MATERIAL STANDARD

FOR

INSULATION OF HVAC&R FIELD

ORIGINAL EDITION

OCT. 1996

This standard specification is reviewed and updated by the relevant technical committee on Aug. 2002(1), Dec. 2006(2) and Nov. 2013(3). The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

Each type of insulating materials covered in this Standard are required to be processed and fabricated into standard engineered products to fulfill its thermal and acoustic requirement .Thus providing savings in energy and preventing the seepage of condensation on its outer surfaces. The indicated insulating materials are made from many kind of noninterfaced raw materials, and the "Specification Requirements" is covered under Part I of this Standard. The Part II of this Standard represents the "General Administrative and Procedural Requirements" and a section is proposed as "Data Sheet", which covers all type of insulation normally applied in the HVAC&R field. The "Appendices" provide information on application of insulating materials and other general procedures.

1. SCOPE

This Standard covers the minimum requirements of materials, construction and characteristics of thermal insulation material used for HVAC&R applications suitable for commercial, institutional, industrial practices including Oil, Gas and Petrochemical affiliated installations.

It includes insulation material for pipes (steel, copper, or plastic), air ducts (galvanized or aluminum sheets or fiberglass ductboard), tanks, vessels, valves, fittings including sandwich panels or foamed-in-place insulation for walls, floor and ceiling of refrigerated chambers.

The insulation material covered are both for thermal and acoustic requirements as called for by the HVAC&R industry. Each type covers the accessory item and available in wide range of shapes, thicknesses and sizes, as specified.

This Standard does not cover the following type of insulating material:

- Cryogenic and hazardous applications.
- Building materials and products.
- Asbestos type or organic type of insulation.
- Insulation for hydrocarbon and processing system and power generation.
- Material for vibrations.
- Reflective-type of insulation.
- Hot oil or hot asphalt insulation.

Note1:

This standard specification is reviewed and updated by the relevant technical committee on Aug. 2002. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 162 on Aug. 2002. These modifications are included in the present issue of IPS.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on Dec. 2006. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No 293 on Dec. 2006. These modifications are included in the present issue of IPS.

Note 3:

This standard specification is reviewed and updated by the relevant technical committee on Nov. 2013. The approved modifications by T.C. were sent to IPS users as amendment No. 3 by circular No 400 on Nov. 2013. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the company and the vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM C16: 2012	"Standard Test Method for Load Testing Refractory Shapes at High Temperatures"
ASTM C423: 2009	"Standard Test Method for Sound absorption and Sound absorption Coefficients by The Reverberation Room Method."
ASTM E96/E96M: 2010	"Standard Test Method for Water Vapor Transmission of Materials"
ASTM C552: 2012	"Standard Specification for Cellular Glass thermal Insulation"
ASTM C533: 2012	"Standard Specification for Calcium Silicate Block and pipe Thermal Insulation"
ASTM C383: 1997	"Standard Specification for Wet Adhesion of Thermal Insulating Cement to Metal"
ASTM C1029: 2010	"Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation"
ASTM A653/A653M:2010	"Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process"
ASTM C 578: 2007	"Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation"

BSI (BRITISH STANDARDS INSTITUTION)

BS EN ISO 9001: 2008	"Quality Management Systems Requirements"
BS EN 12664: 2001	"Thermal Performance of Building Materials and Products Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods Dry and Moist Products of Medium and Low Thermal Resistance"
BS EN 12667: 2001	"Thermal Performance of Building Materials and Products Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods Products of High and Medium Thermal Resistance"
BS EN 12939: 2001	"Thermal Performance of Building Materials and Products Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods – Thick Products of High and Medium Thermal Resistance"
BS ISO 1922: 2012	"Rigid Cellular Plastics – Determination of Shear Strength"
BS 476-4: 2007	"Fire Test on Building Materials and Structures – Part 4: None-Combustibility Test for Materials"
BS 476-6: 2009	"Fire Test on Building Materials and Structures – Part 6: Method of Test for Fire Propagation for Products"
BS 476-7: 2011	"Fire Test on Building Materials and Structures – Part 7: Method of Test to Determine the Classification of the Surface Spread of Flame of Products"
BS 476-11: 2007	"Fire Test on Building Materials and Structures – Part 11: Method for Assessing the Heat Emission from Building Materials"
BS 5422: 2009	"Method for Specifying Thermal Insulation Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating Within the Temperature Range -40 ˚C to +700 ˚C"

BS EN 485-1: 2009	“Aluminium and Aluminium Alloys- Sheet, Strip and Plate – Part 1: Technical Condition for Inspection and Delivery”
BS EN 485-2: 2008	“Aluminium and Aluminium Alloys-Sheet, Strip and Plate – Part 2: Mechanical Properties”
BS EN 485-3: 2008	“Aluminium and Aluminium Alloys-Sheet, Strip and Plate – Part 3: Tolerances on Dimensions and form for Hot-rolled Products”
BS EN 485-4: 1994	“Aluminium and Aluminium Alloys-Sheet, Strip and Plate – Part 4: Tolerances on Shape and Dimensions for Cold-Rolled Products”
BS EN 515: 1993	"Aluminum and Aluminum Alloys Wrought Products-Temper Designations"
BS EN 573-1: 2004	“Aluminium and Aluminium Alloys- Chemical Composition and form of Wrought Products – Part 1: Numerical Designation System”
BS EN 573-2: 1995	“Aluminium and Aluminium Alloys- Chemical Composition and form of Wrought Products – Part 2: Chemical Symbol Based Designation System”
BS EN 573-3: 2009	“Aluminium and Aluminium Alloys- Chemical Composition and form of Wrought Products – Part 3: Chemical Composition and form of Products”

DIN (DETACHES INSTITUTE FOR NORMING)

DIN 4102-11: 1985	"Fire Behavior Building Materials and Building. Components"
DIN 4109	"Sound Insulation in Buildings"
DIN 52613	"Thermal Insulation Testing Determination of Thermal Conductivity by The tube Method"
DIN 52617	"Determination of the Water Absorption Coefficient of Construction Materials"

UL (UNDERWRITERS LABORATORIES INC)

UL 181: 2008	“Factory-Made Air Ducts and Air Connectors”
UL 723: 2010	“Test for Surface Burning Characteristics of Building Materials”

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA 90A: 2012	"Standard for the Installation of Air – Conditioning and Ventilating Systems"
NFPA 90B: 2012	"Standard for the Installation of Warm Air Heating and Air Conditioning Systems"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 9001: 2008	“Quality Management Systems- Requirements”

IPS (IRANIAN PETROLUM STANDARDS)

IPS-E-GN-100 "Engineering Standard for Units"

IPS-M-TP-710 "Material and Equipment Standard for Thermal Insulation"

3. DEFINITIONS AND TERMINOLOGY

3.1 Calcium Silicate

Insulation composed principally of hydrous calcium silicate, and which usually contains reinforcing fibers.

