Insafoam Insulation (Malaysia) SDN. BHD.

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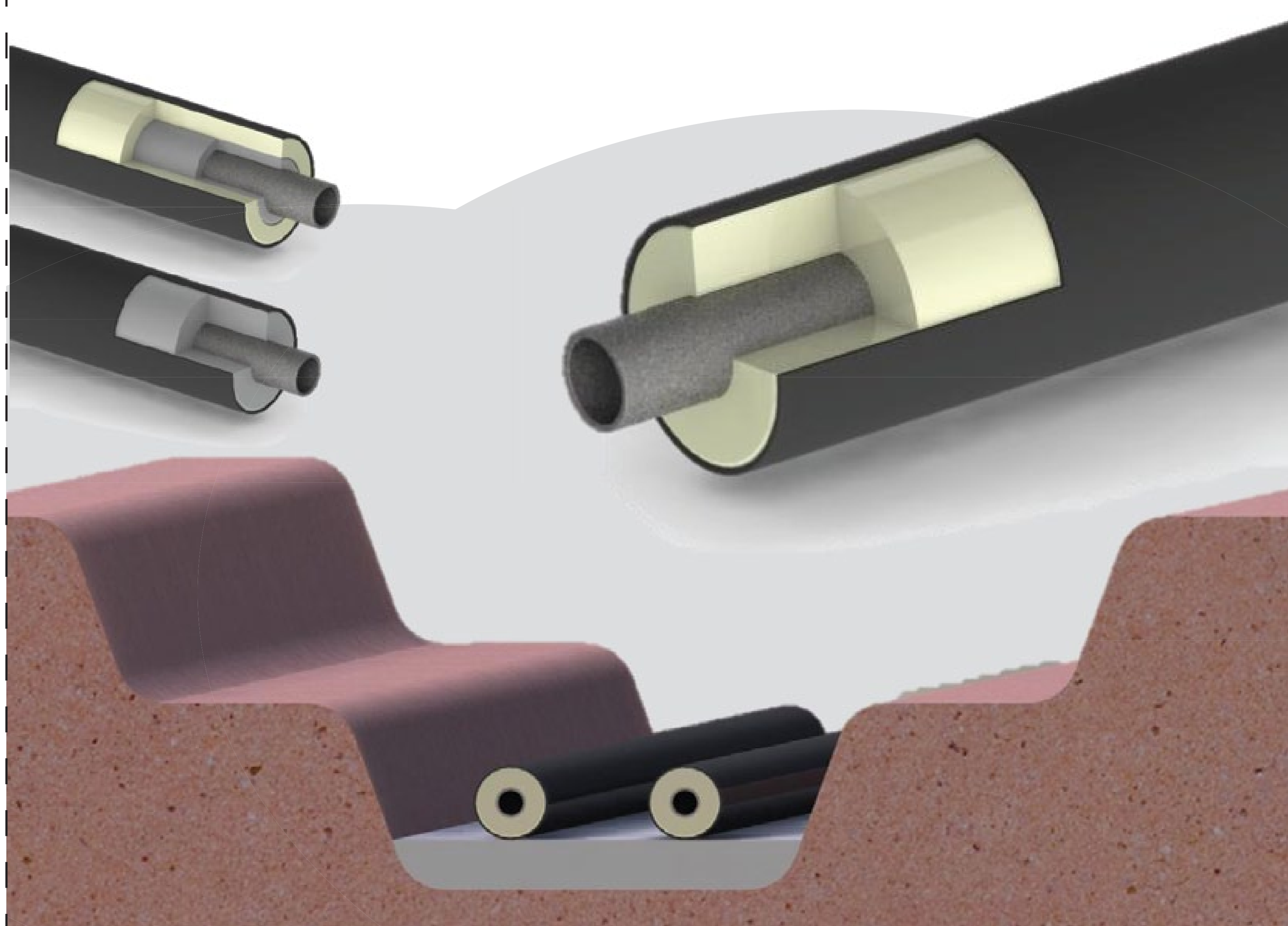
INSAFOAM

