
	TECHNICAL SPECIFICATION		Nº I-ET-3010.00-1200-431-P4X-001						
	CLIENT:								SHEET 1 of 21
	PROJECT:								
	AREA:								
SRGE	TITLE: THERMAL INSULATION FOR MARITIME INSTALLATIONS							INTERNAL	
								ESUP	
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INDEX OF REVISIONS									
REV	DESCRIPTION AND/OR REVISED SHEETS								
0	ORIGINAL								
A	PERSONNEL PROTECTION ITEMS 4.3.2 AND 4.5.3 REVISED								
B	GENERAL REVISION								
C	ITEM 4.1.4; 5.1.1.1.; 5.2.1; 6.1.5; 6.1.6; 7.2.8; 9.5.1 AND FIGURE A-5 REVISED ACCORDING CLARIFICATION NOTICE DUE BIDDERS QUESTIONS								
D	ITEM 6.1.6; AND 6.2 REVISED ACCORDING CLARIFICATION NOTICE DUE BIDDERS QUESTIONS								
E	GENERAL REVISION ACCORDING TO THE REQUIREMENTS OF IOGP S-738								
F	REVISED WHERE INDICATED								
G	REVISED WHERE INDICATED								
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CHECK	MARIANO	TMCAMPOS	FRAGOMENI	CJMI	CJV5	SXED	QM66	CJH4	
APPROVAL	JUVENTINO	JUVENTINO	GONZALEZ	U32N	U32N	U32N	U32N	U32N	
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OBJECTIVE

This Specification establishes the technical requirements for the execution of external thermal insulation of surfaces of equipment, structures, and piping to be supplied to PETROBRAS FPSOs. This specification complements:

- NORSOK M-004,
- IOGP S-738 and its amendments (IOGP S-738L and IOGP S-738Q)

This specification is written as an overlay to IOGP S-738, version 1.0, December 2020, following the section structure of this standard, to assist in cross-referencing the requirements. The IOGP S-738 specification is based on NORSOK M-004.

If a section or subsection of: NORSOK M-004 or IOGP S-738 is not mentioned in this document, it means that no supplementary requirements and no modifications are considered in this respective section. Then, the respective section of IOGP S-738 or NORSOK M-004 is mandatory. All modifications into NORSOK M-004 or IOGP S-738 requirements are identified in this document with: **Add** (add to section or add new section), **Replace** (part of or entire section) or **Delete**.

In addition to the requirements of this technical specification, SELLER shall follow all the requirements of the Exhibit I (Scope of Work), as well as Exhibit III (Directives for Engineering Execution), Exhibit IV (Directives for Construction and Assembly), Exhibit V (Directives for Procurement), Exhibit VI (Directives for Planning and Control), Exhibit VII (Directives for Quality Management System) and Exhibit VIII (Directives for Commissioning Process).

The requirements herein listed are applicable to all players performing such related activities within the scope of this unit, including SELLERS, manufacturer, main SELLER, subSELLERS, suppliers, sub suppliers, integrators, constructors, and all technical personnel involved. Within the scope of this document, they are all referred to as being a SELLER.


SECTION I – COMPLEMENTARY REQUIREMENTS TO IOGP S-738 AND NORSOK M-004

1 SCOPE

2 NORMATIVE REFERENCES

Add to List

- | | |
|--------------------------------|--|
| NORSOK M-004 | - Piping and Equipment insulation |
| IOGP S-738
(December 2020) | - Supplementary Specification to NORSOK M-004
Insulation for Piping and Equipment |
| IOGP S-738L
(December 2020) | - Information Requirements for Insulation for Piping
and Equipment |

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- IOGP S-738Q (December 2020) - Quality Requirements for Insulation for Piping and Equipment
- API RP 583 - Corrosion Under Insulation and Fireproofing
- CINI Manual - Committee Industrial Insulation Standards
- ISO 12944-2 - Paints and varnishes - Corrosion protection of steel structures by protective paint systems. Part 2: Classification of environments
- EN 14304 - Thermal insulation products for building equipment and industrial installations - Factory made flexible elastomeric foam (FEF) products - Specification
- EN 14707 - Thermal insulating products for building equipment and industrial installations - Determination of maximum service temperature for preformed pipe insulation

Delete to Section

- IOGP S-715 - Supplementary Specification to NORSOK M-501 Coating and Painting for Offshore, Marine Coastal and Subsea Environments

Add to Section

2.1 CLASSIFICATION SOCIETY

SELLER shall perform the work in accordance with the requirements of the Classification Society.

SELLER is responsible to submit to the Classification Society the documentation in compliance with stated Rules.

2.2 GOVERNMENT REGULATION

- NR 26 - Safety Signaling
- NR-37 - Health and Safety on Oil Platforms

Brazilian Regulatory Standard and Classification Society Rules are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein. In case of conflict, SELLER shall submit an issue to BUYER's clarification.



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2.3 REFERENCE DOCUMENTS

- DR-ENGP-I-1.15 - COLOR CODING
- DR-ENGP-M-I-1.3 - SAFETY ENGINEERING
- I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING
- I-ET-3010.00-1200-956-P4X-003 - THERMAL SPRAY COATING APPLICATION OF ALUMINUM
- I-ET-3010.00-1200-955-P4X-001 - WELDING
- I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS
- I-ET-3010.00-1200-970-P4X-003 - REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION

3 TERMS AND DEFINITIONS

Add to Section

Terms and definitions are also established in the latest revision of I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS.

