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EPS POLYSTYRENE MANUAL

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A: INTRODUCTION

EPS (expanded polystyrene) is a closed cell, resilient, lightweight rigid cellular plastics material produced in a range of densities between 10 kg/m3 and 35 kg/m3.

The main applications for products manufactured from EPS are thermal insulation systems (wall, roof and sub-floor), ceiling panels and other decorative surfaces, concrete voids and block outs, pipe insulation, protective packaging, floatation and buoyancy applications, and stage sets.

Manufacturing process

Pre expansion

Expanded polystyrene is supplied as plastic beads in which an expanding agent, usually pentane, has been dissolved. In the presence of steam the thermoplastic polystyrene softens and the increasing vapour pressure of the expanding agent causes the beads to expand up to 50 times their original volume. During this stage the degree of expansion is controlled to achieve the desired density. Expanded polystyrene does not contain any ozone depleting substance and none is used in its manufacture.

Conditioning

From the pre-expander the beads are gently transported to large hoppers for ageing. The time of ageing is set to cool and stabilise the beads and allow for infusion of air to replace the expanding agent in the cells.

Moulding

After conditioning, the beads are charged into a closed mould where they are further expanded and fused together by steam heating.

Finishing

The freshly moulded blocks of EPS are passed through temperature controlled ovens to remove moisture and the final traces of the expanding agent, and to provide blocks of constant dimensional stability.

B: PRODUCT DATA

EPS CHARACTERISTICS

Dimensions: Standard size is 2400mm x 1200mm, 3600mm x 1200mm
Other dimensions available on request

Thicknesses: Standard thicknesses are: 10mm, 15mm, 20mm, 25mm, 30mm, 40mm, 50mm, 75mm, 100mm, 150mm, 200mm, 250mm, and 300mm
Other thicknesses available on request

Type of Edge: Straight Edge

Colour: White

Surface: Smooth face

PROPERTIES

The physical properties are primarily determined by the moulded density for well made oven cured EPS. (See Fig. 1 to 4).
However, these properties will be affected by raw material and manufacturing variations, and for this reason Australian Standard 1366-3-1992 specifies the classes in terms of performance properties rather than density.
The standard lists Nominal Density for each class (See Table 2), but these densities should be regarded as a guide only as the physical properties shown in Table 1 may be achieved by EPS of other densities.

Table 1: Physical properties of EPS, according to AS 1366, Part 3-1992

		Class						
Physical property	Unit	L	SL	S	M	H	VH	Test method
Compressive stress at 10% deformation (min.)	kPa	50	70	85	105	135	165	AS 2498.3
Cross-breaking strength (min.)	kPa	95	135	165	200	260	320	AS 2498.4
Rate of water vapour transmission (max.) measured parallel to rise at 23ºC	µg/m².s	710	630	580	520	460	400	AS 2498.5
Dimensional stability of length, width, thickness (max.) at 70ºC, dry condition 7 days	percent	1	1	1	1	1	1	AS 2498.6
Thermal resistance (min.) at a mean temperature of 23ºC (50mm sample)	m².K/W	1	1.13	1.17	1.20	1.25	1.28	AS/NZS 4859.1
Flame propagation characteristics: - median flame duration (max.) - eight value (max.) - median volume retained - eight value (min.)	 SD SD percent percent	 2 3 15 12	 2 3 18 15	 2 3 22 19	 2 3 30 27	 2 3 40 37	 2 3 50 47	AS 2122.1
1 W/m.K=6.93 Btu in/ft².h.ºF								

Table 2: Nominal Density, kg/m3

Class					
L	SL	S	M	H	VH
11	13.5	16	19	24	28

Mechanical properties

The density dependency of the main physical properties of EPS can be seen in (Fig.1 to 4): Compressive strength, Cross Breaking strength (flexural strength) Tensile strength and shear strength.

