INTERPLANT STANDARD - STEEL INDUSTRY		
IPSS	**CODE OF PRACTICE FOR THERMAL INSULATION OF COLD SERVICES** *Based on IS 7240:1981* *(Superseded by IS 14164:2008)*	**IPSS:1-06-031-17 (*Second Revision*)** Formerly : IPSS:1-06-031-02 (First Revision)

0. FOREWORD

0.1 This Inter Plant Standard prepared by the Standards Committee on Pipes, Fittings, Valves and Piping Layout, IPSS 1:6 with the active participation of the representatives of all the steel plants and established manufacturers of thermal insulating materials, was adopted as IPSS Standard in the year of 1993.

0.2 In view of updating the Indian Standards this IPSS Standard has been further revised in December 2002 and in July 2017.

0.3 Interplant Standards for steel industry primarily aim at achieving rationalization and unification of parts and sub-assemblies used in steel plant equipment and accessories, and provide guidance in indenting stores or equipment for existing or new installations by individual steel plants. For exercising effective control on inventories, it is advisable to select a fewer number of sizes (or types) from among those mentioned in this standard for the purpose of company standards of individual steel plants. It is not desirable to make deviations in technical requirements.

0.4 In preparation of this standard, the assistance has been derived from the following :

Sl No.	Indian Standard (IS)	Description of IS
1.	277:2003	Specification for galvanised steel sheets (plain and corrugated) (fifth revision) Amendment-3
2.	737:2008	Specification for wrought aluminium and aluminium alloy steel and strip for general engineering purpose (fourth revision)
3.	1322:1993 (R2003)	Bitumen felts for water proofing and damp proofing (third revision)
4.	3069:1994	Glossary of terms, symbols and units relating to thermal insulation materials (first revision)
5.	3150:1982	Specification for hexagonal wire netting for general purposes (second revision)
6.	14164:2008	Expanded polystrene for thermal insulation purpose (first revision)
7.	IS 14164:2008	Code of practice for industrial application and finishing of thermal insulating materials at temperature from (- 80 deg C) to (+ 10 deg C)
8.	8183:1993	Specifications for bonded mineral wool (first revision) Amendment-1
9.	9743:1990	Thermal insulation finishing cements (first revision)
10.	9842:1993	Specifications for pre-formed fibrous pipe insulation (first revision)
11.	12436:1988	Specification for polyurethane foam insulation.
12.	13205:1991	Code of practice for the application of polyurethane insulation by the in-situ pouring

		method.

1. SCOPE

1.1 This Standard covers the method of selection and application of thermal insulation materials for cold surface on equipment, piping and accessories, operating between (-80 deg C) to (+10 deg C), for refrigeration and air conditioning plants, ductings, chilled water as applicable in the steel industry.

2. MATERIALS

2.1 The insulation materials shall be :

a) Bonded mineral wool conforming to IS 8183:1993 (first revision). The material shall be mineral wool made from slag, rock or glass processed from molten state into fibrous form bonded with a suitable binder.

b) Pre-formed fibrous pipe insulation conforming to IS:9842-1993 (first revision).

c) Expanded polystrene block and pre-formed pipe sections of self extinguishing grade conforming to IS 14164:2008.

d) Rigid polyurethane blocks and pipe sections as per IS 12436:1988.

e) In-situ Polyurethane/ Polyisocyanurate insulation conforming to IS 13205-1991.

2.2 The minimum bulk density (Kg/cum) of insulating materials shall be as follows :

a)	Resin bonded mineral wool in form of slabs/mats.	32
b)	Resin bonded mineral wool pipe sections.	85
c)	i) Expanded polystyrene block (flat)	15
	ii) Expanded polystyrene pipe sections	20
d)	Polystyrene blocks and pre-formed pipe sections.	36

3. THICKNESS OF INSULATION

3.1 The thermal conductivity of insulation material shall be as given in respective IS codes. The recommended minimum thickness of insulation provided in Table 1 to 4 are calculated based on the following conditions:

a)	Ambient temperature	$40^{O}C$
b)	Relative humidity	85%
c)	Wind speed	1 m/s
d)	Finishing material	Aluminium/GI sheet

In case actual site conditions are expected to vary considerably over extended periods, or finishing material is other than Aluminium, alternate

thicknesses suitable to such conditions can be obtained from the manufacturer/applicators.