4 SYMBOLS AND ABBREVIATIONS

5 QUALIFICATION REQUIREMENTS

5.1 Qualification of personnel

5.1.1 Qualification of insulation system installation personnel


Replace first paragraph with

Personnel installing insulation and cladding shall be individually qualified by the certified organization as specified in I-ET-3010.00-1200-970-P4X-003-REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION, the insulation material manufacturer, the non-metallic cladding manufacturer or the insulation SELLER.

5.1.2 Qualification of supervisors, foremen and QC personnel

Replace first paragraph with

Personnel carrying out inspection or verification shall be as specified in I-ET-3010.00-1200-970-P4X-003- REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION.

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5.3 Insulation procedure

Add new section

5.3.4. Isometrics and drawings

The pipings isometric and equipment general arrangement drawing shall state the designated and thickness of insulation.

The isometrics shall state the location for the insulation windows for inspection.

6 MATERIALS

6.2 Selection of insulation materials

Add to section

The default insulation material for Class 1, 2, 4, and 9 is Aerogel for operational temperature bellow 250°C, and for cyclic service temperature.

Mineral wool insulation materials shall not be applied directly over uncoated stainless steel materials, austenitic stainless steel (such as AISI 316 or AISI 316L), duplex and superduplex stainless steels or super-austenitic stainless steels. An aluminum foil (wrapped around the equipment or pipe) is required to protect the base metal.

Chilled water piping insulation material shall be Flexible Elastomeric Foam (FEF) with metallic cladding. The adhesive shall be applied as FEF manufacturer instructions.

6.3 Selection of cladding

6.3.1 Metallic cladding

6.3.1.1

Replace first paragraph with

Type of stainless steel cladding shall be one of the following:

- ASTM 240M type SS316;
- EN10088-2 number 1.4401;


The stainless steel cladding shall have 2D finish.

The thickness of the stainless steel cladding shall be according to table 4.

6.7 Accessories

Add new sections

6.7.1. SEAL

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Stainless steel seal type 316, according to ASTM A167 and A480, 12.7 mm or 19 mm width and with a thickness of 1.0 mm (Figure A.1).

6.7.2. SCREW

Self-tapping Type A stainless steel screw type 316, 1/8 "diameter, 1/2" length, slotted pan head.

Self-tapping Type A stainless steel screw type 316, 3/16 "diameter, 3/4" length, hexagonal head with slotted, crimped.

6.7.3. WASHER

Stainless steel flat washer type 316, for 3/16 "bolt, 7/8" outside diameter, internal diameter of 7/32 inch and thickness of 1/16 inch.

Stainless steel flat washer type 316, for 1/8 inch bolt, 5/8 inch outer diameter, 5/32 inch inner diameter and 3/64 inch thickness.

6.7.4. QUICK COUPLING AND CLASP

Fastening and quick coupling of type 316 stainless steel, according to ASTM A167 and A480 / A480M. The requirements of dimensions at Figure A.2 shall be followed.

SELLER may present an alternative configuration for BUYER previous approval.

6.7.5. INSPECTION WINDOWS

The inspection windows for periodic measurements of thickness in pipes and pressure vessels shall be in accordance with Figure A.3 and Figure A.4. Whenever possible the solution presented at Figure A.4 shall be used.

SELLER may present an alternative configuration for BUYER previous approval.

6.7.6. HEXAGONAL WIRE REINFORCEMENT MESH

Consisting of wire of diameter 0.56 mm to 0.86 mm (BWG 24 to 20), 12 mm or 25 mm mesh of stainless steel according to ASTM A492, type 316.

6.8 Insulating coating

Add to Section

The PAINT MANUFACTURER shall present documented testing or field experience relevant to the specific intended use for the insulation coating for BUYER evaluation.

Add new section

6.9. Coating under insulation

The requirements for coating under insulation shall be in accordance with I-ET-3010.00-1200-956-P4X-002 – GENERAL PAINTING.

7 DESIGN ENGINEERING

7.1 Designing for insulation

Replace third paragraph with



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Insulation adjacent to flanges in piping and equipment shall be terminated to allow removal of bolts without damage to insulation. Minimum free space from the flange to the nearest part of the insulation shall be equal to 1.2 times the bolt length, and not to be less than 130 mm. If the exposed section between the flange and the insulation is greater than 300 mm, removable insulation shall be installed. The termination of the weather protection shall not allow ingress of water.

7.1.1 Class 1: Heat conservation

Add to list

- Piping and equipment sporadically cooled or heated as: Relief valves and relief systems (except for products with pour point above room temperature); Vents and drains (except for products with pour point above room temperature); Flare system; Drainage system;
- Fans, blowers and reciprocating compressors, centrifugal and rotary;
- Chillers and condensers, with their associated pipes;
- Mixers;
- Nameplate;
- Supports of pipes and equipment.
- Vapour traps;
- Expansion joint bellows;
- Flanged neck with a length equal to or less than 300 mm;
- Hoses;

Add to end of section

Instruments shall be insulated in order to assure, on the outer surface, a temperature not above 60°C. The reading of the instruments shall be kept possible after insulation.