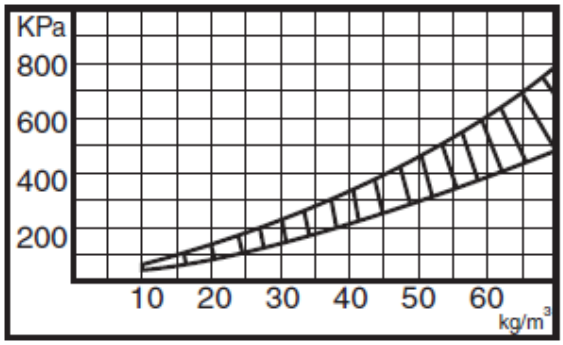

Fig. 1: Stress at 10% deformation v density

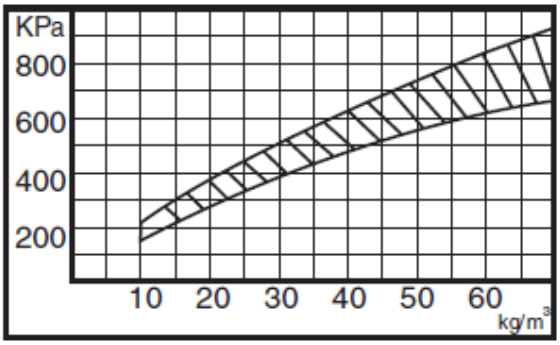

Fig. 3: Tensile strength v density

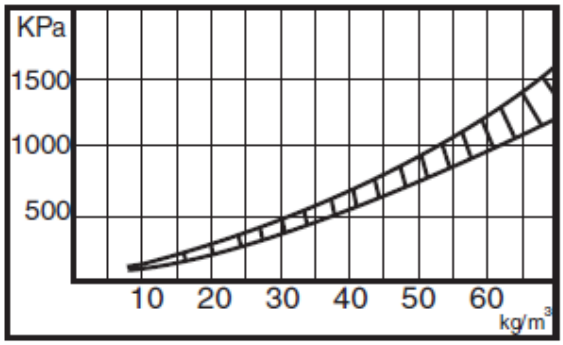

Fig. 2: Cross-breaking strength v density

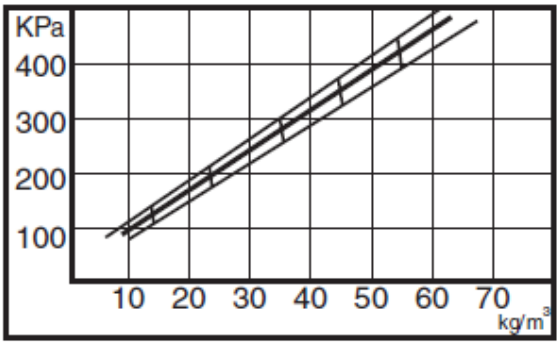

Fig. 4: Shear strength v density at 23°C

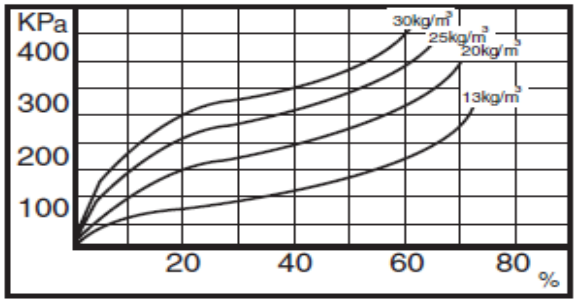

Fig. 5: Stress v compressive strain

Compressive creep

It is common to report only the compressive stress at 10% deformation but the latter is often taken from complete stress-strain curves as shown in (Fig.5). Although it appears to deform elastically over a range of comprehensive loads, EPS that has been stressed will, with the release of all stress, retain some permanent deformation.
(Fig.1 to 5) can be useful for short term loads where some deformation is acceptable. For long term loads (Fig.6), showing compressive creep under constant loads versus time, should be used. It should be noted that compressive Strength in AS 1366.3 is a performance characteristic at 10% deformation and should not be taken as a universal design loading recommendation.

