TICA

HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

INSULATION DESIGN GUIDE INCORPORATNG BCA 2013 SECTION J

FOR

THERMAL AND ACOUSTIC INSULATION

IN

VICTORIA

For HVAC, Industry Air Handling Equipment,
Chilled Water and Heating Water Piping
and Boiler Flues

April 2014 Edition (updated for BCA 2013)

VICTORIAN DIVISION OF THE INSULATION CONTRACTORS ASSOCIATION OF AUSTRALIA

ASSOCIATION STATEMENT

- We provide and install Energy Saving Products
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- We provide and install products that Conserve Natural Resources.
- We provide and install products that Control Surface Temperature.
- We provide and install products that Enable Processes to Operate Properly.
- We provide and install products that are normally unseen yet improve the environment.
- We provide and install products that reduce carbon dioxide emissions.
- We provide and install products, the only non-energy products that will pay for themselves.
- We provide and install products that keep products hot and cold.
- We provide and install products that will reduce operating cost for businesses.

Forward: Using This Guide

Insulation product information can change as manufacturers improve their products and new ones are introduced. TICA recommends that for the most up-to-date product information, suppliers be contacted direct for their latest product data sheets. Many TICA supplier members operate up-to-date web-site pages which can also assist in product specification.

The TICA Insulation Design Guide should be cross-referenced to appropriate Australian Standards, which are listed at the start of the guide. Considerable more detail is available in these Standards on performance and installation requirements than can be covered in this TICA guide and reference to there is strongly recommended.

New BCA 2010 Energy Efficiency Provisions in this guide were on 1 May 2010 (subject to arrangements by the State and Territories). Readers should use the BCA 2010 for ultimate insulation decisions due to the details it provides.

The TICA “Insulation Guidance Note” should be seen as an initial step in the specification of products and installation procedures. It is not designed to override other specifications written by consultants in the field but rather act as an information base in a field where much information is not readily accessible in one place.

THESE ORGANISATIONS ARE COMMITTED TO IMPROVING STANDARDS IN THE INDUSTRY – THEIR ENDEAVOURS SHOULD BE SUPPORTED.

TICA Victorian Members

Contractors		
Company	**Location**	**Contact**
A.Tomballe Insulations	1 Fink St WILLIAMSTOWN NORTH 3016	Frank Tucci Ph: 03 9391 5802 Fax: 03 9391 2836 Mob: 0418 567 731
Allen Insulation (Mansfield)	50 Cummins Rd MANSFIELD 3722	Peter Watkins Ph: 03 5775 1133 Fax: 03 5775 1133 Mob: 0428 330 451
Allen Insulations (Vic)	40 Fleet St SOMERTON 3062	Andrew Duke Ph: 03 8339 0331 Fax: 03 8339 0334 Mob: 0411 751 151
AMV Insulation	F3 415 Hammond Rd DANDENONG 3175	Michael Vidic Ph: 03 9702 2468 Fax: 03 9702 2489 Mob: 0418 329 728
Marino Insulations	8 Wood St LONG GULLY 3550	Leo Liddell Ph: 03 5443 3353 Fax: 03 5442 5990 Mob: 0418 313 830
Mulgrave Insulation	F1/10 Viewtech Pl ROWVILLE 3178	John Toombs Ph: 03 9764 3412 Fax: 03 9764 3476 Mob: 0409 932 159
Total Insulation (Vic)	2/16 Jarrah Dr BRAESIDE 3196	Mark Stewart Ph: 03 9580 7679 Fax: 03 9580 7756 Mob: 0412 396 923
V.I.C. Insulation Contractors	51 Murchison Cres CLAYTON SOUTH 3169	Malvin Vann Ph: 03 9547 3756 Fax: 03 9547 9788 Mob: 0428 888 833