INSAPIPE Underground Catalogue



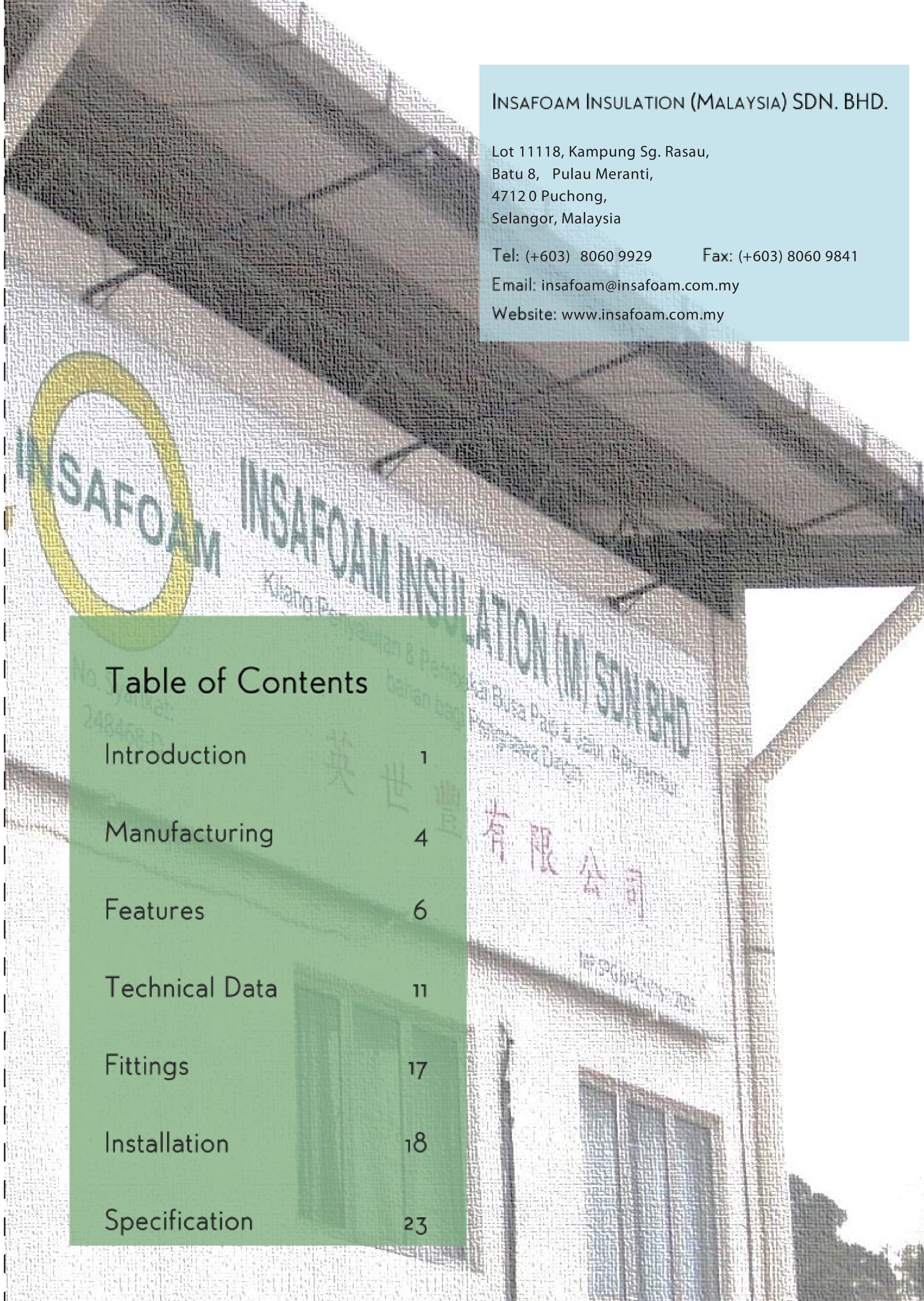


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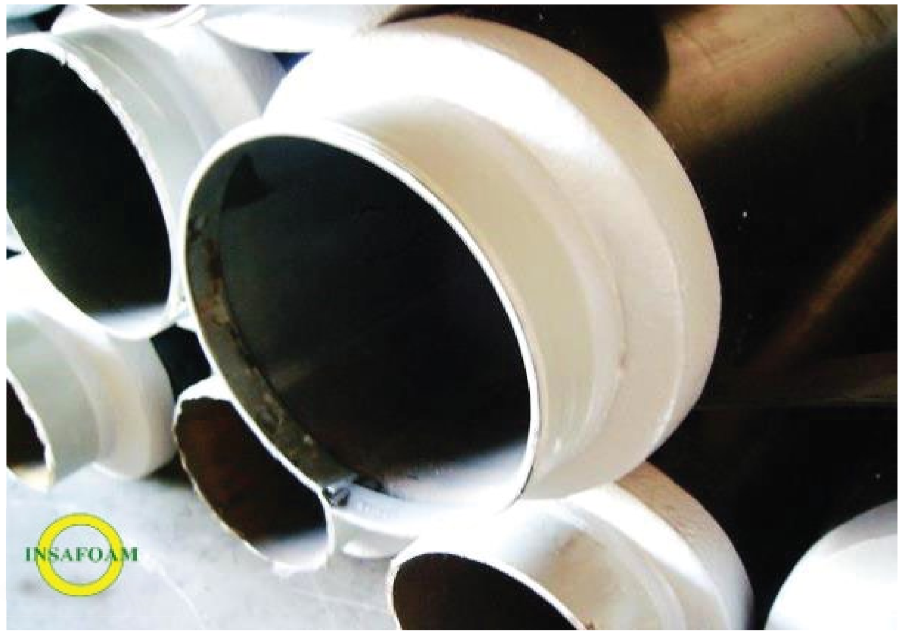
Table of Contents

INSAPIPE Underground

INSAPIPE Underground is a range of pre-insulated pipes specifically designed for transporting hot or cold fluids underground. INSAPIPE Underground is designed for direct burial into an unlined trench. INSAPIPE Underground consist of 3 main components; an internal steel pipe, the insulation layer and a HDPE jacket.

INSAPIPE Underground is available in a range of thickness to suit the different performance requirements for the application.