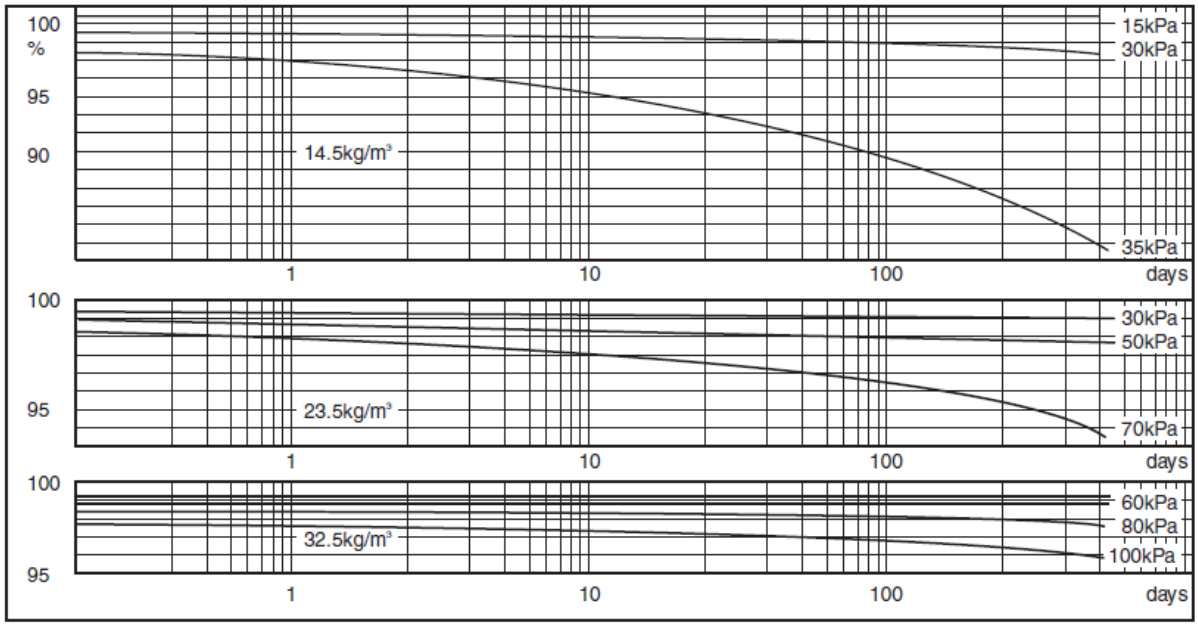

Fig. 6: Compressive creep: stress strain curves for extended periods of time

Floatation properties

The density of EPS is low compared with water, with a nominal density range from 10 to 25 kg/m3 compared with water at 1000 kg/m3. The water buoyancy per cubic metre of EPS is determined by subtracting its kg/m3 density from 1000. The result is the weight in kilograms which a cubic metre of EPS can support when fully submerged in water.

Thermal properties

The low thermal conductivity (K value) of EPS characterises its exceptional insulating properties. (See Fig.7).
As (Fig.8) shows, EPS has a remarkably high R value compared with most other insulating material used in similar applications. EPS gains its thermal resistance from the stabilised air trapped within its cellular structure; it contains no fluorocarbon blowing agent that might cause depletion of ozone in the upper atmosphere.

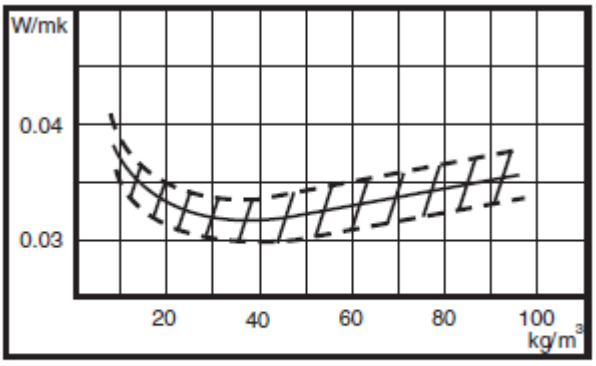

Fig. 7: Thermal conductivity at 10ºC v density

Design thermal properties

As Australian Standard 1366 Part 3 is a minimum conformance standard, the thermal resistances quoted will be achieved, as a minimum, in 97.5% of cases in a statistical sample, when tested at a mean sample temperature of 23ºC.
Thermal resistance varies with mean insulation temperature, where mean insulation temperature is the average of the temperature on either side of the insulation.
For design purposes the average thermal resistance is a better guide than the minimum thermal resistance.
A full listing of design thermal conductivity values for each class of EPS at differing mean temperatures is shown on Table 8.

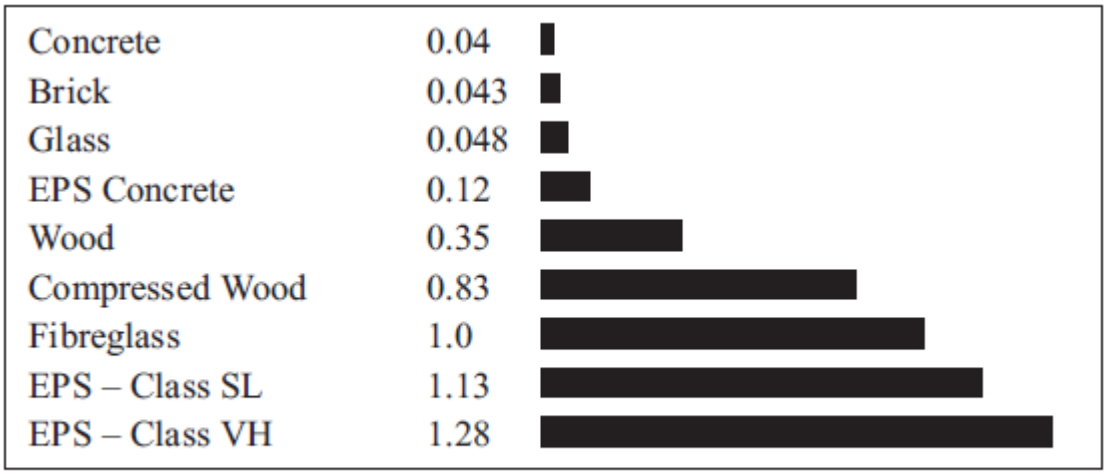

Fig. 8: Typical R Values, various insulating materials 50mm thick

Low temperature operation

EPS does not become brittle at sub-zero temperatures. The testing of specimens at –75ºC for 48 hours demonstrates no loss of impact resistance compared with specimens tested at +23ºC. It is able to withstand temperature cycling and thereby assure long term performance without the loss of structural integrity of physical properties; core specimens taken from 20 year old freezer rooms show no deterioration. Unlike some other insulating materials, the K value of EPS decreases at lower average mean temperatures (See Fig.9).