For in-situ polyurethane/polyisocyanurate insulation, the recommended thickness of insulation can be taken as indicated in Table-3.

4. AUXILIARY MATERIALS

4.1 Paint – For anti-corrosive treatment, either suitable anti-corrosive primer as per IS 2074:1979 or anti-corrosive bituminous paints shall be used before application of insulation materials.

4.2 Adhesive/Joint sealer for foam plastic insulation – Bituminous adhesive sealant suitable to retain its sealing properties at prevailing temperatures, and non-corrosive to carbon steel, aluminium and stainless steel, shall be used.

4.3 Wire netting – The wire netting to be used as containment materials for flexible insulation shall be GI hexagonal wire netting mesh size of 24 SWG x 19 mm conforming to IS 3150:1982.

4.4 Vapour Barrier – The vapour barriers to be used with the insulation shall be as follows :

a) *Membrane type (can be used for all type of insulation*)

i) 500 gauge polythene sheet followed by Hessian Cloth.
ii) 0.1 mm thick Al. foil laminated to Kraft Paper of 60 gms per sq mtr.

Note: Bituminous emulsion type mastic treatment shall be provided at joints.

b) *Mastic type*: Foster mastic or equivalent (not to be applied on expanded polystyrene).

c) *Hot Melt Material*: Such as blown grade bitumen only for foam plastic insulation.

4.5 Reinforcing Materials

i) Glass fabric-open weave - 10 mesh glass cloth 5 mm thick to be used for emulsion type vapour barrier as well as weather barrier.

ii) Glass fiber tissue - Non-woven fabric of glass fibers reinforced with glass yarn having average weight 50 gms per sq m to be used only for hot melt materials like - Bitumen.

4.6 Sheet metal cladding - Aluminum sheet as per IS 737:2008 or G.I. sheet as per IS 277:1992 shall be rolled, grooved and retained in place with minimum 50 mm overlap of cladding sheet at all longitudinal/circumferential joints. The joints shall be rendered after proof by incorporating 25 mm wide bituminous water proofing felt (IS 1322:1993) or metal joint sealer, with the joints being arranged at 8 or 4 O'clock position to shed rain water. Aluminum sheets of 22 SWG and G.I. sheets of 24 SWG are recommended.

4.7 Bands - Aluminum bands 22 SWG x 25 mm / G.I. bands 24 SWG x 25 mm shall be used at centre to centre distance of 300 mm max over aluminum sheet/G.I. sheet respectively and at all overlaps.

5. APPLICATION

5.1 Sequence of Application (see also **Fig-1**)

a) Removal of existing insulation, if any
b) Surface preparation as per clause 5.2.1
c) Provision of adhesive where required
d) Insulating material as per clause 5.2.2
e) Vapour barrier as per clause 5.2.3
f) Vapour barrier protector like Kraft paper, Hessian cloth
g) Reinforcement for outer plastering followed by cement plaster or outer protection of metal cladding
h) Painting wherever needed.

5.2 Method of application

5.2.1 Surface preparation – The surface to be insulated shall be dry and free from grease, dirt, rust and scale, etc. Before applying insulation the surface shall be painted with a suitable anti-corrosive coating as detailed in clause 4.1.

5.2.2 Insulation - While applying multi-layer insulation, thickness of any layer shall not exceed 75 mm, all joints shall be staggered and each layer shall be separately secured by binding wires. Each layer shall preferably be of equal thickness as far as possible. The insulation shall be provided with any one of the types described below :

a) Flexible insulation

The resin bonded insulation in the form of slabs or mats of specified density and thickness shall be applied closely fitted to the surface. The edges shall be closely butted together. The joints of the second and subsequent layers shall be staggered.

b) Pre-formed insulation

Pre-formed insulation, made from resin bonded mineral wool, expanded polystyrene or PU foam shall be in the form of sections in 2 halves upto 350 mm and in multiple segments for larger diameters. These sections are to be fitted closely to the surface and to be secured in place by means of binding wire, metal bands, or adhesives. The joints shall be closely butted. The insulation shall be secured in place by means of bituminous adhesive applied on pipe/equipment surface and mating face of insulation and / or 20 SWG G.I. wire wound tightly around the insulation. The sharp ends of the wire shall be bent inwards and pressed inside the insulation to avoid puncture of vapour barrier.

c) In-situ insulation

The technique of applying in-situ polyurethane/polyisocyanurate insulation is a preferred method for many thermal insulation applications such as for process and refrigeration plants, piping and other equipments. Application of insulation shall be carried out as per IS 13205:1993.