7.2 Calculation of insulation thickness

7.2.1 Class 1,2,4 and 9


Add to section

For hot insulation the greater thickness resulting from the following approaches shall be used:

- a) Personnel Protection: The calculation of the insulation thickness required for personnel protection is based on limiting the surface temperature to the maximum allowable value. This is a safety requirement;
- b) Special purpose requirements: The minimum required insulation thickness for purpose of Process Control or any other requirements established by the project.

For cold insulation the greater thickness resulting from the following approaches shall be used:

- a) Condensation control: When the process temperature is below the maximum ambient temperature, the minimum required insulation thickness which prevents surface condensation is calculated;
- b) Maximum Heat Gain: When the process temperature is below the maximum ambient temperature, the minimum insulation thickness is calculated required to achieve the maximum allowable heat gain;

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- c) Special purpose requirements: The minimum required insulation thickness for the purpose of Freeze Protection, Process Control, boil-off control or any other requirements established by the project;

For cold conservation, the thermal insulation shall assure, on the outer surface, a temperature above the dew point.

For product fluid maintenance in pipes, the insulation shall be dimensioned in such a way that the temperature of the product at the end of the line is at least 10°C above its pour point.

A reference table for insulation thickness class 1 and 3 are presented Appendix B.

7.2.2 Class 3

Replace first paragraph with

For processes with operating temperature below 0 °C or above 60°C, personnel protection, class 3, shall be used.

Add to section

The personnel protection shall be done only on equipment and piping in which the outer surfaces are located at a height less than 2 m of any floor or at a lateral distance of less than 1 m of walkways and normal working area.

Where it is not possible to apply metallic protection by screens / perforated guards due to layout, a thermal insulation may be applied with previous approval; this item is not applicable for flanged joints where personnel protection shall always be executed by screens / perforated guards.

8 INSTALLATION AND INSPECTION

8.1 General

Add to section

The recommendations regarding design stated at API RP 583 to mitigate corrosion under insulation shall be followed.

Construction and Finishing details of CINI Manual not conflicting with this technical specification are considered approved design.

Inspection windows shall be provided in carbon steel piping systems, pressure vessels and tanks, in order to allow inspection for ultrasonic measurement and control of wall thickness loss. The location of these inspection holes shall be previously submitted for BUYER approval.

Expansion joints shall be added whenever a rigid thermal insulator is installed, according to the maximum spacing oriented in Table 1. The expansion joints shall be wide between 20 mm and 25 mm. The joint filling shall be made with flexible insulating material.

Table 1 - Maximum Spacing for Expansion Joints

Temperature (°C)	Maximum joint spacing expansion (m)	
	Ferritic Steels	Austenitic steels
100	23	14
150	12	8,5
200	8	6
250	6	4,5
300	5	3,5

Based on Table 4 of ASTM C1696.

8.1.3 Insulation with vapour barrier

Add to section

In order to avoid condensation on pipe supports or penetration of water, shall be used of insulated prefabricated pipe supports or the vapour barrier shall extend with a minimum length of 3 times the insulation thickness on the support area.

8.2 Piping insulation

Add to section

The interference pieces shall be assembled to the same thickness as the insulation of the pipe or equipment to which they belong, extending in a length equal to four times the thickness of the insulation or at least 300 mm (Figure A.8).

Pipes supported directly on supports with rebar or similar shall have the insulation interrupted in the region of the support. Piping with skids shall be insulated in the support region (Figure A.6 and Figure A.7).

Contraction joints shall be provided for every 25 m of pipe length.

NOTE The existence of a flange or valve along the stretch replaces the shrink joint.

For pre molded insulation installation, the Figure A-9 shall be observed.

8.3 Vessel insulation

8.3.1 Vessel insulation

Add to section

Removable insulation covers shall be provided for removable vessels heads. For heat exchangers the Figure A-10 shall be observed.

Pressure vessel with a perimeter greater than 6 000 mm and a temperature of operation above 150°C shall have, in the support straps of the last layer of the insulating material and protection plate, a sine or helical spring for each 6,000 mm or fraction, on the perimeter, to compensate for thermal expansion

8.4 Cladding

8.4.1 Metallic cladding

Add to section

All screws and rivets shall be sealed to prevent infiltration of water through the hole in the protective cladding.