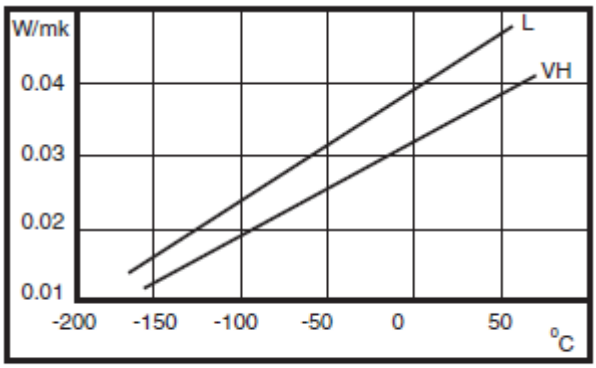

Fig. 9: Indicative thermal conductivity v temperature

High temperature operation

The effect of elevated temperatures on the mechanical properties is an accelerating decline in the values shown in (Fig.1 to 5) until at approximately 85ºC the so-called zero strength is reached. (See Fig.10). EPS should not be continuously exposed to temperatures in excess of 80ºC as expansion and blistering may occur

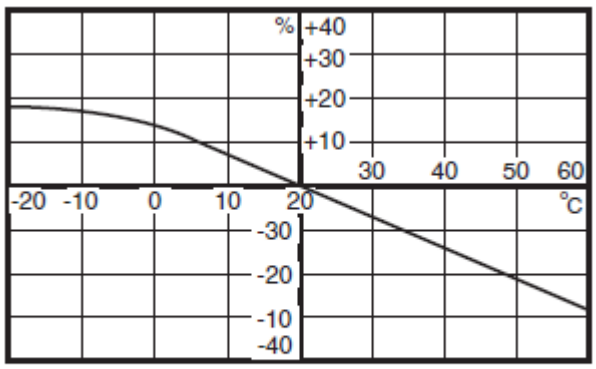

Fig. 10: Change in stress at 10% deformation, relative to K value at 20ºC, v temperature

Effect of moisture on K value

The dimensional stability and mechanical properties of EPS are not affected by water but because absorbed water will increase the K value, as with all insulating materials, care should be taken in designing insulated structures to take account of water and water vapour that may be present.

While Table 3 shows that certain amounts of water are absorbed by EPS under various conditions, Table 4 demonstrates that the loss of R values in EPS as a result of this moisture absorption is minimal. Overseas research has so revealed that the decay in thermal resistance caused by moisture is considerably less for EPS than for either extruded polystyrene foam or cellular glass. (See Fig.11).

As with other building materials care should always be taken to keep EPS dry before and during installation.

Table 3: Moisture gain of EPS by liquid water absorption

Time Period	Test Condition	% by volume
1 day	ASTM C-272	2.5
7 days	Submersion	3.0
7 days	10 metre submersion	3.0
90 days	Submersion	6.0
550 days	Submersion	7.8
1000 days	Burial in wetted soil	1.7

Table 4: Typical thermal performance by EPS thickness after vapour induced moisture gain.

Moisture Gain (% by volume at 25mm)	R value retention%			
	25mm	50mm	75mm	100mm
2	96	98	99	99
4	92	96	97	98
6	89	94	96	97
8	86	92	95	96
10	84	90	93	95
12	82	89	92	94
14	80	88	91	93

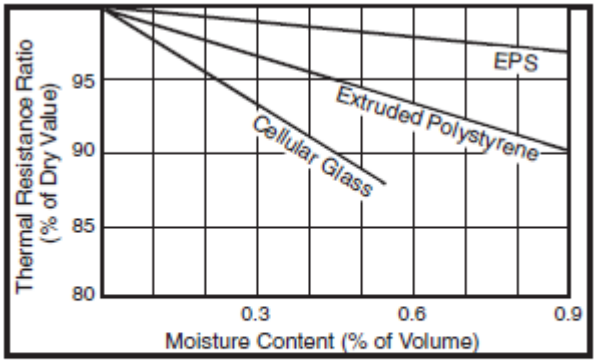

Fig. 11: Thermal resistance v's moisture content curves for EPS, extruded polystyrene and cellular glass