3.2 Cellular Elastomeric

Insulation composed principally of natural or synthetic elastomers, or both, processed to form a flexible, semi-rigid, or rigid foam which has a predominantly closed-cell structure.

3.3 Cellular Glass

Insulations composed of glass processed to form a rigid foam having a predominantly closed-cell structure.

3.4 Cellular Polystyrene

Insulation composed principally of polymerized styrene resin processed to form a rigid foam having a predominantly closed-cell structure.

3.5 Cellular Polyurethane

Insulation composed principally of the catalyzed reaction product of polyisocyanate and polyhydroxy compounds, processed usually with fluoro-carbon gas to form a rigid foam having a predominantly closed-cell structure.

3.6 Cellulosic Fiber

Insulation composed principally of cellulose fibers usually derived from paper, paperboard stock, or wood, with or without binders.

3.7 Facing

A protective or decorative (or both) surface applied as the outermost layers of an insulation system.

3.8 Heat Flux, q

The heat flow rate through a surface of unit area perpendicular to the direction of heat flow.

(q in SI units: W/m^2)

(q in inch-pound units: $Btu/h/ft^2$)

(The definition has been used as heat flux density, or density of heat flow rate defined as a real density of heat flow rate by ISO).

3.9 Insulation

Any material that is a poor conductor of heat, and thus can serve to keep heat confined or excluded by preventing or resisting heat transfer..

3.10 Jacket

A form of facing applied over insulation. (It may be integral with the insulation, or field-applied using sheet materials).

3.11 Mastic

A material relatively viscous consistency that dries or cures to form a protective finish, suitable for application to thermal insulation in thickness greater than 30 mils (0.76 mm) per coat.

3.12 Mineral Fiber

Insulation composed principally of fibers manufactured from rock, slag, or glass, with or without binders.

3.13 Perlite

Insulation composed of natural perlite ore expanded to form a cellular structure.

3.14 Vermiculite

Insulation composed of natural vermiculite ore expanded to form an exfoliated structure.

3.15 Water Vapor Retarder (Barrier)

A material or system that adequately impedes the transmission of water vapor under specified conditions.

4. UNITS

This Standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. CONFLICTING REQUIREMENTS

In case of conflict between documents relating to the inquiry or the purchase order the following priority of documents shall apply:

- **First Priority:** Purchase order (including attachments) and variations thereon.
- **Second Priority:** Data-requisition sheets and submittals.
- **Third Priority:** This specification.

All conflicting requirements shall be referred to the company in writing. The Company will issue confirmation documents if needed for clarification.

PART I

MATERIAL SPECIFICATION REQUIREMENTS

6. GENERAL PRODUCT REQUIREMENTS

6.1 Characteristics

The thermal insulation covered in this Standard shall meet the following characteristics conforming to ASTM Standard C-16.

a) Resistance to fire, vermin, non-objectionable odors and vapors;

b) The materials and its expertise shall meet the health and safety requirements during storing, handling, installation and after installation;

6.2 Thermal Capabilities

The thermal transmission factor representing thermal conductivity, thermal conductance, thermal resistivity, and thermal resistance shall meet the minimum requirement of ranges mentioned below:

a) Thermal conductivity (K)	0.01 to 0.05 kcal/m. hr. °C
	(0.08 to 0.4) BTU. in/ft². hr .°F.
b) Thermal conductance	1 to 23 kcal/m². hr. °C
	(5 to 113) BTU/ft². hr. °F
c) Thermal resistivity	20 to 100 m. hr. °C/kcal
	(2.5 to 12.5) ft². hr. °F/BTU. in
d) Thermal resistance	0.045 to 1 m². hr .°C/kcal
	(0.009 to 0.2) ft². hr. °F/BTU

6.3 Insulating Types

The insulating type covered in this Standard are as follows:

a) Fiber glass/glass wool

(Blanket or in rolls, preformed or sectional, rigid or semi-rigid)

b) Cellular glass

(Blanket or in rolls, preformed or sectional, rigid or semi-rigid)

c) Synthetic vinyl rubber (elastomeric)

(Preformed, sectional or semi-rigid)

d) Cork board-expanded

(Sectional or rigid slabs)

e) Polyurethane

(Pre-formed or sectional, rigid panels or foamed-in-place)

f) Poly styrene-expanded

(Sectional or rigid panels)

g) Calcium silicate

(Section or rigid panels)

Note:

For recommended thermal insulation application, reference is made to Appendix "A"

7. FIBERGLASS INSULATION

7.1 General

The fiber glass insulating materials with mineral fibers (rock, slag or glass) shall be based on pure fibers made from non-combustible inorganic fine glassfiber. It shall be moisture-resistant, free of non-fibrous material with an average fineness of 4 thousandth of a millimeter. The glass fibers shall be impregnated with synthetic resin, polymerized at high temperature and the finish shall preferably be yellow or white in color. The thermal conductivity shall be measured at a mean temperature of 25°C (77°F).

7.2 Material Requirements

The material shall be available in following type conforming to DIN 4102 or approved authoritative international body as mentioned in the data sheet.

7.3 Fiberglass Blanket

7.3.1 It shall be in mattes of fine glass fibers sewn onto galvanized wire mesh suitable for up to 500°C (932°F) with thermal conductivity to be equal or less than 0.028 kcal/m .hr .°C. It shall preferably be available in rolls of 1m × 5 m in thicknesses of 50, 75 and 100 mm (2"-3"-4").

7.3.2 It shall be in matt s of fine glass fibers for thermal and sound insulation faced with aluminum kraft vapor barrier provided with 50 mm (2") overlap at one side, suitable for up to 250°C (482°F) with thermal conductivity to be equal or less than 0.029 kcal/m .hr .°C.

The dimensions shall preferably be available in following configuration.

LENGTH mm	WIDTH mm	THICKNESS mm	DENSITY kg/m^3
3000	500	75	30
5000	500	50	30
8000	500	30	30

7.4 Pre-Moulded Pipe Insulation

It shall be concentric in pre-mould shape, made of fine glass fibers bonded with phenolic or thermosetting resin and faced with reinforced aluminum foil, suitable for up to 250°C (482°F) with thermal conductivity to be equal or less than 0.029 kcal/m. hr. °C. It shall preferably be available in lengths of 1000 mm, thicknesses of 25 mm - 50 mm - 75 mm (1"- 2"- 3"), density of 70 kg/m^3 and inside diameter from 20 mm (¾") to 460 mm (18").

7.5 Rigid and Semi-Rigid Fiberglass

It shall be in rigid or semi-rigid slabs made of fine glass fibers bonded with phenolic or thermosetting resin capable to withstand high compression and tearing strength, thermal conductivity to be equal or less than 0.026 kcal/m. hr .°C. It shall preferably be available in thicknesses of 25 mm - 40 mm - 50 mm - 65 mm (1"- 1½" - 2" - 2½") and in dimensions of 1200 × 1000 mm at 90 - 100 kg/m^3 density.