Manufacturers/Suppliers		
Company	**Location**	**Contact**
Australian Urethane & Styrene	F32 9 Ashley St WEST FOOTSCRAY 3012	Bill Baini Ph: 03 9687 7500 Fax: 03 9687 7399 Mob: 0417 137 977
Baron Insulation	19 Pascal Rd SEAFORD 3198	Andrew Davidson Ph: 03 9776 4006 Fax: 03 9776 4007 Mob: 0408 319 356
Bradford Insulation Group	159 Wellington Rd CLAYTON 3168	Adam Rowe Ph: 03 9265 4000 Fax: 03 9265 4011 Mob: 0427 988
Fletcher Insulation	Greens Road DANDENONG 3175	Peter Regener Ph: 03 9580 6900 Fax: 03 9587 3220 Mob:
H B Fuller Company	16 Red Gum Dr DANDENONG SOUTH 3175	Robin Storey Ph: 03 9797 6236 Fax: 03 9797 6299 Mob: 0409 946 197
AFC Industries	35 Metrolink Circuit, Campbellfield VIC 3061	Sam Garro Ph: 03 9303 7383 Fax: 03 9303 7139 Mob: 0402 002 012

THERMAL INSULATION CONTRACTORS ASSOCIATION OF VICTORIA

This insulation Guide defines the requirements of quality, materials and workmanship, which shall be adopted in the supply, and installation of thermal and acoustic insulation in the Heating Ventilation and Air-Conditioning (HVAC) Industry.

The standards referred to in the formulation of this specification are listed below:

AS 1045-1988	Measurement of Sound Absorption in a Reverberation Room Note: This standard has been replaced by AS ISO 354.
AS ISO 354	Measurement of Sound Absorption in a Reverberation Room
AS 1301.419S-1989	Water Vapour Transmission Rate of Paper.
AS 1366.1-1992	Rigid Cellular Polyurethane.
AS 1366.2-1992	Rigid Cellular Polyisocyanurate.
AS 1366.3-1992	Rigid Cellular Polystyrene – Moulded.
AS 1530.3-1999	Simultaneous Determination of Ignitability, Flame Propagation, Heat Release and Smoke Release.
AS 1668.1-1998	The use of Ventilation and Air-conditioning in Buildings Part 1: Fire and Smoke Control in Multi-Compartment Buildings.
AS 2352-1980	Glossary of Terms for Thermal Insulation of Buildings. Note: This standard is no longer available.
AS/NZS 4200.1-1994	Pliable Building Membranes and Underlays “Materials”.
AS4254.1-2012	Ductwork for air-handling systems in buildings - Flexible duct
AS 4254.2-2012	Ductwork for air-handling systems in buildings - Rigid duct
AS 4426-1997	Thermal Insulation of Pipework, Ductwork and Equipment - Selection, Installation and Finish.
AS 4508-1999	Thermal Resistance of Insulation for Ductwork Used in Building Air-conditioning. Note: The minimum thermal performance of insulation provided in AS 4508 have been superseded by the requirements of the Energy Efficiency Provisions of the BCA since 2006. Insulating in accordance with this standard will result in **non-compliance** with BCA 2012 Part J.

AS/NZS 4859.1	Materials for the Thermal Insulation of Buildings, Part 1: General Criteria and Technical provisions
ASTM C 335	Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
ASTM D 828 SMACAA	Fibrous Glass Duct Construction Standard.
BS 874-1990	Methods for Determining Thermal Insulating Properties, With Definitions of Thermal Insulation Terms.
ASTM C 518-1993	Thermal Conductivity Materials by means of the Heat-flow Meter.
BS 5422 - 1990	Method for Specifying “Thermal Insulating Materials on Pipes, Ductwork and Equipment” (In temperature range – 40ºC to + 700ºC).
BS 5970 - 1981	Code of Practice for “Thermal Insulation of Pipework and Equipment” (in the temperature range –100 ºC to +870 ºC)