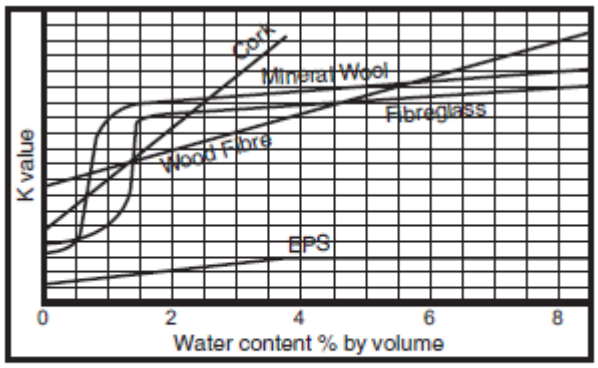

Fig. 12: The effect of moisture on K values, various insulating materials

Water vapour transmission properties

Although EPS has a low water vapour transmission rate it is not considered a vapour barrier. This breathability characteristic reduces any tendency towards the formation of vapour dams. As (Fig.12) shows, of all the material used for insulation purposes, EPS is one of the most resistant to the adverse affects of moisture. In applications where the high humidity and high temperature differentials are likely a vapour barrier should be installed. Normally the vapour barrier should be installed on the warm side of the structure with the insulation as near as possible to the cold side.

Acoustic properties

Because EPS has a closed cell structure, it offers only a limited absorption of airborne sound. Structure borne sounds, transmitted through such structures as walls and pipes, may be effectively isolated by the use of floating floor systems. For this type of sound insulation, EPS with the required dynamic stiffness can be obtained by compressing the sheets by 50 to 60 percent and then allowing them to recover to 80 to 90 per cent of their original thickness.

Chemical properties

EPS is resistant to virtually all aqueous media including dilute acid and alkalis. In addition, it is resistant to water-miscible alcohols such as methanol, ethanol and i-propanol, and also to silicon oils. EPS has limited resistance to paraffin oil, vegetable oils, diesel fuel and Vaseline. These substances may attack the surface of EPS after long term contact. EPS is not resistant to hydrocarbons, chlorinated hydrocarbons, ketones and esters.
Paint containing thinners and solutions of synthetic adhesives naturally fall in to the same category, and this should be taken into account in any painting or bonding operation.
Anhydrous acids such as glacial acetic acid or fuming sulphuric acid destroy EPS
Prolonged exposure to UV light causes yellowing and embrittlement of EPS, which should therefore be protected from direct outdoor exposure.

When using EPS for form work applications, sometimes it is necessary to use a product to disintegrate the EPS to leave the void. Using a natural based product is suitable on building sites as it is compliant to the work safe and union requirements. Our recommendation is using a product called “D-Limonene”. It is available in 20 Litre Drums. Contact us to order this product.

Resistance to fungi and bacteria

Fungus attack has not been observed on EPS, and it does not support bacterial growth. Surface spoilage (in the form of spilt soft drink, sugar, etc) can however supply the nutrient for fungal or bacterial growth.

Resistance to ants, termites, rodents and marine borers

Since it has no food value, EPS does not attract ants, termites, or rodents, however, it is not a barrier to them. Ants, termites and rodents will chew through EPS to reach food or establish a comfortable home. Marine borers can attack EPS, as they do wood and EPS should be protected by an anti-fouling paint over a suitable water based primer.

Electrical properties

The electrical characteristics of EPS (See Table 5) and air are similar. This applies to arc resistance, as well as other electrical properties. The EPS melts about the path of an arc as soon as the arc penetrates it. Dielectric loss of EPS is quite low.

Table 5: Electrical properties (Normal density 16kg/m^3)

Frequency cps.	Dielectric Constant	Dissipation Factor	Loss Factor	Volume Resistivity	Surface Restivity	Dialectric Strength
60	1.19	.0005	.0006			
1000	1.07	.0005	.0006	$3.8x10^{13}$	$9.18x10^{6}$	49
1000000	1.02	.0005	.0006			

Flammability properties

Expanded polystyrene products are combustible and should not be exposed to open flame or other ignition sources. As with all other organic material, insulation products must be considered combustible and to constitute a fire hazard if improperly used or installed. The material contains a flame retardant additive to inhibit accidental ignition from small fire sources. Table 6 shows test results for EPS and other common building materials to provide a guide as to how these products compare. Intending users of EPS should take note of our storage suggestions.

Table 6: Comparative testing of Early Fire Hazard properties for selected materials

Material	Ignitability Index (0 -20)	Spread of Flame Index (0-10)	Heat Evolved Index (0-10)	Smoke Produced Index (0-10)
Isolite® with sisalation 450 facing	0	0	0	0-1
Isolite® sandwhich panel faced both sides with 0.65mm Steel	0	0	0	0
Isolite® expanded polystyrene	12	0	3	5
Isothane® rigid polyurethane	18	10	4	7
An Australian Hardboard (4.75mm)				
- Bare	14	6	7	3
- Impregnated with fire retardant	0	0	0	7
An Australian Softboard (12.70mm)				
- Bare	16	9	7	3
- Impregnated with fire retardant	4	0	0	7
T&G Boarding (25 x 100mm)				
- Bluegum	11	0	3	2
- Oregon	13	6	5	3
Plywood, Coachwood Veneer (4.75mm)				
- Bare	15	7	7	4
- Impregnated with fire retardant	12	0	3	5

Coefficient of linear thermal expansion

The coefficient of linear thermal expansion for EPS is 6.3 x 10-5 m/m deg K.