In-situ foaming is particularly suited to:

i) Where complicated shapes are involved which would not lend themselves to easy insulation treatment using preformed rigid materials.

ii) Where a joint free insulation is desired or where the number of joints is to be kept to a minimum.

iii) Where very high disbonding stresses (such as leeward wind forces) are to be encountered by the insulation system.

iv) Where speedy installation coupled with high reliability of applied insulation is sought.

5.2.3 Vapour Barrier

a) The vapour barrier, when membrane type, shall be applied over the final layer of insulation with minimum 50 mm overlaps and all joints being properly sealed. When it will be mastic type/hot melt bituminous type, the vapour barrier shall be applied in two layers with a layer of reinforcement in between.

b) Vapour barrier applied over the insulation shall be carried down over all exposed edges (for example fittings on pipes or skits on vessels) and bonded to the surface of the pipe or vessel and sealed by means of hot bitumen or bitumen mastic. When insulating long runs of pipes the ends of the insulation shall be sealed off at suitable intervals and the vapour seal shall be carried dow to the pipe surface and sealed with hot bitumen or mastic.

5.2.4 Finishing – The insulation shall be finished by any one of the methods described below :

a) Cement plaster – The finishing cement plaster free from asbestos suitable for indoor/outdoor applications as per IS 9743:1990 shall have a total thickness of 12 mm applied in two layers and shall be reinformed with chain link mesh 20 SWG x 20 mm.

Note : 1) One coat of oil/cement paint may be applied over the plaster in case of indoor application.

2) Two coats of bitumen emulsion with an intervening layer of glass cloth reinforcement of 10x10 mesh shall be applied over the plaster as weather barrier for outdoor application.

b) Sheet metal – Aluminium or G.I. cladding shall be used to provide the final finish. The outer surface shall be painted if required by the user. Sheet metal cladding shall preferably be secured by metal bands. The joints shall be properly grooved and overlapped 50 mm minimum. Pop rivets or self tapping screws shall not be used as they may puncutre the underlying vapour barrier.

6. INSULATION SUPPORTS

6.1 These will depend on the type of insulation materials used, mode of application and shall be adequate to prevent displacement of the insulation and its vapour barrier during operation. These supports shall hold the insulation in place and prevent its slipping. In addition they shall provide necessary anchorage for lacing wire or wire netting which may be required to hold the insulation in place, or to provide support to the final finish. The supports shall penetrate only partly through the

insulation preferably upto 75 percent of the total insulation thickness. But in no case shall the supports protrude through the final finish to avoid punctures in the final vapour barriers.

6.2 Fittings - On pipes and vessels fittings shall be covered with separate insulation capable of being removed without disturbing the main insulation and its vapour seal.

6.3 All stiffener angles, insulation supports, hangers or metal connections in direct contact with the cold surface shall be insulated with same thickness of the adjoining insulation and extended to 6 times the thickness of insulation.

6.4 Vertical pipes with diameter of more than 80 mm shall have support rings at intervals not exceeding 2 M to prevent insulation from collapsing. Supporting rings or lugs shall also be installed near the pipe bends.

7. SPECIAL CONSIDERATIONS

7.1 Surface protection prior to insulation – All pipes and metal surfaces to be insulated shall be cleaned and painted with bituminous paint in two coats. (In case of carbon steel, bituminous paint shall be applied after giving a shop coat of zinc chromate red oxide primer).

7.2 Cladding over insulation

7.2.1 Aluminum Cladded system

i) The aluminum sheet shall conform to IS 737:2008 alloy designation 31000 in the following thicknesses :

Upton 600 mm dia over insulation	0.71 mm
601 mm dia and above	0.91 mm

ii) All cladding joints shall have a synthetic rubber based metal sealant provided in a bead of approximately 6 mm dia.

iii) Bands of following sizes shall be provided over cladding at all overlapped (telescopic) joints and at intervals of 300 mm (max) :

Up to 300 mm diameter over insulation	A1 bands 25 x 0.91 mm
301 to 600 mm	A1 bands 25 x 1.2 mm
601 and above	SS bands 25 x 1.2 mm