7.6 Fiberglass Felts

7.6.1 It shall be in felts of fine glass fibers bonded with phenolic or thermosetting resins and glued on reinforced or non-reinforced kraft aluminum foil with 50 mm overlap on one side.

7.6.2 It shall posses the following properties:

a) Thermal conductivity equal or less than 0.038 kcal/m.hr.°C;

b) Sound absorption coefficient at frequencies of 200/2000 Hz for thickness of 30 mm at 0.5 to 0.6;

c) Moisture absorption capacity of 0.05%;

d) Non-combustible.

7.6.3 It shall be in available in thicknesses of 30-40 and 50 mm lengths of 20000 and 10000 mm, width of 1200 mm and density range from 12 to 24 kg/m³ (0.75 to 1.5 lb/ft³).

7.7 Fiberglass Duct Board

7.7.1 It shall be in flat rigid fiberglass duct board available in sizes 25, 40, 50 mm (1", 1½", 2") thickness for fabrication of rectangular air handling ducts. The medium pressure board shall be made from flame-attenuated inorganic glass fibers bonded with thermosetting resin.

7.7.2 Double density slip-joint edges shall be premoulded into the board, creating a male connection along one side and male on the other. The medium pressure board shall be faced from one side with a heavy duty foil facing consisting of foil, fiber glass scrim reinforcement and two layers of kraft paper, laminated in a foil-kraft, scrim-kraft pattern. The facing shall be extended over the full width of the male slip-joint edge to serve as an integral stapling tab at the circumferential joints.

7.7.3 The joint shall be suitable for maximum service temperature of 121°C (250°F) maximum positive pressure of 89 mm (3.5") water gage and a maximum air velocity of 12 m/s (2400 fpm).

7.7.4 The duct board shall be specially designed to provide air duct, thermal insulation, noise absorption and vapor retarder in a single product.

7.7.5 It shall be listed by UL when tested in systems in accordance with UL 181, Class 1, "standards for safety of air ducts" complying with NFPA 90 A and 90 B. The sound absorption coefficient shall be in accordance with ASTM C- 423 test procedure. The surface burning characteristics shall meet the minimum requirements of UL 723. (Standard for surface burning characteristics of building material.)

Note:

The fiberglass duct board shall be used for medium pressure ducting application for static pressure up to 3.5" WG. Particularly where space, noise and supports are problematic.

8. CELLULAR GLASS INSULATION

8.1 General

8.1.1 The cellular glass insulation shall be lightweight minimum 128 kg/m³ (8 lb/ft^3) impermeable rigid composed of millions of completely sealed inorganic glass cells without the use of any binder or fillers. It shall be tested in accordance with ASTM E 96/E 96M with perm-in permeability rating.

8.1.2 It shall be suitable from -42.8°C to 120°C (-45°F to 250°F), for surface operating temperature

for both indoors and outdoor locations, above ground or under ground applications.

8.1.3 It shall be capable to provide the following salient features:

- fire protection, and shall not absorb flammable, liquids or vapors.

-corrosion-resistant, and shall be unaffected by common chemicals and by most corrosive plant atmosphere without promoting metal corrosion.

- dimensionally stable, unaffected by temperature differential and humidity. It shall not swell, warp, shrink or otherwise distort.

- compressive strength, withstanding any crush loads.

- resist moisture, in both liquid and vapor form.

- dimensional thickness, to ensure proper nesting of pipe insulations in multi-layer applications.

8.2 Physical and Thermal Properties

The physical and thermal properties of the cellular glass insulation shall be not less than the values mentioned below. (Table 1 ASTM C 552: 2012)

PHYSICAL REQUIREMENTS[A]

TYPE I BLOCK	
Properties	
Density, lb/ft^3 (kg/m^3)	
Minimum	6.12 (98)
Maximum	8.62 (138)
Compressive strength, capped,[B] min, psi (kPa) (Capped material in accordance with Test Methods C240)	60 (415)
Compressive resistance, uncapped, min, psi (kPa) (Uncapped at 0.2-in. deformation)	35 (242)
Flexural strength, min, psi (kPa)	41 (283)
Water absorption, max, volume %	0.5
Water vapor permeability, max, per·in. or grains·in. of thickness/ h·ft^2·in. Hg (ng·Pa^{-1}·s^{-1} ·m^{-1})	0.005 (0.007)
Hot-surface performance warpage, in. (mm), max	0.125 (3)
Cracking	see 12.8.1
Behavior of materials in a vertical tube furnace	passed
Surface burning characteristics[C]	
Flame spread index, max	5
Smoke developed index, max	0
Mass Loss Corrosion Rate	≤ DI
Apparent Thermal Conductivity [D,E] : flat block, max	
(Btu-in./h·ft^2°F) (W/m·K) at mean temperature of:	
°F (°C)	
400 (204)	0.58 (0.084)
300 (149)	0.48 (0.070)
200 (93)	0.40(0.058)
100(38)	0.33 (0.047)
75 (24)	0.31 (0.045)
50 (10)	0.29 (0.043)
0 (–18)	0.27(0.038)
–50 (–46)	0.24 (0.034)
–100 (–73)	0.21 (0.031)
–150 (–101)	0.19(0.027)
–200 (–129)	0.17 (0.025)
–250 (–157)	0.15 (0.022)
–300 (–184)	0.14 (0.020)
TYPE II PIPE AND TUBING	
Apparent thermal conductivity [D,F,G,H]	
Pipe insulation, max, (Btu·in./h·ft^2°F) (W/m·K) at mean temperature of:	
°F (°C)	
400 (205)	0.69 (0.099)
300 (149)	0.56 (0.081)
200 (93)	0.46 (0.066)
100 (38)	0.37 (0.053)
Hot-surface performance warpage, in. (mm), max Cracking	0.125 (3) see 12.8.1

[A] Physical property requirements shown are for the materials in the as manufactured condition. They do not necessarily represent the values of these properties under certain in-service conditions, depending on the type of installation and the ultimate temperature exposure.

[B] For information on higher density and compressive strength material, contact the manufacturers.

[C] For Types II and III, smoke developed index and flame spread index will remain constant with some fabrication techniques and will change with other fabrication techniques. For applications requiring a flame spread index of 25 and a smoke developed index of 50, contact fabricator or manufacturer.

[D] Thermal transmission properties of insulation will vary with temperature, temperature gradient, thickness, and shape. Note the apparent thermal conductivity values in the table are based on samples tested under conditions specified in 12.3 These are comparative values for establishing specification compliance. They do not necessarily represent the installed performance for the insulation under use conditions differing substantially from the test conditions.

[E] Evaluated at a small temperature difference in accordance with Practice C1058.

[F] Evaluated at a large temperature difference in accordance with Practice C1058.

