
OD	Outside Diameter
PTC	Production test coupons
SS	Stainless steel
SPDT	Single pole double throw
STAAD	Software for structural design
UL	Underwriters Laboratory
UST	Ultrasonically Tested

A. SCOPE

This specification covers the general requirements for the thermal and mechanical design, materials, fabrication, workmanship, inspection, testing and supply of ACHE and is intended to supplement the minimum requirements of the applicable codes and standards.

This specification shall not be considered limiting and it shall be Vendor's responsibility to comply with all requirements of Material Requisition/Purchase Requisition/Bid Documents (referred to as enquiry documents), to which this specification is attached.

B. SPECIFIC REQUIREMENTS

The Standard applicable for ACHEs shall be API Standard 661, Seventh Edition July 2013 except to the extent modified hereunder. The section, paragraph and figure numbers refer to those used in API 661. "New" applies to entirely new paragraph presently not included and to be inserted in the numbering order of API-661. "Addition" applies to an addition to the original Para. "Modified" applies to modification of applicable portion of the API-661 Para.

4. GENERAL

4.1 (Modified) The pressure design code shall be ASME Section VIII Division 1, unless specified otherwise. Here in after referred to as Code.

5. PROPOSALS

5.10 (New) The proposal shall include power consumed by the motor and required motor kW.

6. DOCUMENTATION

Vendor shall furnish documents as per Vendor Data Requirements specified in the requisition.

7. DESIGN

7.1 Tube Bundle Design

7.1.1.8 (Addition) There shall be practically no air gaps in bolted joints (plenum to beam, in between parts of plenum etc.). However these gaps shall be limited to 0.5 mm (maximum).

7.1.1.13 (New) The bundle side frame shall have minimum 5 mm thickness for tube lengths less than 6 m and bundle width up to 2 m and shall have 8 mm thickness (minimum) for greater tube lengths or bundle widths. Only one joint is permitted in the frame. The weld, if any, shall be full penetration weld, shall be ground flush from inside and DP tested.

7.1.6.0 Type of header

7.1.6.3 Plug Headers

7.1.6.3.4 (New) For strength welded tube to tube sheet joint, if clearance between the top/bottom/side/partition plate and tube is less than 18mm or the plug size is less than tube OD plus 9mm, then Vendor shall demonstrate his experience by giving past references and by performing mock up to prove his capability in this regard. The mock-up shall be done before the submission of design or drawings.

7.1.7 **Plugs for Tube Access**

7.1.7.6 Plug shall not project into the header box.
(Addition)

7.1.8 **Gasket**

7.1.8.10 For plug headers, only solid soft metal gaskets are to be used.

7.1.9 **Nozzles and other connections**

7.1.9.5 All connections shall be flanged irrespective of flange rating.
(Modified)

7.1.9.7 Bolt holes shall straddle principal centrelines.
(Addition)

7.1.9.8 Fabricated transition pieces wherever indicated in this clause shall not be permitted.
(Addition) Swaged CS nozzles shall be normalised if the thickness exceeds 16mm or if they are not formed in the normalising range. Hot-formed SS nozzles to be solution annealed.

7.1.9.10 Slip-on flanges shall not be used.
(Modified)

7.1.9.11/12/15/18/21 Threaded connections shall not be used.
(Modified)

7.1.9.23 All process nozzles of 3"NB and above shall be provided with 3 no. stiffeners and process nozzles of 2"NB and below shall be provided with 2 no. stiffeners. Size of stiffener shall be 50 wide x 8thk.
(New)

7.1.10 **Maximum allowable moments and forces for nozzles and headers**

7.1.10.5 Minimum nozzle load shall be twice the API 661 limit. For Air coolers of 600# nozzle flange rating and above, the same shall be 3 times API 661 limit. Structural components shall be designed for these loads.
(New) Nozzle loads in excess of these loads, if specified by purchaser, shall be considered.

7.1.11 **Tubes**

7.1.11.3 For extruded fins (integral type) the minimum tube thickness applies to the inner tube.
(Addition)

7.1.11.5 Fins serrated on the outside edge may be used only for CS fins.
(Addition)

7.1.11.7 L-fins shall not be used.
(Addition)

7.1.11.14 The mechanical bond between tube and embedded fins shall be tested as follows:
(New)

- i) Cut fin to obtain a sector with a chord of approx. 12mm at the root of the fin.
- ii) Pull out the fin sector by hanging weights or any other appropriate method. Acceptance criteria shall be a force of at least 3.0 kg.

- iii) 1% of the total number of tubes per size, fin diameter, fin pitch shall be tested at two locations along the tube length. Tubes, which pass the test, may be used after stitching of fin portions across the cut.
- iv) In the event of any tube failing to comply with pull out test requirements, a further two tubes shall be re-tested and, if the results are satisfactory, the tubes can be accepted. If, however, the further test results are unsatisfactory, the entire lot of tubes shall be rejected.
- v) The pulling test shall not be carried out within 25mm from each fin connection point.

Two cross-section cutaways shall be made for inspection of tube grooving and fin bonding per each machine setting (i.e. one tube for each type of tube and fin detail and minimum one test per order).

7.2 Air side Design

7.2.1.2 (Addition) If the control of air flow is to be achieved by use of auto variable fans or variable speed drives at least 50% of the fans are to be made auto variable, unless specified otherwise. Auto variable fans or variable speed drives, if used, shall be located towards that end of the bundle where inlet nozzle(s) is/are located.

7.2.1.4 (Addition) Drivers, gear boxes, transmission components, instrumentation, louver actuator and positioner etc. shall not be installed in the hot air stream.

7.2.2 Noise Control

7.2.2.1 (Addition) Permissible noise level of the ACHE measured shall not exceed 85 dB (A) with all fans running at full load. Measurement shall be taken one meter from bundle on the header access walkways and 1 m from the bay limits on the motor maintenance platform. The permissible noise levels 1 meter below the motor shall be 90 dB (A) maximum. Vendor shall demonstrate these noise level limits during run-in tests. Vendor shall furnish noise datasheet after order.

7.2.3 Fans and Fans Hubs

7.2.3.1 (Modified) Two or more fans aligned in the direction of tube length shall be provided for each bay. All fans in a bay shall be arranged for independent operation. Common fans cooling more than one process duty shall be used only on approval from Purchaser.

7.2.3.5 (Addition) Fans shall be designed for a noise level of maximum 80dB (A), keeping in mind the overall limits as per 7.2.2.1. Fan tip speed shall be suitably selected. Fan manufacturer shall furnish noise level datasheet for fans.

7.2.3.17 (New) Fan shall be selected so that the design under fouled condition satisfies the following requirements with reference to fan performance curves:

- a) The design point shall lie on the performance curve for which fan blade angle is atleast 5degrees and preferably 10 degrees less than the largest blade angle at which fans operate satisfactorily.
- b) The design point shall not lie on the performance curve in proximity to the stall region which the manufacturer shall indicate in the fan curves.

- 7.2.3.18 (New) Approved suppliers for fans are MOORE (UK or USA), COFIMCO (Italy), HUDSON (USA) and ILMED VENTILAZIONE INDUSTRIALE (Italy).**
- 7.2.3.19 (New) Fan datasheet shall be forwarded to motor supplier and frame size shall be able to take all torque/ loads/ thrust imposed by fan. Vendor shall submit necessary calculation after order.
Vendor shall obtain and furnish the fan details from fan supplier as per the fan specification sheet including fan GD²value, torque vs speed curves, fan rpm etc. Vendor shall also furnish the drive make, motor make and frame size. Based on this data, the drive details shall be developed by vendor and submitted to CLIENT/EIL. Vendor shall furnish these drive details to the drive supplier and get the confirmation from him on the adequacy of the drive to transmit the required power. Vendor shall furnish to the motor supplier the requirements of GD², torque vs speed characteristics of fan and loads on motor from the drive affecting the selection of motor bearing, rating & frame size etc. Vendor shall ensure that the motor supplier has selected suitable motor as per motor specifications and datasheets for the conditions specified. Vendor shall obtain EIL approval for drive selection before procurement of the same.
- 7.2.4 Fan Shafts And Bearings**
- 7.2.4.0 (New) Fans shall be provided with QD bushes (minimum 10mm thickness) for attachment to fan shaft. Fan assemblies shall be fitted with their own thrust bearing situated at the drive end and a steady bearing at the outer end. The thrust bearing shall be capable of carrying any thrust loads transmitted by the driver. The thrust bearing inner race shall be mechanically locked by means of split rings to prevent accidental downward movement of shaft.
- 7.2.6 Fan Guards**
- 7.2.6.1 (Modified) Removable galvanised steel fan guard shall be provided on each fan for forced as well as induced draft units. A hinged door shall be provided on the fan guard of fan diameter greater than 2m, to attend to problems without removing entire fan guard.
- 7.2.7.2 Electric Motor Drivers**
- 7.2.7.2.1 (Addition) All electrical equipment shall be selected to suit the specified hazardous area classification, and the environment in which these have to operate. Area classification shall be as specified in the enquiry documents.
Vendor shall provide plate guards made from galvanized steel plates on the motor assemblies to avoid ingress of rainwater and capable of withstanding washing down by water hose. Details of the guards shall be developed by the vendor and submitted for information.
- 7.2.8 Couplings and Power Transmissions**
- 7.2.8.2 Belt Drives**
- 7.2.8.2 **Belt drives shall be high torque type, positive drive belts and shall be either HTD of Gates or Fenner; PG-GT of Gates; or TORQUE DRIVE PLUS of Fenner unless specified otherwise by the Purchaser.**
- 7.2.8.2.4 (Addition) Belt drive tensioning means shall be adjustable without the need to remove the guard and without losing the alignment of the pulleys.

7.2.8.2.14 (New) Pulley wheel shall be of cast iron or steel. All pulleys shall be dynamically balanced. Pulleys shall be thoroughly cleaned of rust, grease, and dirt and shall be shop coated. Belt drive pulleys shall be supplied by Vendors approved by belt supplier indicated in Para 7.2.8.2.1 and shall be certified accordingly.

7.2.8.2.15 (New) Belts shall be heavy duty, oil resistant, antistatic, fire resistant and have neutral twist and shall be selected to suit the specified hazardous area classification. Belt drives shall not be used for offshore applications where only gear box shall be used.

Vibration switches

7.2.9 (New) "Bidder to note that vibration cut-out switches shall be provided as per Cl 7.2.9 B of 6-15-0071.

Vibration switches shall be with gold plated DPDT contact with rating 24V DC, 2 Ampere. This shall supersede clause 7.2.9 B Point c of 6-15-0071."

7.2.10 Louvers

7.2.10.15 (Addition) Requirements for each pneumatic actuator:

- (a) The positioner shall have mechanical pneumatic louver position feedback. For electrical or electronic control signals, a I/P converter located at grade or local platform shall be used.
- (b) Each change in signal shall give a proportional change in louver angle from fully closed to fully open repeatable to within 5 degrees for the same instrument air pressure signal, increasing or decreasing.
- (c) There shall be a minimum of one actuator per bay, a minimum of one actuator per unit and minimum of one actuator per 15 m² of louver surface area.
- (d) The actuators shall be suitable for an air supply pressure of 9.5 kg/cm² (g) design, 7 kg/cm² (g) normal and 2.5 kg/cm² (g) minimum. Purchaser will specify the exact air supply pressure. Any pressure reduction system on the supply air shall be in Vendor's scope.
- (e) The signal to actuator shall be 0.2 to 1.0 kg/cm² (g) for fully closed to fully open position unless specified otherwise.

7.2.10.17 (Modified) Where a single controller operates more than one actuator, isolation valves or other means shall be provided by Vendor to allow maintenance.

7.2.10.19 (Modified) With loss of control air pressure the louver shall lock in at 'fully open position' unless specified otherwise.

7.2.10.20 (Addition) Provision shall be kept for manual operation of all louvers.

7.2.10.21 (Addition) Provide legible indicator that indicates "angles of louver blade" and "open" or "closed" position.

~~7.2.10.26 Approved suppliers for louvers are CHITTOM (Calgary, Alberta, Canada), AIRCO FIN (Holland) and GEI Hamon Industries (India).~~

7.3 Structural Design

7.3.1.5 (Modified) For induced draft units, tube bundles shall be removable without requiring removal of the platforms. For forced draft units, the bundles shall be removable without separately supporting or dismantling of the fan, plenum, or platforms and without requiring disturbance of the structure or adjacent bays.

7.3.1.7 (New) The structural design shall be done on a reputed software package based on stiffness method of analysis e.g. STAAD PRO. Spliced joint is not permitted in columns and bracings. Beams of length 6 m and below shall not have a splice joint, however for length above 6 m one splice joint may be permitted subject to the following:

- i) It is not located at the point of maximum bending moment or shear.
- ii) It shall be full penetration weld duly DP tested.
- iii) Suitable size of connecting plate shall be welded on both sides of the web and preferably inside of flange.

7.3.1.8 (New) In order to meet the vibration requirements it is preferred that the drive assembly shall not be suspended from plenum but supported on the main column.

7.3.1.9 (New) The structural assembly shall be done by bolting only so that the same can be easily dismantled. However, structural modules like platforms and brackets may be pre-welded and bolted to columns at site. Steel structure shall be shop assembled (where possible) and match marked before despatch.

7.3.1.10 (New) Piping support loads on structure, if specified by Purchaser, during detailed engineering shall be considered by Vendor.

7.3.2 Vibration Testing

7.3.2.2 (Addition) Vibration check shall be made on each motor (both driving and non-driving ends). Motor base plate, fan or motor supporting beams, main structure columns with all machines running individually and also with all machines running together at their full load. Motor and bearing blocks shall also be checked for any abnormal heating by running all the machines for sufficient time. Vendor shall arrange necessary instrumentation for carrying out the vibration check; and shall carry out modifications, if required.

7.3.3 Structural Design Loads and Forces

7.3.3.5 (Addition) Thermal force reaction shall be based upon an effective coefficient of friction equal to 0.3.

7.3.4 Plenums

7.3.4.6 (Modified) Minimum thickness of steel sheet material used in construction of plenums shall be 2.8 mm (12 gauge) minimum, if the construction is transition type or straight box type. If it is inclined panel type as in case of induced draft then the minimum thickness shall be 3 mm for fan diameter up to 1.2 m (i.e. 4 feet) and 4 mm for larger size of fans.

7.3.5 Mechanical Access Facilities

7.3.5.1 Access platform shall be provided on all four sides of a continuous bank of bundles.
(Modified) Stair shall be provided on one side and ladder on the other side.

7.3.5.2 Maintenance platform shall be provided, unless specified otherwise, beneath each
(Modified) drive assembly to provide access for removal and replacement of all drive components. An unobstructed platform area extending at least 900 mm in any plan dimension on all sides of the driver and drive components shall be provided. However such platforms shall not extend beyond the bay plan limits. Ladders shall be provided for access to induced fan for maintenance.

Fan and motor assemblies shall be designed for remote lubrication from maintenance platform without shutting down the equipment. Suitable SS tubing (1/4" diameter) shall be provided outside the fan and motor guards to permit lubrication of fan shaft bearing and motor shaft bearing without shutting down the fans and/or motors. These connections shall be accessible from maintenance platform and terminated at one point. Vendor to develop detailed drawing.

7.3.5.3 Platform for header access shall have minimum clear width of 900 mm.
(Addition)

7.3.5.4 Grating shall be provided. These shall be anti-skid type, removable with maximum
(Addition) length of 1.5 m.

~~7.3.5.9 Headroom clearance of 2400mm below motor suspension shall be maintained.~~
(New)

7.3.6 Lifting Devices

7.3.6.1 Positioning of lifting lugs shall be such that horizontal balance of bundles is obtained.
(Addition)

8. MATERIALS

8.1.1 All materials shall be new. Material of construction as specified in the
(Addition) requisition or data sheets in the general terms. Materials shall conform to relevant ASME specifications, or equivalent thereof.

8.1.8 Tubes (New)

- i. Actual yield strength and maximum hardness of tubes should be checked at the time of procurement and it should be ensured that these are lower than those of tube sheet, in order to achieve a sound expanded tube-to-tube sheet joint.
- ii. Tubes shall be eddy current tested in addition to hydro test at the mill. For eddy current testing entire metal column of the tube shall be used.
- iii. Hydro test pressure shall be higher of actual exchanger pressure or as required as per ASME Section II.

8.1.9 All pipes shall be seamless and hot finished. Dimensions and tolerances shall be in
(New) accordance with ASME 36.10 or 36.19 as applicable per material specification.

~~8.3 Louvers~~

~~8.3.2 Louver bearings shall be guaranteed for life and shall never require lubrication.~~
(Addition)

~~8.3.3 Louver blades shall be made of corrosion resistant material like aluminium. Louver frame shall be made of aluminium or steel. Steel louver frames shall be hot dip galvanized.~~
(Modified)

8.4 Other Components

8.4.1 Aluminium fin material shall not be less than 99.5% pure (SB 209 Alloy 1060)
(Addition) For offshore applications fin shall be to SB 209 Alloy 3003 Temper O.

8.4.2 **Fan blade material**
(Modified) Fan blades shall be of aluminium alloy. Aluminium alloys for fan blades shall be selected to be resistant to stress corrosion cracking. Fan hub and blade material shall be non-sparking type. Copper content in aluminium blade should not exceed 0.4%.

8.4.6 Solid metal gaskets for shoulder plugs shall be dead soft annealed. It is recommended that Soft Iron and Soft SS gaskets for plugs shall have hardness of minimum 15 BHN less than the material of plug and plug sheet. Hardness of Soft Iron gaskets shall not exceed 90 BHN and that of Soft SS gaskets shall not exceed 140 BHN. This shall be a hold point for AI.
(Modified)

8.4.7 Fan shaft shall be to either SA 105 or EN 24 (hardened and tempered and UST). CS pipes may be used for shaft housing. Bearing housing shall be to SA 105.
(New)

8.4.8 Material for instrumentation valves and tubing shall be SS. All instrumentation shall be suitable for the hazardous area classification for electrical safety.
(New)

9. FABRICATION

9.1.1.1 All welding procedures shall be submitted to AI for approval. All welding shall be done with electrodes, fillers and fluxes of reputed make with proven reproducibility of results. Brand names shall be specifically approved by AI. Only low hydrogen electrodes shall be used for all CS pressure parts welds.
(Addition)

9.1.1.3 Backing strips shall not be used.
(Addition)

9.1.1.5 Repairs to base material and welds shall not be made without the approval of the AI.
(New)

9.1.1.6 Non-pressure attachments, such as lugs or structural steel supports, shall be attached to the pressure parts with a continuous weld. All double fillet welds in contact with hydrogen stream shall be vented. All LAS weld attachment to pressure retaining component shall be full penetration weld and ground to a smooth concave contour.
(New)

9.1.2 Plug Headers

9.1.2.1 Partition plates and stiffening plates to plugsheet and tubesheet welding shall be full penetration welds.
(Modified)

9.3 Tube-to-tube sheet Joints

9.3.3 Expanded tube-to-tube sheet joints

9.3.3.0 Expanded tube-to-tube sheet joints shall be in accordance with EIL specification no.

(New) 6-15-0004.

9.3.4 Welded tube-to-tube sheet joints

9.3.4.0 (New) Unless otherwise specified in mechanical datasheets, Welded tube-to-tube sheet joints shall be in accordance with EIL specification no. 6-15-0003 for ferritic and austenitic materials. Seal welded joints are not acceptable.

9.6 Alignment and Tolerances

9.6.1 (Addition) Gasket flange faces on stacked units shall not be out of parallel by more than 0.8 mm (1/32 inches).

9.6.5 (New) The face of each gasket contact surface shall lie between two parallel planes 0.8 mm (1/32 inches) apart.

9.6.6 (New) Tolerance on tube length after fining shall be -0mm, +3.0mm
Tolerance on fin OD shall be -0mm, +0.8mm

9.8 Finishing

(New) All welds in the area 250 mm from the ends in the bottom of header (where the header is resting on frame channel) shall be ground flush. In a split header all welds in bottom plate of top header and top plate of bottom header shall be ground flush. Inside corners of openings for nozzles to be rounded off to 3 mm radius.

10.1 Quality Control

10.1.2 Radiography

(Modified) Minimum radiography shall be spot. Radiography shall be 100% if the thickness of weld exceeds code requirements. For hydrogen, lethal, sour, amine and caustic service 100% radiography shall be done irrespective of thickness.

Radiography can be substituted by 100 % UST provided either a print out is submitted or AI witnesses the examination. If radiography is being substituted by UST, magnetic particle examination shall be carried out in addition to UST.

Wherever radiography is indicated as full all long and circumferential seams including flange to neck, pipe to pipe and pipe to fitting shall be 100% radiographed.

10.1.6 (Addition) When set-on connections are used, the header plates shall be UST in the area of attachment for a radial distance equal to twice the thickness of plate and no laminations shall be permitted.

10.1.8/9 (Modified) Tubes shall be manufactured full length without any circumferential welds.

10.1.12 (New) All nozzle attachment welds and pass partition plate to header plate attachment welds shall be examined by MP or LP test for crack detection. Examination shall apply to root pass after back chipping or flame gauging (where applicable) and to the complete weld.

10.1.13 (New) When impact tests are required on material as per Code or specification the welds shall also be qualified for impact test. In such case following special requirements shall apply to the welding procedure qualification:

- i) Qualification tests shall be made on plates of the ASME specification as specified for the ACHE using welding electrodes of AWS/SFA specification and wire & flux of the specification and brand as are to be used on the job.
- ii) Welding current and travel speed shall be considered essential variables in order to ensure that production welding is substantially equivalent to the procedure qualification.
- iii) Welded test plates shall be subjected to a total thermal history expected of the finished ACHE. Additionally one extra stress relieving cycle shall be considered for site repair.
- iv) Charpy V-notch impact tests shall be made on the weld and heat affected zone of the test plate for each welding procedure to be qualified. Test procedure shall be in accordance with UG 84 of Code. Test temperature shall be MDMT. Impact energy requirements shall be as per Table 2.15 of SA 20 of ASME Sec. II Part A or UG 84 of Code whichever is stringent.

10.1.16 (New) In addition to stamping the specification and manufacturers' symbol as specified in ASME, on one of the ends the size of the studs shall be clearly punch marked. Similarly the nuts shall have the size punch marked on one of the faces. In case of tapped hole the size shall be punch marked near the hole without disturbing the gasket seating area. Further for all alloy and SS bolts & nuts shall also be identified by distinct colour marking at the stud end and bolt side face.

10.2 Pressure Test

10.2.3 (Modified) Potable water with chlorides less than 25 ppm by weight shall be used in hydrostatic testing of units with SS or monel materials exposed to the test medium.

11. PREPARATION FOR SHIPMENT

11.1 General

11.1.1 (Modified) All units shall be dry, thoroughly cleaned and free from loose scale and other foreign matters before shipment.

11.1.2 (Addition) Tube bundles shall be completely dried by passing hot air for sufficient time until no increase in relative humidity of outgoing air is observed. After drying all CS and LAS bundles shall be purged with dry nitrogen at 0.25 kg/cm². The bundle shall be provided with pressure gage to monitor nitrogen pressure and 1/2" non-return valve.

11.1.3 (Modified) All connections not provided with blind shall be provided with gasketed steel covers fastened by four bolts or 50% of the required flange bolting whichever is greater.

11.1.6 (New) Fin tubes shall be protected with heavy-duty wire mesh duly stiffened to prevent damage by personnel walking on top during shipping, handling, erection etc. The protective cover including the heavy-duty wire mesh shall be hot dip galvanised.

MATERIAL OF CONSTRUCTION FOR AIR HEATER

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

A 11.06.2024

ISSUED FOR BIDS

CSM

PKP

TK

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
MATERIAL OF CONSTRUCTION: ITEM No.		701-EA-1001A TO 701-EA-1028A (28 BUNDLES), 701-EA-1001B TO 701-EA-1028B (28 BUNDLES), 701-EA-1001C TO 701-EA-1028C (28 BUNDLES), 701-EA-1001D TO 701-EA-1028D (28 BUNDLES), 701-EA-1001E TO 701-EA-1028E (28 BUNDLES).			