THERMAL INSULATION CONTRACTORS ASSOCIATION OF VICTORIA

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SECTION 1

TICA (VICTORIA) OVERVIEW

OF THE

BCA 2013 THERMAL

INSULATION REQUIREMENTS

FOR

PIPEWORK AND DUCTWORK

FOR

COMMERCIAL BUILDINGS

CLASS 2 TO 9

SECTION 1: TICA (VICTORIA) OVERVIEW OF BCA 2013 THERMAL INSULATION OF PIPEWORK AND DUCTWORK FOR COMMERCIAL BUILDINGS

In 2006 the Building Code of Australia (BCA) introduced Energy Efficiency provisions for Class 2-9 commercial buildings for the first time. These include minimum insulation requirements for the building envelope, air-conditioning and ventilation systems as well as heating and chilling such as piping, vessels, heat exchangers and tanks.

This guide provides Thermal Resistance Values for Victoria based on insulation requirements nominated in Part J5 of BCA 2013 as applied to air-conditioning systems. For States other than Victoria refer to the BCA or other TICA State websites.

The BCA 2013 insulation requirements are referenced as follows:

J5.2 Ductwork Insulation and Sealing

An air-conditioning unit or system that heats or cools a building must have any supply and return ductwork insulated and sealed.

Insulation must be provided on ductwork and fittings used for heating or cooling with insulation complying with AS/NZS4859.1. Ductwork insulation requirements do not apply to heating or cooling ductwork and fittings:

(i) Within the only or last room that is served by the system,
(ii) Return air ductwork in, or passing through a conditioned space,
(iii) Ductwork for outside air and exhaust air associated with a heating or cooling system.

See Section 4 for the minimum thermal insulation in these applications.

J5.4 Insulating of Piping, Vessels, Heat Exchanges and Tanks.

This specification contains the requirements for the insulating of piping, vessels, heat exchangers and tanks containing heating or cooling fluids.

(i) Heating fluids include hot water, steam and condensate.
(ii) Cooling fluids include refrigerant, chilled water, brines and glycol mixtures but not condenser cooling water to or from a cooling tower.

In the case of both types of heating and cooling piping systems, specific pipe insulation material R-values must be achieved.

Similarly for vessels, heat exchangers and tanks, there are specific material R-value requirements for:

(i) Glycol refrigerant pipes operating up to $2^{o}C$.
(ii) for refrigerant cooling water between 2 and $20^{o}C$
(iii) for heating water
(iv) for steam pipelines

Piping insulation requirements do not apply for piping located within the conditioned space where piping and fittings which provide heating and cooling to that space are within the last

or only room that is served by the system, for piping within a concrete slab, piping supplied as an integral part of a piece of plant or inside an air-handling unit fan-cool unit or the like.

Where a contractor deviates form the DTS Provisions in BCA 2013, they must undertake an Alternative Solution to meet the performance requirements.

Products used for thermal insulation should be supplied with R-Value certification to AS/NZS4859.1 on a project by project basis to confirm compliance before proceeding with installation.

Final acceptance from the building certifier must be obtained before accepting the Thermal Insulation values details in this guide.

SECTION 2

BCA 2013 SECTION J5.4

PROVISIONS FOR VICTORIA

FOR

HEATING WATER AND

STEAM PIPING AND VESSELS

USED FOR

HEATING WATER AND STEAM

1. BCA 2013 PIPE INSULATION ENERGY EFFICIENCY PROVISIONS

The BCA 2013 Specification J5.4 (Table 2a) requires that pipework used for heating water piping and cooling water piping be thermally insulated to a particular minimum Material R-Value depending on the Climate Zone the building is located in. Table 1 is specific to the requirement of Victoria only and covers Climate Zones 6 and 7 in the BCA Climate Zone map.

The BCA 2013 gives three possible locations of pipework for consideration:

(a) located internally, here pipework is inside the building but is subject to the temperatures of a conditional space it does not serve.

(b) located within a wall space, an enclosed sub-floor or an enclosed roof space, here the pipework is inside the building but is subject to temperatures of an unconditioned space.