[G] Single layer or inner layer on a multilayer system piping insulation fabricated in half sections has the potential to exhibit stress cracks above 250°F (122°C). The thermal performance in this range is characterized with cracks present.

[H] At this time, pipe insulation cannot be tested below ambient temperatures. See 12.3, Note 2.

8.3 Shapes

The insulation shall be available in following shapes:

- flat tapered blocks and boards up to Boards up to 178 mm (7") to 38 mm (1.5")

thickness. Dimensions shall be to manufacturer's standard product.;

- curved segments, leveled head and lag segments;

- pre-moulded pipes and tubing insulation shall comply to ASTM C-552 from 12.7 mm to 600 mm (½" to 24") size and up to 100 mm (4") thickness.

The insulation for pipes shall be UL rated factory applied available for steel or copper pipes with following facings as directed:

a) Aluminum jacketed 4-mils-thick factory applied.

b) Mastic finished glass-fabric jacket applied with a high melting point asphalt.

c) Special vinyl/aluminum laminated jacket.

Note:

The insulation thickness of pipes shall be determined by highest operating temperature at which the piping normally operates.

9. FLEXIBLE RUBBER FOAM (ELASTOMERIC)

9.1 General

9.1.1 The production of closed cell flexible synthetic rubber foam shall be CFC-free preferably black in color, resistance to building material, and purchases recommended from approved European suppliers.

9.1.2 All production process shall be realized under quality control procedures in compliance with BS-EN-ISO-9001-2008.

9.1.3 For explanation of 'Class 0', 'Class 1' and 'limited combustibility' reference is made to Appendix 'B'.

9.2 Material Specification

9.2.1 Based on British standard class 1 fire reaction

The specification requirement shall be as follows:

9.2.1.1 Technical characteristics:

a) Thermal conductivity at 0°C mean temperature: 0.034 W (m.K)

according to BS EN 12664, 12667, 12939 test method.

b) Water vapor resistance factor >2500

according to BS ISO 1922 test method.

c) Reaction to fire: Class 1

- Fire performance: surface spread of flame: Class 1

according to BS 476 Part 7-1987 test method.

- Behavior in fire: shall not generate flaming droplets

-Wall penetrations: standard fire test shall be 180 minutes

d) Wall thickness tolerances: (engineered wall thicknesses)

For a given nominal wall thickness, the actual wall thickness shall increase with pipe diameter in order to provide a constant outer surface temperature under a given set of ambient and service conditions. (The increase shall be able to follow a logarithmic function).

e) Environmental factors:

- Noise reduction: Up to 30 dB (A)

according to DIN 4109 test method.

- Resistance to UV rays: shall be good, but protective flexible and water based paint (special formulation) recommended for outdoors applications shall be provided. External cladding or coating for indoor applications shall not be required.

Note:

For resistance rates to chemical, relevant data from manufacturer's shall be provided.

9.2.1.2 Production range

a) The manufacturer's product shall meet the following temperature range:

- tubes from -40°C (-40°F) to +105°C (221°F)

- sheets from -40°C (-40°F) to 85°C (185°F)

b) The manufacturers shall have available minimum requirements of the following production range.

Tubes: 6, 9, 13, 19, 25, 32 mm walls; 6 to 140 mm pipe OD; Length: 2 m; suitable for ¼" to 4¼" OD Copper pipes; ⅜" to 5" NB Steel pipes

Sheet: 6, 9, 13, 19, 25, 32 mm insulation thickness.

Tape: Self adhesive 3 mm thick, 50 mm wide rolls.

Insulated and water vapor resistant pipe supports: 15 to 168 mm pipe OD; suitable for ½" to 6" NB Steel pipes.

9.2.1.3 Recommended accessories

The following accessories, as required, shall be made available:

a) Specific adhesive to provide binding at molecular level thus obtaining complete hermetic city of the system.

b) Specific cleaner for surface preparation prior to installation of insulation.

9.2.2 Based on British Standard class 0 fire reaction

The specification requirement shall be as follows.

9.2.2.1 Technical characteristics

a)Thermal conductivity at 0°C mean temperature: 0.038 W/(m .K)

according to BS EN 12664, 12667, 12939 test method.

b) Water vapor resistance factor >2500

according to BS ISO 1922 test method.

c) Reaction to fire: Class 0

- Fire performance: Surface spread of flame: Class 1

according to BS 476 Part 7 test method.

- Fire propagation : Total index of performance (i): Less than 12

Sub index of performance (ii): Less than 6

according to BS 476 Part 6-1989.

- Behavior in fire: nil flame spread; shall not generate flaming droplets.

- Wall penetrations, standard fire test: shall be 180 minutes.

d) Other factors

For wall thickness tolerances, environmental factors and resistance to UV rays, descriptions mentioned in British Standard Class 1 Fire Reaction shall comply (Clause 9.2.1.1 of this Standard).

9.2.2.2 Production range

Description mentioned in Clause 9.2.1.2 shall comply.

9.2.2.3 Recommended accessories

Description mentioned in Clause 9.2.1.3 shall comply.

9.2.3 Based on DIN Standard B1 fire reaction

The specification requirement shall be as follows:

9.2.3.1 Technical characteristics

a) Thermal conductivity at 0°C mean temperature: <=0.036 W(m .k)

according to DIN 52613 test method.

b) Water vapor resistance factor >3000

according to DIN 52617 test methods.

c) Fire reaction

- Material Class: DIN 4102-B1

Minimal surface spread of flame, PA-III 2.768

- Behavior in fire: Self-extinguishing, shall not generate flaming droplets, and will not spread flame.

- Fire resistance: wall penetrations to R90 (DIN 4102, Part 11)

d) Other factors

For wall thickness tolerances, environmental factors and resistance to UV rays, descriptions mentioned in British Standard Class 1 Fire Reaction shall comply (Clause 9.2.1.1 of this Standard) .

9.2.3.2 Production range

Description mentioned in Clause 9.2.1.2 shall comply.

9.2.3.3 Recommended accessories

Description mention in Clause 9.2.1.3 shall comply.

Note:

Nesting shall be allowed on pre-moulded pipe insulation materials.

10. POLYURETHANE INSULATION

10.1 General

The polyurethane insulation shall be suitable for temperatures from -40°C to 107°C (-40°F to 225°F) and be factory processed with standard ratio of polyol and is ocyanate chemicals either in the form of expanded sandwich panels or in the form of high density premoulded or sectional insulation for pipes. The solutions shall be mixed in appropriate ratio and applied with required quantity of activator. (The manufacturer shall advise whether continuous production method or batch production method are used). For more information see relevant Parts of IPS-M-TP-710.

10.2 Insulation for Sandwich Panels

10.2.1 The expanded polyurethane panels shall be faced factory applied with two steel facings in minimum thickness of either 0.8 mm (24 gage) aluminum or 0.5 mm (26 gage) galvanized sheet. The inside of the sheet shall preferably be corrugated (to increase rigidity and bending resistance of the panel).