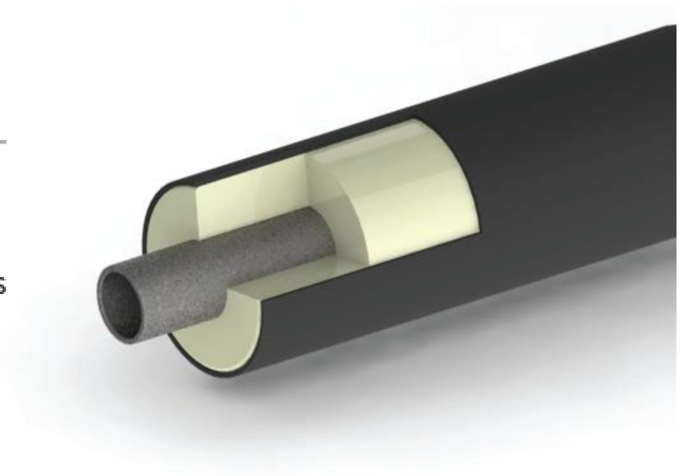
Trenches

Polyurethane foam is the main insulator of choice for INSAFOAM. However, because the maximum operating temperature of polyurethane is 130° C, polyurethane should not come into direct contact with a surface of temperature higher than 110° C. Therefore, calcium silicate is included for higher fluid temperatures. The variation of the composition of the insulating layer with different fluid temperatures is shown below.

Low Temperatures

(Between 0° C and 110° C)

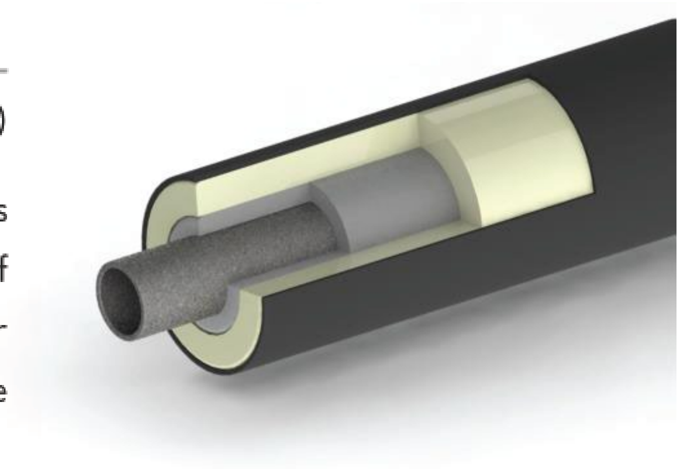
The insulation layer consists of only polyurethane.



Medium Temperatures

(Between 110° C and 500° C)

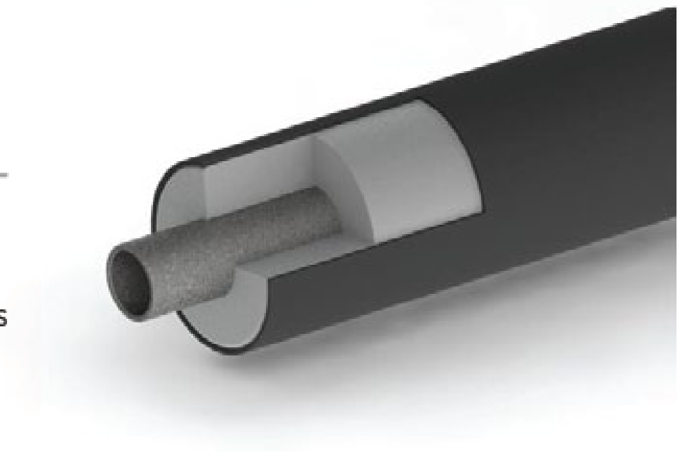
The insulation layer consists of a combination of polyurethane on the outer surface and calcium silicate on the inner.



High Temperatures

(500° C and above)

The insulation layer consists of only calcium silicate.

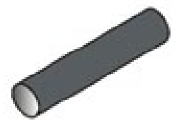


INSAPIPE Underground

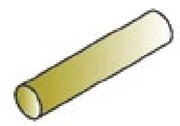
Manufacturing Method

INSAPIPE Injection System

The pipe and HDPE jacket are held in place using moulds and spacers. The chemical mixture of polyol, isocynate and blowing agent is then injected into the annular space between the pipe and the HDPE jacket. The chemical mixture reacts and expands. The moulds at both ends of the pipe and jackets hold the expanded foam in and the foam expands to fully occupy the space.



Raw Material



Blasting & Painting (Optional)

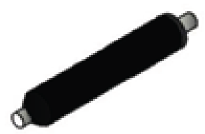
Produce HDPE Jacket

Position on Moulds

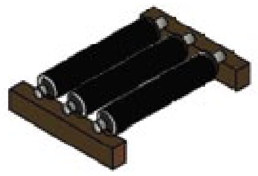
Inject PU Chemical Mixture

Cut off Excess PU

Apply Bitumen on Exposed Face



Packing & ID Label

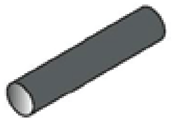


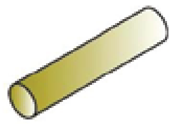
Ready For Dispatch

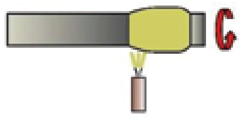
INSAPIPE Underground

INSAPIPE Spray System New Technology!

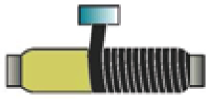
The liquid chemical mixture of polyol, isocynate and blowing agent is sprayed evenly onto the pipe surface using an airless, high pressure hydraulic gun. The liquid mixture on the pipe surface then reacts and foams up to the desired insulation thickness. HDPE is then extruded directly onto the polyurethane foam to form the protective jacket.