APPENDIX A – FIGURES

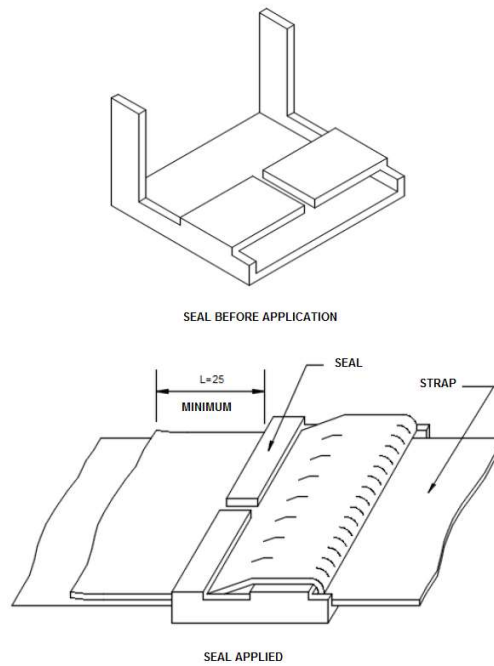


Figure A.1 - SEAL

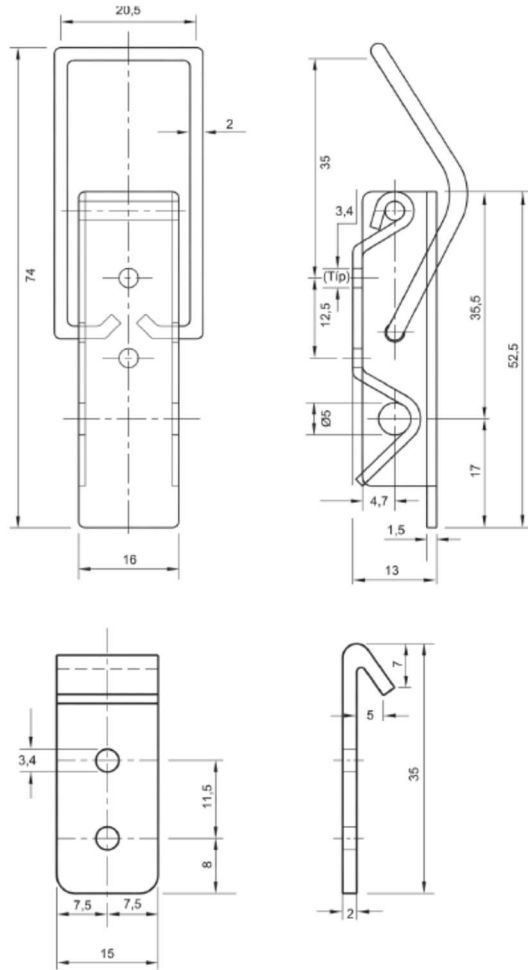
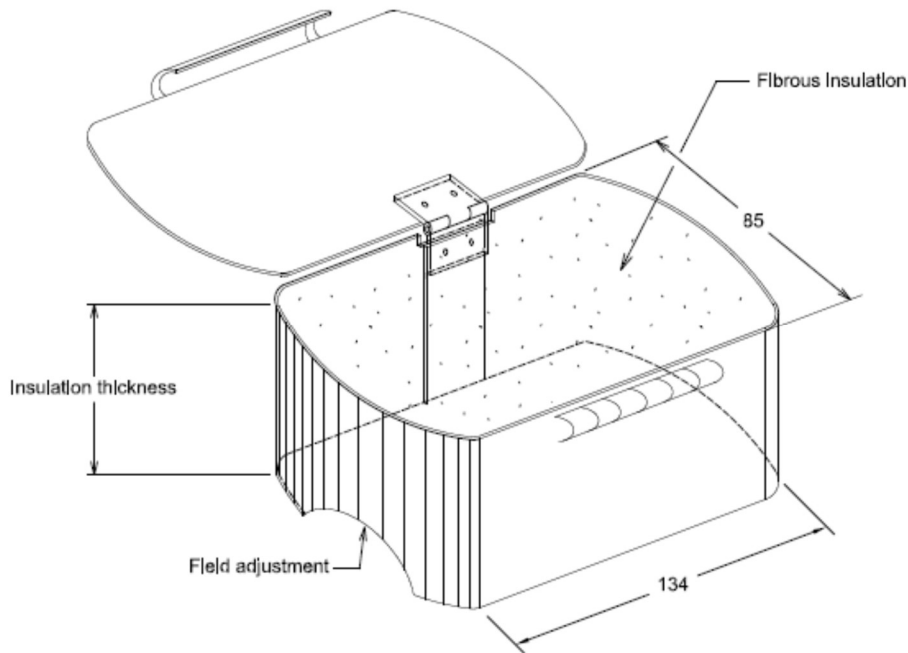
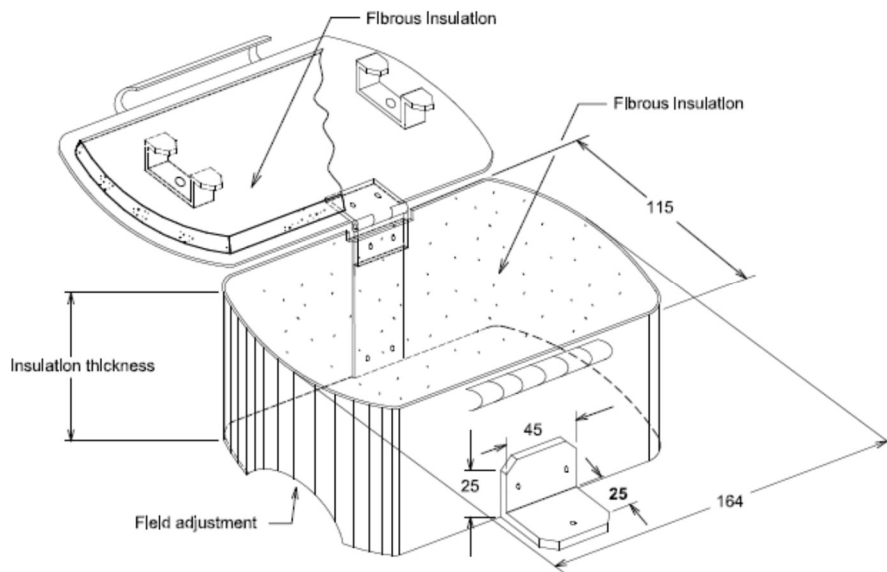