(c) located outside the building or in an enclosed sub-floor or an unenclosed roof-space, here pipework is outside the building or exposed to direct sunlight.

A brief list of Thermal Insulation R-Values is provided after Table 1 for common generic pipe insulation products used for heating and cooling pipework.

TABLE 1

*Minimum Material R-Value For Heating Water Piping For Victoria**

Deemed-to-Satisfy Provision for Specification J5.4 BCA 2013

Location	No More Than 65kW Heating Capacity Water Piping	More Than 65kW Heating Capacity Water Piping
Located internally	R1.0	R1.0
Located within a wall space, enclosed sub-floor or an enclosed roof space	R1.1	R1.1
Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	R1.2	R1.5

* Climate Zones 6 and 7

For steam and condensate piping, BCA 2013 Section J5.4 requires pipe insulation to achieve the following DTS minimum R-Values as shown in Table 2.

TABLE 2

Minimum Material R-Values For Insulation For Pipework Carrying Steam and Condensate

Temperature Range	**Nominal Pipe Size**				
	15mm to 40mm	**50mm to 80mm**	**100mm to 125mm**	**150mm**	**200mm**
Steam and Condensate Not more than 120^{o}C	R1.0	R1.0	R1.3	R1.3	R1.3
Steam more than 120^{o}C	R1.5	R1.5	R1.5	R1.8	R2.1

Thermal Insulation (R-Values) and Thicknesses For Pipe Insulation Products

R values vary depending on the diameter of the pipe and thickness of insulation.
The Australian Standard method used to calculate the insulation material R-value for a preformed pipe section is as follows: R = (r2loge (r2/r1))/k
The following R-Values examples are for the product without foil or air-film contribution to the R-Value.

Glasswool Sectional Pipe Insulation

25.4mm O.D. x 25mm wall R1.2
50.8mm O.D. x 38mm wall R1.8
76.1mm O.D. x 50mm wall R2.2
168.3mm O.D. x 50mm wall R1.9

Nitrile Foamed Rubber (eg: Armaflex)

12.7mm O.D. x 9mm wall R0.35
15.9mm O.D. x 13mm wall R0.75
19.1mm O.D. x 19mm wall R0.82
25.4mm O.D. x 25mm wall R1.08

Polyethylene Foam Tubing (e.g.: Thermobreak)

12.7mm O.D. x 10mm R0.48
15.9mm O.D. x 15mm R0.76
19.1mm O.D. x 20mm R1.0
25.4mm O.D. x 25mm wall R1.3
50.8mm O.D. x 40mm wall R1.9
76.1mm O.D. x 50mm wall R2.3
168.3mm O.D. x 50mm wall R2.0

SL Grade Polystyrene Pipe Sections

25.4mm O.D. x 25mm wall R1.0
50.8mm O.D. x 38mm wall R1.4
76.1mm O.D. x 50mm wall R1.8
168.3mm O.D. x 50mm wall R1.5

2. PIPEWORK INSULATION MATERIALS

Insulation covering pipework should completely cover the pipe and be tightly secured with wire, straps or adhesives.

The operating temperature of the pipe will determine the type of insulation best suited to the application. The insulation should provide satisfactory long-term service under conditions of normal usage.

At the elevated temperatures, eg over 350 ºC, insulation needs to withstand shrinkage, loss of compressive strength and sometimes vibration.

Preformed pipe sections that are bonded to form a substantially rigid insulation or tubing in the case of elastomeric insulation should be selected to have an internal tube diameter to fit snugly around a pipe.

Pipe insulation materials and their maximum operating temperature include:

PIPE INSULATION PRODUCT	MAXIMUM TEMPERATURE RATING ºC
Expanded Polystyrene	75
Polyurethane	100
Nitrile Foamed Rubber	105
Polyethylene Foam	105
Phenolic Foam	120
Polyisocyanurate Foam	140
Glasswool	450
Foamglass	482
Rockwool	650
Calcium Silicate *	1000

*Depends on grade of Calcium Silicate.