Following materials shall be used for all air cooled heat exchanger components unless specified otherwise:

S. NO.	NAME OF PART	MATERIAL	REMARKS
1.	TUBE SHEETS	SA 516 GR 60	
2.	PLUG SHEETS	SA 516 GR 60	
3.	TOP/ BOTTOM /SIDE PLATES	SA 516 GR 60	
4.	STIFFENING/TENSION STRIPS/ PARTITION PLATES	SA 516 GR 60	
5.	PLUGS/COUPLINGS PLUGS/ NOZZLE FLANGES/ EYE BOLTS / LWN	SA 105	
6.	NOZZLE PIPES	SA 106 GR B	
7.	BLOCKS	SA 516 GR 60	
8.	PLUG GASKETS	Soft Steel (Note-1)	
9.	NOZZLE STUDS/NUTS	SA 193 GR.B7M/ SA 194 GR.2HM	
10.	TUBES (WITH EXTRUDED FINS)	SA 179 (ANNEALED)	
11.	FINS	ALUMINIUM (SB 209 ALLOY 1060)	
12.	NAME PLATE / BRACKET	SS / SA 516 GR60	
13.	LIFTING LUGS	SA 516 GR60	
14.	HALF TUBE SUPPORTS	ALUMINIUM	
15.	BUNDLE FRAME BOLTING	S275JR CONFORMING TO BS EN10025 / SA 516 Gr. 70	
16.	NOZZLE GASKETS	SPWD (Note-2)	
17.	SPACER PLATES	STAINLESS STEEL (SS316L)	
18.	EQUAL TEE/PIPE FITTINGS	SA234 WPB	

Notes:

- Soft iron gaskets for plug shall have hardness of min. 15 BHN less than the material of plug or plug sheet. In no case the hardness of the gasket shall exceed 90 BHN.
- Spiral Wound Gaskets for nozzles shall be 4.5 thk with grafoil filler and 3.2 thk inner and outer ring. Dimension as per ASME B16.20.
- All CS Materials (pressure parts) shall be fully killed.
- Tubes (CS) shall be fully killed and in annealed condition.
- Hardness of Base Metal, Weld metal and HAZ shall be limited to 200 BHN for all CS materials in contact with process fluid.

SPARE LIST FOR AIR HEATERS

B	27.08.2024	REISSUED WITH MR	CSM	PKP	TK
A	11.06.2024	ISSUED WITH MR	CSM	PKP	TK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1.1 Mandatory Spares:

The following mandatory spares shall be included by the Vendor in the quoted base price:

Sl. No.	Part Description	Quantity Required
Static Equipment		
1.	Gaskets for nozzles with blind flanges	400%
2.	Gaskets for plugs	200%
3.	Plugs	20%
4.	Belts	100%
5.	Bearings	100%
6.	Bolts & nuts for all nozzles with Blind Flange	20% (minimum 4)
7.	Set of Hub (Drive & Driven), pulley (Drive & Driven) and lock bush	5%
8.	Fan drive shaft with lock nut	5%
9.	Fan Assembly	5%

Vendor shall ensure that mandatory spares are shipped along with the main equipment.

1.2 Commissioning Spares & Special Tools and Tackles:

Commissioning spares and Special Tools & Tackles are to be recommended and supplied by the Vendor. **Price for the same shall be included in base price.**

Vendor shall ensure that all spares required for commissioning of the plant / equipment based on his experience of similar past projects and as recommended by the equipment manufacturer are procured in time and are available before commissioning.

Any commissioning spare and special tools & tackles which are required over and above than the list (recommended by Vendor) shall be provided free of charge by Vendor. Any leftover (unused) spares after commissioning, out of those included by Vendor in his offer, shall be handed over to the owner.

1.3 Two Years Operation & Maintenance Spares:

List of additional spares (with quantity) required over and above mandatory spares for 2 years operation and maintenance shall be recommended by Vendor along with the offer. **Price for the same shall not be included in base price and to be quoted separately.**

NOTES:

- Wherever % age is identified, Vendor shall supply next rounded figure.
- The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.

FAN DATA SHEET FOR AIR HEATER

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

B	27.08.2024	ISSUED FOR BIDS	CSM	PKP	TK
A	11.06.2024	ISSUED FOR BIDS	CSM	PKP	TK

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
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FANS FOR AIR COOLED HEAT EXCHANGERS

FAN CATEGORY		1	2	3	4	5				
	DIAMETER (FT)	17					<p style="text-align: center;">INLET CONE AND FAN RING DETAIL</p>			
	NO. OF BLADES	*								
	MATERIAL OF BLADES	ALUMINIUM								
	PITCH ADJUSTMENT (AUTO/MAN)	MANUAL (NOTE-1)								
	PITCH AT FAIL SAFE POSITION MIN/MAX/IN POSITION									
	HUB MATERIAL	@								
BORE DIAMETER (mm)	**									
BY VENDOR	FAN MAKES, CLASS, SERIES, FAN WEIGHT, GD2, AND TORQUE VS SPEEDCURVE, BUSH NO. AND DETAIL, FAN INLET RING DETAIL AND SHAFT LENGTH ETC.					} *				
EXCHANGER ITEM NO.	QUANTITY REQUIRED		AIR QTY/FAN Kg/hr.	STATIC PRESSURE mm H2O	RPM	PITCH ANGLE	ABS FAN HP (EACH)	MOTOR HP*** (EACH)		
701-EA-1001A to 701-EA-1028A	28		510715	11.7	*	*	32(2)	40		
701-EA-1001B to 701-EA-1028B	28		510715	11.7	*	*	32(2)	40		
701-EA-1001C to 701-EA-1028C	28		510715	11.7	*	*	32(2)	40		
701-EA-1001D to 701-EA-1028D	28		510715	11.7	*	*	32(2)	40		
701-EA-1001E to 701-EA-1028E	28		510715	11.7	*	*	32(2)	40		
TOTAL QUANTITY REQUIRED	140									

@ ALUMINIUM, STAINLESS STEEL OR CS HUB MATERIAL SHALL BE HOT DIP GALVANISED OR ZINC PLATED.

*TO BE FURNISHED BY VENDOR.

** VENDORS RESPONSIBILITY.

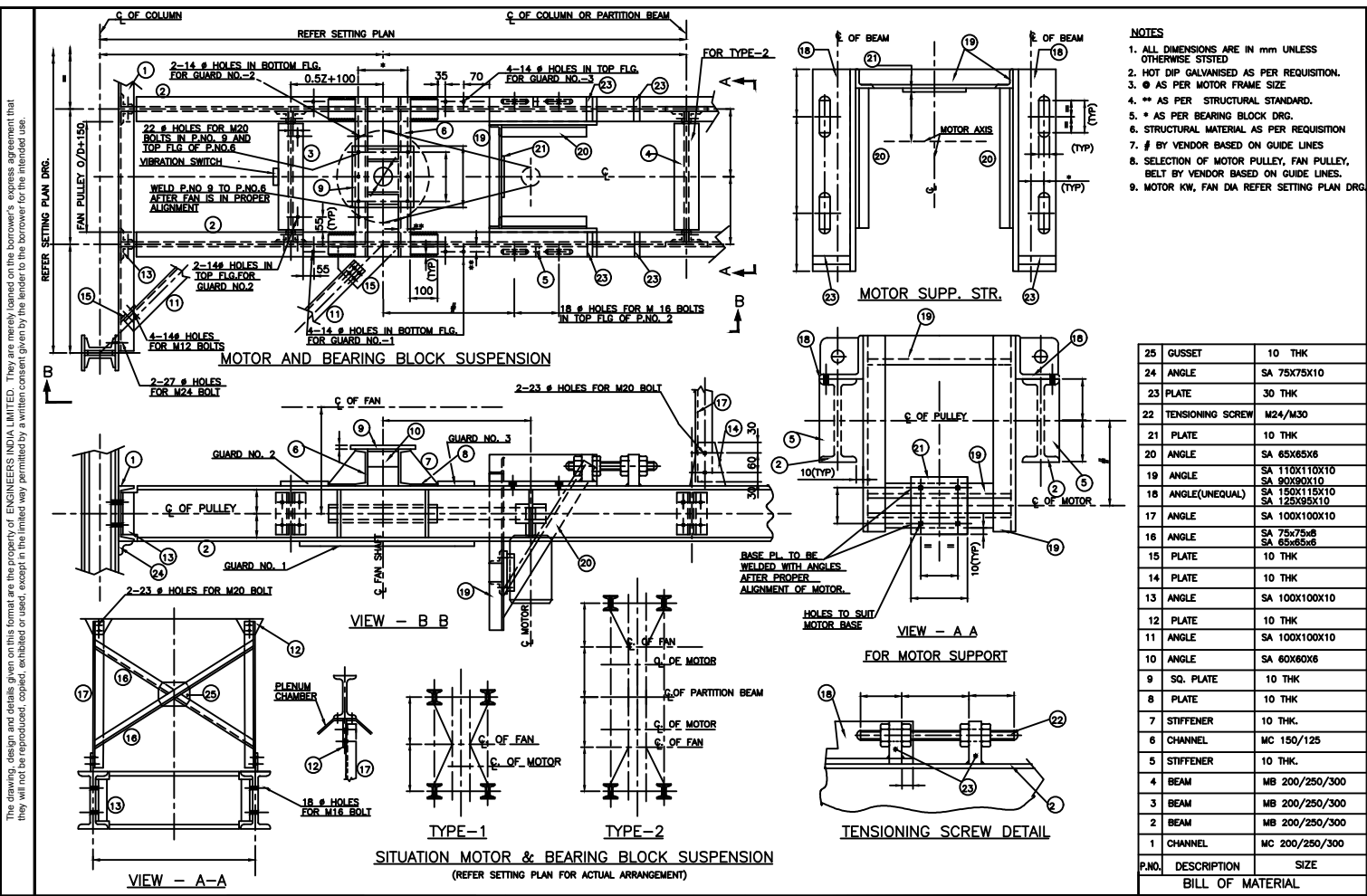
*** HP INDICATED IS MINIMUM ACCEPTABLE. HIGHER HP IF REQUIRED SHALL BE PROVIDED BY VENDOR WITHOUT ANY COST & TIME IMPLICATION.

NOTE:-

- ALL FANS ARE OF MANUALLY ADJUSTABLE PITCH TYPE AS MENTIONED IN THE RESPECTIVE SETTINGPLAN.
- POWER CONSUMPTION PER FAN AT AMBIENT AIR TEMPERATURE OF 23 °C SHALL NOT EXCEED THE VALUE SPECIFIED. FAN SUPPLIER SHALL CONFIRM THIS DATA WITH SUPPORTING CALCULATIONS.
- FANS ARE TO BE SUITABLE FOR OPERATION AT MINIMUM AMBIENT AIR TEMPERATURE OF 10 °C.

4. Minimum air temperature 10 deg C and maximum air temperature 40.6 deg C
5. Air humidity minimum 0% to 100%.
6. Bearings of fans and motors to have individual vibration probe extension or frame to have provision of taking vibration physically.
7. **Layout of the air heaters should be such that cold air does not form a closed loop affecting efficiency adversely and fog formation does not effect visibility.**
8. Air heater structure shall be provided with appropriate penetration sealers to provide barrier against the penetration of moisture and ingress of chlorides.
9. The design of air heater shall ensure proper condensate collection & quick removal of condensed water from air heater system to reservoir.
10. Permanent maintenance facility for air heaters shall be provided
11. Mechanical equipment should be preferably located above tube bundle to avoid being exposed to water drops from the tube bundles.
12. Ensure easy cleaning of the tube bundle.
13. Complete air heater loop (i.e. Including piping and tube bundle shall be chemically cleaned before commissioning.
14. Air heater fans should be of low rpm.
15. Start/ Stop push buttons to be provided at Air heater platform. Stop push button to be provided at Grade level also
16. Provide vibration transmitter for each air heater unit.
17. The configuration of this Air Heaters shall be as per plot plan available in requisition
18. Manual adjustable 2 pitch fan blades shall be considered

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- NOTES**
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED
 2. HOT DIP GALVANISED AS PER REQUIREMENT.
 3. Ø AS PER MOTOR FRAME SIZE
 4. ** AS PER STRUCTURAL STANDARD.
 5. * AS PER BEARING BLOCK DRG.
 6. STRUCTURAL MATERIAL AS PER REQUIREMENT
 7. # BY VENDOR BASED ON GUIDE LINES
 8. SELECTION OF MOTOR PULLEY, FAN PULLEY, BELT BY VENDOR BASED ON GUIDE LINES.
 9. MOTOR KW, FAN DA REFER SETTING PLAN DRG.

P.NO.	DESCRIPTION	SIZE
25	GUSSET	10 THK
24	ANGLE	SA 75X75X10
23	PLATE	30 THK
22	TENSIONING SCREW	M24/M30
21	PLATE	10 THK
20	ANGLE	SA 65X65X6
19	ANGLE	SA 110X110X10 SA 90X90X10
18	ANGLE(UNEQUAL)	SA 150X115X10 SA 125X85X10
17	ANGLE	SA 100X100X10
16	ANGLE	SA 75x75x8 SA 65x65x6
15	PLATE	10 THK
14	PLATE	10 THK
13	ANGLE	SA 100X100X10
12	PLATE	10 THK
11	ANGLE	SA 100X100X10
10	ANGLE	SA 60X60X6
9	SO. PLATE	10 THK
8	PLATE	10 THK
7	STIFFENER	10 THK.
6	CHANNEL	MC 150/125
5	STIFFENER	10 THK.
4	BEAM	MB 200/250/300
3	BEAM	MB 200/250/300
2	BEAM	MB 200/250/300
1	CHANNEL	MC 200/250/300

ENGINEERS INDIA LIMITED
NEW DELHI

JOB NO. : B861 UNIT : 701
CLIENT M/S KONKAN LNG LIMITED
PLANT KLL LNG PLANT

REV.	DATE	REVISION	BY	CHK	APPROVED
A	12.06.2024	ISSUED FOR BIDS/ENGG	NS	CSMPKP	TKR

TYPICAL DETAIL OF MOTOR SUSPENSION ASSEMBLY WITH HTD BELTS (FOR REFERENCE ONLY)

DRAWING NO.	REV.
B861-701-80-42-SK-3009	A

SHEET 1 OF 1

GUIDELINES TO VENDOR FOR BELT SELECTION

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER SYSTEM

CLIENT : M/S KONKAN LNG LIMITED

JOB NO : B861

B	27.08.2024	ISSUED FOR BIDS	CSM	PKP	TK
A	11.06.2024	ISSUED FOR BIDS	CSM	PKP	TK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. Belt pulley selection shall meet the requirements of the requisition and shall be as per the procedure given in the belt manufacturer's catalogue with the following limitations:
 - a) Belt width shall not exceed the smaller pulley outer diameter.
 - b) Fan shaft centre to motor shaft centre distance shall not exceed 8 times the smaller pulley diameter.
 - c) Belt service factor shall be minimum as specified in the requisition. Design power is belt service factor multiplied by the motor kW.
 - d) No. of teeth of smaller pulley in contact with belt shall be not less than 6.
 - e) "8M" belt pitch shall not be used for above 15 kW. of motors.
 - f) "3M" and "5M" belt pitches shall not be used.
2. ~~Bearing block drawing dimensions~~
 - a) ~~Dimension 'A' = Distance from Centre line of fan to QD bush edge + 2.5 mm~~
 - b) ~~Dimension 'B' = Fan QD bush length~~
 - c) ~~Dimension 'C' = 0.5* (taper lock bush length) + 2.5 mm~~
 - d) ~~Dimension 'D' = taper lock bush length~~
3. Small pulley centre line to motor centre line distance ("~~E~~" in motor suspension detail) shall be decided based on the following:
 - a) Small pulley taper lock bush centre to be located midpoint of motor shaft key.
 - b) Pulley rim shall clear motor casing by at least 25mm.
4. Fan and pulley guards shall be provided such that gap between structural member & guard is 5 mm (max).

JOB SPECIFICATION (ELECTRICAL) FOR AIR HEATERS

PROJECT : EPCM SERVICES FOR AMBIENT AIR HEATER PROJECT

OWNER : M/S KLL

JOB NO. : B861

B	21.08.2024	REVISED & ISSUED WITH MR	CS	RKS	ANPS
A	28.05.2024	ISSUED WITH MR	CS	RKS	ANPS
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1.0 GENERAL

- 1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the air heaters of AAH Project at KLL, DHABOL. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the material Requisition. In case of any conflict amongst various documents enclosed with MR, the most stringent requirement shall govern and Owner/EIL decision in this regards shall be final.
- 1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2.0 SCOPE

- 2.1 Vendor's scope, in each case, shall include sizing, design engineering, manufacturing, supply, testing at manufacturer's works, packing and delivery at site of electrical equipment including supply of all commissioning spares, mandatory spares, special tools & tackles and quotation for two years recommended spares as per the specifications and data sheets enclosed with the requisition. The major electrical equipment's involved are:-
- Main Motors for Air heaters Fans as per enclosed data sheet.
 - LCS (one at grade level and another at elevation near motor) with canopy for each Air Heater Fan
 - Vendor's scope shall include erection and Testing of each motor and LCS along with connected Fan. The location of LCS at ground level shall be around 15 meters near to Air heater area. Exact location shall be informed during detail engineering.
 - Vendor's scope shall also include the trial run of all the Fans with motors and assistance during pre-commissioning and commissioning activities of all Electrical equipment's under the Air heater package.
 - Motors shall be provided with vibration probes (X, Y axis) for measuring bearing vibration (as applicable)
 - Vendor shall supply cable glands and tinned copper lugs for equipment supplied by them.
 - Inspection & testing as per the applicable standard specification & inspection test plan attached with the MR for electrical items.
 - Mandatory spares for motors.
 - Two-year operation and maintenance spares.
 - commissioning spares as recommended by the equipment manufacturer.
 - Special tools and tackles required, if any, for erection, site assembly and maintenance of motors as recommended by the equipment manufacturer.
 - Any other electrical equipment not specifically mentioned above but required for normal operation of the Air cooler Fans.
 - All data & drawings as per vendor data requirements, data sheets, specifications and referenced codes and standards.

3.0 EXCLUSIONS

- 3.1 Supply of 415V feeders for motors, other misc electrical loads.
- 3.2 Supply and laying of all power, control cables from field to Substation.
- 3.3 Earthing grid outside skid.
- 3.4 All cable trays / trenches for owner's cables

4.0 UTILIZATION VOLTAGE

Utilization voltage for motor, anti-condensation heaters based on their ratings shall be as listed below:

- | | | | |
|-----|---------------------------|---|-------------------------------|
| a.) | Motors rated upto 160kW | : | 415V \pm 10%, 50Hz \pm 3% |
| b.) | Anti-condensation heaters | : | 240V \pm 10%, 50Hz \pm 3% |

(For 22 kW and above)

c.) System fault level : 65kA for 1 second

5.0 SITE CONDITIONS

The equipment and the installation shall be suitable for continuous operation under the following site conditions:

Altitude above MSL : Less than 1000m above MSL
Seismic Zone : As per IS-1893
Environment : Dusty, Tropical & Corrosive as in Hydrocarbon Industry.

6.0 The temperature profiles at site location are tabulated below:

Location	Maximum/ Minimum Ambient Temperature	Equipment design temperature	Humidity
KLL, Dhabol	38.9 °C / 10 °C	40 °C	90%

7.0 SPECIAL REQUIREMENTS

7.1 Motors shall fulfill the following requirements: -

7.1.1 MV motors (<1100V) shall conform to EIL Specification 6-51-0064 and motor data sheet no. B861-701-16-50-DS-6002. All motors shall be IE3 type, all motors rated 22kW and above shall be provided with space heater. Separate terminal box shall be provided for the same.

7.1.2 All opening in the motor terminal boxes shall be supplied with blanking plugs so that the motor is transported with sealed terminal boxes.

7.1.3 The enclosure type / area classification for motors Local control stations (LCS) shall be as listed below:

Sr. No.	Tag No.	Motor starting	Enclosure Type	Area Classification
1.	701-EA-1001A TO 701-EA-1028A, 701-EA-1001B TO 701-EA-1028B, 701-EA-1001C TO 701-EA-1028C, 701-EA-1001D TO 701-EA-1028D, 701-EA-1001E TO 701-EA-1028E	DOL	Industrial, IP-65	Safe area
2.	LCS near motor (for S.no 1 above)	one at grade level and another at elevation for each motor	Industrial, IP-65	Safe area

7.2 Motors shall not have dual winding.

7.3 External fan cooled/water cooled motors shall not be preferred.

7.4 For MV motors PTC thermistor shall be provided where process/DCS monitoring is required.

7.5 Motors shall be provided with vibration probes (X, Y axis) for measuring bearing vibration

- 7.6 Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.
- 7.7 All performance parameters for MV motors shall be as per IS 12615 for IE-3 except starting current. For all MV motors, starting current shall be limited to max. 700% subject to IS tolerance.
- 7.8 Vendor shall supply cable glands and tinned copper lugs for all equipment supplied by them. For outdoor equipment, double compression type Nickel plated brass weatherproof (min IP 55) cable glands shall be supplied. Cable glands to be supplied with the vendor supplied equipment's (outdoor installation) shall meet all the requirement of IS/IEC-60079. Cable lugs shall be crimping type. All cable lugs shall be long barrel type. Lugs having sector shaped or circular barrel shall be used for making connections for cables having sector shaped or circular geometry of conductor respectively. Material of lugs shall be selected as given below:

Sr. no.	Description	Material
1	Copper conductor cable & copper bus bar/ terminals	Tinned Copper
2	Copper conductor cable & Aluminium bus bar/ terminals	Bi-metallic(tinned Cu barrel with Al palm)
3	Aluminium conductor cable & Copper bus bar/ terminals	Bi-metallic(Aluminium barrel with tinned copper palm)
4	Aluminium conductor cable & Aluminium bus bar/ terminals	Aluminium

- 7.9 GI canopy shall be provided for all outdoor equipment.
- 7.10 All opening in the motor terminal boxes shall be supplied with weatherproof (min. IP 65) blanking plugs so that the motor is transported with sealed terminal boxes. The cable entries of all terminal boxes of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized weatherproof (IP 65 minimum) Metallic Sealing Plugs to prevent water entry/ingress in motor windings through openings meant for cable entry in terminal boxes at construction site till the time motors are erected and cable terminations are carried out. However, same will be replaced by associated flameproof cable glands and lugs to be also supplied by Contractor along with motors as specified in MR.
- 7.11 Vendor to provide mounting arrangement for vibration probes on motor (for other details pertaining to vibration probe refer elsewhere in MR).
- 7.12 Structural Supporting arrangement for Owner's cable trays, lighting fixtures and lightning rods (air terminals) for lightning protection system wherever required shall be provided. Exact details shall be provided during detail engineering.
- 7.13 Field ammeters shall be provided for all motors above 5.5kW.
- 7.14 Variation / Clarifications against the standard specification of MV Motor 6-51-0064 shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.
- 7.15 Cl.6.3.1 of specification 6-51-0064 Rev.2 stands modified as below:
"The minimum degree of motor enclosures including terminal boxes and bearing housing shall be **IP-65** as per IS/IEC"
- 7.16 Each motor shall have a separate push button station for motor. LCS shall be provided with separate push button for start, stop, local/ remote selector switch, auto/manual selector switch as per operation requirement. Analogue ammeter shall be provided for all motors > 5.5 kW. All the STOP Push buttons, Emergency STOP push buttons shall be shrouded type only.
- 7.17 The Local control stations (LCS) shall conform to EIL spec no. 6-51-0014.
- 7.18 First sentence Cl.5.1.2 of specification 6-51-0014 Rev.6 stands modified as below:
"The control station shall be suitable for use in outdoor open locations and shall have minimum **IP-65** degree of protection".
- 7.19 2 nos. Weatherproof Local control stations (LCS) (IP-65) shall be provided for each motor tag (one at grade level and another at elevation near motor) with canopy.
- 7.20 LCS to be mounted at the grade level shall have Stop Push Button only.

- 7.21 All push button stations shall be provided with 2 nos. earthing lugs/studs.
7.22 Earthing of Motor and LCS shall be suitable to terminate for 10 MM (3/8") dia G.I. wire rope and 8 SWG solid G.I. wire respectively

8.0 SPARES

- 8.1 Commissioning spares, special tools & tackles for all electrical equipment's are included in Vendor's scope of supply.
8.2 Following Mandatory Electrical spares are included in vendor's scope of supply:

Sl. No.	Item Description	Quantity
1.0	MV induction motors	(10% spares for each rating & type)
1.1	Bearing (DE & NDE)	1 set
1.2	Terminal studs/bushing assembly	1 set each

Mandatory spares as indicated above do not cover commissioning spares.

Mandatory spares as indicated above do not cover two-year O&M spares.