Figure A.2 - QUICK COUPLING AND CLASP



Box for measuring thickness of pipe up to 2 1/2 in nominal diameter



Box for measuring thickness of pipe up to 3" in nominal diameter of larger

Figure A.3 – INSPECTION WINDOW



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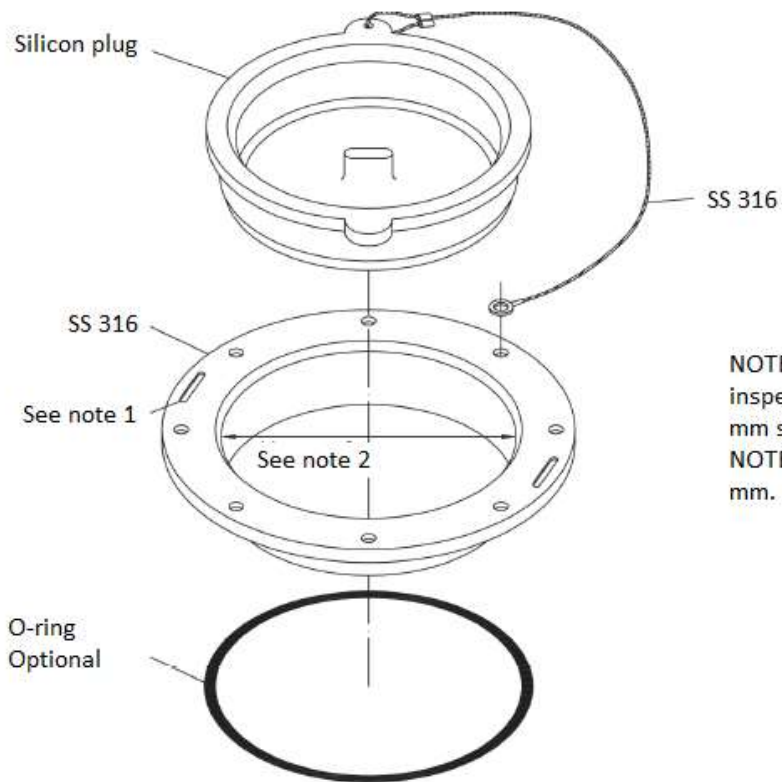
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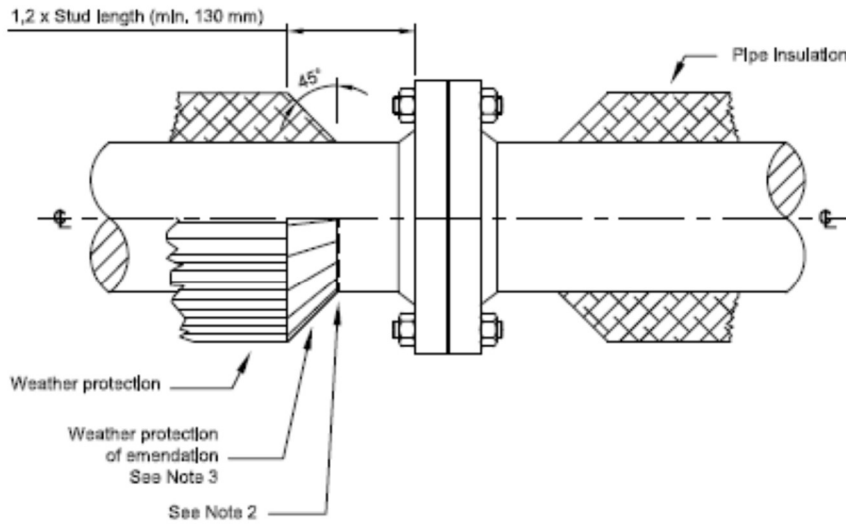
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NOTE 1 Oblong hole for fixing the inspection window using a 12.7 mm strap.
NOTE 2 Minimum opening of 100 mm.

Figure A.4- INSPECTION WINDOW



Thermal Insulation of Flanged Connections

Note 2: Cladding weather protection

Note 3: The thermal insulation close to flanges shall be designed in order to allow the removal of studs and bolts without damage to the insulation.