A detailed listing of most insulating product is given in AS 4426-1997 “Thermal Insulation of Pipework, Ductwork and Equipment – Selection, Installation and Finish”. Section 2.

Further information on the terminology used for insulating materials can be found in AS 2352-1980.

Some characteristics of products detailed in the previous table are presented below; for more detailed information contact manufacturers for data sheets summarised earlier in this guide.

(i) Expanded Polystyrene 75 ºC maximum

Description
Predominantly used for chilled water applications and for temperatures down to approximately –20 ºC. Manufactured to AS 1366 "Rigid Cellular Plastic Sheets for Thermal Insulation Part 1 – Rigid Cellular Polystyrene to SL or S grade for pipe insulation". Supplied in half sections with heavy duty foil laminate barrier vapour barrier facing. Product supplied as fire retardant grade; for operating temperatures below 10 ºC use an appropriate vapour barrier as detailed in BS 5970-1981 Figure 40.

Thermal Performance
Thermal conductivity 0.034 to 0.041 W/mK depending on density. (SL Grade is .038 W/mK).

Early Hazard Fire Performance (AS 1530 Part 3)

	Plain	Foil Faced
Ignitability	11	0
Spread of Flame	0	0
Heat Evolved	2	0
Smoke Developed	5	0

(ii) Nitrile Foamed Rubber 105 ºC maximum

Description
Flexible closed cell elastometric insulation supplied in 2 metre lengths in a slit or unslit form. Available in tubular, sheet or roll form, these products can be rejoined with adhesive supplied by manufacturers.

The sealed outer surface and the closed cell nature of the product enable its use on cold pipework and equipment without a vapour barrier. For outdoor applications metal casing or painting of the insulation is recommended to protect the insulation from damage by sunlight.

Thermal Performance
Thermal conductivity = 0.04 W/mK at 20 ºC mean temperature.

Early Hazard Fire Performance (AS 1530 Part 3)

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	4 (3 for FR Grade)

(iii) Polyurethane 100 ºC maximum

Description
Closed cell, rigid insulation available in half pipe sections or rigid sheets. Product has low thermal conductivity and closed cell structure giving product particular advantages for very low temperature applications down to –40 ºC.

Thermal Performance
Thermal conductivity = 0.027 W/mK at 25 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3)

Ignitability	18
Spread of Flame	10
Heat Evolved	4
Smoke Developed	7

(iv) Polyethylene Foam 105ºC maximum e.g. Thermobreak

Description
Closed cell insulation available in pipe insulation, sheets and rolls. The closed cell nature of the product provides a built-in vapour barrier. Foil faced options gives the product additional fire retardant properties. Suitable for hot water, chilled water and air-conditioning ductwork where thermal and condensation control is required. Some products are supplied with adhesive closing system or plastic closure along the length of the pipe insulation.

Thermal Performance
Thermal conductivity = 0.032 W/mK at 23 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3) for foil faced product

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	1

(v) Polyisocyanurate Foam 140 ºC maximum

Description
Similar properties and applications to polyurethane foam but with higher upper temperature limit and better early fire performance properties.

Thermal Performance
Thermal conductivity = 0.027 W/mK at 25 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3)

	Unfaced	Foil Faced
Ignitability	16	0
Spread of Flame	0	0
Heat Evolved	0	0
Smoke Developed	5	0

(vi) Glasswool Pipe Insulation 450 ºC maximum

Description
Rigid, resin bonded one piece insulation manufactured with glass fibre. Product supplied split and hinged for fixing over pipe in either plain or faced versions. Facings include heavy duty foil laminate, alfoil or calico or Foster 30-36 coating.

Product suitable for hot water and steam pipes. Handling and installation of Glasswool should be done in accordance with the Worksafe Code of Practice, "National Code of Practice For Safe Use of Synthetic Mineral Fibres".