- 8.3 Vendor shall submit a list with unit prices of recommended spares for two years of normal operation for all electrical equipment along with their bid.
8.4 Recommended list of maintenance spares for two years operation shall include the following as a minimum for motors. Vendor shall ensure & quote for the same accordingly.
- Bearing for DE/NDE-one set
 - Terminal box cover with screws
 - Fan
 - Terminal block

9.0 Vendor List

List of approved vendors for Electrical equipment/components shall be as indicated in the Vendor List-Electrical (Doc. No. B861-701-16-50-OD-6002) attached with the MR.

10.0 Attachments:

S. No.	Document No.	Document
1.	B861-701-16-50-LL-6002	Technical Confirmation List
2.	B861-701-16-50-DS-6002	Squirrel cage induction motor data sheet
3.	B861-701-16-50-VR-6002	Vendor Data Requirement
4.	B861-701-16-50-OD-6002	Vendor List (Electrical)
5.	6-51-0014	Specification for Industrial type control stations
6.	6-51-0064	Specification for MV Motors
7.	6-51-0081	Specification for Electrical Equipment Installation
8.	6-51-0087	Specification for field inspection, testing and commissioning of Electrical Installation
9.	6-81-1014	Inspection and test plan for Industrial control stations
10.	6-81-1064	Inspection and test plan for energy efficient medium voltage motors
11.	7-51-0104	Typical arrangement for earthing of motor
12.	7-51-0106	Typical earth connection for push button station.

**JOB SPECIFICATION
(INSTRUMENTATION)**

FOR

**AIR COOLER EXCHANGERS
(701-EA-1001A/B/C/D/E to 701-EA-1028A/B/C/D/E)**

FOR

AMBIENT AIR HEATERS IN KLL LNG TERMINAL

MR No.: B861-701-EA-MR-6002

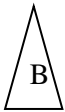
B	22.08.24	Issued for Bids	DP	RK	RK
A	24.05.24	Issued for Bids	DP	RK	RK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1.0 GENERAL

- 1.1 The purpose of this specification is to define requirements and philosophy of instrumentation for Air Cooler exchanger covered in this requisition.
- 1.2 All Air Cooler exchangers shall be supplied with Vibration Probes & Transmitters instead of Vibration Switches (even if indicated in the P&IDs)

2.0 VIBRATION PROBES/ TRANSMITTERS (Following shall supplement the clause 7.2.9 of 6-15-0071)

- A) Vibration Probes & Transmitters shall be supplied for vibration measurement. This shall override any vibration switch type shown in the P&IDs / other document. Quantity of instrument shall be as per the P&IDs / other document attached with MR.
- B) Vibration Probes/ Sensors shall be inertia sensitive type with the vibration range suitable for the offered fan. Set point shall be adjustable throughout the range i.e. 0 to 100%
- C) The Vibration transmitters shall be two wired system, loop powered with 24V DC, 4-20 mA output, load driving capacity of 500 ohm (minimum).
- D) Probes/ Transmitters shall be weatherproof to IP65, and it shall be suitable for area classification as specified elsewhere in the MR.
- E) The Probe/ Transmitter assembly shall have two cable entries as a minimum, each of ½" NPT size. In case vendor standard model does not support two entries, the Transmitter housing shall be supplied with integrally mounted 3-way junction box. The junction box shall be certified for specified area classification. Flying Lead wires are not acceptable. Additional openings shall be plugged with metallic blind plug.
- F) Vibration Probes/ Transmitters shall be located at motor suspension beams as close to the motor as possible. Probes/ Transmitters shall be readily accessible for maintenance from platform without any interference.
- G) Vibration Probes/ Transmitters shall be supplied from manufacturer of repute. In ADDITION SHALL HAVE PROVEN REFERENCES OF OPERATING SATISFACTORILY FOR A PERIOD OF minimum 4000hrs, in the similar type of application. Probes/ Transmitters of prototype design or not having proven references shall not be supplied.
- H) Fans to automatically stop at high vibration.
- I) Single pair Cable between vibration sensor/probes & vibration transmitter shall also be supplied by the vendor (consider cable distance of 50m for each vibration probe/transmitter) along with junction box for termination of purchaser supplied 12P or 6P (confirmed during detail engg) multi pair signal cable. Junction box shall be weather proof to IP-65 .Cable shall be armoured type only. Further cabling from junction box to purchaser's DCS/PLC shall be done by purchaser.



-
- J) Single pair cabling shall be done on FRP perforated cable tray (std width sizes 60mm,150mm, minimum thickness shall be 2.5mm) upto 12P/6P junction boxes.
- K) All cable glands from sensor to transmitter and transmitter to junction box shall be supplied vendor. Cable glands shall be with PVC cover suitable for armoured cable. All cable entry to sensor/transmitter & junction box to transmitter shall be ½”NPT. Vendor shall also provide cable gland for purchaser cable from junction box of 1.5” NPT/ 1”NPT . All unused entry ports in the junction boxes shall be provided with weather proof metallic plugs.
- L) Vendor to note that maximum 8 single pair cable for one 12P JB / 4 single pair cable for one 6P JB shall be considered for grouping , Accordingly number of junction boxes shall be calculated for all the fans. It is vendors responsibility to route the cable from individual vibration transmitter upto junction boxes (via suitable cable tray size) and termination of single pair cables at junction box end.
- M) Vendor shall provide junction boxes and cable/cable glands ,cable trays from approved vendors enclosed in the MR.
- N) Vendor shall provide the documents as per the VDR (B861-701-16-51-VDR-6002 Rev-B) enclosed in the MR .
- O) Vendor to supply mandatory spares 10% or min 1 no. of each type for the following:
- 1.Vibrationprobes/transmitter .
 2. 12/6 Pair junction box with cable glands.

JOB SPECIFICATION FOR SURFACE PREPARATION AND PROTECTIVE COATING

1	04/09/24	Revised & Issued as Job Specification	JATIN	SAHIL	SRIDHAR
0	16/04/24	Issued as Job Specification	JATIN	SAHIL	SRIDHAR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

Abbreviations:

AS	:	Alloy Steel
ASTM	:	American Society for Testing and Materials
AWWA	:	American Water Works Association
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
GI	:	Galvanized Iron
ID	:	Internal Diameter
ISO	:	International Organization for Standardization
LTCS	:	Low temperature Carbon Steel
MS	:	Mild Steel
MR	:	material requisition
NB	:	Nominal Bore
NA	:	Not applicable
OD	:	Outside Diameter
OSHA	:	Occupational Safety and Health Act
RCC	:	Reinforced Cement Concrete
RH	:	Relative humidity
SS	:	Stainless Steel
SOR	:	Schedule of Rate
SSPC	:	Steel Structure Painting Council
WFT	:	Wet Film Thickness

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1.0 GENERAL

- 1.1 This technical specification shall be applicable for the work covered by the contract and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that the CONTRACTOR shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.
- 1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the CONTRACTOR. Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of the job.
- 1.3 This specification covers the requirement for protective coating for new construction.
- 1.4 The selected environmental classification for atmospheric environments is C5 (very high durability), as specified in ISO 12944-2. This classification is designed for coastal exposure and incorporates the requirements for industrial areas with aggressive atmospheres.

2.0 SCOPE

- 2.1 Scope of work covered in the specification shall include, without being limited to, the following:

This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys, if any. The items listed in the heading of tables of paint systems are indicative only. However, the CONTRACTOR is fully responsible for carrying out all the necessary painting, coating and lining job on external and internal surfaces as per the tender requirement.

2.2 Extent of work

- 2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All un-insulated carbon steel and alloy steel equipment like vessels, columns, storage tanks, exchangers, parts of boilers etc.
- All un-insulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated carbon steel, alloy steel and stainless steel parts of equipment, vessels, boilers, chimneys, stacks, piping and steam piping and other insulated items present, if any.
- All items contained in a package unit.

- All structural steel work, pipes, structural steel supports, walkways, handrails, ladders, platforms etc.
- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining.
- Identification of colour bands on all piping, as required, including insulated aluminum clad, galvanized, SS and nonferrous piping.
- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminum clad, galvanized, SS and non-ferrous piping.
- Marking / identification signs on painted surfaces of equipment and piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than OWNER supplied materials)
- Application of pre-erection/fabrication and shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection.
- All CS piping, equipment, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of applied coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the OWNER, the same shall be painted as per the relevant specifications:

- a. Un-insulated austenitic stainless steel.
- b. Plastic and/or plastic coated materials.
- c. Non-ferrous materials like aluminum, Ni alloys, galvanized steel.

In general Galvanized steel doesn't require painting. However if painting is required due to OWNERs instructions, contractual or for colour coding requirement then coating system in Table 4.0 shall be followed.

2.3 Unless otherwise instructed, final paint coating (i.e. application of field primer, intermediate and top coats) on pre-erection/ shop primed equipment shall be applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract:

International Organization for Standardization (ISO):

ISO 12944: Corrosion Protection of steel Structures by Protective Paint System

ISO 1461: Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods.

ISO 8501-1/ SIS-05 59 00: Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness— Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

ISO 8502-3: Preparation of steel substrates before application of paints and related products -Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

ISO 8502-9: Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 9: Field method for the conductometric determination of water-soluble salts

ISO 2808: Paints and varnishes - Determination of film thickness

ISO 2811: Paints and varnishes — Determination of density\

National Association for Corrosion Engineer (NACE):

NACE RP 0287: Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

NACE SP 0198: Control of Corrosion under Thermal Insulation and Fireproofing Materials

NACE SP 0188: Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

Steel Structures Painting Council (SSPC)

SSPC SP: surface preparation methods.

SSPC Painting manual Vol.1 Good Painting practices

SSPC Painting manual Vol.1 Systems & specification

SSPC VIS 1: Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SSPC AB1: Mineral and Slag Abrasives

SSPC PA 2: Measurement of Dry Paint Thickness with Magnetic Gauges

American Society for Testing and Materials (ASTM):

ASTM Volume 6.01: Paint - Tests for Chemical, Physical, and Optical Properties; Appearance

ASTM Volume 6.03: Paint -- Pigments, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles

ASTM D6677-18: Standard Test Method for Evaluating Adhesion by Knife

ASTM D5894-16: Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)

ASTM D870-15: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion

ASTM D2485-18: Standard Test Methods for Evaluating Coatings for High Temperature Service

ASTM D2247-15: Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity

ASTM D4417-21: Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

ASTM D4541-22: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM D4060-19: Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

ASTM D4752-20: Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

ASTM D638: Standard Test Method for Tensile Properties of Plastics

ASTM D4940-15: Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives

ASTM D4285-83: Standard Test Method for Indicating Oil or Water in Compressed Air

ASTM D543-21: Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

ASTM C868-02: Standard Test Method for Chemical Resistance of Protective Linings

ASTM G8-96: Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

ASTM B117-19: Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM D1475-13: Standard Test Method for Density of Liquid Coatings, Inks, and Related Products

ASTM D823-18: Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels

ASTM D2369-10 (2015): Standard Test Method for Volatile Content of Coatings

ASTM D1640/D1640M-14(2018): Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings

ASTM D522/D522M-17: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

ASTM D968-17: Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D1044-13: Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion

ASTM D1849-95 (2019): Standard Test Method for Package Stability of Paint

ASTM D2247-15: Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity

ASTM D5146-10(2019): Standard Guide to Testing Solvent-Borne Architectural Coatings

RAL CLASSIC: Color matching system

General notes for clause 3.0

The CONTRACTOR shall arrange, at his own cost, to keep a set of latest edition of above mentioned standards and codes at site. The paint manufacturers' instructions shall be followed as far as practicable at all times for the best results. Particular attention shall be paid to the following:

- a. Instructions for storage to avoid exposure as well as extremes of temperature.
- b. Surface preparation prior to painting shall be followed as per Table-4 to 11 of this standard.

- c. Mixing and thinning.
- d. Application, recommended limit on time intervals in between coats & DFT.

4.0 EQUIPMENT

- 4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning, all equipment, scaffolding materials, shot & grit blasting equipment, air compressors etc. required shall be suitable for the work and shall be arranged by the CONTRACTOR in sufficient quantity at the site. The manufacturers test certificates / data sheets for all the above mentioned items shall be reviewed by Engineer-In-Charge at site before start of the work.
- 4.2 All paint spraying equipment, including mixers, shall be thoroughly cleaned before mixing of new materials. All coating materials shall be mixed and thoroughly stirred in accordance with the instructions of the paint Manufacturer. Sufficient agitation to maintain good mixing shall be applied until the product is used. If air is entrapped in the product during mixing/stirring, sufficient time should be allowed for the air bubbles to escape before application. Only thinners specified by the paint Manufacturer shall be used.

5.0 SURFACE PREPARATION, SHOP PRIMER / COATING APPLICATION, REPAIR AND DOCUMENTATION

5.1 General

- 5.1.1 In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by the Engineer-In-Charge.
 - a. Abrasive blast cleaning
 - b. Mechanical or power tool cleaning
- 5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. Before surface preparation by blast cleaning, the surface shall be cleaned to remove all grease, oil etc. as per SSPC-SP-1.
- 5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity >85%. In case of internal coating of storage tanks, dehumidifier shall be used to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during entire period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning

completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on the substrate.

5.1.4 The Engineer in-Charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances, the CONTRACTOR shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the OWNER.

5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray as recommended by the paint manufacturer, on dry surface. This should be done immediately and in any case within 4 hours of cleaning of the surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 The external surface of RCC chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCl solution for about 15 minutes shall be carried out. The surface must be thoroughly washed with water to remove acid and loose particles and then dried completely before application of paint.

5.2 Procedure for surface preparation

5.2.1 Air blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives listed below and at an appropriate distance & angle depending on nozzle size maintaining constant velocity and pressure. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. The compressed air shall be free from moisture and oil. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust.. Blast cleaning shall not be done outdoors in bad weather without adequate protection. If there is dew on the metal surface, it shall be cleaned. If possible, a vacuum collector shall be installed to collect and recycle the abrasives.

The surface roughness profile for carbon steel and low alloy steels to be coated shall be in accordance with the written recommendations of the paint Manufacturer and shall be measured as per ASTM D4417, method B. When not specified by the paint Manufacturer or otherwise specified in this specification, the surface roughness profile shall be between 40 μm and 70 μm for coatings up to thickness 500 μm and between 70 μm and 125 μm for coating systems over 500 μm thickness. In all cases, the surface roughness shall have a sharp angular profile.

If stainless steel, hot dip galvanised or non-ferrous metal surfaces are to be painted then blast cleaning shall be carried out by sweep blasting, using a fine non-iron containing abrasive.

On galvanised surfaces, the zinc layer shall not be damaged; a smooth uniform surface roughness shall be achieved. No defects such as break through or crisping of the zinc

layer shall occur. The surface roughness shall be in the range of 20 µm to 30 µm or as agreed with the paint Manufacturer.

Abrasives for use in blast cleaning steels shall be in accordance with ISO 8504-2. Test methods shall be in accordance with the tests specified in the ISO 11125 and ISO 11127 series for metallic and non-metallic abrasives respectively. Each batch of abrasive should be tested to check that the abrasive meets the requirements as specified in the relevant ISO standard.

The conductivity of non-metallic abrasives to be used for stainless steels shall be maximum 15 mS/m. For all other non-metallic abrasives, the conductivity shall not exceed 25 mS/m.

OWNER/PMC shall approve the use of alternative abrasive materials.

Abrasives specification

Type	Generic Name	Standard
Metallic	Iron grit	ISO 11124-2
	Steel grit	ISO 11124-3
Natural mineral	Staurolite	ISO 11126-9
	Garnet	ISO 11126-10
Synthetic mineral	Coal slag	ISO 11126-4
	Aluminum oxide	ISO 11126-7

Selection of abrasives

Steel or iron grit is commonly used as recyclable abrasives. When steel shot is used, it shall be used together with steel grit. The shot content of such a mix shall not exceed 67 %. For blasting stainless steel, non-(free) iron containing abrasive shall be used, e.g. Garnet or aluminium oxide.

Abrasives used for blast cleaning shall be free from oil, grease, moisture, chloride contamination etc. and shall have crystalline silica not more than 1%.

5.2.2 Mechanical or power tool cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of the surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale etc. shall be removed by clean rags and /or washed by water/steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-compatible shop coat primer

For equipment on which application of total protective coating (primer + intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with the paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipment (coated with primer & finishing coat) should not be repainted unless paint is damaged. Repair of primer shall be carried out as per Table-3 of paint

systems depending upon the compatibility of paint. Intermediate and final coats over repaired primer shall be as per applicable tables mentioned in this specification.

- 5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer, unless otherwise specified. If shop primer is not compatible with field primer, then shop coated primer should be completely removed before application of selected paint system for a particular environment.
- 5.6 For package units/equipment, shop primer/ coating system should be as per the paint system given in this specification. However, manufacturers' standard can be followed after review by EIL/OWNER but shall adhere to the minimum DFT specified in ISO-12944-5; C5 (Very high durability). In this case, guarantee of the coating system lies with package/Original equipment manufacturer. For system under insulation, minimum guidelines as per NACE RP 0198 shall be followed.

5.7 Coating procedure and application

All coatings shall be applied by airless/ air assisted spray except for the following special cases with prior approval from Engineer-in-charge, where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

- 5.7.1 Surface shall not be coated in rain, wind or in an environment where injurious airborne elements exist, when the steel surface temperature is less than 3 °C above dew point, when the relative humidity is greater than 85%, when the temperature is below 10°C and when the ambient/substrate temperature is below the paint manufacturers recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20 km per hour.
- 5.7.2 Blast cleaned surface shall be coated with complete application of primer as soon as practicable but in no case later than 4 hours the same day.
- 5.7.3 To the maximum extent practicable, each coat of paint shall be applied as a continuous film with uniform thickness and free of probes. Any spots or areas missed in application shall be re-coated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness specified by manufacturer.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for re-coating when an additional coat can be applied without the development of any detrimental film irregularities such as lifting or loss of adhesion of the under coat. Manufacturer's instructions shall be followed for inter coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate the complete coverage of the surface. The tinting material shall be compatible with the material underneath and shall not be detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with steel structure paint manual Vol.1 & Vol.2 by SSPC, USA

5.7.7 Brush application of paint shall be in accordance with the following:

- a. Brushes shall be of a style and quality that will enable proper application of paint.
- b. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough/pitted steel. Wide flat brushes are suitable for large flat areas but they shall not have width over 5 inches.
- c. Paint shall be applied into all corners.
- d. Any runs or sags shall be brushed out.
- e. There shall be a minimum of brush marks left in the applied paint.
- f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

5.7.8 For each coat, the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of coated surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat. If this exceeds, the paint material has possibly deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturers' specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.

5.9 Spot repair of damaged primer

5.9.1 Where pre-erection/shop primer has been damaged at isolated localized spots during handling and transportation or after erection / welding, its repair shall be done as given below and as per the Table-3 of this specification.

5.9.2 Surface preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface, over the intact adjacent surface surrounding the damaged area, by emery paper.

Primer coating: One coat of F-8/F-9/F-12 shall be applied (as per the applicable design temperature and in conjunction with Table-3) wherever damage was observed on pre-erection / pre fabrication or shop primer.

5.9.3 If damaged areas are found to be extensive and spread over large areas (as required by Engineer-in charge), then entire pre-erection/pre-fabrication/shop primer shall be removed by blasting to achieve SSPC-SP-10 and entire blasted surface shall be primed again with F-8/ F-9 or F-12, as applicable, for the intended design temperature. (See note of Table-3). If the prepared surface lies adjacent to a sound coated surface, the surface preparation shall overlap the coated surface by at least 50mm. The remainder of existing coated surface shall be properly protected with shields or screens to prevent any possible damage to the coating.

5.10 Assessment of painting requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and choose the appropriate table.
- Identify the design temperature from the technical documents.
- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
- Identify the shop priming requirement from based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table-3.

5.11 Documentation / records

5.11.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.

5.11.2 Daily progress report with details of weather conditions, particular of applications, no. of coats and type of materials applied, anomalies, progress of work versus program.

- 5.11.3 Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
- 5.11.4 Particulars of surface preparation and paint application during trials and during the work.
- 5.11.5 Details of non-compliance, rejects and repairs.
- 5.11.6 Type of testing equipment and calibration.
- 5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 -5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information in accordance to 5.11.2 – 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

TABLE-1: SURFACE PREPARATION STANDARDS

Sl. No.	GRADE OF SURFACE CLEANLINESS	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)		
		ISO 8501-1/ SIS-05 59 00	SSPC, USA	NACE, USA
1	Solvent cleaning	-	SSPC-SP-1	-
2	Manual or hand tool cleaning	St 2	SSPC-SP-2	-
3	Mechanical or power tool cleaning	St 3	SSPC-SP-3	-
4	White metal	Sa 3	SSPC-SP-5	NACE No.1
5	Near white metal	Sa 2½	SSPC-SP-10	NACE No.2
6	Commercial Blast	Sa 2	SSPC-SP-6	NACE No.3
7	Brush-off Blast for SS, galvanized steel and non-ferrous metals	-	SSPC-SP-16	-

6.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows.