Figure A.5 - INSULATION OF FLANGES

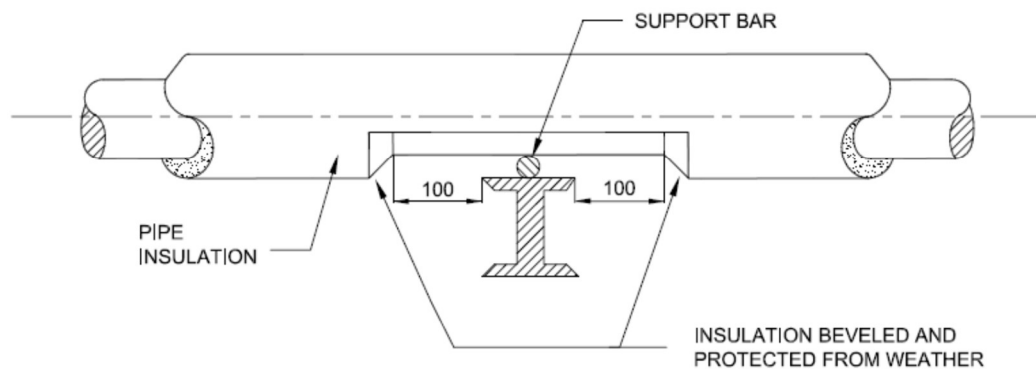


Figure A.6 - PIPING SUPPORTS

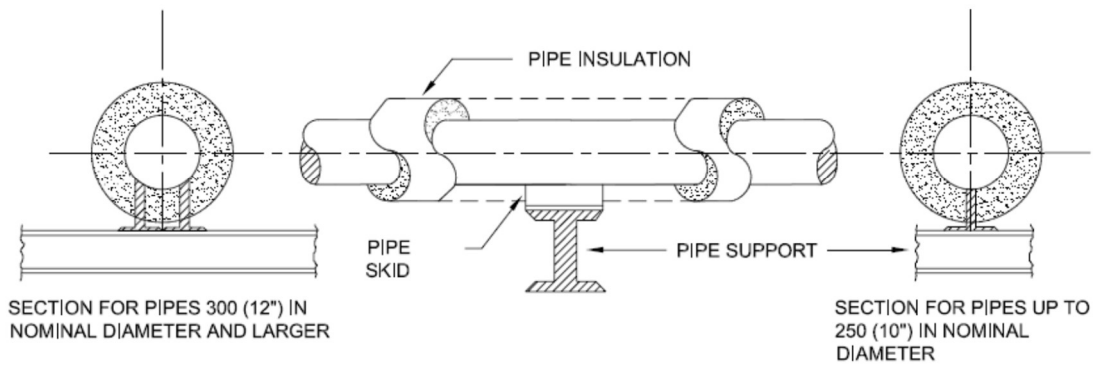
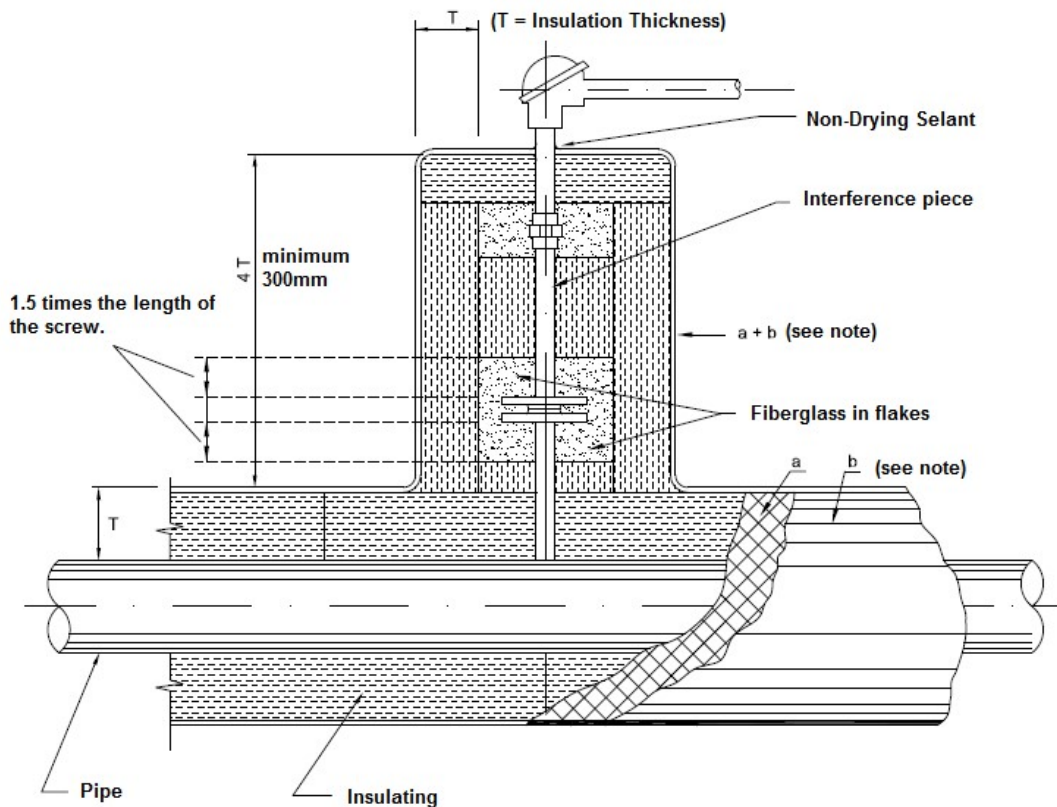


Figure A.7 – PIPING WITH SHOE



(Note: a = Steam Barrier
b = Protection against interferences).

Figure A.8- PART INSULATION INTERFERENCE CONNECTED TO PIPE.