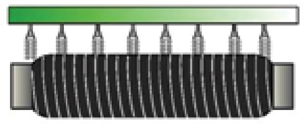

Raw Material


Blasting & Painting (Optional)

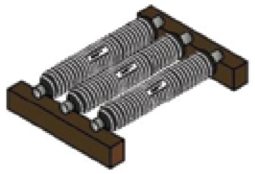

PU Spray Foam


Insulation Inspection


HDPE Jacketing


HDPE Jacket Quenching


Packing & ID Label


Ready For Dispatch

Features & Benefits

Zero Maintenance

The tight insulation provided by the polyurethane foam and the HDPE jacket ensures that the external face of the steel pipe is not exposed to the environment. This makes certain that corrosion experienced by the external face of the steel pipe is minimal.

Superior Thermal Performance

Polyurethane foam is the main insulator of choice for INSAPIPE Underground. Polyurethane is one of the best insulating material commonly used and a thermal conductivity as low as 0.021 W/m K can be achieved. This means that the specified thermal performance can be provided with a thinner insulation.

Insulator thickness required to achieve the same thermal resistance of 4 m K/W.

Insulator	Thermal Conductivity (W/m K)	Thickness (mm)
Polyurethane Foam	0.021	84
Expanded Polystyrene	0.032	128
Rock Wool	0.038	152
Glass Fibre	0.045	180
Calcium Silicate	0.060	240

Reduced Installation Time and Field Cost

INSAPIPE Underground pre-insulated pipes come ready for installation. This means that the only insulation that needs to be done on site is at the joints. Therefore, installation time can be significantly reduced. In addition, the insulating process is done in a factory-controlled environment, i.e. no damp insulations, no reliance on site skill, no reduction in quality due to site condition or remoteness and no weather delays.

Moisture Resistant

The structure of the polyurethane foam consists of more than 92% closed cells. This makes it resistant to penetration of other fluids. The polyurethane foam also attaches very tightly to the steel pipe, preventing water from seeping between the 2 materials. On top of that, the polyurethane layer is covered by a watertight HDPE jacket.

Environmentally Friendly

The polyurethane foam used by INSAFOAM is CFC-free and non-fibrous. In addition, the gassing agent used to produce the foam has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

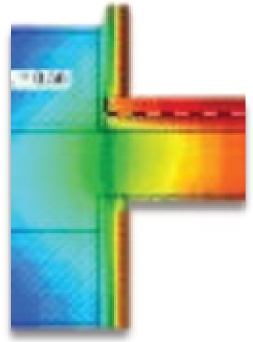
Fire Resistant

INSAPIPE Underground has a 2 hour fire rating to enhance safety and is compliant to Class 'O' fire rating.

UV and Chemical Resistant Jacket

INSAPIPE Underground comes with HDPE jackets as standard. The HDPE used contains UV retardant additives that make it resistant to UV rays. The HDPE jacket is also resistant to most chemicals and salts.

No Heat Bridges



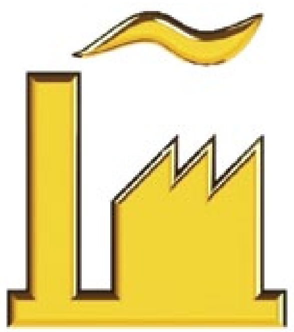
Heat bridges occur when the insulating layer of the pipe is interrupted by another material of lower heat resistance. This increases the heat gained by the fluid in the pipe by decreasing the overall heat resistance of the insulation. Condensation is also more likely to occur at the position of heat bridges because of the higher amount of heat conducted, leading to lower surface temperatures at those positions.

INSAPIPE Underground pre-insulated pipes avoid heat bridges by being supported outside the jacket. Therefore, there is no penetration through the insulator, avoiding the issues stated above.

High Mechanical Strength

The HDPE jacket used is impact resistant. Also, the combined mechanical strength of polyurethane and the HDPE jacket is fairly significant and this makes pre-insulated pipe systems resistant to physical effects.

New Improved Manufacturing Method*



Traditionally, pre-insulated pipes are manufactured by injecting polyurethane foam in between a jacket and pipe held in place by moulds and spacers. Due to the uncured polyurethane being injected from one end and the effects of gravity, the polyurethane foam produced have different densities and therefore, different characteristics. By spraying polyurethane foam onto pipe, we ensure that density and hence, the thermal and mechanical properties remain consistent.

Injected Foam	Spray Foam New Technology!
May have voids	No insulation voids
Not fully concentric	Fully concentric
Jacket may not be fully bonded	Jacket fully bonded
Inconsistent density	Consistent density
Inconsistent compressive strength	Consistent compressive strength
Inconsistent thermal conductivity	Consistent thermal conductivity
Predetermined increments	Precise thickness
Difficult inspection leading to lower quality	Easy inspection leading to higher quality
Can be used for pipes diameters less than 400 mm	Pipe diameter must be more than 400 mm
Can be used for complicated fittings	Can only be used on straight pipes

* Only available for pipes with outer diameters of 400 mm and above.

Insulated pipes manufactured from the spray method are provided with end seals. This prevents water penetration into the foam during raining season and avoids water absorption in case of a leak.

Technical Data

Insulator Properties

The insulator used is polyurethane foam and is available in multiple densities. The density controls the strength of polyurethane foam, its thermal properties and the percentage of closed cells in the foam. Within the range of densities offered, there is an inverse relationship between the mechanical strength of the polyurethane foam and its thermal conductivity.