TABLE-2: PAINT MATERIALS
(Refer to *general notes* at the end of this table)

DESCRIPTION	P-6	P-7	P-4
Technical name	Epoxy Zinc Phosphate Primer	Cold Galvanizing product	Etch Primer/Wash Primer
Type and composition	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack synthetic resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.
Volume solids % Minimum	49	37	9
DFT per coat, μ	40-50	40-50	8-10
Theoretical covering capacity in m^2 /coat/ litre	9.8-12.2	3.4-4.4 m^2 /kg	9.0-11.2

Weight per litre in Kg/litre	1.4±0.05	2.67 kg at 15 ^o C	1.2±0.05
Touch dry at 30 ^o C (max.)	30 min.	10 min.	2 hrs.
Hard dry at 30 ^o C (max.), hrs	8	24	24
Over-coating interval, hrs	Min. 8	Min. 4	Min. 4-6
Pot life at 30 ^o C for two component paints, hrs	6 - 8	NA	NA
Adhesion (ASTM D 4541)	>7	NA	NA
Temperature resistance (min) ° C (ASTM D 2485) *Note 8	80 (Method A)	50 (Method A)	NA

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-2	F-3	F-6A/B	F-6C
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating
Type and composition	Two-pack aliphatic isocyanate cured acrylic finish paint (free of alkyd/polyester resins).	Single pack Plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-Pack Aromatic polyamine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented with MIO.	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented

Volume Solids % Minimum.	40	36	57	98
DFT per coat, μ	30-40	30-40	100-125	250-500
Theoretical covering capacity in m^2 /coat/litre	10-13.3	9-12	4.6-5.7	2-3.9
Weight per liter in Kg/litre	1.15 \pm 0.03	1.15 \pm 0.03	1.42 \pm 0.03	1.40 \pm 0.03
Touch dry at 30 C (max)	30 min.	30 min.	3 hrs	3 hrs
Hard dry at 30 $^{\circ}$ C (max.), hrs	8	8	16	16
Full cure at 30 $^{\circ}$ C (for immersion/ high temperature service)	NA	NA	5 days	5 days
Over-coating Interval, hrs	Min.12.	Min. Overnight	Min. Overnight Max. 5 days	Min. 8. Max. 48
Pot life (approx.) at 30 $^{\circ}$ C for two component paints, hrs	5-8	NA	3-6	0.5
Adhesion (ASTM D 4541)	>5	>4	>7	>8
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 or <100 mg /1000 cycles/CS10	NA	NA	NA
Temperature resistance (min.) $^{\circ}$ C (ASTM D 2485) *Note 8	80 (Method A)	60 (Method A)	80 (Method A)	120 (Method A)

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-7	F-8	F-9 (primer)	F-11	F-12
Technical name	High build coal tar epoxy coating.	Self-priming type surface tolerant high build epoxy coating (complete rust control Coating)	Inorganic zinc silicate Coating	Heat resistant synthetic medium based two pack Aluminum Paint suitable up to 250°C dry temp.	Heat resistant silicone Aluminum Paint suitable up to 540°C dry temp.
Type & composition	Two pack polyamide cured epoxy resin blended with coal tar medium, suitably pigmented	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test as per ASTM D4752.	Heat resistant synthetic medium based two pack Aluminum paint suitable up to 250°C.	Single pack silicone resin based medium with Aluminum flakes.
Volume Solids % Minimum.	62	75	57	35	18
DFT per coat in μ	100-125	100-125	65-75	15-20	15-20
Theoretical covering capacity in M ² /coat/ litre	5-6.2	6-7.5	7.6-8.8	17.5-23.3	9-12
Weight per liter in Kg/litre	1.40±0.03	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03
Touch dry at 30°C (maximum), hrs	4	3	0.5	3	0.5
Hard dry at 30°C (maximum), hrs	48	24	12	12	24

Full cure 30°C (for immersion /high temperature service)	5 days	5 days	NA	NA	NA
Over-coating interval, hrs	Min. 24 hrs max.5days	Min. 10	Min. 12 hrs at 20°C & 50% RH	Min. 24	Min. 24
Pot life at 30°C for two component Paints, hrs	4-6	1.5	4-6	NA	NA
Adhesion MPa (ASTM D 4541)	>5	>5	>5	NA	NA
Temperature resistance (min.) ° C (ASTM D 2485) *Note 8	80 (Method A)	80 (Method A)	400 (Method B)	250 (Method A)	540 (Method B)

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener	Inert polymeric matrix coating suitable for under insulation for CS and SS.	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating.
Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two component glass flake filled vinyl ester lining for under immersion services up to 90 deg. C.
Volume Solids % Minimum.	67	67	50	98	98

DFT per coat in microns	100-125	75-100	100-125	300-450	500-600
Theoretical covering capacity in M ² /coat/ litre	5.4-6.7	6.7-8.9	4-5	2.2-3.3	1.6-2
Weight per liter in Kg/litre (mix paint)	1.45±0.03	1.65±0.03	>1.3	1.7	>1.2
Touch dry at 30°C (max) , hrs	4	3	1	2	2
Hard dry at 30°C (max), hrs	24	24	16	24	4
Full cure 30°C (for immersion / high temp service)	168 hrs (7 days)	168 hrs (7 days)	NA	168 hrs (7 days)	96 hrs (4 days)
Over-coating interval	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.6 hrs Max. Not applicable	Min. 16 hrs Max.21 days	Min. 4 hrs Max.3 days
Pot life at 30°C, hrs (for two component paints)	4	4-6	1	1	50 min-1 hr
Adhesion, MPa (ASTM D 4541)	>6	>7	NA	>8	>7, Tensile strength >20N/mm ² (ASTM D 638)
Temperature resistance (min.) °C (ASTM D 2485) *Note 8 & 9	125 (Method A)	150 (Method A)	650 (Method B)	150 (Method A)	90 (Method A)

General notes for TABLE-2:

- Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of

- paints required, include the losses during application. Minimum specified DFT should be maintained in any case.
2. All primers and finish coats should be ambient temperature curing and air drying unless otherwise specified.
 3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa 2 ½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However in another case if this specification requires the surface preparation of Sa 2 ½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2 ½.
 4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
 5. Higher specific gravity of F-9 is also acceptable.
 6. Internationally recognized & acceptable testing method shall be used for lab testing wherever testing standards are not mentioned.
 7. Touch dry, hard dry, pot life, full cure period, & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the values of these parameters along with weight per liter may be permissible with the discretion of engineer-in-charge only.
 8. Temperature resistance tests (ASTM D2485) shall be carried out for minimum required temperature resistance indicated.
 9. Wherever ASTM D 2485 method B is applicable, test results of the panels subjected to salt spray (ASTM B 117) after muffle furnace exposure shall be submitted for pre-qualification purpose.
 10. F-6A shall be suitable for immersion services in line with recommendations in tables-7
 11. F-6C shall be suitable for immersion services of hydrocarbons and DM water (in line with recommendations in table-7)
 12. F-7 shall be suitable for immersion service of hydrocarbons & underground service up to 80 Deg C minimum.
 13. F-14 shall be suitable for under insulation service up to 125 Deg C.
 14. F-15 shall be suitable for high temperature immersion & under insulation services in line with recommendations from table-6 to 11.
 15. F-17 shall be suitable for high temperature immersion service and underground services as recommended in table-7 to 8.

7.0 COATING SYSTEMS

Coating systems (primers, finish paints etc.) based on area classification/environments/applications are tabulated in Table-4 to Table-10. Repair of pre-erection/pre-fabrication & shop priming after erection/ welding shall be done as per Table-3.

TABLE-3: REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

(For all un-insulated CS, LTCS & low alloy steel items in all environments)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
3.1	-45 to 80	SSPC-SP-3	1 coat of F-8 @ 125 μ DFT/coat	125	See Note-1 below and clause 5.9.3
3.2	81 to 400	SSPC-SP-3	1 coat of F-9 @ 65-75 μ DFT/coat	65-75	
3.3	401 to 550	SSPC-SP-3	1 coat of F-12 @ 20 μ DFT/coat	20	

Notes for Table-3:

- 1: The application and repair of pre-erection/pre-fabrication or shop primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-8/ F-9 or F-12 as applicable.

TABLE-4: COATING SYSTEM FOR GI ITEMS

(Refer clause 2.2.2)

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)	Remarks
4.1	Up to 60	Hot Dip Galvanizing to 80-85 microns (575-610 gm./m ²) as per ISO 1461, surface preparation as per SSPC SP 16 & ISO 12944-4 & + 1 coat of F-6B @ 100μ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	140μ of finish coat (excluding the thickness of galvanizing)	Special primers like etch primer may also be considered for coating on galvanized surfaces

General notes for Table-4:

1. No galvanized specimen shall have thickness less than 80 microns.
2. Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice ISO 1461, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.

3. After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table-4 above (i.e. 1 coat of F-6B @ 100 μ DFT/coat + 1 coat of F-2 @ 40 μ DFT/coat).
4. Galvanized gratings don't require painting in general until otherwise specified elsewhere or as per the requirement of the OWNER. Galvanized items may require painting to meet the colour coding requirement of the OWNER. Contractor has to ensure the applicable colour coding prior to application of coating as per this clause.

TABLE-5: COATING SYSTEM FOR CORROSIVE AREAS (PROCESS UNITS, COOLING TOWER, DM, CPP AND OFFSITES)

(For all un-insulated above ground CS, LTCS & low alloy steel piping, equipment, structures, valves, vessels & columns, furnace stacks etc.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
5.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75 μ DFT/ coat	-	-	65-75	
5.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75 μ DFT/ coat	1 coat of P-6 @ 40 μ DFT/ coat	2 coats of F-6B @ 100 μ DFT/coat + 1 coat of F-2 @ 40 μ DFT/coat (2x100 + 40= 240)	345-355	a)No over coating on F-9 is allowed b) F-12 shall be ambient temperature curing type
5.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75 μ DFT/ coat	-	2 coats of F-12 @ 20 μ DFT/coat 2x20=40	105-115	
5.4	400-540	SSPC-SP-10; 2 coats of F-12 @ 20 μ DFT/coat	-	2 coats of F-12 @ 20-25 μ DFT/coat (2x20=40)	80	Surface profile for this coating system shall be 20-30 μ m

NOTES for TABLE-5:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The CONTRACTOR is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated as per tender document and scope of work.
2. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and spread over large areas, the Engineer-In-Charge may decide & advise re-blasting and re-application of the primer coat. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table-3.
3. Flare line within unit or offsite areas shall be coated as per clause 5.3 of Table-5.
4. For external surface of RCC Chimney, 2 coats of F-6 B@ 100 μ DFT/coat to obtain a total DFT of 200 μ shall be applied after proper surface preparation as per guidelines in clause 5.1.6.

TABLE-6: EXTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
6.1	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
6.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75 μ DFT/coat + 1coat of P-6 @ 40 μ DFT/ coat	2 coats of F-6B @ 100 μ DFT /coat + 1 coat of F-2 @ 40 μ DFT/ coat	345-355	
6.1.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80 μ DFT/ coat + 1 coat of F-15 intermediate coat @ 80 μ DFT/coat	1 coat of F-15 finish coat @80 μ DFT/ coat + 1coat of F-2 @ 40 μ DFT/ coat	280	-

6.1.3	151 to 400	SSPC-SP-10	1coat of F-9 @ 65-75 μ DFT/coat	2 coats of F-12 @20 μ DFT/ coat or 1 coat of F-16 @ 125 μ DFT / coat	105- 115 or 190- 200	
6.2	External surfaces of bottom plate (in contact with soil) for all storage tanks.					
6.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75 μ DFT/ coat	3 coats of F-7@ 100 μ DFT/coat (3x100=300)	365- 375	F-7 should be suitable for immersion service
6.2.2	81 to 150	SSPC-SP-10	1 coat of F-17 primer @ 400 μ DFT/ coat	1 coat of F-17 finish coat @ 400 μ DFT/ coat	800- 825	-
6.3	For underside of the bottom plate (not in contact with soil) (in case tank is not lifted during PWHT) (Note- 2)					
6.3.1	-29 to 400	SSPC SP-10	1 coat of F-16 @ 125 μ	1 coat of F-16 @ 125 μ	250- 300	This coating system is also applicable for temperature ranges not covered in 8.2 above

Notes for TABLE-6:

1. All paint coating application including primer for tanks shall be carried out at field after erection and completion of entire welding.
2. For underside of bottom plate as per clause no.6.3.1:
 - a) Painting shall be carried out before laying the bottom plate for tanks with non-Post Weld Heat Treatment (PWHT).
 - b) For tanks with PWHT, painting shall be carried out after PWHT.
 - c) In case tank is not lifted during PWHT then painting shall be applied before laying the bottom plate.

TABLE-7: INTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
7.1	Potable, Raw & Fire water All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
7.1.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100 μ DFT/coat	2 Coats of F-6A @ 100μ DFT/ Coat (2x100=200)	300	-
7.2	De-mineralized (DM) water & Condensates etc.: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
7.2.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100μ DFT/coat	2 coats of F-6C @ 200μ DFT/ coat (2x200=400)	500	Single coat of F-6C @ 400 μ is also acceptable
7.2.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	1 coat of F-15 intermediate coat @ 80μ DFT/coat + 1 coat of F-15 finish coat @ 80μ DFT/ coat (80+80=160)	240	-
7.3	Hydrochloric acid (HCl) 10 %: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
7.3.1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100μ DFT/ Coat	2 Coats of F-20 @ 500μ DFT/ Coat	1100	-
7.4	Alkalis up to 50 % concentration: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
7.4.1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	2 Coats of F-6 A @ 100μ DFT/coat (2x100=200)	280	-
7.5	Other Corrosive liquids and chemicals All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					

7.5.1	Up to 150°C	SSPC-SP-10	-	1 coat of F-17 @ 375µ DFT/coat	375-425	-
7.6	Ethylene glycol tanks: Internal shell-full height, bottom plate, underside of roof and all accessories					
7.6.1	All	SSPC-SP10	-	3 coats of vinyl chloride co-polymer @ 75µ /Coat; (3x75=225)	-	-

TABLE-8: COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND VESSELS

Sl. No.	Design Temp. in °C	Surface Preparation & Shop Primer	Coating system		Total DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
8.1	Underground carbon steel plant piping					
For underground piping in Firewater service						
8.1.1	25 to 80	-	SSPC-SP-10; 1 coat of synthetic fast drying primer 25 @µ DFT/ coat	1 layer of coal tar tape coating @ 2mm +1 coat of synthetic fast drying primer 25 @µ DFT/ coat + 1 layer of coal tar tape coating @ 2mm /layer as per EIL Std. Spec. 6-79- 0011	-	-
For all underground piping in other service lines						
8.1.2	25 to 80	-	As per document B861-000-06-42-PLS-04	3layer polyethylene (3LPE) coating as per document B865-000-06-42-PLS-04		
For all underground plant piping						
8.1.3	81 to 150	-	SSPC-SP-10; 1 coat of F-17 primer @400 µ DFT/ coat	1 coat of F-17 @ 400 DFT/coat	800	Note-1
8.2	External side of underground storage vessels					
8.2.1	-45 to 80	SSPC-SP -10; 1 coat of F-9 @ 65-75µ DFT/ coat	-	3 coats of F-7 @ 100µ DFT/coat	365-375	-

8.2.2	81 to 150	SSPC-SP-10	1 coat of F-17 primer @400 μ DFT/ coat	1 coat of F-17 @400μ DFT/ coat	800	Note-1
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Notes for TABLE-8:

1. This coating system can be used for the lines/equipment/vessels which have operating temperature between ambient and 150 °C (normal operating temperature) with occasional rise in the temperature up to 200°C

TABLE-9: COATING SYSTEMS FOR UNDER INSULATION (ALL UNIT AREAS & OFFSITES)

(For insulated piping, equipment, storage vessels, tanks, columns etc. of CS, LTCS, Alloy steel & stainless steels in all environments.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating system		Total DFT Microns (min.)	Remarks
			Primer	Finish paint		
9.1	Carbon steel, LTCS and Alloy steel Piping, Storage tanks, Vessels, Equipment etc.					
9.1.1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 75μ DFT/coat	None	2 coats of F-15 @75μ DFT/coat	225	Note 1
9.1.2	126 to 450	SSPC-SP-10; 1 coat of F-16 @ 125μ DFT/coat	None	1 coat F-16 @ 125μ DFT/coat	250	
9.2	Stainless Steel, Duplex Stainless steel, Super Duplex stainless steel & Piping, Tanks, Vessels & Equipment etc.					
9.2.1	-45 to 125	SSPC-SP-16; (15-25μ surface profile) 1 coat of F-15 @75 μ DFT/coat	None	2 coats of F-15 @75μ DFT/coat	225	Note 1
9.2.2	126 to 650	SSPC-SP-16; (15-25μ surface profile) 1 coat of F-16 @125μ DFT/coat	None	1 coat of F-16 @125μ DFT/coat	250	

9.3	Cyclic service of CS, LTCS, SS, & Alloy Steels (Note-1)					
9.3.1	-45 to 150 (Note-1)	SSPC-SP-10 For CS, LTCS & low Alloy steel. SSPC-SP-16 for SS; (15-25 μ surface profile) 1 coat of F-15 @75 μ DFT/coat	None	2 coats of F-15 @75 μ DFT/coat	225	Note-2&3
9.3.2	-180 to 650	SSPC-SP-10 for CS, LTCS & Alloy steel. SSPC-SP-16 for SS (15-25 μ surface profile) 1 coat of F-16 @ 125 μ DFT/coat	None	1 coat of F-16 @ 125 μ DFT/coat	250	-

Notes for Table-9

1. Coating system for any other design temperature range not covered in Sr. No. 9.1 & Sr. No. 9.2 shall be as per Sr. No. 9.3.2.
2. In case of overlapping of cyclic temperature ranges as mentioned in 9.3.1 and 9.3.2 then clause 9.3.1 shall be followed.
3. Alternatively, for this temperature range, 1 coat of F-17 @ 400 μ is also acceptable.

General notes for TABLE-9:

1. "Cyclic Service" is characterized by rapid or periodical temperature fluctuation or temperature cycles or as defined in the process datasheet.
2. The blasting abrasives for SS and alloy steels shall be aluminum oxide or garnet only.
3. The coating system applicable for any other temperature range shall be reviewed if it is encountered.

TABLE-10: INTERNAL COATING SYSTEM FOR GLYCOL WATER VESSELS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
10.1	-45 to 150	SSPC-SP-10	2 coats of F-17 primer @ 400 μ DFT/ coat	800	See Note below

Note for Table-10: Coating system is applicable only if requirement is specified in the data sheets of the respective equipment/vessel.

GENERAL NOTES FOR TABLE: 5 TO 10

1. For uninsulated or insulated items, scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, and PR etc.

8.0 STORAGE & HANDLING

- 8.1 All paints and painting materials shall be stored in rooms only which are to be arranged by CONTRACTOR and approved by Engineer-In-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE- NO NAKED LIGHT-HIGHLY INFLAMMABLE" shall be clearly displayed outside. Manufacturers' recommendation shall be followed for storage and handling of paint materials.

9.0 COLOUR CODE

The colour coding system as per Annexure-1 of this specification shall be followed.

9.1 Identification

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines, ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on this specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

9.2 Ground colour

On un-insulated pipes, the entire pipe has to be painted in ground colour. On metal clad insulated lines, minimum 2 m long portion should be painted.

9.3 Colour bands

9.3.1 Location of colour bands:

- a. At battery limits.
- b. Intersection points & change of direction points in piping.
- c. Midway of piping section, near valves, across culverts.
- d. At 50 m interval on long stretch pipes.
- e. At starting and termination points.

9.3.2 Minimum width:

<u>NB</u>	<u>Width</u>
-----------	--------------

3" and below	75 mm
Above 3" to 6"	NB X 25 mm
Above 6" to 12"	NB X 18 mm
Above 12"	NB X 15 mm

For insulated pipes, NB indicates OD of the insulation.

Sequence: Colour bands shall be arranged in sequence as shown above and the sequence follows the direction of flow. The width of the 1st Band to 2nd band is 4:1.

Wherever deemed required by process department or safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of black and golden yellow as per IS : 2379.

9.4 Identification markings on equipment/piping

Equipment tag numbers shall be stenciled/neatly painted using normal 'Arial' lettering style on all equipment and piping (both insulated & un-insulated) after completion of all paint works. Lettering colour shall be either black or white, depending upon the background, so as to obtain good contrast.

Operations group shall specify the location of the marking.

Size of the marking shall be as follows:

Columns, vessels, heaters	:	150 mm
Pumps and other machinery	:	50 mm
Piping	:	OD / 2 with maximum 100 mm
Storage tanks	:	(as per drawings)

9.5 Colour coding for control valve

- | | | |
|----------------------|---|---------------|
| a) Carbon steel body | : | Light grey |
| Alloy steel body | : | Canary yellow |
| Stainless steel body | : | Natural |
- b) The actuator of the control valve shall be painted as:
- | | | |
|--|---|-------|
| Direct action (open on-air failure) valves | : | Green |
| Reverse acting (close on-air failure) valves | : | Red |

The painting status shall be comprehensively updated every 6 months for compliance.

10.0 IDENTIFICATION OF VESSELS, PIPING ETC.

- 10.1 Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or un-insulated) after painting. Line number in black or white shall be stenciled on all the piping of more than one location as directed by Engineer-In-Charge. Size of letter printed shall be as below:

Column & vessels	:	150 mm (high)
Pump, compressor & other machinery	:	50 mm (high)
Piping	:	40-150 mm

10.2 Identification of storage tanks

The storage tanks shall be marked as detailed in the drawing.

11.0 QUALITY CONTROL, INSPECTION AND TESTING

11.1 All painting materials including primers and thinners brought to site by CONTRACTOR for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturers' test certificates. Paint formulations without certificates are not acceptable (see section 13.0 & 14.0).

11.2 The CONTRACTOR must produce test certificate from pre-qualified paint manufacturer for various tests as detailed out in section 14.0 of this document. The Engineer-In-Charge shall have the right to test wet samples of paint at random for verifying quality of paint supplied. CONTRACTOR shall arrange to have such tests, when required by Engineer-in-Charge, performed at his cost at any one of the NABL accredited laboratories.

Samples for the test will be drawn at random in presence Engineer-In-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

11.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and CONTRACTOR shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- a) Surface preparation
- b) Primer application
- c) Each coat of paint

Following tests are to be carried out during surface preparation:

- Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP-1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- a) Visual inspection - continue degreasing until all visible signs of contamination are removed.

- b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination. Continue degreasing and inspection till test is passed.
- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m² of blasted surface and a minimum of 3 checks per shift.
 - Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m². Checks shall be done on each component at least once per 200 m² of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of ISO 12944-4 (water cleaning). After cleaning, surface shall be retested for salt after drying.

Blast Profile Measurement: (In-Process testing during actual production before application coating)

The angular profile depth measurement shall be done by profile tape as per method ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m² of blasted surface. At each spot three measurements shall be taken over an area of 10 cm² and average of measurements to be recorded and reported. If profile is less than specified range, blasting shall continue till greater specified depth profile is achieved.

Tests for blasting media, blasting air

Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

- a) Inspection for the absence of oil contamination shall be conducted using following procedure :
- Fill a small clean 200 ml bottle half full of abrasive.
 - Fill the bottle with potable water, cap and shake the bottle.
 - Inspect water for oil film/slick. If present, the blasting media is not to be used.
- b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.
- c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate or zinc rich epoxy or zinc phosphate. Any defect noticed during the various stages of inspection shall be rectified by the CONTRACTOR to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, CONTRACTOR shall be responsible for rectifying any defects found during final inspection/guarantee period/defect liability period as defined in general conditions of the contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to OWNER, the extra coat should have prior approval of Engineer-in-charge.

11.4 Final inspection of finished coating shall consist of the following:

- 1) **Coating dry film thickness check:** DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-PA-2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.
- 2) **Adhesion testing:** Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m² of coated surface.
- 3) **Holiday detection check:** Holiday testing shall be conducted in accordance with NACE SP0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP0188. Any holiday is unacceptable and should be marked and repaired immediately.

The CONTRACTOR shall arrange for spot checking of paint materials for specific gravity, glow time (ford cup) and spreading rate.

12.0 GUARANTEE

The CONTRACTOR shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

13.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/SUB-CONTRACTOR

Painting CONTRACTOR who is awarded any job for EIL, Projects under this standard must have necessary equipment, machinery, tools and tackles for surface preparation, paint application and inspection. The CONTRACTOR must have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The CONTRACTOR supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

14.0 QUALIFICATION/ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM

14.1 Pre-qualification of paint coating manufacturer and his products

Paint manufacturer meeting the following requirements shall be considered by the CONTRACTOR for supply of the paint products.

- Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past 5 years.
- Manufacturer should possess past experience of supplying his products to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms in the past 5 years.
- Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms.
- The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should possess ISO 14000 certificate.
- The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.

CONTRACTOR shall procure the paint materials from the qualified manufacturer meeting above requirements and after obtaining prequalification testing approval as per requirements mentioned in clause 15.2 below.

14.2 Pre-Qualification Testing procedure:

The paint manufacturer engaged by the mechanical contractor shall carry out the tests in NABL accredited government laboratories like national test house (NTH), as a part of qualification. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters mentioned in Table-2 (typical characteristics) and Table-11 (tests on coating systems) of this specification. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in the respective tables. Contractor shall furnish these test certificates along with all necessary supporting documents/information to EIL for approval/ acceptance. The paint manufacturer will be qualified and approved by EIL for supply of paints after review/assessment of the submissions made by the contractor. Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing accordingly for paints supply to EIL projects.

TABLE-11: PRE-QUALIFICATION TESTING

SYSTEM No.	COATING SYSTEM	REFERENCE CLAUSE (from table-3 to 12)	TOTAL DFT μ (min)
1.	F-9+P6+F6B+F2	5.2	345
2.	F12+F12+F12+F12	5.4	80
3.	F15+F15+F15	7.2.2	240
4.	F16+F16	9.3.2	250
5.	F17	7.5.1	375
6.	F8	3.1	125
7.	F20+F20	7.3.1	1100
8.	F6A+F6C+F6C	7.2.1	500
9.	F6A+F6A+F6A	7.1.1	300

S. No.	TEST	FOR SYSTEM NUMBER	DURATION	ACCEPTANCE CRITERIA
1.	<u>Cyclic Test</u> Salt Spray : 72 hrs. Drying in air: 16 hrs. UV-A340 nm weather meter: 80 hrs. One cycle: 168 hrs. (25 cycles at 168 hrs. each cycle) (ASTM D5894)	1	4200 hrs	Shall pass. No chalking, cracking, flaking, blistering or peeling shall be observed.
2.	Chemical Resistance Test (ASTM D543)			
2a.	10% & 40% NaOH	3,5,7 & 9* *H ₂ SO ₄ solution pH = 5.0 to 5.5 for system 9	1000 hrs	Shall pass. No cracking, discoloration, blistering, peeling or softening of film shall be observed.
2b.	5% H ₂ SO ₄		168 hrs	
2c.	Xylene		4 weeks	
2d.	Acetone		4 weeks	
2e.	Ethanol		4 weeks	
2f.	Kerosene		4 weeks	
2g.	Sea water		2000 hrs	
3.	Immersion in DM/DI water @90° (ASTM C868)	3,5 & 7	30 days	No softening, blistering or film damage.
4.	Resistance to DM water using water immersion. (ASTM D870)	8	2000 hrs	Shall pass. No chalking,

				cracking, flaking, blistering or peeling.
5.	100% Humidity Test (ASTM D2247)	1 to 9 (except system-2)	1440 hrs	Shall pass
6.	Thermal Shock Resistance Test; 5 cycles @ 30 minutes in furnace at 120 ° C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method A)	2,3 & 4 (For system-2, testing to be done after heating the panels at 175°C for 2 hrs.)	-	Shall pass
7.	Cathodic Disbondment Test (ASTM G8 @60°C)	3 & 5	-	Shall pass

Each coating product to be qualified shall be identified by the Specific gravity of base and curing agent (ISO 2811). The identification shall be carried out on the batch, which is used for the pre-qualification testing.