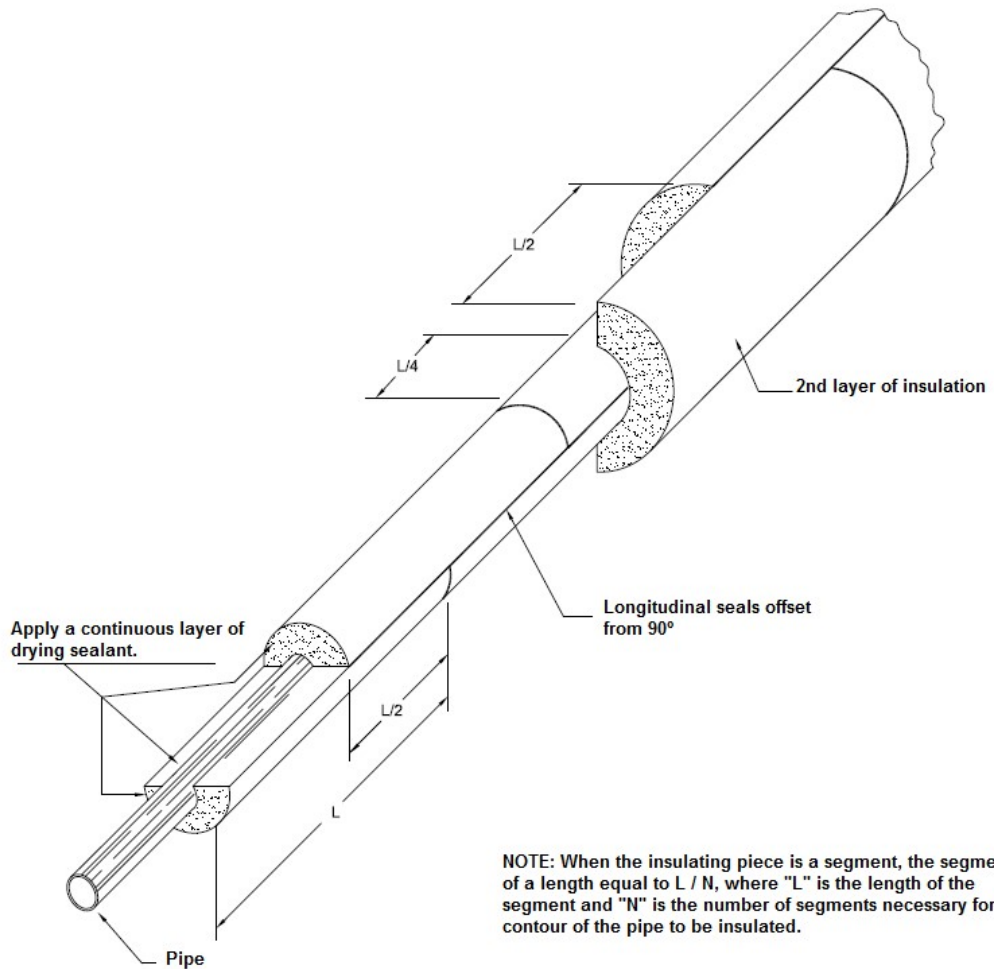


Figure A 9 - DISPOSITION OF PRE-MOLDED INSULATED PART.