7.2.2 Galvanised/Galvalume sheet cladded system

i) Specification for cladding material shall be as per IS 277:1992 with class 2 galvanisation or galvaume protected steel and thickness of sheet shall be used as below :

Upto 600 mm dia over insulation	0.6 mm
601 mm and above	0.8 mm

ii) All cladding joints shall have a synthetic rubber based metal sealant provided in a bead of approximately 6 mm dia.

iii) -Bands shall be provided at all overlapped (telescopic) joints at intervals of 300 mm maximum in the following sizes :

Upto 300 mm dia meter over insulation	GI bands 25 x 0.6 mm
301 to 600 mm	GI bands 25 x 0.8 mm
601 and above	GI bands 25 x 0.5 mm

7.3 Refer Appendix-1 for special considerations for Coastal Locations.

8. GENERAL

Any details not specified in this standard shall be as agreed between suppliers/applicators and client.

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TABLE – 1

RECOMMENDED MINIMUM THICKNESS (mm) CHART FOR RESIN BONDED MINERAL WOOL (SLAB / MATTRESSES)

DESIGN CRITERIA

Ambient temperature	$40^{O}C$
Relative humidity	85%
Wind speed	1 m/s
Insulation material density	32 kg/cum
Finish	Aluminium sheet/G.I. sheet

Pipe DN	**Operating temperature, Deg C**									
	10	0	-10	-20	-30	-40	-50	-60	-70	-80
15	35	45	50	55	65	70	75	80	85	95
20	35	45	55	60	65	70	80	85	90	100
25	40	45	55	65	70	75	85	90	95	105
32	40	50	60	65	75	80	85	95	100	110
40	40	50	60	70	75	80	90	95	105	110
50	45	55	65	70	80	85	95	100	110	120
65	45	55	65	75	85	90	100	110	115	125
80	45	55	70	75	85	95	105	110	120	130
100	50	60	70	80	90	100	110	120	125	135
125	50	60	75	85	95	105	115	125	130	140
150	50	65	75	85	95	105	115	125	135	145
200	55	65	80	90	100	110	125	135	145	155
250	55	70	80	95	105	115	130	140	150	160
300	55	70	85	95	110	120	130	145	155	165
350	55	70	85	100	110	120	135	145	160	170
400	55	70	85	100	110	125	135	150	160	175
450	55	75	85	100	115	125	140	150	165	175
500	55	75	90	100	115	125	140	155	165	180
550	55	75	90	105	115	130	145	155	170	185
600	60	75	90	105	115	130	145	160	170	185
X	65	80	100	120	135	155	175	195	210	230

NOTE: Pipe DN (x) stands for above DN 600 & flat surface. All thicknesses indicated are in mm.

TABLE – 2

RECOMMENDED MINIMUM THICKNESS (mm) CHART FOR EXPANDED POLYSTYRENE

DESIGN CRITERIA

Ambient temperature	$40^{O}C$
Relative humidity	85%
Wind speed	1 m/s
Insulation material density	15 kg/cum
Finish	Aluminum sheet/G.I. sheet

Pipe DN	Operating temperature, Deg C									
	10	0	-10	-20	-30	-40	-50	-60	-70	-80
15	35	40	50	55	60	65	70	75	80	85
20	35	45	50	60	65	70	75	80	85	85
25	35	45	55	60	70	75	80	85	90	90
32	40	50	55	65	70	80	85	90	90	95
40	40	50	60	65	75	80	85	90	95	100
50	40	50	60	70	75	85	90	95	100	105
65	45	55	65	75	80	90	95	100	105	110
75	45	55	65	75	85	90	100	105	110	115
100	45	60	70	80	90	95	105	110	115	120
125	50	60	70	80	90	100	105	115	120	125
150	50	65	75	85	95	105	110	120	125	130
200	50	65	80	90	100	110	115	125	130	135
250	55	65	80	90	105	115	120	130	135	140
300	55	70	80	95	105	115	125	135	140	145
350	55	70	85	95	105	120	125	135	140	150
400	55	70	85	95	110	120	130	140	145	150
450	55	70	85	100	110	120	130	140	150	155
500	55	70	85	100	110	125	135	140	150	155
550	55	70	85	100	115	125	135	145	150	160
600	55	75	90	100	115	125	135	145	155	160
X	60	80	100	115	135	150	165	175	185	195

NOTE: Pipe DN (x) stands for above DN 600 & flat surface. All thicknesses indicated are in mm.