14.3 Information to be furnished during delivery of paint materials:

CONTRACTOR along with delivery of paint material has to furnish following information from paint manufacturer to EIL for acceptance/approval of products:

a) Batch test certificates:

Along with paint products delivery to site from the pre-qualified coating manufacturer, CONTRACTOR has to produce test certificate (from paint manufacturer) for each category of product for the following test items. All test results must mention clearly the batch no. and category of product tested. Tests to be conducted for following properties:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)

b) Product information sheet/ technical data sheet for each category of product.

The contractor shall be fully responsible for the quality of the paints products as per prequalification testing. After the paint materials are supplied to site, the supplier shall organize random sampling and testing in a NABL laboratory as per discretion

of the Engineer-in-charge. Failing to meet the specified quality requirements may cause rejection of the paint products.

15.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests (sec. 14.2), Batch testing (sec. 14.3) and Inspection testing (sec. 11.0))

15.1 Samples of coating materials should be submitted to the laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory.

15.2 All test panels should be prepared by testing laboratory. Surface preparation for a system shall be done in accordance with this specification. For individual products testing, minimum shall be Sa 2.5. Colour photographs of test panels should be taken before and after the test and should be enclosed along with test report. Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

15.3 Manufacturers should intimate EIL, details of sample submitted for testing, name of testing agency, date, and contact personnel of the testing agency.

ANNEXURE-1: COLOUR CODE

DABHOL LNG PROJECT

TITLE	PAINTING AND COATING SPECIFICATION	REV	DATE	PAGE NO.
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TABLE 2 - Colour Coding for Piping

FLUID	MAIN COLOUR	BAND	STRIPE
LNG	Ochre 08C35 RAL 1002 10YR7/6	None	None
Natural Gas Vapour incl. Vent	Ochre 08C35 RAL 1002 10YR7/6	Primrose 10E53 RAL 1018 6.25Y8.5/13	None
Seawater	Olive 12D45 RAL 6025 2.5GY4/6	None	None
Seawater - Fire	Olive 12D45 RAL 6025 2.5GY4/6	Fire Red 04E53 RAL 3000 7.5R4.5/16	None
Service Water	Olive 12D45 RAL 6025 2.5GY4/6	Terracotta 04D45 RAL 3011 7.5R3/10	None
Service Water - Fire	Olive 12D45 RAL 6025 2.5GY4/6	Terracotta 04D45 RAL 3011 7.5R3/10	Fire Red 04E53 RAL 3000 7.5R4.5/16
Cooling Water -Methanol/Glycol	Chocolate Brown 06C39 RAL 8003 7.5YR3/6	Pure White 00E55 RAL 9003 N9.5	Sky Blue 18E53 RAL 5015 10B4/10
Heating Water -Methanol/Glycol	Chocolate Brown 06C39 RAL 8003 7.5YR3/6	Pure White 00E55 RAL 9003 N9.5	Terracotta 04D45 RAL 3011 7.5R3/10
Potable Water	Olive 12D45 RAL 6025 2.5GY4/6	Sky Blue 18E53 RAL 5015 10B4/10	None
Plant Air	Light Blue 20E51 RAL 5012 5PB6/10	None	None
Instrument Air	Light Blue 20E51 RAL 5012 5PB6/10	Emerald Green 14E53 RAL 6032 5G5/10	None
Nitrogen	Ochre 08C35 RAL 1002 10YR7/6	Fire Red 04E53 RAL 3000 7.5R4.5/16	None
Drains (Effluent)	Pitch Black 00E53 RAL 9005 N1.5	None	None
Drains (Hydrocarbons)	Pitch Black 00E53 RAL 9005 N1.5	Primrose 10E53 RAL 1018 6.25Y8.5/13	None
Lube/Seal Oil	Chocolate Brown 06C39 RAL 8003 7.5YR3/6	Emerald Green 14E53 RAL 6032 5G5/10	None

DABHOL LNG PROJECT

TITLE	PAINTING AND COATING SPECIFICATION	REV	DATE	PAGE NO.
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TABLE 3 - Colour Coding for Structures, Tanks and Equipment

SERVICE

COLOUR

Primary Steel Structures and Pipe-Racks
Pipe Supports and Embedments

Pale Olive 12D43
No RAL Equivalent
2.5GY6/8

Concrete Frames of Buildings

Cloud-White 22B15
RAL 9002
10PB9/1

Pipe-Bridges and other Primary Structure
passing over Roads

Brick Red 04E51
RAL 2012
7.5R6/12

LNG Tank Roof*

Pure Bright White 00E55
RAL 9010
N9.5

Secondary Structure, Walkways, Grating

Granite 00A05
RAL 7004
N7

Masonry Cladding for Buildings

Cream-White 08C31
RAL 1014
10YR9/2

Steel Cladding for Buildings

Sea-Grey 20C37
RAL 5023
5PB5/6

Roof Cladding for Buildings

Cloud-White 22B15
RAL 9002
10PB9/1

Fire Water Tank

Arctic Blue 18E50
RAL 5024
7.5B6/8

*Painted in accordance with Whessoe LGA specification 6732-000-WHME-PR-9549-00 Project Painting Requirements. Note that the steel tank walls are left in their primed state, and not painted further.

DABHOL LNG PROJECT

TITLE	PAINING AND COATING SPECIFICATION	REV	DATE	PAGE NO.
DOCUMENT	6732-000-MW-SP-7403-00	C4	06.10.00	13 OF 24

Valves, Non-Cryogenic*

As final stripe for piping component, see Table 2 - e.g Fire Red 04E53 for firewater

Mechanical and Electrical Equipment**

For repair use Cloud-White 22B15 or Cream-White 08C31 as suitable

Fire Hydrants, Control Panels, Extinguisher Panels, Doors

Fire Red 04E53
RAL 3000
7.5R4.5/16

Electrical Panels and Doors (site-painted)**

Pottery Orange 06E51
RAL 2003
2.5YR7/11

Medical Equipment, First Aid Boxes and Panels, Doors

Emerald Green 14E53
RAL 6032
5G5/10

Washing and Hygiene Station Doors

Sky Blue 18E53
RAL 5015
10B4/10

*Cryogenic valves are supplied with 100 μ barrier coat - no further painting required. Carbon steel valves are supplied with epoxy primer only, and require painting to comply with system 6, complete with colour coat.

**Mechanical and electrical equipment is supplied pre-coated at manufacturer with manufacturer standard 'off-white' to specification 6732-000-ME-SP-5211-00 Specification for Surface Preparation and Painting of Equipment; no further painting is required.

NOTE: this colour scheme does not cover any requirement for notices and signs required to comply with safety or traffic regulations in force. The Contractor must apply such notices and signs as are required by local law.

Project	EPCM Services for Ambient Air Heating System at KLL	Client	KONKAN LNG - SITE OFFICE
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Unit	Ethylene Glycol AAH system	Location		Job No.	B861	Unit No.	701
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PURCHASER'S DATA

A. Site Conditions			
1.	Maximum Ambient Temperature	°C	38.9
2.	Minimum Ambient Temperature	°C	10
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude	mm	<1000
6.	Environment:		Humid and highly Corrosive
B. Technical particulars			
1.	Motor Tag no.:		AS PER MR
2.	Driven Equipment name:		AS PER MR
3.	Voltage:	V	415 +/- 10 %
4.	Phase:		Three
5.	Frequency:	Hz	50 +/- 3 %
6.	Fault level:	kA	65
7.	Method of starting:		D.O.L
8.	Winding Connection:		Delta
9.	No of Terminals:		6
10.	Cable size:	mm ²	Later
11.	Cable type:		AYFY
12.	Temperature rise:	°C	90
13.	Cooling:		IC411
14.	Insulation class:		F
15.	Temperature rise Limited to insulation class		B
16.	Hazardous area classification:		safe area
17.	Dust classification		NA
18.	Gas group:		NA
19.	Dust Group		NA
20.	Type of explosion protection:		Industrial Safe area
21.	Prestart purging for Ex(n) motor		Not Required
22.	Type of ingress protection:		IP 65
23.	Color shade:		632 as per IS 5
24.	Thermisters:		
25.	RTD:		Not Required
26.	BTD:		Not Required
27.	RTD/BTD monitoring device:		Not Required
28.	Applicable specification:		6-51-0064
29.	Efficiency:		IE 3

DRIVEN EQUIPMENT MANUFACTURER'S DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
B	11-JUL-2024	ISSUED WITH MR	CHINTAKUNTLA SHANKAR	ARVIND NP SINGH	ARVIND NP SINGH
A	28-MAY-2024	ISSUED WITH MR	RAJIV KUMAR SAHA	RAJIV KUMAR SAHA	ARVIND NP SINGH

Project EPCM Services for Ambient Air Heating System at KLL **Client** KONKAN LNG - SITE OFFICE

Unit Ethylene Glycol AAH system **Location** **Job No.** B861 **Unit No.** 701

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkg	
	Torque required Maximum	mkg	
10.	GD2 of eqpt including flywheel	kqm ²	
	excluding flywheel:	kqm ²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER'S DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkg	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kqm ²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kq	

B	11-JUL-2024	ISSUED WITH MR	CHINTAKUNTLA SHANKAR	ARVIND NP SINGH	ARVIND NP SINGH
A	28-MAY-2024	ISSUED WITH MR	RAJIV KUMAR SAHA	RAJIV KUMAR SAHA	ARVIND NP SINGH
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project EPCM Services for Ambient Air Heating System at KLL Client KONKAN LNG - SITE OFFICE

Unit Ethylene Glycol AAH system Location Job No. B861 Unit No. 701

25.	Thermisters, quantity	no.	
	make: type:		
26.	RTD, quantity:	no.	
	make: type:		
27.	BTD, quantity	no.	
	make: type:		
28.	Shaft voltage:	V	
29.	Critical speed, 1st/2nd stage:	RPM	
30.	Canopy:		

Notes

- 1 Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
- 2 Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
- 3 GI canopy shall be provided for all outdoor motors.
- 4 For Approved makes of motors refer else where in the MR..
- 5 The starting current shall be limited to as per IS 12615.
- 6 Vibration probes shall be provided for each motor
- 7 Starting time calculations shall be based on operating conditions specified on Purchase Requisition eg. open valve condition/closed valve condition, at no load/full load, as applicable.

B	11-JUL-2024	ISSUED WITH MR	CHINTAKUNTLA SHANKAR	ARVIND NP SINGH	ARVIND NP SINGH
A	28-MAY-2024	ISSUED WITH MR	RAJIV KUMAR SAHA	RAJIV KUMAR SAHA	ARVIND NP SINGH
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

VENDOR DATA REQUIREMENTS FOR BIDS

A	12-JUN-2024	Issued For Bids	CSM	PKP	TK
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	GENERAL ARRANGEMENT DRAWING SHOWING BUNDLES WITH NOZZLE LOCATION & ORIENTATION, SERVICE PLATFORMS, STAIRS, LADDERS, DETAILS OF COLUMN SUPPORTS, CLEARANCE ETC. (DRAWN TO SCALE)		✓		✓	<i>Documents shall be submitted within 6 to 8 weeks. (NOTE-6)</i>
2.	DETAILED FABRICATION DRAWINGS OF BUNDLE & FRAME DRAWN TO THE SCALE INCLUDING TUBE BUNDLE DRAWING WITH MATERIAL SPECIFICATIONS SHOWING THICKNESS, DIMENSIONS, COMPONENT DETAIL, GASKET DETAIL, NOZZLE LOCATION AND ORIENTATION, TUBE TO TUBE SHEET JOINT DETAIL		✓		✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
3.	DRIVE SELECTION, MOTOR SUSPENSION, FAN AND PULLEY GUARDS, BEARING BLOCK DETAILS, QD BUSH DETAILS, INLET CONE DETAILS ETC			✓	✓	<i>Documents shall be submitted within 6 to 8 weeks. (NOTE-6)</i>
4.	DRAWINGS OF STRUCTURALS,SUPPORTS DETAILS AND PLENUM CHAMBERS (DRAWN TO SCALE)			✓	✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
5.	LIST OF MANDATORY SPARE PARTS WITH DETAILS		✓		✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
6.	COMPLETE DESIGN CALCULATION FOR AIR COOLER STRUCTURE, LIFTING LUGS, ETC AS APPLICABLE.			✓	✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
7.	FAN PERFORMANCE CURVES/LOUVERS PERFORMANCE CURVES			✓	✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
8.	VIBRATION SWITCHES DATASHEET			✓	✓	<i>submitted within 4 to 6 weeks. (NOTE-6)</i>
9.	NOISE DATASHEETS			✓	✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
10.	LUBRICATION PIPING DRAWING			✓	✓	<i>Documents shall be submitted within 4 to 6 weeks. (NOTE-6)</i>
11.	AS BUILT DRAWINGS & DOCUMENTS ABOVE DOCUMENTS			✓	✓	<i>Documents shall be submitted within 2 weeks after delivery.</i>
12.	MANUFACTURER'S DATA REPORT				✓	<i>Documents shall be submitted within 6 to 8 weeks. (NOTE-6)</i>

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
13.	INSPECTION AND TESTING PLAN @				✓	Duration of Submission: within 4 weeks after LOI
14.	MATERIAL TEST CERTIFICATES @				✓	Duration of Submission: within 1 week after Final Inspection
15.	WELDING PROCEDURES AND QUALIFICATION TEST REPORTS @				✓	Duration of Submission: within 5-8 weeks after LOI
16.	DESTRUCTIVE AND NON-DESTRUCTIVE TEST REPORTS @				✓	Duration of Submission: within 5-8 weeks after LOI
17.	RADIOGRAPHIC EXAMINATION REPORTS WITH FILMS @				✓	Vendor shall store these films for 5-Year after Delivery
18.	HEAT TREATMENT PROCEDURE AND TIME TEMPERATURE CHARTS @				✓	Duration of Submission: within 1 week after Final Inspection
19.	COMPLETION CERTIFICATES (INCLUDING INSPECTION CERTIFICATE, HYDROSTATIC TEST CERTIFICATE, LOCAL CODE REQUIREMENTS, RUBBING OF CODE STAMP AND NAME PLATE ETC.) @				✓	Duration of Submission: within 1 week after Final Inspection
20.	PACKING AND FORWARDING INSTRUCTIONS @			✓	✓	Documents shall be submitted within 2 weeks before delivery.
21.	INSTRUCTIONS AND CHECKLIST FOR ERECTION, INSTALLATION, TRIAL RUN & CATALOGUES FOR OPERATIONAL AND MAINTENANCE OF FAN/BELTS/PULLEY/VIBRATION TRANSMITTERS/MOTOR CATALOGUES @				✓	Documents shall be submitted within 6 to 8 weeks. (NOTE-6)
22.	PROCEDURE FOR PICKLING & PASSIVATION (FOR SS ITEMS ONLY) @				✓	Duration of Submission: within 4 weeks after LOI
23.	MANUAL FOR MAINTENANCE, CLEANING & LUBRICATION @				✓	Documents shall be submitted within 2 weeks before delivery.
24.	LIST OF TOOLS & TACKLES REQUIRED FOR MAINTENANCE (RECOMMENDE BY BIDDER)			✓	✓	Documents shall be submitted within 4 to 6 weeks. (NOTE-6)
25.	DULY FILLED WITH SIGN AND STAMPED TECHNICAL COMPLIANCE STATEMENT (B861-80-42-TCL-6002)	✓				

Notes :

- "TICK" denotes applicability.
- Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
- All post order documents shall be submitted / approved through EIL eDMS portal
- Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
- DCI shall be prepared by vendor based on the VDR attached with the requisition and shall be submitted with in 15 days of FOA.
- Duartion of submission marked against each drawing/document shall be considered from date of FOA.

VENDOR DATA REQUIREMENTS FOR AIR FIN COOLERS(INSTRUMENTATION)

B	22-AUG-2024	Issued with MR	DP	RK	RK
A	28-MAY-2024	Issued with MR	DP	RK	RK
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

S. N O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Drawing and Document Schedule		✓		✓	
2.	Purchase Requisition along with Technical catalogue for all vendor supplied instruments			✓	✓	
3.	Instrument Specification / Datasheets for all instruments (including Alarm Set points and catalog with model decoding)		✓		✓	Note-11
4.	Spare part list for Mandatory Spares		✓		✓	
5.	Complete catalogues with part list for all vendor supplied instruments, control, etc.			✓	✓	
6.	Installation, operation, Programming and maintenance manuals			✓	✓	
7.	Dimensional drawings			✓	✓	

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bidder shall furnish filled in data sheet for each tag after range selection, material selection etc. with make and model nos. These data sheets shall be reviewed / retained for records by purchaser after placement of order. Proper selection of instruments, materials etc. shall be bidder's responsibility. Any necessary change required later for meeting the specification shall be done by the bidder without any price or delivery implications. While filling the instruments data sheets, the following shall be taken care:
 - i) All the relevant data shall be filled in. If any point is not applicable then N/A shall be indicated.
 - ii) Make and model number of the offered instruments shall be indicated with model decoding details for offered instrument, without model no. data sheet shall not be reviewed.

**VENDOR DATA REQUIREMENTS
FOR
AIR FIN COOLERS(INSTRUMENTATION)**

-
- iii) Vendor seal with signature shall be provided and bidder shall ensure the correctness of the process data.
 - iv) Instruments tag numbers /data sheet numbers shall be indicated.

VENDOR DATA REQUIREMENTS FOR AIR HEATER PACKAGE

A	28-MAY-2024	ISSUED WITH MR	CS	RKS	ANPS
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

FLAMEPROOF CONTROL STATIONS

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Dimensional/Assembly Drawings : GA Drawings (For control station and canopy)		✓		✓	
3.	Dimensional/Assembly Drawings : Installation and mounting details			✓	✓	
4.	Wiring Diagram And Terminal Details			✓	✓	
5.	Type Test Certificate from Independent Test Lab			✓	✓	
6.	Statutory approval certificate			✓	✓	
7.	BIS Licence			✓	✓	
8.	List of Maintenance Spares			✓	✓	
9.	List of Special Tools & Tackles			✓	✓	
10.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note-1**
11.	Test Records				✓	
12.	Data Books/ Manuals : Installation Manual				✓	
13.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
14.	Data Books/ Manuals : Catalogues/ Brochures				✓	
15.	Equipment storage procedure at site				✓	

MV MOTOR

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Confirmation of Technical Compliance (B861-701-16-50-LL-6002)	✓				
3.	Data Sheets (Duly filled-in)		✓		✓	
4.	Dimensional/Assembly Drawings : GA Drawing For motors < 75kW			✓		
5.	Dimensional/Assembly Drawings : GA Drawing For motors >= 75kW		✓			

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
6.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✓	✓	
7.	Dimensional/Assembly Drawings : Terminal Box Arrangement			✓	✓	
8.	Dimensional/Assembly Drawings : Name Plate Drawing			✓	✓	
9.	Performance Curves : Speed Torque Curves			✓	✓	
10.	Performance Curves : Speed-Current/Time Curves			✓	✓	
11.	Performance Curves : Thermal Withstand Curves (Hot & Cold)			✓	✓	
12.	Performance Curves : P.f. & Efficiency Curves			✓	✓	
13.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note-1**
14.	Test Records				✓	
15.	Type Test Certificates for similar equipment			✓	✓	
16.	List of Commissioning Spares			✓		
17.	List of Maintenance Spares			✓		
18.	List of Mandatory Spares		✓			
19.	List of Special Tools & Tackles			✓		
20.	Data Books/ Manuals : Installation Manual				✓	
21.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
22.	Data Books/ Manuals : Catalogues/ Brochures				✓	
23.	Equipment storage procedure at site				✓	

Notes :

- "TICK" denotes applicability.
- Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
- All post order documents shall be submitted / approved through EIL eDMS portal.
- Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
- Refer - 6-78-0001: Specification for quality management system from Bidders.
- Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
- All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
- Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
- "@" indicates submission of documents to Inspection Agency.
- Bill of Material shall form part of the respective drawing.

VENDOR DATA REQUIREMENTS FOR PROTECTIVE COATINGS-B861-701-EA-MR- 6002

0	27-MAY-2024	ISSUED FOR BIDS	JJ	SAHIL	SS
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

COATING SYSTEMS

S. N O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Painting Scheme / Schedule/specifications (Including particulars of surface conditions, surface preparation and coating system etc. and inspection).		✓		✓	
3.	Paint manufacturer's Credentials/PTR (Past Track record)			✓	✓	
4.	Paint Pre-qualification Certificates as per the specifications.		✓		✓	
5.	Paint datasheets and Material safety Datasheets (MSDS)		✓		✓	
6.	GA Drawing of the equipment for which the painting schedule is proposed		✓		✓	

Notes :

- "TICK" denotes applicability.
- Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
- All post order documents shall be submitted / approved through EIL eDMS portal.
- Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
- Refer - 6-78-0001: Specification for quality management system from Bidders.
- Refer - 6-78-0002: Specification for documentation requirements from Contractors.
- Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
- All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
- Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).