Toxicity

The heat of combustion of solid polystyrene polymer is 40, 472kJ/kg; combustion products are carbon dioxide, water, soot (carbon), and to a lesser extent carbon monoxide.
A CSIRO report comments that the toxicity of gases associated with the burning of EPS is no greater than that associated with timber. Extensive research programs have been conducted overseas to determine if thermal decomposition products of EPS present toxicity hazard. The test results have revealed that the toxicity of the decomposition products appears to be no greater than for wood and decidedly less than other conventional building products.

Table 7: Maximum Toxicity Index

	Toxicity Index due to:				
Material	HCN	CO	CO2	HC1	Total
Acrylic fibre	1.19	0.02	<0.01	-	1.21
Nylon	0.43	0.08	0.01	-	0.52
Wool	0.33	0.04	0.01	-	0.38
PVC	-	0.27	<0.01	0.29	0.36
Urea-formaldehyde foam	0.26	0.01	<0.01	-	0.27
Rigid polyurethane foam	0.05	0.05	<0.01	-	0.10
Polystyrene	-	0.09	0.01	-	0.10
White pine	-	0.09	0.003	-	0.09

Thermal conductivity design values – W/m K

(a) Determine mean temperature of insulation in 0C
To = Temperature on outside surface of insulation
Ti = Temperature on inside surface of insulation
(b) Select the class of EPS from AS 1366.3
(c) Look up relevant K value in the table for the mean temperature in 0C Thermal conductivity quoted in W / m K

$$T_{mean} = \frac{To + Ti}{2}$$

Table 8: Thermal Conductivity W/mK

Class – Temperature	L	SL	S	M	H	VH
0	.0398	.0370	.0360	.0349	.0337	.0321
1	.0391	.0372	.0361	.0350	.0338	.0322
2	.0393	.0374	.0363	.0351	.0339	.0323
3	.0394	.0375	.0364	.0353	.0341	.0325
4	.0396	.0377	.0366	.0354	.0342	.0326
5	.0397	.0378	.0367	.0356	.0343	.0327
6	.0399	.0380	.0369	.0357	.0344	.0328
7	.0401	.0382	.0370	.0358	.0346	.0330
8	.0402	.0383	.0372	.0360	.0347	.0331
9	.0404	.0385	.0373	.0361	.0348	.0332
10	.0406	.0386	.0375	.0362	.0349	.0333
11	.0407	.0388	.0376	.0364	.0351	.0335
12	.0409	.0389	.0378	.0365	.0352	.0336
13	.0410	.0391	.0379	.0367	.0353	.0337
14	.0412	.0393	.0381	.0368	.0354	.0338
15	.0414	.0394	.0382	.0369	.0356	.0340
16	.0415	.0396	.0384	.0371	.0357	.0341
17	.0417	.0397	.0385	.0372	.0358	.0342
18	.0419	.0399	.0387	.0373	.0359	.0343
19	.0420	.0401	.0388	.0375	.0361	.0345
20	.0422	.0402	.0390	.0376	.0362	.0346
21	.0423	.0404	.0391	.0378	.0363	.0347
22	.0425	.0405	.0393	.0379	.0364	.0348
23	.0427	.0407	.0394	.0380	.0366	.0350
24	.0428	.0408	.0396	.0382	.0367	.0351
25	.0430	.0410	.0397	.0383	.0368	.0352
26	.0432	.0412	.0399	.0384	.0369	.0353
27	.0433	.0413	.0400	.0386	.0371	.0355
28	.0435	.0415	.0402	.0387	.0372	.0356
29	.0437	.0416	.0403	.0388	.0373	.0357
30	.0438	.0418	.0405	.0390	.0374	.0358
31	.0440	.0419	.0406	.0391	.0376	.0360
32	.0441	.0421	.0408	.0393	.0377	.0361
33	.0443	.0423	.0409	.0394	.0378	.0362
34	.0445	.0424	.0411	.0395	.0379	.0363
35	.0446	.0426	.0412	.0397	.0381	.0365
36	.0448	.0427	.0414	.0398	.0382	.0366
37	.0450	.0429	.0415	.0399	.0383	.0367
38	.0451	.0431	.0416	.0401	.0384	.0368
39	.0453	.0432	.0418	.0402	.0386	.0370
40	.0454	.0434	.0420	.0404	.0387	.0371
41	.0456	.0435	.0421	.0405	.0388	.0372
42	.0458	.0437	.0423	.0406	.0389	.0373
43	.0459	.0438	.0424	.0408	.0391	.0375
44	.0461	.0440	.0426	.0409	.0392	.0376
45	.0463	.0442	.0427	.0410	.0393	.0377
46	.0464	.0443	.0429	.0412	.0394	.0378
47	.0466	.0445	.0430	.0413	.0396	.0380
48	.0467	.0446	.0432	.0415	.0397	.0381
49	.0469	.0448	.0433	.0416	.0398	.0382
50	.0471	.0450	.0435	.0417	.0399	.0383
51	.0472	.0451	.0436	.0419	.0401	.0385
52	.0474	.0453	.0438	.0420	.0402	.0386
53	.0476	.0454	.0439	.0421	.0403	.0387
54	.0477	.0456	.0441	.0423	.0404	.0388
55	.0479	.0457	.0442	.0424	.0406	.0390
56	.0481	.0459	.0444	.0425	.0407	.0391
57	.0482	.0461	.0445	.0427	.0408	.0392
58	.0484	.0462	.0447	.0428	.0409	.0393
59	.0485	.0464	.0448	.0430	.0411	.0395
60	.0487	.0465	.0450	.0431	.0412	.0396