Thermal Performance
Thermal conductivity = 0.033 W/mK at 23 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3)

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	0

(vii) Rockwool Pipe Insulation 650 ºC maximum

Description
Rigid resin bonded pipe insulation supplied in one piece lengths slit and hinged. Manufactured from melted basalt rock and by binding fibres with resin. Rockwool has high compression resistance and lower binder level than Glasswool. Available in hydrophobic grade and also low soluble chloride grade for special applications, typically supplied at 120kg/m³ density and above.

Thermal Performance
Thermal conductivity = 0.034 W/mK at 23 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3)

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	0

Handling of Rockwool insulation should be done in accordance with the Worksafe Code of Practice, "National Code of Practice For Safe Use of Synthetic Mineral Fibres".

(viii) Calcium Silicate Pipe Insulation

Description
Preformed rigid pipe sections available as two half pieces for smaller diameter pipes and as preformed lags for larger pipes. Used mainly for higher temperature industrial applications and in some industries requiring a non-fibrous insulation. Typically supplied at densities of 160 to 320kg/m³, product has high compression resistance.

Thermal Performance
Thermal conductivity = 0.04 W/mK at 23 ºC mean temperature.

Early Fire Hazard Performance (AS 1530 Part 3)

Ignitability	0
Spread of Flame	0
Heat Evolved	0
Smoke Developed	0

3. PROTECTIVE FACINGS FOR HOT INSULATED PIPE SYSTEMS

There are a wide range of protective facings for the insulation products summarized in below. The protective facing chosen depends on the application, eg indoor or outdoor use, impact resistance, chemical resistance etc. Protective coverings can give pipework an attractive appearance or allow pipe insulation to be colour coded for product identification.

The most common facings include aluminium foil in either heavy duty foil laminate or 120 micron Alfoil, coatings that are applied in situ, polyvinyl chloride jacketing and numerous sheetmetal jacket options.

Some covering materials also serve the additional role as acoustic sound barriers eg sheetmetal and barium loaded vinyl.

Hot pipework insulation systems rarely require vapour barrier characteristics specified for systems operating at less than 10 ºC, instead breather type coatings are quite acceptable.

(i) Factory Applied Aluminium Foil Laminates and Alfoil

Foil laminates should be manufactured to AS/NZS 4200.1 and be of either Medium or Heavy Duty. These products incorporate a reinforcing mesh between the foil/kraft paper layers which provide the required tear and puncture strength.

(ii) Breather Coatings (on-site application)

There are a range of brush on coatings eg Foster 30-36 and Foster 30-90 that can be applied once the pipe insulation is in place. For specific details, refer to H. B. Fuller, Foster Specification Guide No. 1. Application of coatings also involve the use of a reinforcing mesh embedded into the first coat. Upon drying a second top coat is applied.

(iii) Polyvinyl Chloride Jacketing

Material: Polyvinyl Chloride (PVC) sheathing 0.5mm thick of low smoke grade. Straight lengths to be precurled, bends and fittings to be moulded to suit bend or fitting. Thickness of insulation should be sufficient to ensure the underside of the PVC is below 60 ºC whilst care must be taken to avoid contact with hot metal. Joints should be arranged in the most sheltered position and sealed with welding solvent recommended by the PVC jacket manufacturer. Outside jacketing to have a 200mm unsealed slide joint every 10 metres for thermal expansion.

For serviceable items provide removable boxes or cover plates to allow access for items requiring maintenance.

(iv) Sheet Metal Cladding

Sheet metal cladding is used to protect insulation for external weather conditions where insulation could be damaged by water. It also provides additional resistance to mechanical damage.

For pipe surfaces where mechanical damage is unlikely, zinc-coated steel of 0.55mm thickness can be used satisfactorily. Stucco finishes can be used for aluminium to break up reflected light as can galvanized and zincalume sheet metals.

Detailed descriptions of these products are given in AS 4426-1997 Section 7.5 and BS 5970: 1981 "Thermal Insulation of Pipework and Equipment" Section 27.5.