10.2.2 The outer side of the sheet shall be provided with securing arrangement to the structure and with longitudinal dovetail grooves capable to provide the following benefits:

a) to secure fastening of the panels to the supporting structure without creating a thermal bridge by using patented steel fixtures.

b) to strengthen the panel so that it will support wind and snow loads.

c) to improve the bond between the foamed-in polyurethane and the two steel sheet facings.

Note:

Where required the manufacturer shall submit the type of polyamide tie bolt and sealing mastic for customer's approval.

10.2.3 The preparation of panel facing shall be based on the following procedures:

a) preliminary treatment consisting of chemical degreasing, brushing, hot water washing.

b) painting of both sides with a coat of primer, furnace treatment and cooling.

c) painting of one side with a coat of acrylic paint, furnace baking and cooling.

10.2.4 The sealing resins for joining the panels shall be based on poly isobutylene and meet minimum requirements of the following data:

- remains permanently plastic and does not harden with time,
- specific weight: 1.7 kg/dm^3
- application temperature: from 0°C to +50°C (32°F to 122°F)
- resistance to sunlight
- resistance to UV rays
- water resistance: excellent,
- resistance to diluted acids and alkali: good,
- resistance to temperature: from -50°C to +100°C (-58°F to 212°F).

10.3 Physical and Thermal Properties

The physical and thermal properties of the expanded polyurethane shall meet the minimum requirements of the following data:

- Structure	**Fine pores, 90 to 95% by volume in closed cells**
- Unit weight range	For insulation: 30 to 60 kg/m³ For construction: 40 to 100 kg/m³
- Crushing strength	For a unit weight of 30 g/l: about 1.5 kg/cm² 60 g/l: about 4 kg/cm² 100 g/l: about 10 kg/cm²
- Resistance to cold	For a unit weight above 30 kg/l: up to -40°C For a unit weight above 80 g/l: up to -200°C
- Resistance to heat	Continuous temperature load: + 120°C Short time: + 180°C Thermal decomposition: +250°C
- Shrinkage	Above a unit weight of 30 g/l and -30°C: 0-0.2% by vol.
- Thermal conductivity	At a unit weight of 40 g/l and +10°C Initial value: 0.014-0.018 kcal/m.h.°C Final value in case of non-diffusion proof covering: 0.020 to 0.023
- Coefficient of thermal expansion	At a unit weight of 40 to 50 g/l: about 5-10 × 10^{-5} 1°C
- Resistance to steam diffusion	At a unit weight of 40-60 g/l: = 50-100 About 5-10 × 10^{-5} 1°C
- Water absorption	When stored under water after 24 hours About 0.5% by volume; after 35 days 2-3% by vol. When stored in damp air
-Combustibilityfor flame resistant uses	To ASTM 1692-59 T: self-extinguishing up to Non-Combustibility covering layers, flame resistant
- Adhesion	To metal and inorganic materials: good to very good
- Rot proofness	Rot proof
- Chemical resistance	Largely resistant to all usual chemicals

10.4 Insulation for Pipes and Fittings

10.4.1 General

The insulation shall be ridged closed cell urethane foam with a K factor value not to exceed 0.15 at 24°C (75°F) mean temperature and shall be self-extinguishing. The urethane foam shall be foamed-in-place in the factory between the pipe and outer jacket causing the foam to bond securely to both surfaces. There shall be no seams throughout, and thickness of foam insulation will be as designated and uniform to within ±6 mm (±¼") throughout.

10.4.2 Facing

The following outer insulation facing shall be made available:

a) Reinforced aluminum

Reinforced aluminum foil 0.1143 mm (0.0045" thick) with minimum (40 micron) foil, scrim kraft where required, complete with :

- insulation coating and adhesives (in drums)
- masking tape and wooden skewer.

b) Jacketing

i) The outer jacket of the factory insulated pipe and fittings shall be of extruded ridged vinyl (PVC), high density polyethylene or spiral wound metal as specified. This jacket shall be waterproof and provide a vapor seal. PVC or PE jacketing on straight lengths of pipe shall be seamless.

ii) The jacketing for field insulated joints shall be with PVC, preformed jacketing material to be supplied by the manufacturer (installed in accordance with the manufacturer's Standard installation instructions).

c) Field insulation for straight joints shall be made as directed either by:

- applying preformed sections of urethane foam to the pipe size.
- foaming urethane-in place for the size of the pipe.

Note:

As indicated in the drawings and or data sheet ,the type of pipe fittings such as, elbows, tees, etc. shall be factory applied of same materials herein specified and in the same dimensions as the pipe to which it is joined.

11. POLYSTYRENE INSULATION (PANEL TYPE)

11.1 General

The polystyrene insulation shall be suitable for temperatures from -53.9 to 73.9°C (-65 to +165°F) and be factory processed with standard ratio of density bonded in the form of various types of rigid panel thermal insulation.

Notes:

1) The manufacturer shall advise whether continuous production method or batch production method are used.

2) Polystyrene material are not recommended for use on pipes.

11.2 Dimensions

The preparation of panel type dimensions shall be available preferably in the following dimensions:

- Width mm (in) from 300 (12) to 1200 (48).
- Length mm (in) from 1200 (48) to 4570 (180).
- Thickness mm (in) from 9.5 (3/8) to 200 (8).

11.3 Physical and Thermal Properties

The physical and thermal properties of cellular polystyrene thermal insulation shall meet the minimum requirements of the following data complying to ASTM C578.

- Density kg/m³ (lb/ft³) : From 12 (0.70) to 48(3.00).
- Thermal resistance km² /W (F.ft². h/Btu): at 25.4 mm (1") Thickness and -3.9°C(25°F) to 43.3°C (110°F): From 0.61 (3.45) to 100 (690).
- Compressive resistance kPa (psi): From 70 (10) to 690 (100.0).
- Water vapor permanence: ng/Pa.S. m² (perm) : From 287 (5.0) to 63 (1.1) at 25.4 mm (1") thickness.
- Dimension stability: 2% maximum (change in dimensions).

12. CALCIUM SILICATE INSULATION

12.1 Material Requirements

The calcium silicate insulation shall be suitable for temperatures from 2°C to 650°C (35°F to 1200°F), factory processed for molded pipe insulation, composing of lime and silica bonded with asbestos-free fibers and complying to ASTM standard section C-533 or approved equal. It shall be completely inorganic and possess the minimum requirements of following features:

a) Light weight;

b) Low thermal conductivity;

c) Great structural strength;

d) Insolubility in water;

e) Suitable for high and low temperature piping surface;

f) Chemically stable.

12.2 Physical and Thermal Properties

PHYSICAL REQUIREMENTS

Note 1: The physical requirements are based on the properties of samples dried or conditioned, or both, as specified in the referenced test methods.