Polyurethane foam is made by combining polyol and isocyanate with a blowing agent. The foam generated is homogeneous. The process used to produce the insulator is CFC-free

Density (kg/m³)	45	50	60
Compressive Strength (kPa)			
Parallel	230	290	470
Perpendicular	210	260	430
Shear Strength (kPa)	252	275	380
Thermal Conductivity (W/m K)	0.021	0.021	0.022
Closed Cell (%)	91%	93%	96%

INSAPIPE Underground

Calculations

Maximum Heat Transfer

A conservative estimate for the heat transfer to the fluid in the pipe can be made by ignoring several negligible resistances to heat transfer. These include the thermal contact resistance between the layers, thermal resistance from convection in the pipe and thermal resistance from the pipe. This simplifies the calculation and the formula to calculate the maximum heat transfer is shown below.

$$Q' = \frac{(T_{atmosphere} - T_{fluid})}{R + R_{soil}}$$

where[†],

Q' = Heat transfer per unit length
$T_{atmosphere}$ = Atmospheric temperature
T_{fluid} = Temperature of the fluid in the pipe
R = Insulator thermal resistance per unit length
R_{soil} = Soil thermal resistance per unit length

Thermal Resistance of Insulation

The heat transfer across the insulating layer is determined by the temperature difference across the layer and the thermal resistance provided by the insulating layer. The thermal resistance of an insulating layer acts as a measure independent of the operating conditions. This can be calculated using the equation below.

$$R = \frac{\ln\left(\frac{D_{Jacket}}{OD}\right)}{2\pi k}$$

where[†],

R = Insulator thermal resistance per unit length
k = Thermal conductivity of insulator
D_{Jacket} = Diameter of the HDPE jacket
OD = Outer diameter of pipe

INSAPIPE Underground

Thermal Resistance of Surrounding Soil

The soil surrounding the underground pipe can also provide significant resistance to heat flow in and out of the pipe. A widely used method for estimating the heat resistance provided by the soil is by making use of a shape conduction factor that simplifies the problem into a 1-D problem.

$$S = \frac{2\pi}{\cosh^{-1}\left(\frac{2z}{D_{Jacket}}\right)}$$

where†,

S = Shape conduction factor
z = Depth of the buried pipe
D_{Jacket} = Diameter of the HDPE jacket

The thermal resistance of the soil is then given by the equation below.

$$R_{soil} = \frac{1}{Sk_{soil}}$$

where†,

R_{soil} = Soil thermal resistance per unit length
S = Shape conduction factor
k_{soil} = Average thermal conductivity of soil

Maximum Temperature after L m

The maximum temperature can be estimated by assuming the temperature change of the fluid inside the pipe is small. This is given by the equation below.

$$T_{max} = \frac{Q' \times L}{\dot{m}C} + T_{fluid}$$

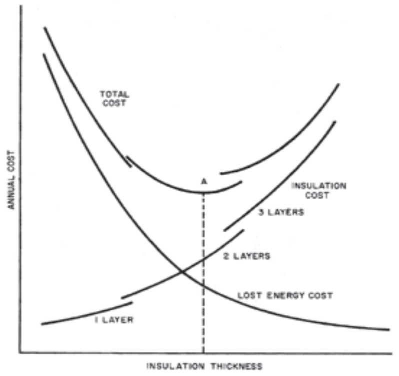
where†,

Q' = Heat transfer per length
L = Pipe length
T_{fluid} = Initial temperature of the fluid in the pipe
$\dot{m}$ = Mass flow rate
C = Specific Heat

† All variables are in S.I. units unless stated otherwise

Product Classes

– Specifying Insulation Thickness

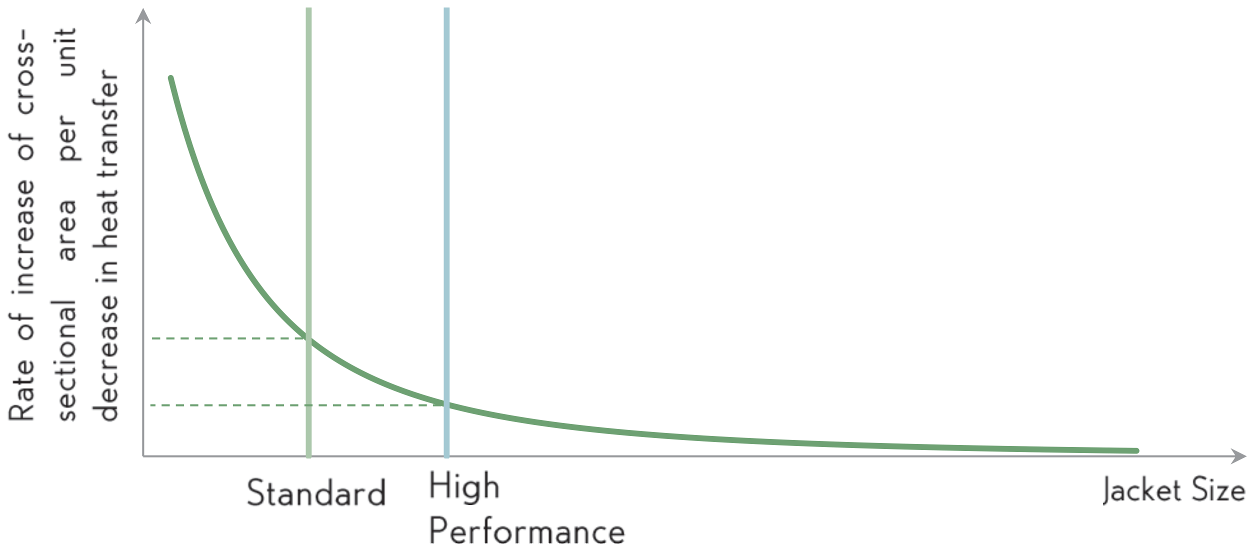


As the insulation thickness increase, the energy lost from heat gained from the surrounding decreases but at a decreasing rate. The insulation cost, however, increases with an increasing rate as the insulation thickness increases.