PROJECT EPCM Services for Ambient Air Heating System at KLL		CLIENT Konkan LNG Limited	
UNIT ETHYLENE GLYCOL AAH SYSTEM		JOB NO. B861	UNIT NO. 701
ITEM NO	701-EA-1001 A/B/C/D/E -1028 A/B/C/D/E		
DESIGN CASE	CASE 1		
SERVICE	ETHYLENE GLYCOL WATER AIR HEATER (NOTE-3)		
DRAFT	FORCED DRAFT (NOTE-16)		
OPERATION	CONTINUOUS		
OPERATING CONDITION			
FLUID HANDLED	ETHYLENE GLYCOL - WATER MIXTURE (36 WT%)		
FLUID RATE	IN	OUT	
TOTAL	KG/HR	2570000 (NOTE-3,19)	2570000 (NOTE-3,19)
VAPOR	KG/HR	0	0
LIQUID	KG/HR	2570000 (NOTE-3,19)	2570000 (NOTE-3,19)
STEAM	KG/HR	0	0
WATER	KG/HR	0	0
NON CONDENSABLE	KG/HR	0	0
OPERATING TEMPERATURE	DEG C	2	18
OPERATING PRESSURE	BARG	7.70	
LIQUID PROPERTIES @ OPERATING TEMP & PRESS			
DENSITY	KG/M3	1058	1052
VISCOCITY	CP	4.4	2.46
SPECIFIC HEAT	KCAL/KG DEG C	0.843	0.853
THERMAL CONDUCTIVITY	KCAL/M HR DEG C	0.36	0.378
SURFACE TENSION (FOR CONDEN.SERVICE)	DYNES/CM		
VAPOUR PROPERTIES @ OPERATING TEMP & PRESS			
MOLECULAR WEIGHT			
DENSITY	KG/M3		
VISCOCITY	CP		
SPECIFIC HEAT	KCAL/KG DEG C		
THERMAL CONDUCTIVITY	KCAL/M HR DEG C		
ALLOWABLE PRESSURE DROP	BAR	0.85	
VELOCITY LIMIT(IF ANY)	M/SEC		
FOULING RESISTANCE	HR M2 DEG C/KCAL	0.00021	
HEAT DUTY	MM KCAL/HR	34.85 (40.5 MW) (NOTE-3,13,18)	
AIR TEMPERATURE	DEG C	23	
OVER CAPACITY FACTOR			
BOTH FLOW & DUTY	% Of Normal		
ONLY FLOW	% Of Normal		
ONLY DUTY	% Of Normal		
SURFACE AREA			
CONSTRUCTION OF EACH BUNDLE			
DESIGN TEMPERATURE	DEG C	(-) 25/65	
DESIGN PRESSURE	BARG	18.8	
FULL VAC DESIGN		YES	
MATERIAL OF CONSTRUCTION DETAILS		MATERIAL	CORROSION ALLOWANCE, MM
TUBES		KCS	
TUBE SHEETS		KCS	3.0
HEADER		KCS	3.0
FINS		ALUMINIUM	
TYPE OF CONTROL REQUIRED			
SPECIAL SERVICE REQUIREMENT			
STEAM COIL REQUIRED			
VIBRATION ALARM REQUIRED			
COOLING CURVE ATTACHED			
VARIABLE SPEED MOTOR REQ			
% FANS			
2	21-AUG-2024	Re-Issued For Engineering	DR
1	28-MAY-2024	Re-Issued For Engineering	DR
0	01-APR-2024	Issued For Engineering	DR
B	18-MAR-2024	Re-issued For Comments	DR
A	23-FEB-2024	Issued For Comments	MS
Format No. 3-0241-1012 Rev.2		Copyrights EIL - all rights reserved	
Rev. No.	Date	Purpose	Prepared By
			Reviewed By
			Approved By

PROJECT	EPCM Services for Ambient Air Heating System at KLL	CLIENT	Konkan LNG Limited
UNIT	ETHYLENE GLYCOL AAH SYSTEM	JOB NO.	B861
MOTORS CONNECTED TO EMERGENCY POWER SYSTEM		UNIT NO.	701
		NO	

NOZZLE DETAILS

SERVICE	SIZE	NO.	RATING	REMARKS	Rev
INLET	6 (NOTE-5)	2 (NOTE-5)	150#		
VENT (FOR EACH UNIT)	2	1	150#		
DRAIN (FOR EACH UNIT)	2	1	150#		
MULTIPURPOSE CONNECTION NOZZLE	2	1	150#		
OUTLET	6 (NOTE-5)	2 (NOTE-5)	150#		

2	21-AUG-2024	Re-Issued For Engineering	DR	JKS	SS
1	28-MAY-2024	Re-Issued For Engineering	DR	JKS	SS
0	01-APR-2024	Issued For Engineering	DR	JKS	SS
B	18-MAR-2024	Re-issued For Comments	DR	JKS	SS
A	23-FEB-2024	Issued For Comments	MS	JKS	SS

PROJECT EPCM Services for Ambient Air Heating System at KLL		CLIENT Konkan LNG Limited	
UNIT ETHYLENE GLYCOL AAH SYSTEM		JOB NO. B861	UNIT NO. 701
ITEM NO	701-EA-1001 A/B/C/D/E -1028 A/B/C/D/E		
DESIGN CASE	CASE 2		
SERVICE	ETHYLENE GLYCOL WATER AIR HEATER (NOTE-3)		
DRAFT	FORCED DRAFT (NOTE-16)		
OPERATION	CONTINUOUS		
OPERATING CONDITION			
FLUID HANDLED	ETHYLENE GLYCOL - WATER MIXTURE (36 WT%)		
FLUID RATE	IN	OUT	
TOTAL	KG/HR	2570000 (NOTE-3,19)	2570000 (NOTE-3,19)
VAPOR	KG/HR	0	0
LIQUID	KG/HR	2570000 (NOTE-3,19)	2570000 (NOTE-3,19)
STEAM	KG/HR	0	0
WATER	KG/HR	0	0
NON CONDENSABLE	KG/HR	0	0
OPERATING TEMPERATURE	DEG C	2	16
OPERATING PRESSURE	BARG	7.70	
LIQUID PROPERTIES @ OPERATING TEMP & PRESS			
DENSITY	KG/M3	1058	1053
VISCOCITY	CP	4.4	2.75
SPECIFIC HEAT	KCAL/KG DEG C	0.843	0.853
THERMAL CONDUCTIVITY	KCAL/M HR DEG C	0.36	0.374
SURFACE TENSION (FOR CONDEN.SERVICE)	DYNES/CM		
VAPOUR PROPERTIES @ OPERATING TEMP & PRESS			
MOLECULAR WEIGHT			
DENSITY	KG/M3		
VISCOCITY	CP		
SPECIFIC HEAT	KCAL/KG DEG C		
THERMAL CONDUCTIVITY	KCAL/M HR DEG C		
ALLOWABLE PRESSURE DROP	BAR	0.85	
VELOCITY LIMIT(IF ANY)	M/SEC		
FOULING RESISTANCE	HR M2 DEG C/KCAL	0.00021	
HEAT DUTY	MM KCAL/HR	30.5 (35.45 MW) (NOTE-3,13,18)	
AIR TEMPERATURE	DEG C	21	
OVER CAPACITY FACTOR			
BOTH FLOW & DUTY	% Of Normal		
ONLY FLOW	% Of Normal		
ONLY DUTY	% Of Normal		
SURFACE AREA			
CONSTRUCTION OF EACH BUNDLE			
DESIGN TEMPERATURE	DEG C	(-) 25/65	
DESIGN PRESSURE	BARG	18.8	
FULL VAC DESIGN		YES	
MATERIAL OF CONSTRUCTION DETAILS		MATERIAL	CORROSION ALLOWANCE, MM
TUBES		KCS	
TUBE SHEETS		KCS	3.0
HEADER		KCS	3.0
FINS		ALUMINIUM	
TYPE OF CONTROL REQUIRED			
SPECIAL SERVICE REQUIREMENT			
STEAM COIL REQUIRED			
VIBRATION ALARM REQUIRED			
COOLING CURVE ATTACHED			
VARIABLE SPEED MOTOR REQ			
% FANS			
2	21-AUG-2024	Re-Issued For Engineering	DR
1	28-MAY-2024	Re-Issued For Engineering	DR
0	01-APR-2024	Issued For Engineering	DR
B	18-MAR-2024	Re-issued For Comments	DR
A	23-FEB-2024	Issued For Comments	MS

PROJECT	EPCM Services for Ambient Air Heating System at KLL	CLIENT	Konkan LNG Limited
UNIT	ETHYLENE GLYCOL AAH SYSTEM	JOB NO.	B861
		UNIT NO.	701

MOTORS CONNECTED TO EMERGENCY POWER SYSTEM	NO
NOZZLE DETAILS	

SERVICE	SIZE	NO.	RATING	REMARKS	Rev
INLET	6 (NOTE-5)	2 (NOTE-5)	150#		
VENT (FOR EACH UNIT)	2	1	150#		
DRAIN (FOR EACH UNIT)	2	1	150#		
MULTIPURPOSE CONNECTION NOZZLE	2	1	150#		
OUTLET	6 (NOTE-5)	2 (NOTE-5)	150#		

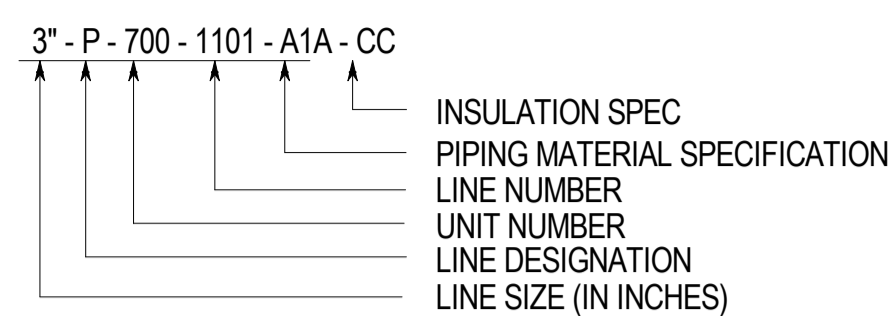
NOTES:

1 REFER P&ID NO: B861-02-42-701-1126~1135 FOR DETAILS.	2
2 VENDOR TO PROVIDE VIBRATION TRANSMITTER FOR EACH AIR HEATER UNIT.	
3 EACH LOOP OF FIVE PLATE HEAT EXCHANGER (700-EP-1001 A/B/C/D/E) IS PROPOSED TO HAVE 28 NUMBER OF AIR HEATER UNITS FOR ETHYLENE GLYCOL WATER HEATING. FOR PHE 700-EP-1001 A THE TAG NO. OF AIR HEATERS IS 701-EA-1001 A TO 701-EA-1028 A. FOR PHE 700-EP-1001 B THE TAG NO. OF AIR HEATERS IS 701-EA-1001 B TO 701-EA-1028 B. FOR PHE 700-EP-1001 C THE TAG NO. OF AIR HEATERS IS 701-EA-1001 C TO 701-EA-1028 C. FOR PHE 700-EP-1001 D THE TAG NO. OF AIR HEATERS IS 701-EA-1001 D TO 701-EA-1028 D. FOR PHE 700-EP-1001 E THE TAG NO. OF AIR HEATERS IS 701-EA-1001 E TO 701-EA-1028 E.	
4 MINIMUM AIR TEMPERATURE IS 10 DEG C AND MAXIMUM AIR TEMPERATURE IS 40.6 DEG C	
5 SIZE AND NUMBERS OF INLET AND OUTLET NOZZLES SHALL BE DETERMINED BY ENGINEERING	
6 THE DESIGN OF AIR HEATER SHALL ENSURE PROPER CONDENSATE COLLECTION & QUICK REMOVAL OF CONDENSED WATER FROM AIR HEATER SYSTEM TO RESERVOIR	
7 BEARINGS OF FANS AND MOTORS TO HAVE INDIVIDUAL VIBRATION PROBE EXTENSION OR FRAME TO HAVE PROVISION OF TAKING VIBRATION PHYSICALLY.	
8 ENSURE LAYOUT OF THE AIR HEATERS SHOULD BE SUCH THAT COLD AIR DOES NOT FORM A CLOSED LOOP AFFECTING EFFICIENCY ADVERSELY AND FOG FORMATION DOES NOT EFFECT VISIBILITY.	
9 ENGINEERING / SMMS TO CONSIDER THAT THE AIR HEATER STRUCTURE SHALL BE PROVIDED WITH APPROPRIATE PENETRATION SEALERS TO PROVIDE BARRIER AGAINST THE PENETRATION OF MOISTURE AND INGRESS OF CHLORIDES.	
10 ENGINEERING SHALL PROVIDE PERMANENT MAINTENANCE FACILITY FOR AIR HEATERS	
11 ENGINEERING SHALL CONSIDER THAT THE MECHANICAL EQUIPMENT SHOULD BE PREFERABLY LOCATED ABOVE TUBE BUNDLE TO AVOID BEING EXPOSED TO WATER DROPS FROM THE TUBE BUNDLES.	
12 ENGINEERING SHALL ENSURE EASY CLEANING OF THE TUBE BUNDLES	
13 COMPLETE AIR HEATERS LOOP (i.e. INCLUDING PIPING AND TUBE BUNDLES) SHALL BE CHEMICALLY CLEANED BEFORE COMMISSIONING.	
14 AIR HEATER SHALL BE DESIGNED FOR AIR HUMIDITY 0% TO 100%. EFFECT OF DEW CONDENSATION ON OUTER SURFACE OF FINNED TUBES AT HIGH HUMIDITY SHALL BE CONSIDERED BY ENGG BOTH FOR THE POINT OF VIEW OF THERMAL PERFORMANCE & FOR THE POINT OF VIEW OF AIR SIDE PRESSURE DROP.	
15 AIR HEATER FANS SHOULD BE OF LOW RPM.	
16 FORCED DRAFT TYPE WITH FAN MOUNTED ON TOP OF BUNDLE	
17 MULTIPURPOSE CONNECTION NOZZLE FOR EACH AIR HEATER UNIT.	
18 SPECIFIED HEAT DUTY IS FOR ONE SET OF AIR HEATER UNITS. i.e. (701-EA-1001 A - 1028 A) OF ONE PHE LOOP.	
19 ETHYLENE GLYCOL WATER FLOW RATE SPECIFIED IS FOR ONE SET OF AIR HEATER UNITS. i.e. (701-EA-1001 A - 1028 A) OF ONE PHE LOOP.	

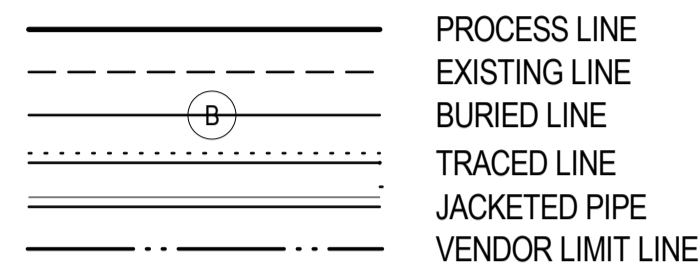
2	21-AUG-2024	Re-Issued For Engineering	DR	JKS	SS
1	28-MAY-2024	Re-Issued For Engineering	DR	JKS	SS
0	01-APR-2024	Issued For Engineering	DR	JKS	SS
B	18-MAR-2024	Re-issued For Comments	DR	JKS	SS
A	23-FEB-2024	Issued For Comments	MS	JKS	SS

LINES

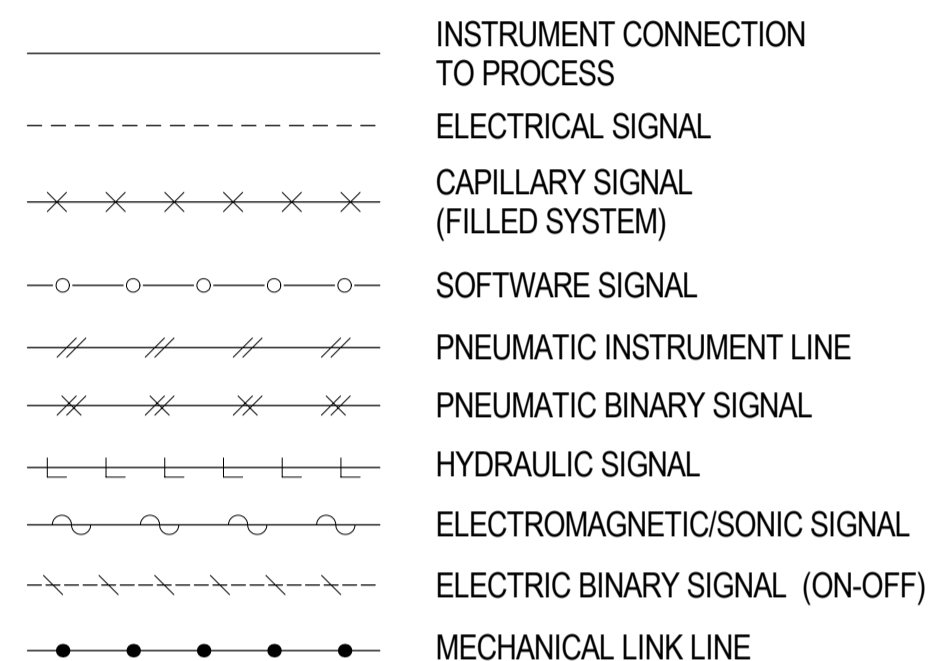
LINE IDENTIFICATION



LINE LEGEND



INSTRUMENT LINE SYMBOLS



LINE DESIGNATION

DESIGNATION

PROCESS LINES

P PROCESS

WATER LINES

CW	COOLING WATER
CDW	CONDENSATE WATER
CHW	CHILLED WATER
EGW	ETHYLENE GLYCOL WATER
HW	HOT WATER
WB	BOILER FEED WATER
WCS	COOLING WATER SUPPLY
WCR	COOLING WATER RETURN
BCS	BEARING COOLING WATER SUPPLY
BCR	BEARING COOLING WATER RETURN
DWK	DRINKING WATER
DM	WATER (DEMINERALISED)
WF	FIRE WATER
WO	UTILITY WATER/ BARRAGE WATER/ DESALINATED WATER
WP	PROCESS WATER
WQ	QUENCH WATER
WR	RAW WATER
WS	SERVICE WATER
WT	TEMPERED WATER
WSV	SOUR WATER
WM	TREATED WATER
WW	WASTE WATER
MW	METHANOL WATER
PW	PORTABLE WATER

STEAM & CONDENSATE LINES

SH	HIGH PRESSURE STEAM
SM	MEDIUM PRESSURE STEAM
SL	LOW PRESSURE STEAM
SVH	VERY HIGH PRESSURE STEAM
CL	LOW PRESSURE CONDENSATE
CM	MEDIUM PRESSURE CONDENSATE
CH	HIGH PRESSURE CONDENSATE
CVH	VERY HIGH PRESSURE CONDENSATE

AIR LINES

AI	INSTRUMENT AIR
AP	PLANT AIR
AB	BREATHING AIR
PA	PROCESS AIR/ COMBUSTION AIR/ REGENERATION AIR

VENT LINES

V VENT ATMOSPHERIC
SV SAFETY VALVE OUTLET (OTHER THAN FLARE ROUTING)

FLARE LINES

FL FLARE VENT ATMOSPHERIC

BLOW DOWN LINES

BC	BOILER BLOW DOWN
BD	BLOW DOWN
CBD	CLOSED BLOW DOWN
CCBD	CAUSTIC CLOSED BLOW DOWN
ABD	AMINE BLOW DOWN
SBD	SOUR WATER BLOW DOWN
LTBD	LOW TEMPERATURE BLOW DOWN

UTILITY OIL LINES

FO	FUEL OIL
HO	HYDRAULIC OIL
FLO	FLUSHING OIL
LSFLO	LOW SULPHUR FLUSHING OIL
HFLO	HEAVY FLUSHING OIL
HTO	HOT OIL
LO	LUBE OIL
MO	MINERAL OIL

UTILITY GAS LINES

FG	FUEL GAS
IG	INERT GAS / NITROGEN
NG	NATURAL GAS
IN	INSTRUMENT NITROGEN

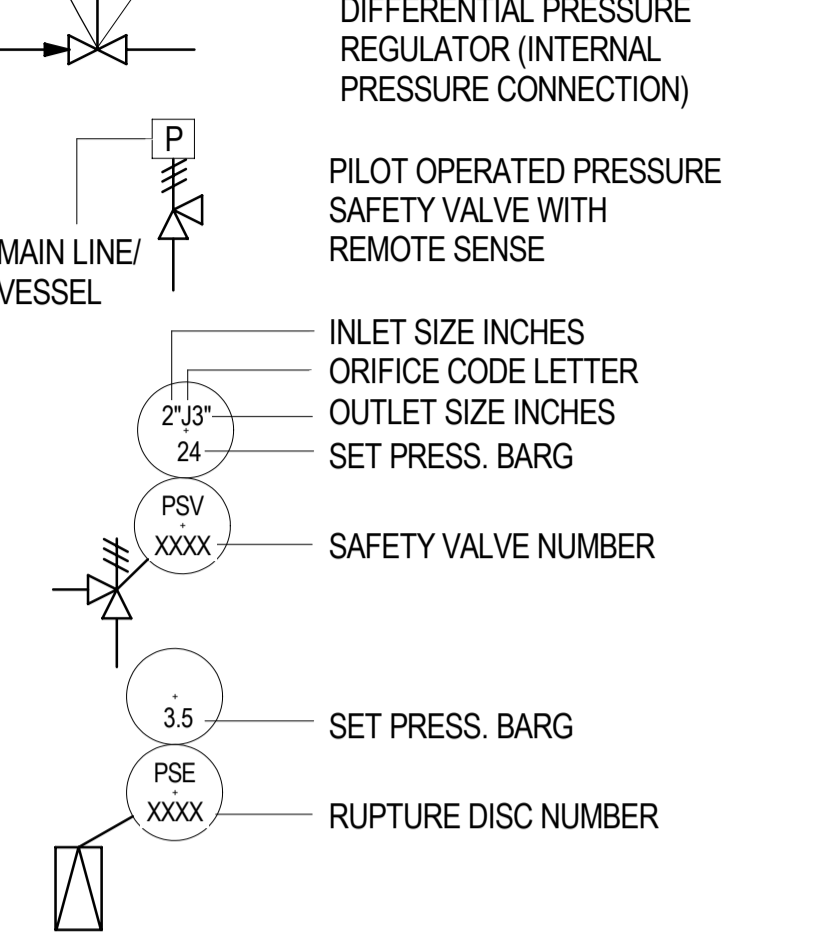
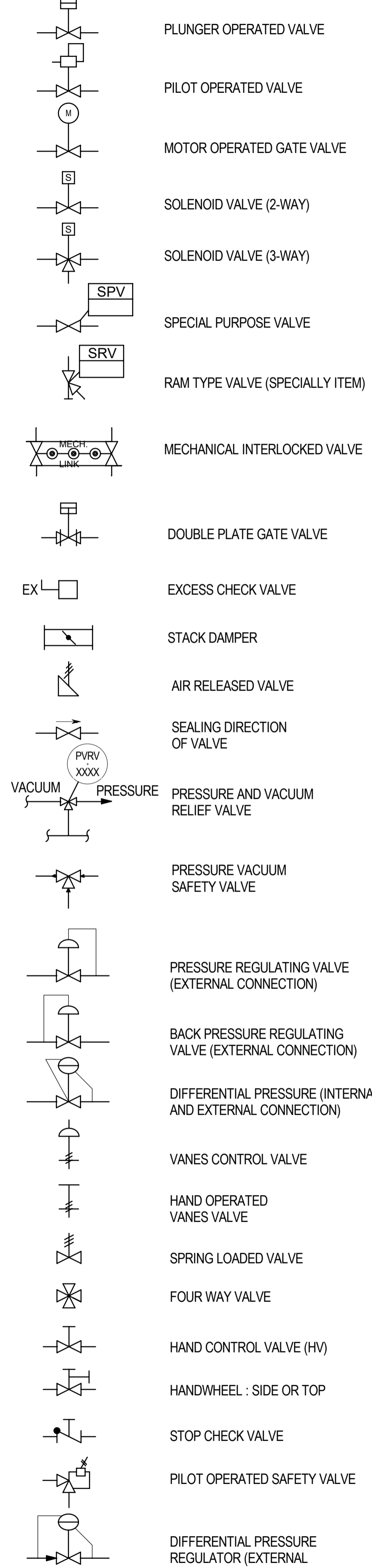
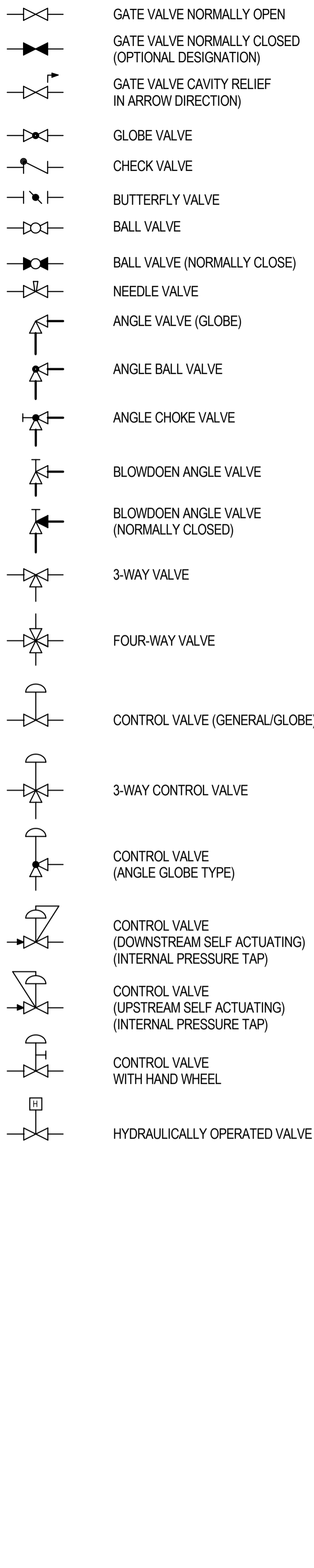
DRAIN LINES