TABLE – 3

RECOMMENDED MINIMUM THICKNESS (mm) CHART FOR POLYURETHANE FOAM

DESIGN CRITERIA

Ambient temperature	$40^{O}C$
Relative humidity	85%
Wind speed	1 m/s
Insulation material density	36 kg/cum
Finish	Aluminum sheet/G.I. sheet

Pipe DN	**Operating temperature, Deg C**									
	10	0	-10	-20	-30	-40	-50	-60	-70	-80
15	30	35	40	45	50	55	60	60	65	70
20	30	35	40	45	50	55	60	65	70	75
25	30	35	45	50	55	60	65	70	75	75
32	30	40	45	50	55	60	65	70	75	80
40	35	40	45	55	60	65	70	75	80	85
50	35	40	50	55	60	65	70	80	85	90
65	35	45	50	60	65	70	75	80	85	90
75	35	45	55	60	65	70	80	85	90	95
100	35	45	55	65	70	75	80	90	95	100
125	40	50	55	65	70	80	85	90	100	105
150	40	50	60	65	75	80	90	95	100	110
200	40	50	60	70	75	85	90	100	105	115
250	40	55	65	70	80	85	95	105	110	120
300	40	55	65	75	80	90	100	105	115	120
350	40	55	65	75	85	90	100	110	115	125
400	45	55	65	75	85	90	100	110	120	125
450	45	55	65	75	85	95	105	110	120	130
500	45	55	65	75	85	95	105	115	120	130
550	45	55	65	75	85	95	105	115	125	130
600	45	55	70	80	85	95	105	115	125	135
X	45	60	75	85	110	110	120	135	145	155

NOTE: Pipe DN (x) stands for above DN 600 & flat surface. All thicknesses indicated are in mm.

TABLE – 4

RECOMMENDED THICKNESS (mm) CHART FOR BONDED MINERAL WOOL (PIPE SECTION)

DESIGN CRITERIA

Ambient temperature	$40^{O}C$
Relative humidity	85%
Wind speed	1 m/s
Insulation material density	85 kg/cum for GLASS WOOL 120 kg/cum for ROCK WOOL
Finish	Aluminum sheet/G.I. sheet

Pipe DN	Operating temperature, Deg C									
	10	0	-10	-20	-30	-40	-50	-60	-70	-80
15	30	40	45	55	60	65	70	75	80	90
20	35	40	50	55	60	70	75	80	85	95
25	35	45	50	60	65	70	80	85	90	100
32	35	45	55	60	70	75	80	90	95	105
40	40	45	55	65	70	75	85	90	100	105
50	40	50	60	65	75	80	90	95	105	110
65	40	50	60	70	80	85	95	100	110	115
80	40	55	65	70	80	90	95	105	115	120
100	45	55	65	75	85	95	100	110	120	130
125	45	55	70	80	85	95	105	115	125	135
150	45	60	70	80	90	100	110	120	130	140
200	50	60	75	85	95	105	115	125	135	145
250	50	65	75	85	100	110	120	130	140	150
300	50	65	75	90	100	110	125	135	145	155
350	50	65	80	90	100	115	125	135	150	160
400	50	65	80	90	105	115	130	140	150	165
450	50	65	80	95	105	115	130	140	155	165
500	50	65	80	95	105	120	130	145	155	170
550	50	65	80	95	110	120	135	145	160	170
600	50	70	80	95	110	120	135	150	160	175
X	55	75	90	110	125	140	160	180	195	215

NOTE: Pipe DN (x) stands for sizes above DN 600 & flat surface. All thicknesses indicated are in mm.

APPENDIX – I

BRIEF DESCRIPTION OF SPECIAL CONSIDERATION FOR COASTAL LOCATIONS

1. Most coastal locations, particularly in the East, involve high wind velocities and cyclonic storms. Selection of cladding thickness and securement of cladding need special care. In all cases, specifications shall feature positive securement at sheeting joints, by pop rivets/self-tapping screws. Insulation systems for large ducts, and such areas shall incorporate external bands over cladding which are the only means of preventing dislodgment of sheeting by the heavy leeward (suction) pressures that are normally encountered.