There is an optimum insulation thickness that minimises the total cost of the system. This optimal thickness differs for each application and pipe size.

INSAFOAM looks to cater to as many applications as possible and we do this through our product classes. 2 product classes are available (standard and high-performance) and the classes correspond to a selected jacket size for each pipe size.

The graph below acts as a guide to accommodate the trade-off between the increasing rate of the cost of insulation and decreasing effect of increasing the insulation when selecting the jacket sizes. As the jacket size increases for the same pipe size, the ratio of the rate of increase in cross-sectional area and the rate of decrease in heat transfer decreases. Selection of the appropriate ration depends on the budgetary and performance requirements.



Standard

Pipe Detail			Jacket Size	Thermal Resistance	Insulation Thickness	Weight	
Standard	NB	OD	D_{Jacket}	R		w/o water	w water
	(mm)	(mm)	(mm)	(m K/W)	(mm)	(kg/m)	(kg/m)
BS 1387 C	50	60.3	140	6.491	40.85	8.19	10.15
BS 1387 C	80	88.9	160	5.262	44.55	12.57	17.60
BS 1387 C	100	114.3	200	4.24	42.85	17.69	25.54
BS 1387 C	125	141.3	225	3.626	43.35	21.72	34.00
BS 1387 C	150	168.3	250	2.999	40.85	25.59	43.27
JIS G3452 Std	200	219.1	315	2.871	47.95	36.29	67.71
JIS G3452 Std	250	273.1	355	2.523	40.95	50.23	99.33
JIS G3452 Std	300	323.9	424	2.165	50	64.13	134.82
JIS G3452 Std	350	355.6	456	1.918	50	79.25	175.47
API 5L 7.9mm	400	406.4	507	1.691	50	90.53	216.21
API 5L 7.9mm	450	457.2	558	1.524	50	101.81	260.87
API 5L 7.9mm	500	508	608	1.387	50	113.09	309.46
API 5L 7.9mm	550	558.8	659	1.261	50	126.85	364.46
API 5L 7.9mm	600	609.6	710	1.166	50	138.38	421.16
API 5L 9.5mm	650	660.4	761	1.085	50	175.06	506.93
API 5L 9.5mm	700	711.2	812	1.005	50	188.62	573.51
API 5L 9.5mm	750	762	863	0.943	50	202.18	644.03
API 5L 9.5mm	800	812.8	913	0.889	50	222.45	725.17
API 5L 9.5mm	850	863.6	964	0.841	50	236.40	803.92
API 5L 9.5mm	900	914.4	1015	0.799	50	250.19	886.45
API 5L 9.5mm	950	965.2	1117	1.107	75	269.65	978.56
API 5L 12.7mm	1000	1016	1168	1.057	75	362.25	1,147.75
API 5L 12.7mm	1050	1066.8	1219	1.011	75	380.46	1,246.47
API 5L 12.7mm	1100	1117.6	1270	0.969	75	398.67	1,349.12
API 5L 12.7mm	1150	1168.4	1321	0.93	75	416.55	1,455.37
API 5L 12.7mm	1200	1219.2	1372	0.895	75	434.78	1,565.90

Exposed Area

INSAPIPE Underground

Fittings

In addition to straight length units, INSAPIPE Underground comes with the following fittings. They are all available pre-insulated and ready to be installed on site.