4. ALUMINIUM FOIL LAMINATE TAPES

A large range of aluminium foil tapes are available for sealing all joins in foil laminate facings used over pipe insulation.

These products are suitable for indoor use only and are used to provide a sealed finish, in the case of chilled water pipe insulation coverings; act as vapour seals at joins or laps in foil.

MATERIAL: Pure aluminum or reinforced self adhesive foil tape, minimum 48 mm wide

5. PIPE SUPPORT REQUIREMENTS

(Supplied and fitted by Mechanical Contractors)

Where required provide selected Ezybloc support blocks not less than twice the width of the support bracket and equal to the insulation wall thickness. If a metal sleeve is required, provide 0.5mm metal sleeve to match the support block.

Insulation of metal sleeve is to be carried out during the construction stage to prevent the removal of brackets at the insulation stage.

Insulation should not be applied at supports until the spacers and metal sheathing (if any) have been applied.

6. PENETRATIONS

MATERIAL:	Rockwool Sectional Pipe Insulation.
REQUIREMENT:	These products are used as part of a fire stopping system where pipes penetrate through masonry walls. Test Certification to AS 1530 Part 4 to provide the required Fire Resistance Level (FRL) is required. Where pipework is insulated on both sides of penetrations, the Rockwool should be metal sheathed within the penetrations and for 300mm either side where possible. *Note:* Spaces between metal sheathing and the penetration wall to be fire rated by the head contractor.

7. EXTENT OF PIPE INSULATION

REQUIREMENT: Insulate the following:
- Steam, Condensate and Heating Water
- Pipework hazardous to personnel eg blow down piping
- Pipe services where trace heating is incorporated
- Boiler flues

Some areas not requiring insulation include hot water pumps, sludge and drain piping carrying hot fluids and condensate waste pipes.

8. PIPEWORK INSULATION THICKNESS

If guaranteed conditions of a fluid at the point of delivery are required, the correct insulation thickness and type of insulation should be recommended by the consultant using published manufacturers data.

Table 1 earlier in this guide provides minimum R-Value requirements for heating water piping for Class 5-9 buildings throughout Victoria.

BOILER FLUES: Use Glasswool or Rockwool pipe insulation or Mesh Faced Rockwood selected to be suitable for the continuous operating temperature of the flue. Typical insulation of 50mm can be used but reference to manufacturers design guides for recommended thickness for higher temperatures is advised. Insulate the full length of flues or exhaust within the building and metal case over the insulation.

* As thermal conductivity of different suppliers products can vary, reference to suppliers data is recommended or the appropriate Natspec reference.

9. PIPE INSULATION APPLICATION

REQUIREMENT: Use the preformed materials to insulate pipes carrying fluids or gas so that the temperature range of the insulation matches the pipe operating temperature.

In the case of pipe diameters that are too large for preformed insulation use mesh covered Rockwool, Glasswool blanket, radiused or bevelled segments or blanket materials. Insulation should not be applied to piping joints until piping pressure testing has been completed.

APPLICATION: Fit the insulation closely to the pipe by springing onto the pipe or securing with bands, tie-wire or adhesive, the method being particular to the type of insulation.

For mineral wool pipe insulation, sections should be held in place with bands or wires at not greater than 450mm spacing and no closer than 50mm from one end, once tightened any exposed ends should be pushed into the insulation material.

Finish the insulation surface to a neat, true, smooth surface without irregularities.

For foil covered pipe insulation, tape all joins with 48mm foil tape on circumferential and longitudinal joints taking care to press down tape joins to give a wrinkle free surface.

For concealed pipework use factory bonded Aluminium foil or foil laminate.

For exposed pipework use 0.5mm zincanned or galvanized cladding over pipework.

Some insulation material such as elastomeric nitrile foam rubber can be sealed with proprietary adhesive (eg Armaflex adhesive).

Circumferential butt joins can be adhered in the same manner after pressure testing of pipe is completed.