C: USES AND APPLICATIONS

EPS insulation

Flame retardant modified EPS is manufactured for use in a variety of insulation applications including metal skin sandwich panels, prefabricated building components and composite ceiling panels. It is also manufactured into a wide range of roof, wall and floor slab products.

EPS in packaging

One of the many other important applications for EPS is packaging, The properties of lightness, shock absorption, low thermal conductance, resistance to moisture and weathering, absence of taste and odour, a soft satiny surface and attractive appearance make EPS an excellent packaging material for sensitive and high unit value products.

EPS in building

Whether it is used as a void block out, form work, cavity filler or as an insulation board inside a sandwich panel, EPS is economical and easy to use in any building application.

D: MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION

Product Names:	EPS Expanded Polystyrene Sheet and Block
Other Names:	EPS Grade L, SL, S, M, H & VH.
U.N Number:	None
Dangerous Goods Class:	None
Subsidiary Risk:	None
Hazchem Code:	None
Poisons Schedule Number:	None
Boiling Point (deg C)	:>240 Decomposes
Melting Point (deg C)	:>100
Vapour Pressure (kPa)	: Not Applicable
Specific Gravity	:0.01-0.04 (foam)
Flash Point (deg C)	: Not Applicable
Lower Explosive Limit (%)	: Not Applicable
Upper Explosive Limit (%)	: Not Applicable
Solubility in Water (g/L)	: Immersible

2. HEALTH HAZARD INFORMATION

A) HEALTH EFFECTS

ACUTE SWALLOWED: Not normally a hazard due to physical form of product. Considered an unlikely route of entry in commercial / industrial environments.

No specific toxic effects. The material may be irritating if swallowed but is practically non-toxic.

ACUTE – EYE: The solid/dust is mildly irritating to the eyes.

ACUTE – SKIN**:** The liquid is regarded as non-irritating to the skin.

ACUTE – INHALED: Not normally a hazard due to non-volatile nature of product. Particulate/dust is mildly irritating to the upper respiratory tract no specific toxic effects. Particles from cutting are normally non respirable size, however, high dust

Concentrations may cause coughing, irritation, even difficulty in breathing, however, these effects are transient, clearing up after exposure ceases.

B) CHRONIC

Considered to be of low toxicity. Primary route of exposure is usually by inhalation of generated dust. As with any chemical product, contact with unprotected bare skin, inhalation of vapour, dust in work place atmosphere: or ingestion in any form should be avoided by observing good occupational work practice. Fumes from hot wire cutting of the material may irritate nose and eyes.

C) FIRST AID

SWALLOWED: Rinse mouth with plenty of water.

EYE: If this product comes in contact with eyes: Wash affected area with water. If irritation continues seek medical attention. Removal of contact lenses after an eye injury should only be undertaken by skilled personal.

SKIN: Brush off dust. In the event of abrasion or irritation of the skin seek medical attention.

INHALED: If dust is inhaled, remove to fresh air. Encourage patient to blow nose to ensure clear breathing passages. Rinse mouth with water. Consider drinking water to remove dust from throat. If irritation or discomfort persists seek medical attention. If fumes or combustion products are inhaled: Move to fresh air. Lay patient down. Keep warm and rested. If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital, or doctor.

ADVICE TO DOCTORS: Treat symptomatically.

3. PRECAUTION FOR USE

EXPOSURE STANDARDS
No exposure limits set by NOHSC or ACGIH

Dusts not otherwise classified, as inspirable dust. Fresh foam may contain residual levels of blowing agent e.g. pentanes

TLV TWA: 600 ppm; 1770 mg/m3; STEL; 750 ppm; 2210 mg/m3

ES TWA: 600 ppm, 1800 mg/m3; STEL; 750 ppm, 2250 mg/m3

IDLH Level: 15,000 ppm

Note: Detector tubes for n-pentane, measuring in excess of 100 ppm, are commercially available.