OWS	OILY WATER SEWER
CS	CHEMICAL SEWER
SS	STROM SEWER
CWRS	CONTAMINATED RAIN WATER SEWER
HY	ACCIDENTALLY OILY SEWER

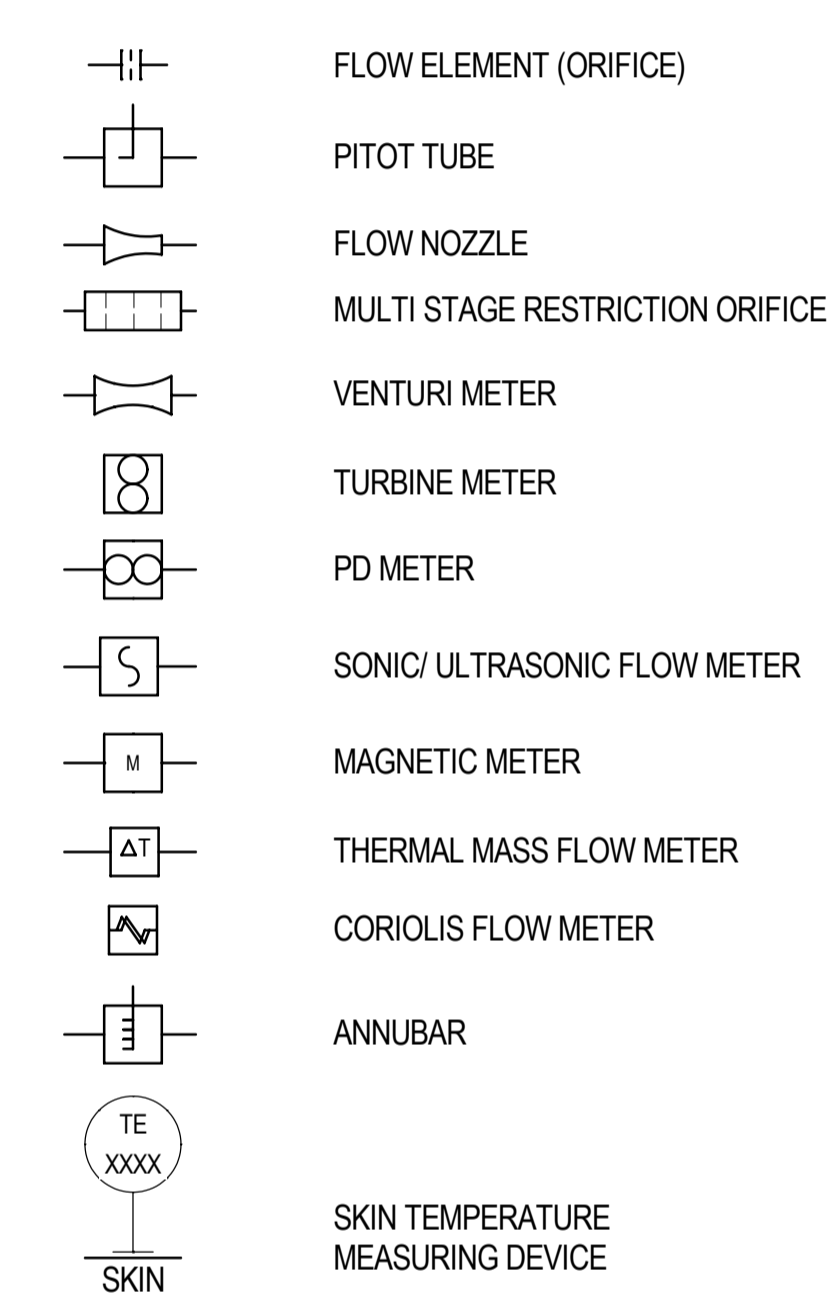
OTHERS

AC	ACID
BOG	BOIL OFF GAS
CA	CAUSTIC
C	OTHER CHEMICALS
CO	CARBON MONOXIDE
CT	CATALYST
DO	DONOR
ETH	ETHANOL
FI	LIQUID FOAMS
FS	SOLUTION FOAMS
FLU	FLUE GAS
ME	METHANOL
NG	NATURAL GAS
LN	LIQUID NITROGEN
LNG	LIQUID NATURAL GAS
LA	LIQUID ADDITIVE (PEROXIDE)
LR	LIQUID REFRIGENT
GR	VAPOUR REFRIGENT
PL	PP RESIN (PELLETS)
PR	PP RESIN (POWDER)
TEA	T2 (TEAL)
SA	SOLID ADDITIVE
RP	PROPYLENE/ PROPANE REFRIGERATION
RE	ETHYLENE REFRIGERATION
RA	AMMONIA REFRIGERATION

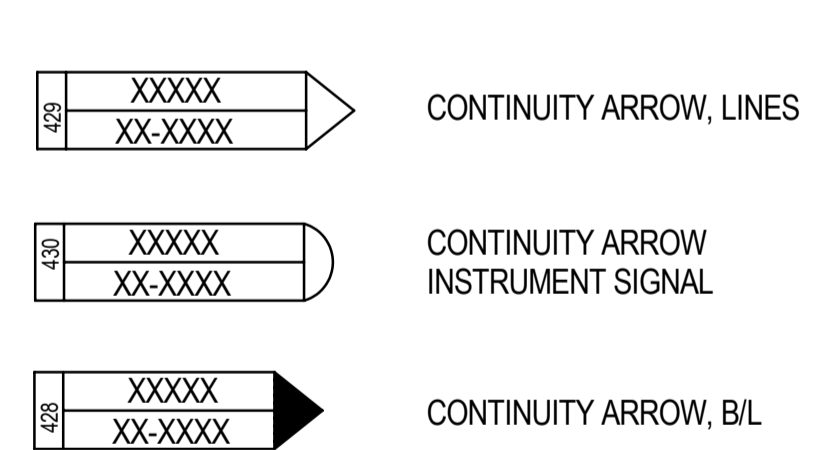
VALVE SYMBOLS



INSTRUMENT SYMBOLS



DRAWING CONTINUITY SYMBOLS



0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
A	17.05.24	ISSUED FOR COMMENTS	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

इंजिनियर्स
इंडिया लिमिटेड
(भारत सरकार का उपक्रम)

ENGINEERS INDIA LIMITED
(A Govt. of India Undertaking)

कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
STANDARD SYMBOLS AND NOMENCLATURE
SHEET 1 OF 3

अनुमाप	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	001	1191	0

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LINE ITEM SYMBOLS

	DRAIN WITH BLIND FLANGE		THREADED PLUG WITH COUPLING																																														
	DRAIN WITH THREADED CAP		FLOW TEE																																														
	EJECTOR/ EDUCTOR/ BOOSTER		FLOW DIRECTION																																														
	SWING ARM		QUICK CONNECTOR STEM AND BODY																																														
	CLOSE SERVICE DRAIN		CONTINUOUS DRAIN																																														
	'T' - TYPE STRAINER		SPEC BREAK																																														
	'Y' - TYPE STRAINER		XXX & YYY-PIPING SPEC																																														
	TEMPORARY STRAINER	<h3>OTHER SYMBOLS</h3> <table border="1"> <tr> <td></td> <td>DIAPHRAGM PRESSURE SEAL</td> </tr> <tr> <td></td> <td>CORROSION COUPON</td> </tr> <tr> <td></td> <td>CORROSION PROBE</td> </tr> <tr> <td></td> <td>RUNNING LIGHT (LOCAL)</td> </tr> <tr> <td></td> <td>RUNNING LIGHT (PANEL)</td> </tr> <tr> <td></td> <td>RUNNING LIGHT (LOCAL PANEL)</td> </tr> <tr> <td></td> <td>RUNNING LIGHT (DCS)</td> </tr> <tr> <td></td> <td>REMOTE TRANSMISSION UNIT</td> </tr> <tr> <td></td> <td>LOCAL MOUNTED INSTRUMENT FOR TWO VARIABLES</td> </tr> <tr> <td></td> <td>TIE IN POINT</td> </tr> <tr> <td></td> <td>VENDOR TIE IN POINT</td> </tr> <tr> <td></td> <td>FUTURE TIE IN POINT</td> </tr> <tr> <td></td> <td>VENT</td> </tr> <tr> <td></td> <td>SAFETY SHOWER AND EYE WASH</td> </tr> <tr> <td></td> <td>BALL FLOAT</td> </tr> <tr> <td></td> <td>AA AERATION AIR</td> </tr> <tr> <td></td> <td>AG AERATION GAS</td> </tr> <tr> <td></td> <td>AS AERATION STEAM</td> </tr> <tr> <td></td> <td>AP AIR PURGE</td> </tr> <tr> <td></td> <td>NP NITROGEN PURGE</td> </tr> <tr> <td></td> <td>OP OIL PURGE</td> </tr> <tr> <td></td> <td>SP STEAM PURGE</td> </tr> <tr> <td></td> <td>SC SAMPLE CONNECTION</td> </tr> </table>			DIAPHRAGM PRESSURE SEAL		CORROSION COUPON		CORROSION PROBE		RUNNING LIGHT (LOCAL)		RUNNING LIGHT (PANEL)		RUNNING LIGHT (LOCAL PANEL)		RUNNING LIGHT (DCS)		REMOTE TRANSMISSION UNIT		LOCAL MOUNTED INSTRUMENT FOR TWO VARIABLES		TIE IN POINT		VENDOR TIE IN POINT		FUTURE TIE IN POINT		VENT		SAFETY SHOWER AND EYE WASH		BALL FLOAT		AA AERATION AIR		AG AERATION GAS		AS AERATION STEAM		AP AIR PURGE		NP NITROGEN PURGE		OP OIL PURGE		SP STEAM PURGE		SC SAMPLE CONNECTION
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	FILTER																																																
	SPECTACLE BLIND																																																
	REMOVABLE SPOOL PIECE																																																
	EXPANDER/ REDUCER																																																
	CAP (WELDED)																																																
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	HOSE CONNECTION																																																
	BLIND																																																
	PLUG																																																
	ADAPTOR																																																
	OPEN DRAIN & FUNNEL																																																
	OPEN DRAIN SYSTEM (W/ LIQUID SEAL)																																																
	BELLOWS																																																
	STEAM TRAP																																																
	AIR TRAP																																																
	RUPTURE DISC																																																
	COUPLING																																																
	SLOPE																																																
	FLAME ARRESTOR																																																
	PULSATION DAMPNER																																																
	VORTEX BREAKER																																																
	FLEXIBLE LINE/ HOSE																																																
	SILENCER																																																
	RAIN CAP																																																
	SPECIALITY ITEM																																																
	EXPANSION JOINT																																																
	SCREEN FILTER																																																
	BLANK FLANGE																																																
	BATTERY LIMITS OR TIE-IN POINTS																																																
	BIRD SCREEN																																																

INSTRUMENTATION SYMBOLS AND LEGEND

NOTE: INSTRUMENTATION SYMBOLS AND LEGEND SHALL BE AS PER ISA "STANDARDS AND RECOMMENDED PRACTICES FOR INSTRUMENTATION AND CONTROL".

IDENTIFICATION LETTERS

	FIRST - LETTERS		SUCCEEDING - LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	
D	USER'S CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATOR		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE TOTALIZE			
R	RADIATION	SAFETY	RECORD		
S	SPEED, FREQUENCY				SWITCH
T	TEMPERATURE				TRANSMIT
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTR, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

1. SPLIT RANGE VALVES: SOME CONTROL LOOPS HAVE TWO CONTROL VALVES ON THE OUTPUT SIGNAL OF ONE CONTROLLER FOR EXAMPLE WITH TWO CONTROL VALVES, ONE VALVE PRESSURIZES AND THE OTHER VENTS A VESSEL. A PLOT SHOWS THE VALVE POSITION VERSES PRESSURE.

IT IS IMPORTANT TO KEEP THE CONTROL LOOP GAIN CONSTANT FOR GOOD SPLIT RENG OPERATION. THE GAIN OF EACH VALVE (INCLUDING THE PROCESS) MUST BE MADE SIMILAR. OTHERWISE LIMIT CYCLING OR POOR CONTROL WILL RESULT.

2. WHERE SEQUENCE VALVE OPERATION IS CALLED FOR, THEY ARE INTENDED TO WORK AS FOLLOWS:

3. OPPOSITE ACTING VALVES CONTROL LOOP NOTED AS OPPOSITE ACTING VALVES HAVE THE FOLLOWING ACTION.

FUNCTION BLOCKS - FUNCTION DESIGNATIONS

NO.	FUNCTION	SYMBOL	NO.	FUNCTION	SYMBOL
1	SUMMING	Σ	12	TIME FUNCTION	
2	AVERAGING	Σ/n	13	HIGH SELECTING	\max
3	DIFFERENCE	Δ	14	LOW SELECTING	\min
4	PROPORTIONAL	K	15	HIGH LIMITING	\max
5	INTEGRAL	\int	16	LOW LIMITING	\min
6	DERIVATIVE	di/dt	17	REVERSE PROPORTIONAL	$-K$
7	MULTIPLYING	X			
8	DIVIDING	\div	18	BIAS	\pm
9	ROOT EXTRACTION	$\sqrt{\quad}$			
10	EXPONENTIAL	X^n	19	CONVERT	\square
11	NON LINEAROR UNSPECIFIED FUNCTION	$F(X)$			

DCS/COMPUTER SYSTEM SYMBOLS

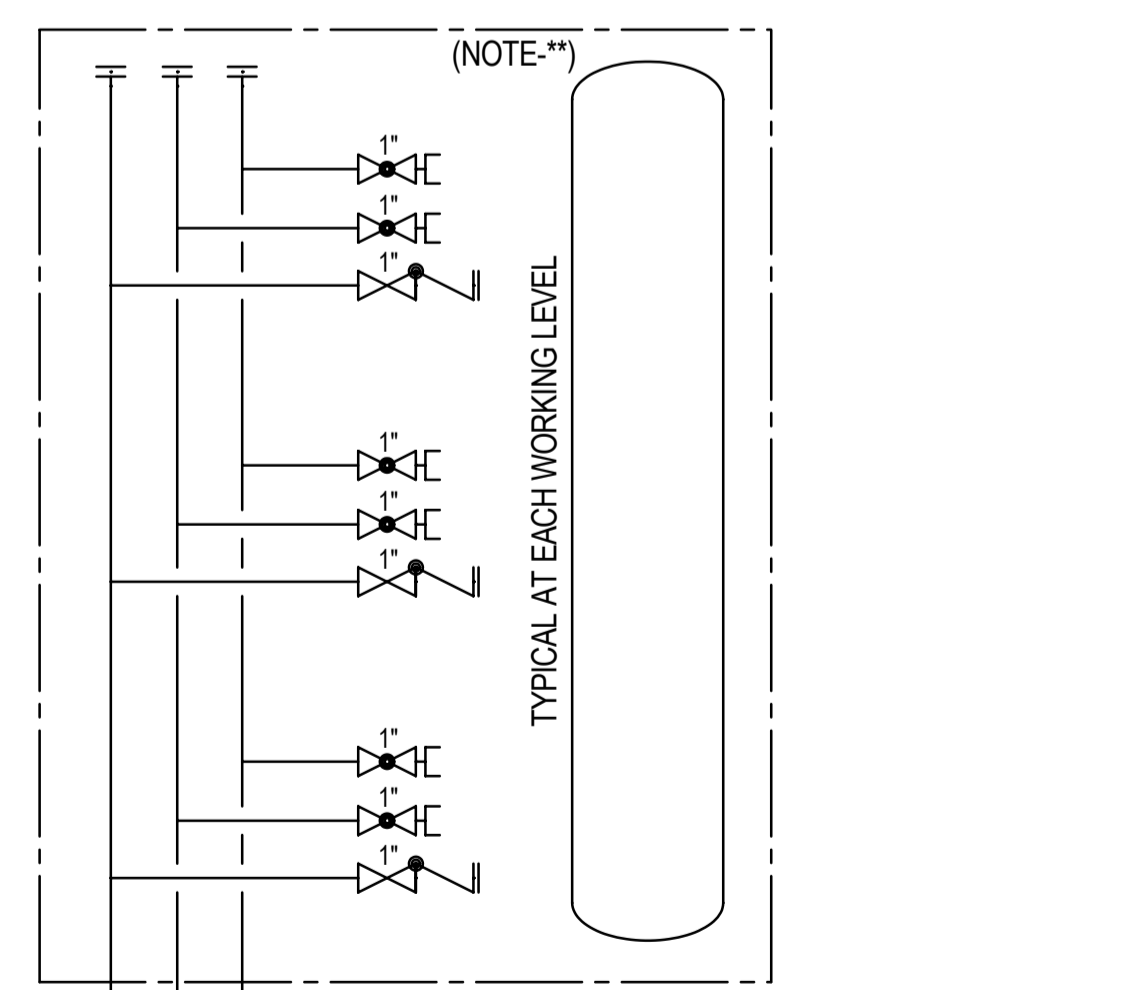
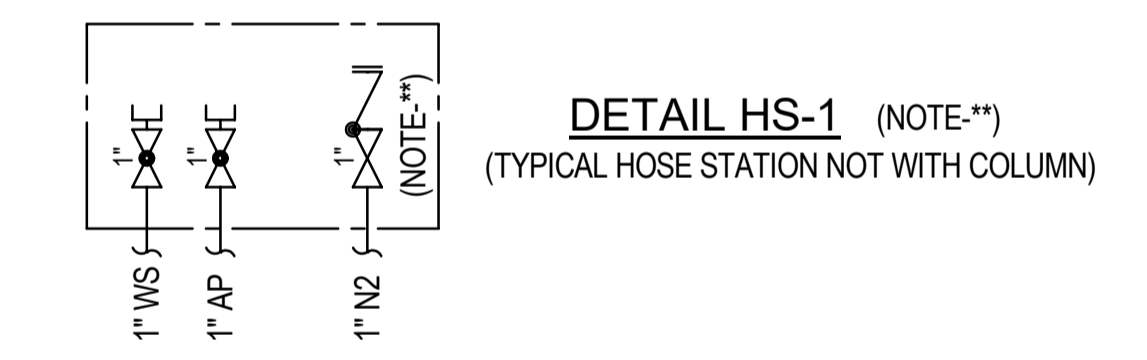
	SHARED DISPLAY INDICATOR, CONTROLLER OR OTHER DEVICES WITH OPERATOR ACCESS TO ADJUSTMENT.
	SHARED DISPLAY DEVICES WITH LIMITED ACCESS TO ADJUSTMENTS LOCATE IN FIELD.
	AUXILIARY OPERATORS INTERFACE DEVICE FOR EXAMPLE, BACK UP CONTROLLER OR MANUAL STATION.
	COMPUTER COMPONENTS NOT ACCESSIBLE TO OPERATOR LIKE I/O INTERFACE, BLIND CONTROLLER OR A SOFTWARE CALCULATION BOX.
	INDICATOR/ CONTROLLER/ RECORDER OR ALARM POINT NORMALLY ACCESSIBLE TO OPERATOR THROUGH VIDEO DISPLAY.
	AUXILIARY COMPUTER COMPONENTS NORMALLY ACCESSIBLE TO OPERATOR.
	SEQUENTIAL LOGIC CONTROL LIMITED ACCESS TO OPERATOR
	SEQUENTIAL LOGIC CONTROL ACCESS TO OPERATOR
	INTERLOCK FUNCTION

INSULATION/ TRACING TYPE

IA	ACOUSTIC INSULATION
CC	COLD CONSERVATION INSULATION
IE	ELECTRICAL TRACED
H	HEAT CONSERVATION INSULATION
IJ	STEAM JACKETED
NIC	NOISE CONTROL
NI	NO INSULATION
IS	SAFETY INSULATION
IT	STEAM TRACED
SIVL	SUPER INSULATED VACUUM LINE
CPP	COLD PERSONAL PROTECTION INSULATION
SC	SURFACE CONDENSATION INSULATION
HPP	HOT PERSONAL PROTECTION INSULATION

FUNCTIONAL SYMBOLS

	FIELD MOUNTED INSTRUMENT
	LOCAL PANEL INSTRUMENT
	REAR LOCAL PANEL INSTRUMENT
	CENTRAL PANEL MOUNTED INSTRUMENT
	REAR CENTRAL PANEL MOUNTED INSTRUMENT



(**) HOSE STATION CONSISTING OF PLANT AIR, SERVICE WATER AND NITROGEN TO BE PROVIDED AS PER DETAIL HS-1 & HS-2. HOSE TO BE OF FLANGE TYPE FOR NITROGEN. OTHER UTILITIES TO HAVE HOSE OF QUICK COUPLING TYPE. NO. OF HOSE STATIONS TO BE DECIDED DURING DETAIL ENGG. NITROGEN HOSE CONNECTION SHALL ONLY BE PROVIDED AS PER REQUIREMENT.

0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
A	16.05.24	ISSUED FOR COMMENTS	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

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KONKAN LNG LIMITED
 EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
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 SHEET 2 OF 3

अनुमाप	कार्य	विभाग	अनुभाग	इकाई	आरेख	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
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GENERAL ABBREVIATIONS

ACC	ACCESSORY
AG	ABOVE GROUND
AT	AIR TRAP
ATM	ATMOSPHERE
B. F.	BOTTOM FLAT INSTALLATION OF ECCENTRIC REDUCER
BL	BATTERY LIMIT
B.V.	BY VENDOR
BW	BUTT WELD
CLO	CLOSED OUTLET VALVE
CO	CLEAN OUT
COMPR	COMPRESSOR
CONN	BUTT WELD
CPLG	COUPLING
C/R	CONTROL ROOM
CS	CHEMICAL SEWER
CSC	CAR SEAL CLOSED
CSO	CAR SEAL OPEN
DIA	DIAMETER
DIAG	DIAGRAM
DR	DRAIN
DWG	DRAWING
EFG	EXTERNAL FIRE GAS EXPANSION
EL	ELEVATION
EV	EMERGENCY VENT
ETF	EXTERNAL FIRE LIQUID VAPORIZATION
FB	FULL BORE
FLG	FLANGE
HC	HYDROCARBON
HDR	HEADER
HH	HAND HOLE
HLL	HIGH LIQUID LEVEL
HP	HIGH PRESSURE
HS	HOSE STATION
INST	INSTRUMENT
ISBL	INSIDE BATTERY LIMIT
LC	LOCK CLOSE
LLL	LOW LIQUID LEVEL
LO	LOCK OPEN
LP	LOW PRESSURE
MAX	MAXIMUM
MIN	MINIMUM
MW	MANWAY
NC	NORMALLY CLOSED
NLL	NORMAL LIQUID LEVEL
NNF	NORMALLY NO FLOW
NO	NORMALLY OPEN
NOZ	NOZZLE
OPC	OFF PAGE CONNECTOR
OSBL	OUTSIDE BATTERY LIMIT
OVHD	OVERHEAD
OWS	OILY WATER SEWER
PL	PIPELINE
PLGD	PLUGGED
PSO	POSITIVE SHUT OFF (CL. VI)
QD	QUICK DISCONNECT
QOEC	QUICK OPENING END CLOSURE
RF	RAISED FACE
RTJ	RING TYPE JOINT
SCH	SCHEDULE
SCR	SCRAPPER
SCV	SUBMERGED COMBUSTION VAPORISER
S/D	SHUT DOWN
SEW	SAFETY SHOWER AND EYE WASH
SPEC	SPECIFICATION
STD	STANDARD
STR	STRAINER
STV	SHELL AND TUBE VAPORISER
SVH	FLEXIBLE HOSE
TL	TANGENT LINE
THD	THREADED
TOP	TAP OFF POINT
TP	TIE - IN POINT
TSO	TIGHT SHUT OFF (CL. IV & V)
TURB	TURBINE
TYP	TYPICAL
UC	UTILITY CONNECTION
UG	UNDER GROUND
V	VENT
VAC	VACUUM
VF	VENDOR FURNISHED
VHP	VERY HIGH PRESSURE

INSTRUMENTATION ABBREVIATIONS

AAH	ANALYSER ALARM HIGH
AAHH	ANALYSER ALARM HIGH HIGH
AF	FLAME ARRESTOR
AR	AUTO RESET
ARWU	ANTI-RESET WIND UP
ASH	ANALYSER SWITCH HIGH
ASHH	ANALYSER SWITCH HIGH HIGH
AV	ACTION VALVE
BE	FLAME SCANNER
BF	BALL FLOAT
CEMS	CONTINUOUS EMISSION MONITORING SYSTEM
CMR	CONTROL ROOM MANUAL RESET (FOR SOV)
CMS	CORROSION MONITORING SYSTEM
CVO	CV WIDE OPEN
DAH	DENSITY ALARM HIGH
DAL	DENSITY ALARM LOW
DG	DRAFT GAUGE
DI	DENSITY INDICATOR
DR	DENSITY RECORDER
DV	DELUGE VALVE
DY	TRANSDUCER FOR SIGNAL FROM DENSITY INSTRUMENT
EDA	ELECTRIC DEFECT ALARM
ESD	EMERGENCY SHUTDOWN
FC	FAIL CLOSE
FAH	CORRECTED FLOW ALARM HIGH
FAL	CORRECTED FLOW ALARM LOW
FCI	CORRECTED FLOW INDICATOR
FCQ	CORRECTED FLOW INTEGRATOR
FCV	SELF ACTUATED FLOW CONTROL VALVE
FF	FOUNDATION FIELD BUS
FL	FAIL LOCK
FLDC	FAIL LOCK DRIFT CLOSED
FLDO	FAIL LOCK DRIFT OPEN
FQ	FLOW INTEGRATOR
FML	MASS FLOW INDICATOR
FMQ	MASS FLOW INTEGRATOR
FMR	MASS FLOW RECORDER
FMR	FIELD MANUAL RESET (FOR SOV)
FO	FAIL OPEN
FR	FLOW RECORDER
FRI	FLOW RATIO INDICATOR
FRIC	FLOW RATIO INDICATOR CONTROLLER
FRR	FLOW RATIO RECORDER
FSD	FIRE DETECTOR
FV	FLOW CONTROL VALVE
FY	TRANSDUCER FOR SIGNAL FROM FLOW INSTRUMENT
GC	GAS CHROMATOGRAPH
GWR	GUIDED WAVE TYPE RADAR LEVEL INSTRUMENT
HCV	CONTROL VALVE WITH REMOTE AND POSITIONING
HIC	MANUAL LOADER
HOV	HYDROCALLY OPERATED VALVE
HS	HAND SWITCH
HSS	HIGH SIGNAL SELECTOR
HV	HAND CONTROL VALVE WITH INCHING FACILITY
HY	MANUAL SIGNAL CONVERTER
HZC	MANUAL POSITION CONTROLLER (INCHING)
I/P	INSTRUMENT SIGNAL TO PNEUMATIC CONVERTER
LD	LEAK DETECTOR
LP	LEAK PROCESSOR
LSS	LOW SIGNAL SELECTOR
LV	LEVEL CONTROL VALVE
LY	TRANSDUCER FOR SIGNAL FROM LEVEL INSTRUMENT
MAG	MAGNETIC TYPE LEVEL INSTRUMENT
ML	MAINTENANCE LIGHT
MOV	MOTOR OPERATED VALVE
MOVG	GAS OPERATED SLAM SHUT OFF VALVE
MOVV	PNEUMATIC MOTOR OPERATED VALVE
MV	MEASURED VARIABLE
NCR	NON CONTACT TYPE RADAR LEVEL INSTRUMENT
NIA	INTERPHASE INDICATOR/ ALARM
OAH	VISCOSITY ALARM HIGH
OAL	VISCOSITY ALARM LOW
ODS	OVERRIDE SWITCH
OI	VISCOSITY INDICATOR