Calcium silicate insulation tends to absorb moisture to varying degrees depending on exposure conditions. It can absorb up to 4 times its dry weight if placed in direct contact with water through improper storage or application.

Note 2: The user is advised that some applications could require the knowledge of the thermal conductivity of the insulation material at mean temperatures above those shown. Consult the manufacturer for data at mean temperatures exceeding those listed.

	Type I	**Type IA**	**Type II**
	Block and Pipe	Block	Block
Use temperature, max, °F (°C)	1200 (649)	1200 (649)	1700 (927)
Density (dry), max, lb/ft^3 (kg/m^3)	15 (240)	22 (352)	22 (352)
Flexural strength, min, psi (kPa)	50 (344)	50 (344)	50 (344)
Compressive strength, min,at 5 % deformation, psi (kPa)	100 (688)	100 (688)	100 (688)
Mass loss by tumbling, max, %			
after first 10 minutes	20	20	20
after second 10 minutes	40	40	40
Soaking heat linear shrinkage, max,%	2	2	2
Hot surface performance:			
warpage, max, in. (mm)	1/4 (6)	1/4 (6)	1/4 (6)
cracking	No cracks completely through the insulation thickness. Surface cracks on hot face are acceptable		
Apparent thermal conductivity[A] (see Note 2)			
Btu-in./h-ft^2-°F (W/m-K)max at mean temperature of:			
100°F (38°C)	0.41 (0.059)	0.50 (0.072)	0.50 (0.072)
200°F (93°C)	0.45 (0.065)	0.54 (0.078)	0.54 (0.078)
300°F (149°C)	0.50 (0.072)	0.58 (0.084)	0.58 (0.084)
400°F (204°C)	0.55 (0.079)	0.61 (0.088)	0.61 (0.088)
500°F (260°C)	0.60 (0.087)	0.64 (0.092)	0.64 (0.092)
600°F (316°C)	0.66 (0.095)	0.67 (0.097)	0.67 (0.097)
700°F (371°C)	0.71 (0.102)	0.70 (0.101)	0.70 (0.101)
800°F (427°C)	...		0.73 (0.105)
900°F (482°C)	...		0.75 (0.108)
1000°F (538°C)	...		0.77 (0.111)
Surface burning characteristics:			
Flame spread index, max	0	0	0
Smoke density index, max	0	0	0
Non-Combustibility	Pass	Pass	Pass
Mass Loss Corrosion Rate	≤ DI		
Stress Corrosion Performance	Pass		
Moisture content, by weight, max %	20	20	20

[A] The thermal transmission properties of calcium silicate block and pipe insulation vary with temperature, temperature gradient, moisture content, thickness, and shape.
Note that the apparent thermal conductivity requirements in the table are based on samples tested under the conditions specified in 12.1.2. These are comparative values for establishing specification compliance. They do not represent the installed performance of the insulation under use conditions differing substantially from the test conditions.

12.3 Available Forms

12.3.1 The insulating materials shall be available in sectional form suitable for IPS pipes from ½" up to 8" for nominal thicknesses up to 100 mm (4") and for copper tubing size up to 3 ⅛".

12.3.2 A suitable vapor barrier jacket shall be factory applied with a preformed minimum 0.4 mm (0.016") thick aluminum sheet with a built-in isolation felt.

12.3.3 Recommended forms in loose fill or powder form shall be available for valves and fittings such as tees, elbows, etc. for site application requirements.

13. INSULATION ACCESSORIES

Where required, the following requirements shall comply:

13.1 Adhesive

The adhesive applicable to the insulations shall be able to provide at molecular level the weather proofing and sealing arrangement in accordance to ASTM Standard test method of C 383.

13.2 Wire

The wire type shall preferably be galvanized annealed iron wire for securing the insulation to surfaces applied and shall be available in following gages.

Pipe 12" and under: 16 gage (1.5 mm)

Vessels and pipes over 12": 14 gage (2 mm)

13.3 Jacketing Materials

13.3.1 Non-Metalic jacketing

13.3.1.1 The non-metalic jacketing materials shall be composed of a single material or a lamination of several components, and be available in the form of rolls or sheets or preformed to fit the surface to which they are to be applied.

13.3.1.2 Where gypsums are used over pipe or vessel insulation, it shall be smoothened with suitable cotton material and coated with heat-resistant paint.

13.3.2 Metalic jacketing

13.3.2.1 Aluminum metalic jacketing shall be based on BS EN 485 Parts 1-4, BS EN 515 and BS EN 573 Parts 1-3 -½ H4 Standard or approved equal, with factory applied polykraft vapor barrier and supplied as follows:

a) 0.23-0.25 mm (0.010") thick × 5 mm (3/16") corrugated for piping 150 mm diameter and smaller.

b) 0.50 mm (0.020") thick × 5 mm (3/16") corrugated for piping over 150 mm diameter, and vessels and equipment 760 mm (30") diameter and smaller.

c) 0.80 mm (0.031") thick × 32 mm (1¼") corrugated for vessels and equipment larger than 760 mm (30") diameter.

d) 0.50 mm (0.020") thick in flat form for vessel and equipment heads and transitions.

13.3.2.2 Galvanized metal jacketing for vessels and tanks shall be to ASTM A-525 commercial grade G90 or approved standard and shall preferably be of 26 gage (0.5 mm) thick for all applications.

13.4 Bands

The available bands shall preferably be of the following types:

a) Bands on vessels and tanks shall be 19 mm wide × 0.51 mm thick (¾" wide × 0.02" thick) galvanized steel with seals.

b) Bands for metal jacket on vessel and pipe over 760 mm (30") shall be 19 mm wide × 0.51 mm thick (¾" wide × 0.02" thick) stainless steel with adequate seals.

c) Bands for metal jacket on tanks shall be 19 mm wide × 0.51 mm thick (¾" wide × 0.02" thick) stainless steel with adequate seals.

d) Bands for metal jacket on piping 760 mm (30") and smaller shall be 13 mm wide × 0.38 mm thick (½" wide × 0.15" thick) stainless steel with adequate seals.

Note:

The customer shall specify where insulation accessories are required as a separate entity for field application.

PART II

GENERAL ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

14. GENERAL REQUIREMENTS

14.1 Marking

14.1.1 All products shall be clearly identified and clearly marked, showing all data called for in this Standard and the purchase order including the following:

- Manufacturer's name and date of production.
- Manufacturer's products designation.
- Material type, dimension, nominal diameter etc.
- Special packaging or marking.
- Net and gross weight of the product.
- Purchase order number and date.

14.1.2 The marking shall be applied in an easily visible area. A separate marker shall be applied on the packaging for the purchaser's order number for example.

+ NIOC No.	**.....**

14.2 Quality Control and Quality Records

14.2.1 Inspection/Quality control and test

14.2.1.1 The purchaser's inspector, or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the product to carry out necessary inspection of the material quality at any stage of work.