L Bends

Straight Tees

Reducers

MiniBends

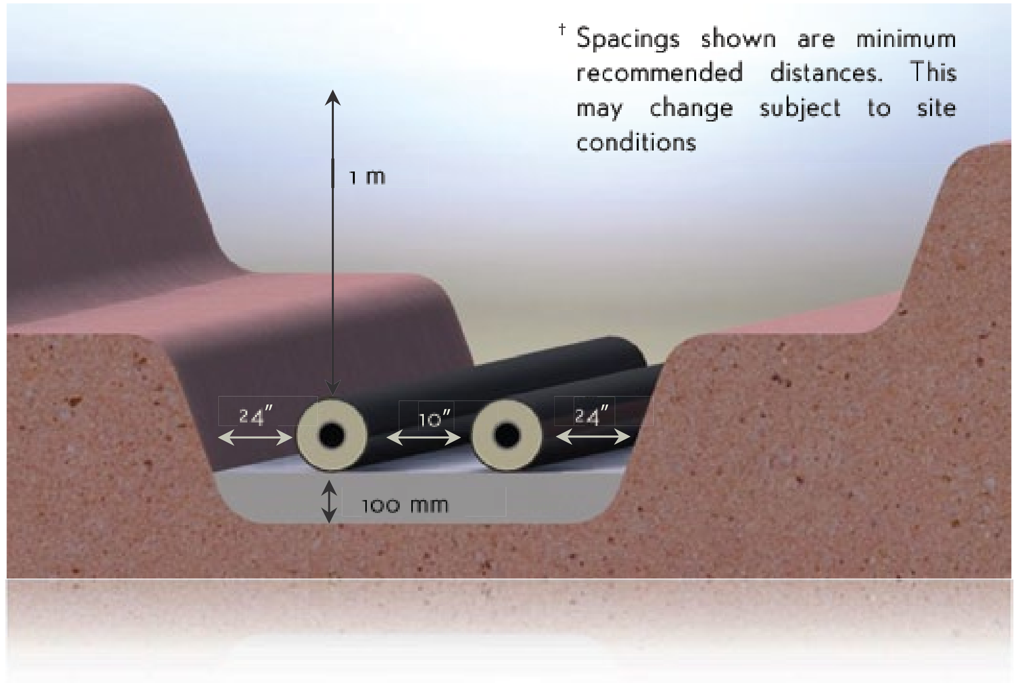
INSAPIPE Underground

Installation

To install INSAPIPE Underground, a trench needs to be excavated, pipes need to be cut to size and joined and finally, the joints need to be insulated. Some points regarding installation are shown here to provide an idea of how INSAPIPE Underground will be installed. A detailed manual for installing INSAPIPE Underground is available in the appendix.

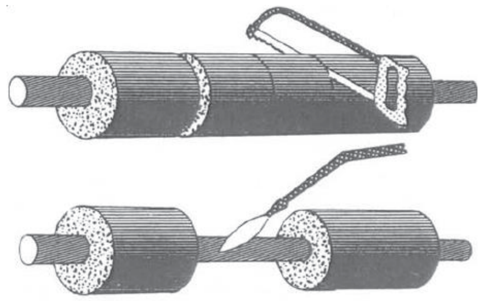
Excavation

The minimum recommended trench width is the sum of all insulation jacket diameters, plus 10" between pipes and 24" between pipe and walls. The depth should allow for 100 mm bedding, the largest pipe diameter and a minimum of 1 m cover above the largest insulation jacket.



Cutting

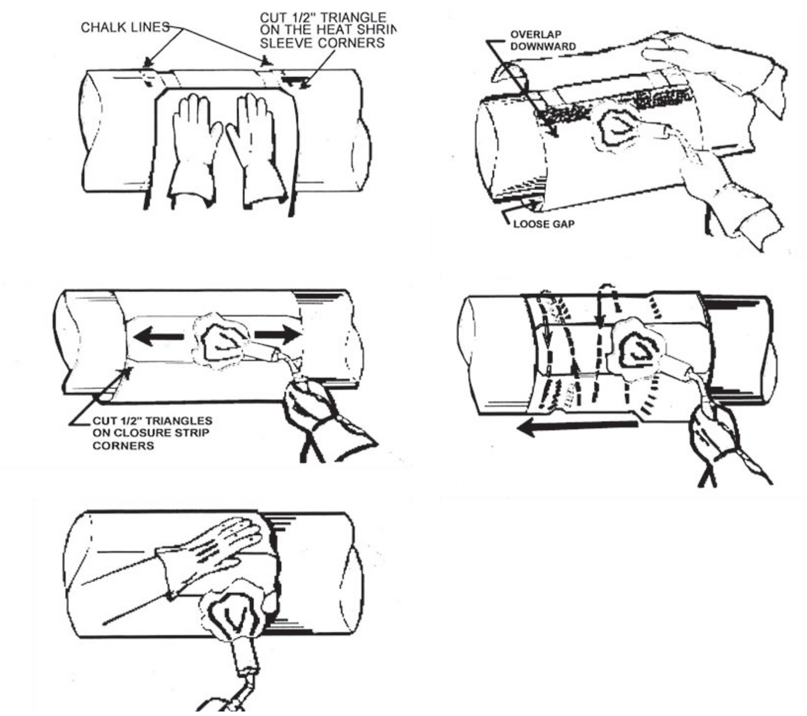
Piping units may need to be cut to field dimensions. A knife, hand saw, or power saw can be used to cut the insulation jacket and insulation. After the insulation has been removed, the service pipe can then be cut and the end preparation restored.



Joining

After the pipes are joined, a layer of polyurethane foam is required for insulation. This is done by wrapping the pre-rolled metal mould around the field joint area and pouring the chemicals to form the polyurethane foam into it.

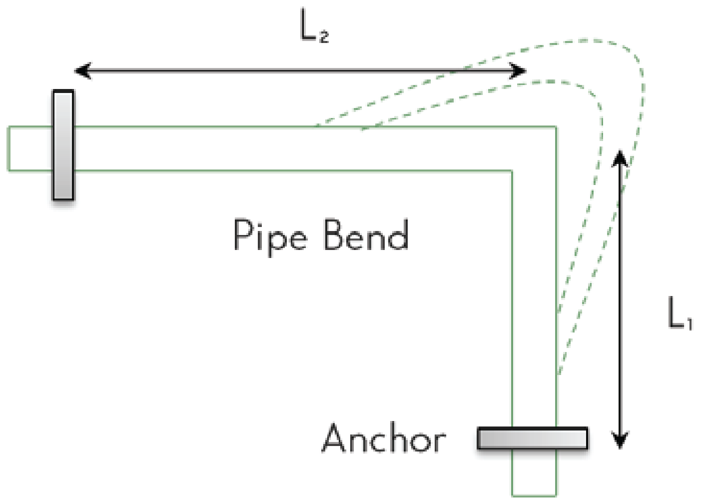
A heat shrink jacket is then used to seal the newly formed polyurethane foam to keep water and moisture from the foam and pipe. The procedures are illustrated below.