PB	PUSH BUTTON
PCV	SELF ACTUATED PRESSURE CONTROL VALVE
PHI	PH INDICATOR
PHIC	PH INDICATOR CONTROLLER
PHR	PH RECORDER
PSV	PRESSURE SAFETY VALVE
PV	PRESSURE CONTROL VALVE
PY	TRANSDUCER FOR SIGNAL FROM PRESSURE INSTRUMENT
RD	RUPTURE DISK
RO	RESTRICTION ORIFICE
RTD	RESISTANCE TYPE TEMPERATURE DETECTOR
SDD	SLOT DIPPING DEVICE
SDV	SHUT DOWN VALVE
SIV	STATION ISOLATION VALVE
SMCS	SCADA MONITORING & CONTROL STATION
SOV	SOLENOID OPERATED VALVE
SRV	SURGE RELIEF VALVE
SS	SPEED SWITCH
SSW	SELECTION SWITCH
SV	SECTIONALIZING VALVE
TCV	SELF ACTUATED TEMPERATURE CONTROL VALVE
TJI	MULTIPOINT TEMPERATURE INDICATOR
TJR	MULTIPOINT TEMPERATURE RECORDER
TSD	TEMPERATURE SAFETY DETECTOR
TSV	THERMAL SAFETY VALVE
TW	THERMOWELL
TV	TEMPERATURE CONTROL VALVE
TY	TRANSDUCER FOR SIGNAL FROM TEMPERATURE INSTRUMENT
XA	COMMON ALARM
XAL	MOTOR RUNNING INDICATION ALARM LOW (OFF POSITION)
XAF	MOTOR FAIL TO TRIP ALARM
XAS	MOTOR FAIL TO TRIP SWITCH
XI	MOTOR RUNNING INDICATION
XL	MOTOR RUNNING INDICATION LAMP
XLH	MOTOR RUNNING INDICATION LAMP HIGH (ON POSITION)
XLL	MOTOR RUNNING INDICATION LAMP LOW (OFF POSITION)
XRL	REMOTE OPERATION INHIBITED INDICATION
XS	DETECTOR SWITCH
XSL	LOCAL/ REMOTE SWITCH
XXI	PIG DETECTOR INDICATOR
XXIS	PIG DETECTOR INDICATOR SWITCH
XV	SHUT OFF VALVE/ ON-OFF VALVE
UA	MULTIVARIABLE ALARM
USA	MULTIVARIABLE SAFETY ALARM/ COMMON TRIP
ZAL	POSITION ALARM LOW (VALVE CLOSE)
ZLH	POSITION LIGHT HIGH (VALVE OPEN)
ZLL	POSITION LIGHT LOW (VALVE CLOSE)
ZSH	POSITION SWITCH HIGH (VALVE OPEN)
ZSL	POSITION SWITCH LOW (VALVE CLOSE)
ZT	POSITION TRANSMITTER

0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
A	16.05.24	ISSUED FOR COMMENTS	GSB	DR	JKS	SS
संख्या	तिथि	संशोधन	डॉन	द्वारा	जाँच	अनुमोदित
No.	DATE	REVISIONS	DRN	BY	CHKD	APPD.

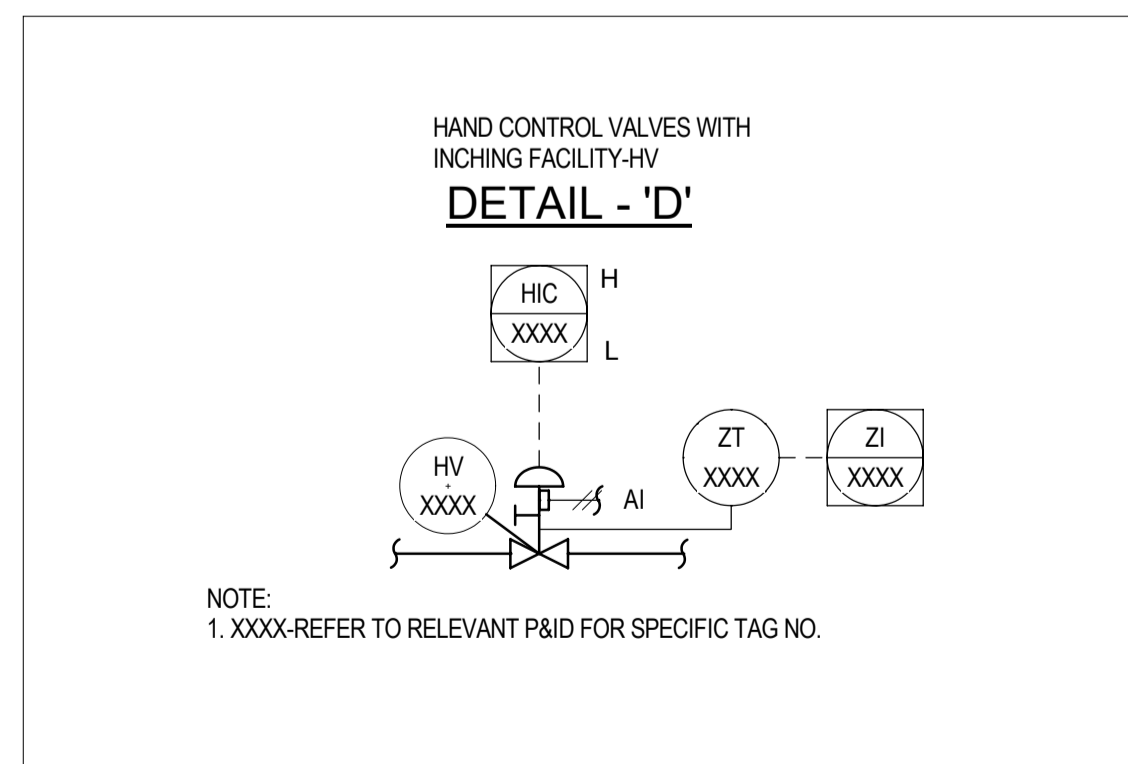
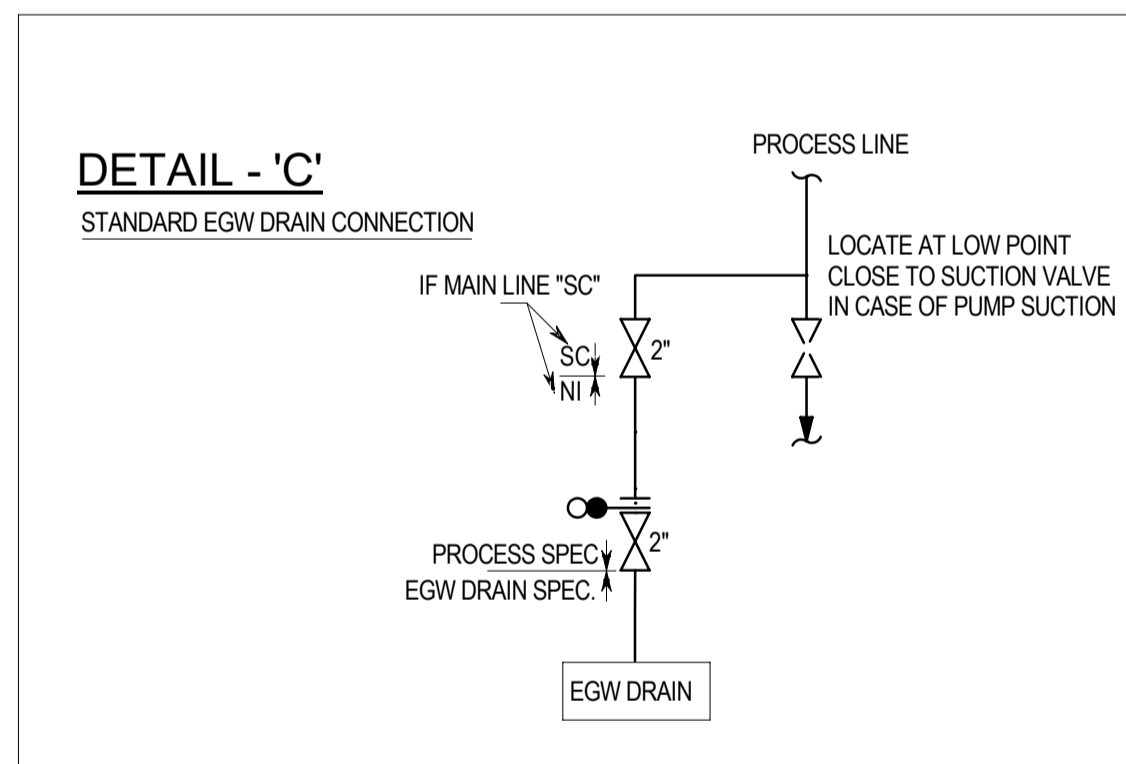
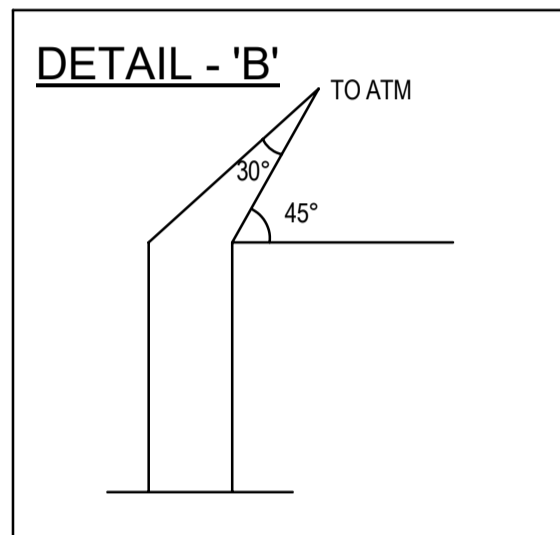
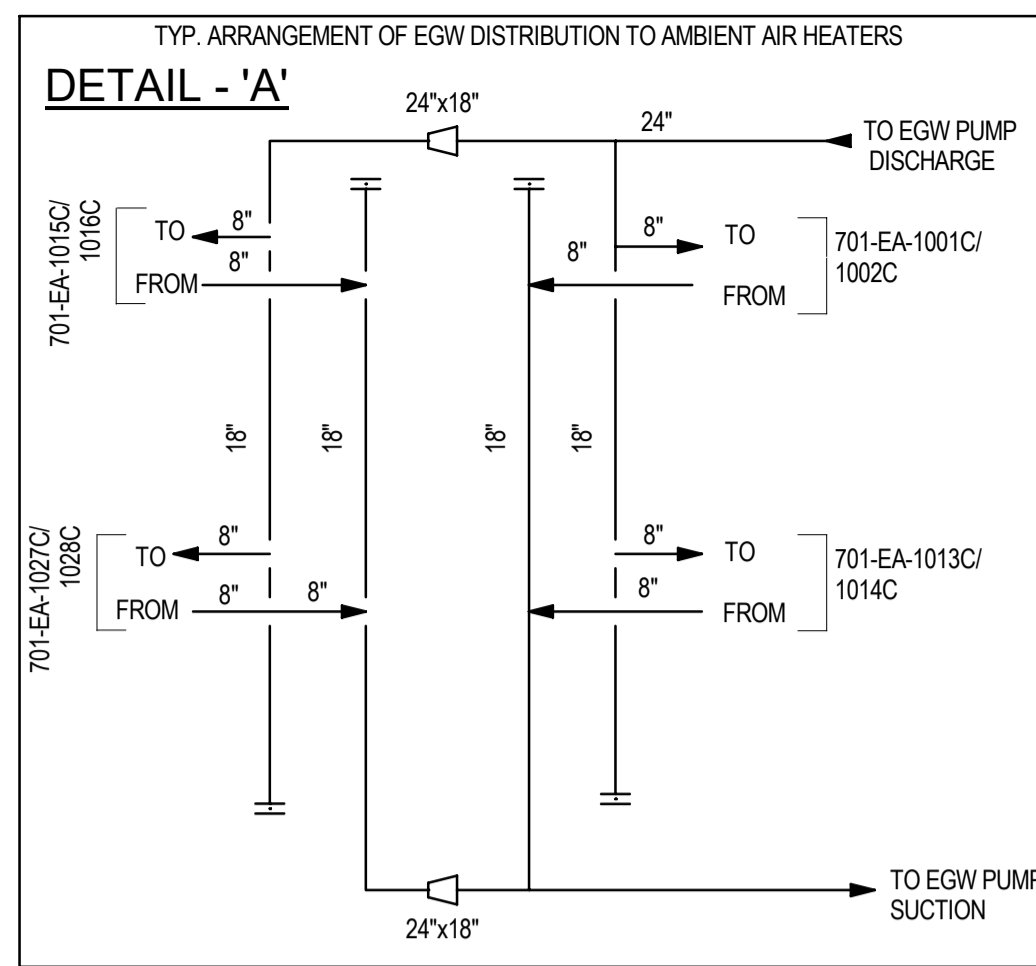

ENGINEERS INDIA LIMITED
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कोंकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
STANDARD SYMBOLS AND NOMENCLATURE
SHEET 3 OF 3

अनुभाग	कार्य संख्या	विभाग	अनुभाग	इकाई	आरेख संख्या	संशोधन
SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B861	02	42	001	1191	0

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NOTES:-

- ALL INDICATED ELEVATIONS ARE WITH REFERENCE TO GRADE LEVEL WHICH IS 0.0MM.
- ALL INSTRUMENT TAG NUMBERS TO BE PREFIXED BY UNIT NUMBER.
- SIZES OF PUMP DRAIN/VENT SHOWN ARE TENTATIVE, WILL BE CONFIRMED BY PUMP VENDORS.
- UNDESIGNATED PIPING AND VALVING ON EQUIPMENT SHALL FOLLOW THE CLASS AND INSULATION OF ASSOCIATED PIPING OF THE EQUIPMENT UNLESS STATED OTHERWISE.
- VALVES AND MANIFOLDS ON INSTRUMENTS ARE NOT SHOWN IN P&ID'S AND SHALL BE AS PER ENGINEERING STANDARDS.
- ALL PSV UPSTREAM PIPING SHALL BE FREE DRAINING TOWARDS VESSEL AND DOWNSTREAM TOWARDS FLARE HEADER. PSV DISCHARGE SHALL JOIN FLARE HEADER AT AN ANGLE OF 45 DEGREE IN THE DIRECTION OF FLOW FOR LINE SIZE OF 2" AND ABOVE.
- ALL HYDROCARBON VENTS TO ATMOSPHERE SHOULD BE VENTED AT MINIMUM 3 METRES ABOVE THE NEAREST OPERATING PLATFORM EXISTING WITHIN A RADIUS OF 15 METRES. OR AS PER OISD STD-109 OR ANY OTHER STANDARD AS MANDATED, WHICHEVER IS MOST STRINGENT. A WEEP HOLE IN THE TAIL PIPE FOR DRAINAGE TO SAFE LOCATION AT LOW POINT OF LINE SHALL BE PROVIDED.
- THE INSTRUMENTATION SHOWN FOR VENDOR PACKAGE UNITS IS MINIMUM PROCESS REQUIREMENT. VENDOR TO PROVIDED ADEQUATE INSTRUMENTATION FOR SAFE OPERATION AND MACHINE SAFETY.
- DRAINS FOR EQUIPMENT LOCATED AT ELEVATED PLATFORMS CAN BE CLUSTERED AND ROUTED TO RESPECTIVE HEADERS
- HIGH POINT VENTS & LOW POINT DRAINS OF PIPING ARE NOT SHOWN IN THE P&ID.
- PSV ISOLATION VALVES (UPSTREAM/DOWNSTREAM) SHALL BE OF FULL PORT SIZE AS PER PIPING STANDARDS. PSV INLET AND OUTLET ISOLATION VALVES SHALL BE INSTALLED SUCH THAT THE VALVE STEM IS EITHER IN HORIZONTAL OR VERTICAL DOWNWARD DIRECTION.
- IF CASING VENT IS NOT PROVIDED, TAPPING SHALL BE TAKEN FROM TOP OF DISCHARGE LINE.
- INSTRUMENT IMPULSE LINES TO BE INSULATED FOR LINES PROVIDED WITH INSULATION AS THAT OF LINE INSULATION TO AVOID CONDENSATION.
- UTILITY CONNECTION NOZZLES SHALL NOT BE FROM BOTTOM.

0	24.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
A	17.05.24	ISSUED FOR COMMENTS	GSB	DR	JKS	SS
संख्या No.	तिथि DATE	संशोधन REVISIONS	डॉन DRN	द्वारा BY	जाँच CHKD	अनुमोदित APPD.

इंजिनियर्स
इंडिया लिमिटेड
(भारत सरकार का उपक्रम)

ENGINEERS INDIA LIMITED
(A Govt. of India Undertaking)

कॉकण एल एन जी लिमिटेड
KONKAN LNG LIMITED
EPCM SERVICES FOR AMBIENT AIR HEATERS AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
GENERAL NOTES AND TYPICAL DETAILS

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशोधन REV.
	B861	02	42	001	1192	0

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- NOTES:
- 701-I-2801 SHALL ALSO BE ACTUATED BY EXISTING TOTAL PLANT ESD THROUGH HS-0001A (MCR) & HS-0001C (PROCESS AREA LIR).
 - 701-I-2802 SHALL ALSO BE ACTUATED BY EXISTING PROCESS ESD THROUGH HS-7000A (MCR), HS-7000B (FIELD) & HS-7000C (PROCESS AREA LIR).
 - REFER EXISTING DOCUMENT 'DCS & ESD SYSTEM CAUSE & EFFECTS (DOC. NO. 6732-000-IN-CE-4181-00)' FOR DETAILS.
 - 701-HS-1801B, 701-HS-2801 & 701-HS-2802 SHALL BE LOCATED IN NEW AMBIENT AIR HEATING FACILITIES AREA I IE UNIT NO. 701.
 - TO BE LOCATED AT SAFE LOCATION NEAR EGW CIRCULATION PUMPS AREA (UNIT NO. 701). THE PUSH BUTTONS SHALL BE MOUNTED AT PLACE, WHERE IT IS EASILY VISIBLE AND ACCESSIBLE TO THE OPERATOR. ESD SWITCHES TO BE PROTECTED FROM ACCIDENTAL IMPACT.



INTERLOCK NO.	ACTUATED BY	ACTION
700-I-1601	700-LALL-1602	TRIP 700-PA-1007 A/S
701-I-1729	701-LALL-1702	TRIP EGW CIRCULATION PUMPS 701-PA-1001 A/B
701-I-1730	701-PAHH-1702	TRIP EGW CIRCULATION PUMPS 701-PA-1001 A/B
701-I-1829	701-LALL-2802	TRIP EGW CIRCULATION PUMPS 701-PA-1002 A/B
701-I-1830	701-PAHH-2802	TRIP EGW CIRCULATION PUMPS 701-PA-1002 A/B
701-I-1929	701-LALL-1902	TRIP EGW CIRCULATION PUMPS 701-PA-1003 A/B
701-I-1930	701-PAHH-1902	TRIP EGW CIRCULATION PUMPS 701-PA-1003 A/B
701-I-2029	701-LALL-2002	TRIP EGW CIRCULATION PUMPS 701-PA-1004 A/B
701-I-2030	701-PAHH-2002	TRIP EGW CIRCULATION PUMPS 701-PA-1004 A/B
701-I-2129	701-LALL-2102	TRIP EGW CIRCULATION PUMPS 701-PA-1005 A/B
701-I-2130	701-PAHH-2102	TRIP EGW CIRCULATION PUMPS 701-PA-1005 A/B
701-I-2201	701-LALL-2204	TRIP 701-PA-1006 A/S
701-I-2601 TO 701-I-2628	701-VAHH-2601 TO 701-VAHH-2628	TRIP FAN MOTORS OF 701-EA-1001A TO 701-EA-1028A
701-I-2801 TO 701-I-2828	701-VAHH-2801 TO 701-VAHH-2828	TRIP FAN MOTORS OF 701-EA-1001B TO 701-EA-1028B
701-I-3001 TO 701-I-3028	701-VAHH-3001 TO 701-VAHH-3028	TRIP FAN MOTORS OF 701-EA-1001C TO 701-EA-1028C
701-I-3201 TO 701-I-3228	701-VAHH-3201 TO 701-VAHH-3228	TRIP FAN MOTORS OF 701-EA-1001D TO 701-EA-1028D
701-I-3401 TO 701-I-3428	701-VAHH-3401 TO 701-VAHH-3428	TRIP FAN MOTORS OF 701-EA-1001E TO 701-EA-1028E
851-I-5501	851-LALL-5501	TRIP SERVICE WATER PUMPS 851-PA-1001 A/B

ESD RELATED INTERLOCKS

701-I-1801 (NOTE-4)	701-HS-1801 A (EXISTING MCR) 701-HS-1801 B (FIELD) 701-HS-1801 C (AAHS C/R) (NOTE-4)	TRIP EGW CIRCULATION PUMPS 701-PA-1001 A/B, 701-PA-1002 A/B, 701-PA-1003 A/B, 701-PA-1004 A/B AND 701-PA-1005 A/B AND ACTUATE ACTIONS (EFFECTS) OF EXISTING INTERLOCK OF CHILLING MEDIUM TEMPERATURE LOW LOW (TALL-7823/7824/7825) (2003)
701-I-2801 (NOTE-1, 4, 5)	701-HS-2801 (FIELD) (NOTE-1, 4, 5)	TRIP EGW CIRCULATION PUMPS 701-PA-1001 A/B, 701-PA-1002 A/B, 701-PA-1003 A/B, 701-PA-1004 A/B AND 701-PA-1005 A/B AND ACTUATE EXISTING TOTAL PLANT ESD.
701-I-2802 (NOTE-2, 4, 5)	701-HS-2802 (FIELD) (NOTE-2, 4, 5)	TRIP EGW CIRCULATION PUMPS 701-PA-1001 A/B, 701-PA-1002 A/B, 701-PA-1003 A/B, 701-PA-1004 A/B AND 701-PA-1005 A/B AND ACTUATE EXISTING PROCESS ESD.



1	06.09.24	ISSUED FOR HAZOP	GSB	DR	JKS	SS
0	30.07.24	ISSUED FOR ENGINEERING	GSB	DR	JKS	SS
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संख्या No.	तिथि DATE	संशोधन REVISIONS	डॉन DRN	द्वारा BY	जाँच CHKD	अनुमोदित APPD.

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EPCM SERVICES FOR AMBIENT AIR HEATERS
AT KLL LNG TERMINAL

पाइपिंग एण्ड इंस्ट्रुमेंटेशन डायग्राम
PIPING AND INSTRUMENTATION DIAGRAM
INTERLOCK DESCRIPTION

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशोधन REV.
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