14.2.1.2 Approval by the purchaser's inspector or assigned representative shall not relieve the vendor of his commitments under the terms of this specification or any associated order.

14.2.1.3 The supplier shall make available technical data, test facilities and samples that the purchaser's representative may require for verification in conjunction with pertinent product.

14.2.1.4 The product should be replaced if measurement, datas and inspection reveal any discrepancies between quoted figures resulting in purchase order and those measured physically.

14.3 Inspection and Certification

14.3.1 Inspection of the material shall be made at the manufacturer's plant, point of shipment or at the port of delivery as agreed upon between the manufacturer and the customer.

14.3.2 The manufacturer's certification shall be furnished to the customer specifying that the material was manufactured, sampled, tested, and inspected in accordance with the specification of this Standard and has been found to meet the requirements based on furnished test results.

14.3.3 Upon customer's request, the manufacturer shall accept the certification of an independent third party indicating conformance to the requirements of this Standard.

Third party representative when specified shall be required to certify the following:

a) Visual and dimensional including tolerance check.

b) Thermal and acoustic test.

c) Operational and safety test.

d) Health and safety test requirements.

e) Efficiency test on vapor-proof retarders.

f) Density and thermal conductivity test.

14.4 Packaging

14.4.1 The material shall be packaged to afford protection against deterioration and damage which may occur during handling, sea shipment to the port, rough road haulage to site and extended storage in tropical areas.

14.4.2 The acceptable packaging method for the insulation material shall be placed in containers that comply with the regulations applicable to the mode of transportation and packed as follows:

a) For fiberglass insulation:

- Matting and felts in kraft paper or plastic bag.
- Premoulded insulation nested in cartons
- Rigid or semi rigid in strong carton boxes.

b) Cork slabs shall be packed in strong corrugated cartons or in shrink film package, as directed by the purchaser.

c) Liquid component shall be in sealed containers, and shall comply to Clause 14 of ASTM C1029.

d) Solid accessories such as resin in jute or polyethylene bags and marked accordingly.

14.4.3 The manufacturer shall advise the purchaser when supplied in manufacturer's packaging standard. It shall be suitable for export, marked with the material name dimension/size/type of material, number of pieces, coverage of the contents and the thermal resistance.

14.5 Vendor's Data

The manufacturer shall furnish the following data in English language to the purchaser at no extra cost. The general information provided by the purchaser to the manufacturer can be based on Appendix 'C', complying, where required to BS 5422.

14.5.1 At quotation stage

a) Descriptive brochures together with production method, applicable performance test certificates and other supportive documents.

b) Where required insulation shall be sampled for qualification tests and special provisions for sampling shall be agreed upon.

14.5.2 At order stage

a) Designation of the product

b) Recommended storage temperature and humidity, and instruction for handling.

c) Health and safety provisions required during the installation and use of the insulating

material which may expose individuals to health and safety hazards.

d) The manufacturer shall provide the purchaser appropriate information regarding any hazards known to him, associated with the designated end-use of the products, and shall be responsible to recommend the protective measures to be employed in its safe storage method, installation procedures and use.

14.6 Guarantee

14.6.1 The manufacturer shall guarantee that the insulating material shall provide its full thermal and/or acoustic performance without hindrance to system efficiency for an operating period of 12 months after installation or 24 months after shipment.

14.6.2 Since the workmanship of material requirements are not easily defined by a numerical value, the insulation shall be free of visual defect that will adversely affect its service and performance quality, such as, blisters, cracks, blowholes, tears, crumpled etc.

14.6.3 Failure to conform to the requirements of the ordered insulating material shall be grounds for rejection. In such case the manufacturer shall be given the right to reinspect the rejected material and replacing same after removal of the nonconforming portion(s). The means of reliably distinguishing and separating non-conforming from conforming materials shall be in accordance to clause 5 of this Standard.

14.7 Coordination Responsibility with Others

14.7.1 In case the product ordered should be processed or tested with the product of other manufacturer(s), the supplier shall coordinate with the participating manufacturer(s) and obtain all dimensional and technical information's allowing for any conditions that may be required.

14.7.2 The supplier shall be responsible for correct and timely communication with the participating manufacturer(s) and for any delay and/or cost claims arising from such communications.

14.7.3 Copies of all correspondence shall be furnished to the purchaser.

14.8 Languages

All correspondence, submittals, certification including testing procedures and edited specifications shall be furnished by the Manufacturer in English and/or Farsi language.

DATA SHEET

- GENERAL

PROJECT ..... LOCATION .....
ORDER No. ..... CUSTOMER ..... *FACTORY
*MANUFACTURER .....YEAR PRODUCED ……..
QUANTITY .....THICKNESS ……..
TYPE ..... SHAPE ……...SIZE.....

- SITE CONDITIONS

COOLING SEASON °C (°F) ..... DB ..... RH%
HEATING SEASON °C (°F) .....DB ……..RH%
LOCATION ..... …..INDOORS ……..OUTDOORS
ELEVATION M (FT) .....LATITUDE .....
ENVIRONMENT ..... DUSTY .....SALIFEROUS..... OTHERS

- SYSTEM MEDIA

++ b CHILLED WATER PIPES b HOT WATER PIPES b STEAM PIPES
++ b DOMESTIC b HOT WATER PIPES
b DUCTS • SUPPLY • RETURN • SOUND LINER
b PANELS • WALLS • FLOOR • PARTITION • CEILING
b EQUIPMENT b VESSELS b VALVES b FITTINGS
b FOAMED-IN PLACE b SITE INJECTION

- INSULATION DATA

* THERMAL CONDUCTIVITY..... kcal/mh °C (Btu/sqft°F)
(AT 25°C MEAN TEMP.)
* DENSITY ..... PERM .....

- INSULATION FORMS

(BLANKET) ..... RIGID .....SEMI -RIGID.....
PREMOULDED .....SECTIONAL ..... LOOSE/FILL .....
TYPE OF ACCESSORIES .....

- INSULATION RETARDER TYPES (VAPOR BARRIERS)

b STRUCTURAL BARRIERS (FLAT, CORRUGATED OR EMBOSSED)
• PLASTIC • ALUMINUM JACKET • GALV. JACKET
b MEMBRANE BARRIERS
• METAL LAMINATED FOILS • TREATED PAPER
• PLASTIC FILM • SHEETS • OTHER (SPECIFY)
b COATING OR SURFACE BARRIERS
• FLUID FORM • SEMI-FLUID FORM

-SPECIAL FEATURES .....
.....

***- SHIPPING DATA**

PACKING TYPE ..... EACH BULK CONTAINS .....
TOTAL SURFACE AREA ..... M^2 (ft^2)
SHIPPING..... WEIGHT (lbs)kg ..... VOLUME M^3 (ft^3)

*** To be supplied by the manufacturer**
++ To be allowed for nesting

Note:
The manufacturers shall furnish together with the data sheet the physical and thermal properties of insulation materials supplied.