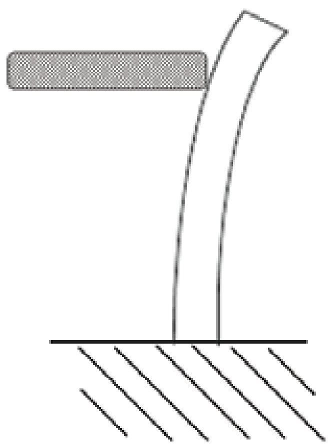


Exposed Areas

Allowing for thermal expansion and contraction

When designing the general layout of insulated pipes, it is important to take into account the stresses caused by thermal effects on the pipe.





The stress experienced in a pipe bend due to thermal expansion or contraction can be estimated by first assuming one side of the bend has expanded and treat the other side as a cantilever whose movement is guided by the expanded pipe.

$$\sigma = \frac{1.5 \times \Delta L_2 \times E \times d_o}{{L_1}^2}, \qquad \Delta L_2 = L_2 \times \propto \times \Delta T$$

where,

σ = Stress in pipe due to thermal effects
E = Young's Modulus
d_o = Outer diameter of pipe
α = Thermal expansion coefficient of pipe
L_1 = Shorter distance to pipe bend from an anchor
L_2 = Longer distance to pipe bend from an anchor
ΔL_2 = Thermal expansion to be absorbed
ΔT = Temperature change of pipe

If the stresses are found to be higher than the yield stress and a change of layout is difficult, an expansion joint or a pipe loop can be used to accommodate the thermal expansion.

Specification - Underground

GENERAL

All piping systems for service reaching a temperature range of -20 to 110°C installed underground as shown on plans shall be a Insapipe Underground preinsulated and prefabricated piping system with all necessary fittings, expansion loops and accessories, etc., as specified.

The preinsulated pipe manufacturer shall be with ISO certification and SIRIM product certification. The manufacturer of pre-insulated pipe must have at least 10 year experience.

SERVICE PIPE

The service pipe shall be in either of the following standard:

1. Steel Pipe in BS 1387 / EN10255 in Medium or Heavy Grade.
2. Carbon Steel Pipe in JIS G3452.
3. Carbon Steel Pipe in API 5L Gr B / ASTM A53 Gr B (ERW / LSAW / SSAW).
4. Carbon Steel Pipe in ASTM A106 (Seamless).
5. HDPE (High Density Polyethylene) Pipe in MS 1058 / ISO 4427 / DIN8074

Surface Threatment

All chilled water service pipe and fittings shall be grit blasted to SA 2.5 by automatic blasting and painted to 200 micron polyamide or polyamine epoxy paint.

JACKET

The outer protective jacket shall impact resistant heavy duty type, High Density Polyethylene (HDPE). The minimum wall thickness for the HDPE Jacket shall be as noted below.

Pipe Size	Min HDPE Jacket Thickness
1200mm	6.4mm
1050mm	6.4mm
900mm	5.7mm
750mm	5.7mm
600mm	5.1mm
500mm	5.1mm
450mm	4.0mm
400mm	4.0mm
350mm	4.0mm
300mm	4.0mm
250mm	4.0mm
200mm	4.0mm
150mm	3.5mm

INSULATION

1. Polyurethane foam shall be environmental friendly. The polyurethane foam shall be applied by spraying the foam directly onto the pipe and extruding the jacket directly on top of the foam.
2. The polyurethane for pipe sizes 12" and above shall be spray applied directly onto the service pipe. The polyurethane insulation shall be visually inspected for void prior to application of HDPE jacket.
3. The polyurethane for pipe sizes below 12" may be injected into the annular space between the service pipe and insulation jacket.
4. The service pipe insulation shall be rigid, closed cell polyurethane with the minimum following properties:

Physical properties of polyurethane foam shall be as follows:

- Density: Minimum : 56 kg/m3
- Thermal Conductivity : Max 0.024 W/moK at 24oC mean
- Compressive Strength : Min 300 kPa
- Closed Cell Content : Min 90%

5. The minimum insulation thickness shall be the following:

Pipe Size	Minimum Insulation Thickness
≤900 mm	50mm
› 900mm	75mm

End Seal

All straight pipe length shall have a water tight end seal on each end. The end seal shall provide a water tight seal between the service pipe and insulation jacket.

FITTINGS

Preinsulated elbows, reducers and tees shall be furnished and installed where shown on plans and shall consist of pipe, insulation and jacket conforming to the same specifications as specified for straight runs.

FIELD JOINT INSULATION

Field Joints shall be insulated with two part liquid polyurethane foam, protected by a galvanized jacket and cover with heat shrink sleeve. The manufacturer shall supply the field joint kit which inclusive of two part liquid polyurethane chemical and heat shrink sleeve.

The field foaming will be performed by the installing contractor under the instruction of a certified manufacturer's field service technician. To ensure proper and complete expansion of the two part polyurethane foam mix, the installer shall be trained by the manufacturer.

Project Locations

01. Singapore
02. Philippines
03. Vietnam
04. Myanmar
05. China
06. Cambodia
07. Bangladesh
08. Doha – Qatar
09. Pakistan
10. Bahrain
11. Thailand
12. UAE
13. Hongkong
14. Brunei
15. India
16. Saudi
17. Papau New Guinea
18. Indonesia
19. Maurities

Remark

Remark