4. ENGINEERING CONTROLS

None under normal operating conditions.

OTHERWISE: Use in a well-ventilated area. General exhaust is adequate under normal operating conditions. If inhalation risk exists, wear SAA approved dust respirator. Correct fit is essential to obtain adequate protection. Local exhaust ventilation required when cutting with hot wire.

5. PERSONAL PROTECTION

EYE: Safety glasses with side shields. Chemical goggles. Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

HANDS/FEET: Wear general protective gloves: i.e. Disposable polythene gloves or cotton gloves or light weight rubber gloves, with barrier cream preferable safety footwear.

OTHER: Overalls. Eyewash unit. The local concentration of material, quantity and conditions of use determine type of personal protective equipment required. For further information, consult specific Foam Sales data or your Occupational Health and Safety Advisor.

6. SAFE HANDLING INFORMATION

STORAGE and TRANSPORT

SUITABLE CONTAINER: No restriction on the type of containers. Taped bundles Plastic/ paper bag Plastic/paper wrap. Packing as recommended by manufacturer: Check all material is clearly labelled.

STORAGE INCOMPATIBILITY: Do not store with organic solvents or oxidizers. Store at ambient temperature. Store away from incompatible materials. No smoking or naked lights or ignition sources. Protect containers from physical damage. Observe manufacturer's storing and handling recommendations.

TRANSPORTATION

No restrictions.

MAJOR SPILLS: Use dry clean up procedures and avoid generating dust. No smoking or naked lights within area. Clean up all spills immediately. Secure load if safe to do so. Bundle / collect recoverable product. Collect remaining material in containers with covers for disposal.

DISPOSAL: Consult manufacturer for recycling options and recycle where possible. Consult State Land Waste Management Authority for disposal. Incinerate residue at an approved site. Recycle containers where possible, or dispose of in an authorised landfill.

FIRE/EXPLOSION HAZARD: Non flammable but combustible in fire conditions. Will burn if heated and ignited.

FIRE: Burns with intense heat. Produces melting, flowing, burning liquid and dense black smoke.

CONTACT POINT

POISONS INFORMATION CENTRE: Perth 13 11 26

POLICE OR FIRE BRIGADE: Perth 000

E: 15 YEAR THERMAL LIMITED WARRANTY

Future Foams hereby warrants to the owner of the building/structure upon which the insulation was installed that, for a period of fifteen (15) years, commencing with the date of company invoice, that the insulation's actual thermal resistance will not vary by more than ten (10) percent from the minimum R-value identified in ASTM C578 on insulation. If the insulation is determined by sampling and tests (conducted as provided below) to not meet warranty value, Future Foams will deliver to the owner of the building on which the insulation was initially installed a quantity of substantial equivalent product to replace the non-performing insulation or, in the alternative, at Future Foams' sole discretion, refund to the owner the original purchase price of the non-performing insulation. In no event shall Future Foams be liable for any other costs or damages, including labour costs. Total Future Foams expense for the life of this warranty will be limited to the original purchase price of the insulation.

CONDITIONS / EXCLUSIONS

The following conditions/exclusions apply to this Warranty:

A. Future Foams' obligations under this warranty are applicable only to insulation supplied.

B. Insulation must be installed in typical building and construction assemblies (including roofing) in strict accordance with all applicable Future Foams specifications, recommendations and guidelines that were in effect at the time of such installation.

C. The building must be owned by the claimant at the time of any warranty claim.

D. This warranty shall be void if, in Future Foams sole judgment, there is damage to the insulation resulting from improper handling and installation, maintenance, intentional or unintentional misuse, negligence, impact of falling objects, vandalism, earthquake, lightning, hurricane, flood, fire, hailstorm, high wind, tornado, excessive UV exposure, cascading roof/floor water, ponding water, immersion in water, non-diffusion open assemblies, or failure or distortion in the walls or foundation of the building/structure, including settling of the building or movement of framing members.

E. Insulation must be stored prior to installation in accordance with Future Foams recommendations.

F. Future Foams does not warrant the compatibility of any other products, whether manufactured by Future Foams or not, including (but not limited to) any roofing membranes or coatings.

G. Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mould formation. No material supplier including Future Foams can give assurance that mould will not develop in any specific system or product.

INSULATION SAMPLING/TESTING

All sampling shall be conducted in accordance with sampling procedures prescribed by Future Foams, and samples of the insulation shall only be taken in the presence of an authorized Future Foams representative.

Testing of insulation samples shall be in accordance with ASTM C518, or the then closest Future Foams-approved effective equivalent thereof. Insulation samples shall be conditioned to equilibrium prior to testing. All sampling and testing costs (including but not limited to costs of insulation covering removal and replacement) shall be at the owner's sole expense.