APPENDICES

(The Appendices are not part of this Standard but are included for information purpose only)

APPENDIX A
THERMAL INSULATION APPLICATION

Proper selection of thermal insulation and vapor retarders must be based on thermal efficiency of the material, physical characteristics required by the location of the material, economic thickness, space available and compatibility of the material with adjacent components. Subject to design engineer's discretion and keeping the above factor in mind, the recommended type of insulation material with vapor barrier, in required thickness suitable for a specific application (subject to permitted temperature range which should be advised to the manufacturer), are as follows:

1) Fiberglass insulating material:

Various types of fiberglass material can be used for domestic hot water supply and return pipes, HVAC supply and return chilled/hot water pipes and supply and return air ducts. The fiberglass insulation can also be used as duct liners or as heat retarders for flue gas. All pipe insulations to be preformed. All valves, flanges and fittings to be insulated with preformed or mitered insulation of the same thickness as the pipes and secured with bands and joint sealer similar to those specified for straight piping.

2) Cellular glass insulating material:

Generally used for industrial application in a wide range of piping, vessel and equipment, covering virtually all standard pipes, valves ,fittings, and curved segments as well as leveled head and lag segments. Since they are chemically inert, unaffected by soil acids and strong enough for direct burial, these insulating materials when properly metal-jacketed are ideal for underground installations. For equipment and vessels, flat blocks, curved sidewall segments or leveled lags shall be used.

3) Synthetic vinyl rubber insulating material:

It can be used for refrigerant suction lines, including tanks, vessels and also on chiller outer shells used by original equipment manufacturers (OEM). Those used for copper pipes are in tubular sections which are slit by a sharp knife and those used for tanks, vessels or equipment are in blanket sheets requiring adhesive bonding. Where condensation is heavy or on sealed joints and buttends, the manufacturer recommends self-adhesive tapes. (It is not economical to use these insulating material on domestic hot water or chilled/hot water piping).

4) Cork insulating material:

It is most suited for refrigerated cold store chambers (outside wall, floor and ceiling), refrigerated doors, acoustical correction and expansion of joints. It can be used for lining purpose both as thermal and acoustic insulation. (It is not economical to use these insulating material on pipes, due to its initial price and elaborate installation requirements).

5) Polyurethane and polystyrene insulating material:

Its application is ideal for refrigerated cold store chambers and used as prefabricated rigid panels for its walls, floor and ceiling including expansion joints. For pipes or metal tanks, foamed-in-place site injection and metal jacketed is more economical and recommended. Pre-moulded pipe insulations are not economical due to its initial price and special requirements for installation.

(to be continued)

APPENDIX A (continued)

6) Calcium silicate insulating material:

The material meets high temperature application for prevention of stress-corrosion cracking. They come in forms of half-round, quarter round or segmented forms along with blocks and preformed elbows . It is mostly suited for use on industrial sites. It is recommended and preferred that the installed insulating material be strapped or wired for proper securing.

Notes:

1) It is strongly recommended that during installation individual manufacturers' instructions be followed.

2) For valves and fittings shaping and molding shall suit the end use. The shape, degree of flexibility and method of holding it in place and the sealing system are the major characteristics of an insulation system.

3) The ratio of work done in the factory to work at the jobsite is important for economics and may be second only to the thickness and K value of the insulating material itself.

4) To prevent shrinkage and expansion, it is strongly recommended that proper maintenance of the finished insulation thickness should be considered.

APPENDIX B

1. CLASS 'O'

- Class O is a term defined in Appendix A of Building Regulations, approved document B, which makes use of British Standard performance ratings to limit the surface spread of flame of a material or product (BS 476: Part 7) and the rate at which heat is released from it (BS 476: Part 6).

- Class O is not a classification identified in a British Standard test and is considered to be a higher class than Class 1.

- A Class O insulating material or the surface of a composite insulating product is one of the following:

a) Composed throughout of material which when tested in accordance with BS 476: Part 4 is rated noncombustible.

b) Composed throughout of material which when tested in accordance with BS 476: Part 11 gives a temperature rise on the specimen of less than 35°C, a temperature rise of the furnace of less than 25°C and a flaming time of less than 10 second.

c) A Class 1 material in accordance with BS 476: Part 7 which has a fire propagation index i of not more than 12 and a value of i_1 of not more than 6 when tested in accordance with BS 476: Part 6.

2. LIMITED COMBUSTIBILITY

Limited combustibility refers to insulation materials of less than 300 kg/m which satisfy (a) or (b) in the Class O definition.

APPENDIX C
GENERAL INFORMATION TO BE SUPPLIED BY THE PURCHASER

As recommended by BS 5422 section 1, the purchaser shall provide the following information in his inquiry, to enable the insulation requirements to be assessed by the contractor or supplier.

a) Type of insulating material required and the form in which the material is to be provide, and whether any portions are to be specially fabricated for ease of removal.

b) Type of finish required.

c) Dimensions of items to be insulated.

Note:

Unless dimensions are adequately detailed in drawings, information is required relating to surface dimensions of flat or large curved areas, external diameters and internal diameters (bores) of pipes, lengths of each size of pipe, numbers and shapes of bends, numbers and types of fittings (valves, flanges, tees, etc.) and space available for insulation especially at flanges and valves

d) Nature of surfaces that are to be insulated and an indication of surfaces for which care is needed and of any specific chemical requirement for the insulation and finish.

e) Location of plant, i.e. whether the plant to be insulated is indoors, outdoors but protected from the weather, outdoors exposed to the weather or carried in ventilated ducts or open trenches.

f) Temperature conditions, i.e. the normal operating temperature, the extreme temperature if other than the normal operating temperature, any fluctuating temperatures and the duration of extreme or fluctuating temperatures.

g) Surrounding atmospheric conditions, including special note of abnormally high or low temperatures, high humidity, flammable conditions, potentially corrosive atmospheres, etc.

h) Special service requirements: Any special service requirements additional to those given in the appropriate section shall be notified to the contractor.

Note:

The additional special requirements could include requirements for the following:

1) resistance to compression;

2) resistance to fire;

3) vibration conditions;

4) exposure to mechanical damage;

5) the presence of corrosive fluid;

6) resistance of surface to ingress of oils and flammable liquids.

i) Bases on which thickness is to be determined.

Note:

Some factors that may determine thickness are as follows:

a) economic thickness;

b) specified heat gain or loss per unit dimension or relative to the complete system;

c) specified temperature on the outer surface of the insulation or finish, e.g. for the protection of personnel (see BS 5970);

d) specified conditions of fluid at the point of delivery, taking into account the rate of flow;

e) special thickness requirements ;

f) maintenance of the temperature of a bulk of static fluid over a specific period;

g) prevention of freezing of the fluid in the system.