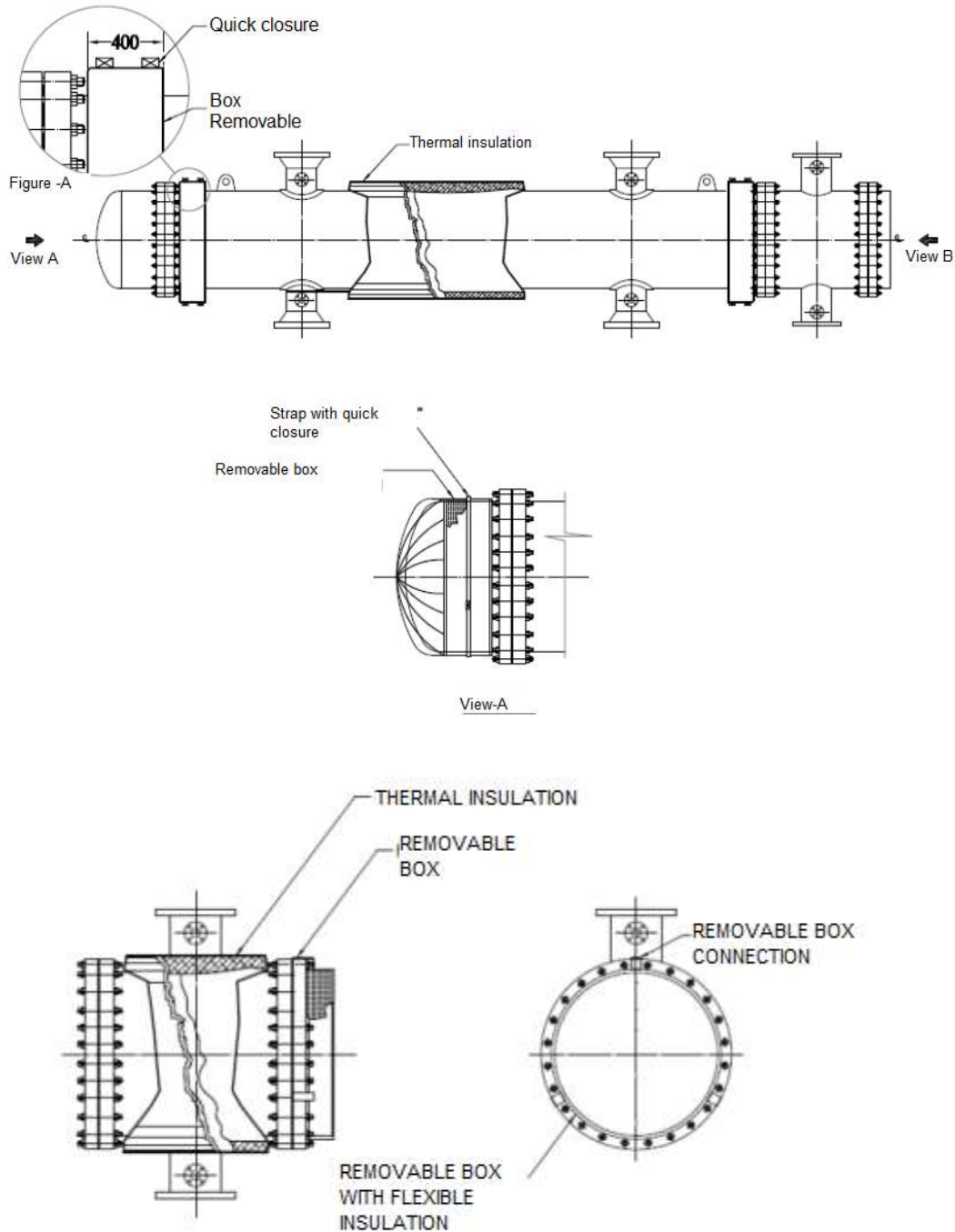


Figure A.10 – THERMAL INSULATION OF HEAT EXCHANGER



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APPENDIX B – REFERENCE TABLES

TABLE B.1 – Aerogel – Thickness of thermal insulation for hot conservation

Pipe NPS (in)	Temperature (°C)								
	50	75	100	125	150	175	200	250	300
1/2"	5	10	10	10	15	15	15	15	20
3/4"	5	10	10	10	15	15	15	15	20
1"	5	10	10	15	15	15	15	20	20
1 1/2"	5	10	10	15	15	15	15	20	20
2"	5	10	10	15	15	15	15	20	20
2 1/2"	5	10	10	15	15	15	20	20	20
3"	5	10	10	15	15	15	20	20	20
4"	5	10	15	15	15	15	20	20	25
6"	5	10	15	15	15	20	20	20	25
8"	5	10	15	15	15	20	20	20	25
10"	5	10	15	15	15	20	20	25	25
12"	5	10	15	15	15	20	20	25	25
14"	5	10	15	15	15	20	20	25	25
16"	5	10	15	15	15	20	20	25	25
18"	5	10	15	15	15	20	20	25	25
20"	5	10	15	15	15	20	20	25	25
22"	5	10	15	15	15	20	20	25	25
24"	5	10	15	15	15	20	20	25	25
26"	5	10	15	15	15	20	20	25	25
28"	5	10	15	15	15	20	20	25	30
30"	5	10	15	15	15	20	20	25	30
32"	5	10	15	15	15	20	20	25	30
34"	5	10	15	15	15	20	20	25	30
36"	5	10	15	15	15	20	20	25	30
38"	5	10	15	15	15	20	20	25	30
40"	5	10	15	15	15	20	20	25	30
42"	5	10	15	15	15	20	20	25	30
Equipment	5	10	15	15	15	20	20	25	30 ¹

Note: For this case the thickness for personnel protection is higher than hot conservation

TABLE B.2 - Aerogel – Thickness of thermal insulation for Personnel Protection

Pipe NPS (in)	Temperature (°C)								
	50	75	100	125	150	175	200	250	300
1/2"	5	5	5	5	5	5	5	5	5
3/4"	5	5	5	5	5	5	5	5	10
1"	5	5	5	5	5	5	5	5	10
1 1/2"	5	5	5	5	5	5	5	10	10
2"	5	5	5	5	5	5	5	10	10
2 1/2"	5	5	5	5	5	5	5	10	10
3"	5	5	5	5	5	5	5	10	10
4"	5	5	5	5	5	5	5	10	10
6"	5	5	5	5	5	5	10	10	15
8"	5	5	5	5	5	10	10	10	15
10"	5	5	5	5	5	10	10	10	15
12"	5	5	5	5	5	10	10	15	15
14"	5	5	5	5	5	10	10	15	15
16"	5	5	5	5	5	10	10	15	20
18"	5	5	5	5	10	10	10	15	20
20"	5	5	5	5	10	10	10	15	20
22"	5	5	5	5	10	10	10	15	20
24"	5	5	5	5	10	10	10	15	20
26"	5	5	5	5	10	10	10	15	20
28"	5	5	5	5	10	10	10	15	20
30"	5	5	5	5	10	10	10	15	20
32"	5	5	5	5	10	10	15	15	20
34"	5	5	5	5	10	10	15	15	20
36"	5	5	5	5	10	10	15	20	20
38"	5	5	5	5	10	10	15	20	20
40"	5	5	5	5	10	10	15	20	20
42"	5	5	5	5	10	10	15	20	20
Equipment	5	5	5	5	10	10	15	20	20



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SECTION II – IOGP S-738 SUPPLEMENTARY SPECIFICATION TO NORSOK M-004 INSULATION FOR PIPING AND EQUIPMENT



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