2. As is well known, atmosphere in a coastal location, in addition to high humidity, also contains higher levels of electrolytes – thereby increasing the potential for electrochemical corrosion. From this angle, the following become important :

   a) All equipment and piping shall be properly cleaned, surface prepared and coated to desired protection standards prior to releasing them for insulation applications. In heated systems, coatings used shall be selected for suitability for peak temperatures expected in service. Field welded areas on shop fabricated and shop coated equipment need care and attention in this regard.

   b) All stainless steel surfaces need special attention due to their sensitivity to chloride attack. Irrespective of the type and nature of the insulant selected, there is likelihood of high chloride pick-up in storage, handling and application and hence, positive protection against direct concentration of leachable chlorides at the interface between the metal and the insulation is mandatory.

c) All exposed surfaces, such as cladding shall be selected to be of materials which will not pit, scale or corrode. Aluminum alloy cladding is preferred in all cases. Where sheet steel is used for any reason, it shall be galvanised with sufficient thickness of coating. Some improved protective techniques such as galvalume treatment or additional coil coating over galvanising are available which will provide superior service life.

d) Bands and securement devices including screws shall preferably be of the same material as the main cladding. Where they have to be of different metals, they shall be so chosen as to ensure that they are not electrolytically dissimilar at the point of contact.

e) Although sealings at joints in cladding and flashing at the terminations in insulation are important in many systems, coastal areas need special care in these areas since water seepage through imperfect joints can be much more serious, since corrosion under insulated systems due to such occurrence remain undetected till it is too late.

Generally, special care is needed in selecting and inspecting all materials forming part of the insulation system such as the material, sealants, mastics and adhesives, etc. since aging and deterioration rates are higher in aggressive environmental conditions per sec.

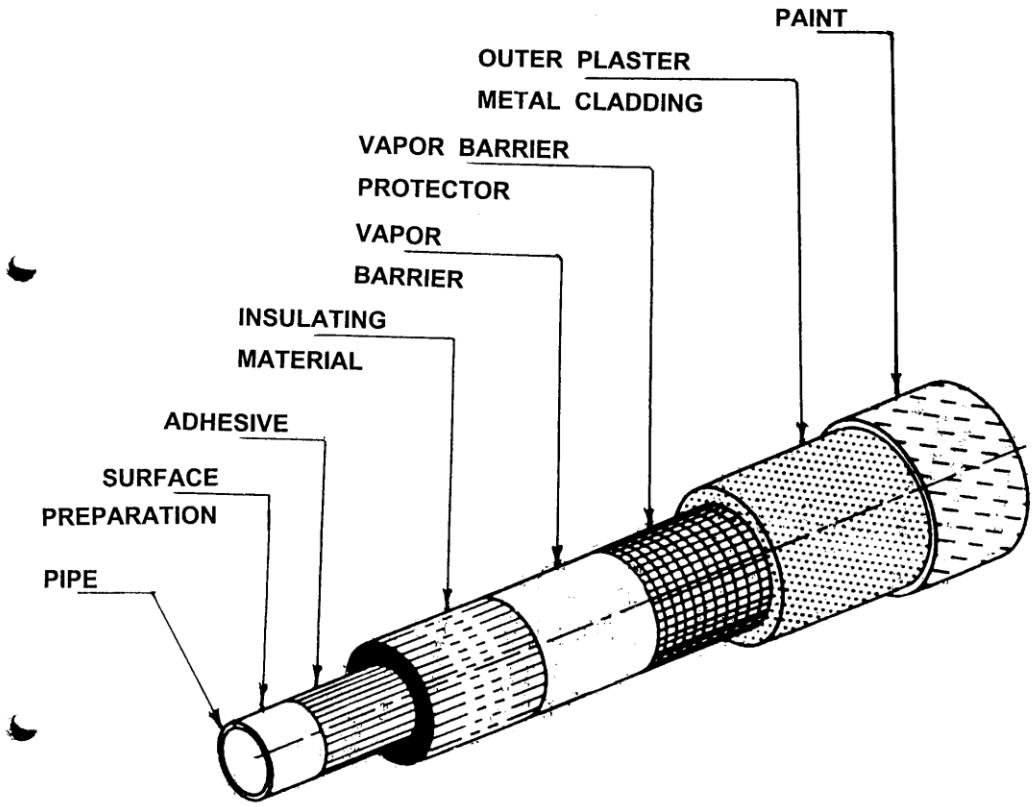

FIG.1 COLD INSULATION - SEQUENCE OF APPLICATION

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