10. METAL SHEATHING

MATERIAL:	0.55mm zinc anneal or galvanized sheet within plant rooms, 0.6mm zinc anneal or galvanized sheet for pipe sizes over 100mm diameter. Metal sheathing shall be applied to all heating water piping that is subject to mechanical damage and in outdoor locations.
INSTALLATION:	Cut and roll sheeting to correct size. Longitudinal and transverse joints to be lapped at a minimum of 40mm. Position longitudinal and vertical joints to the most shielded location. Cone down at terminations and transitions. Clamp sheathing at 500mm maximum centres using 12 x 0.55mm zinc coated steel straps, weatherproof joints with sealant.
BENDS:	Provide pre-drilled lobster back bends containing at least three segments. Use mitred elbows where the size of the pipework or the radius of the bend does not allow the use of segmental bends. Each segment to have an inner and outer swage formed at the transverse edges.
FIXING:	Pop rivets or self tapping screws.
WEATHER-PROOFING:	Weatherproof external joints and fixings with approved silicone.

11. BCA 2013 PROVISIONS FOR INSULATION OF SMALL VESSELS, HEAT EXCHANGERS AND TANKS USED FOR HEATING WATER OR STEAM

Consult manufacturer's data sheets for appropriate flexible grade of insulation suitable for the operating temperature of the vessel.

AS 4426-1997 "Thermal Insulation of Pipework, Ductwork and Equipment – Selection, Installation and Finish". Section 6.4.5 details numerous installation techniques for small vessels and tanks. Insulation should be wrapped around the entire tank or vessel; joins should be tightly butted together.

BCA 2013 Specification J5.4 requires that insulation must achieve a minimum Material R-Value of:

(a) R1.4 if the contents are heating water e.g.: 32kg/m^3 Glasswool

(b) R2.5 if the content is steam e.g.: 32kg/m^3 Glasswool or 60-80kg/m^3 Rockwool

Note: R-Value of an insulation material can be calculated by dividing its thickness (converted to metres) by its thermal conductivity (W/mK) based on the mean temperature of the insulation (i.e. pipe temperature and cladding temperature divided by two).

SECTION 3

BCA 2013 J5.4 (VIC) PROVISIONS

FOR

COOLING WATER

AND

REFRIGERANT

PIPEWORK AND VESSELS

1. BCA 2013 SPECIFICATION J5.4 MATERIAL R-VALUE FOR COOLING WATER AND REFRIGERANT PIPING FOR VICTORIA

The BCA 2013 Section J5.4 also gives DTS material R-Values for cooling water piping for systems of no more than 65kW capacity, 65 to 250kWr and cooling water piping systems more than 250kWr capacity. These values are summarised in Table 3 below.

TABLE 3

Minimum Material R-Value for Cooling Water Piping

Deemed-To-Satisfy Provisions for Specification J5.4 BCA 2013

Location	No More Than 65kWr Capacity	More than 65kW Capacity but No More than 250kWr Capacity	More Than 250kWr Capacity
Located internally	R0.6	R1.3	R1.7
Located within a wall space, an enclosed sub-floor area or an enclosed roof space	R0.7	R1.4	R1.8
Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	R0.8	R1.5	R1.9

Piping to be insulated includes all flow and return piping, cold water piping within 500mm of the connection to the cooling system and pressure relief piping within 500mm of the connection to the cooling system.

For refrigerant, piping BCA 2013 Section J5.4 Table 2a requires pipework to be insulated to minimum material R-Values, these values are summarized in Table 4 below.

TABLE 4

Minimum Material R-Values for Refrigerant Piping

Temperature Range	**Nominal Pipe Size**				
	15mm to 40mm	**50mm to 80mm**	**100mm to 125mm**	**150mm**	**200mm**
Refrigerant Not more than 2°C	R1.3	R1.7	R2.0	R2.0	R2.7
Refrigerant More Than 2°C But Not More Than 20°C	As for cooling water in Table3				

2. PIPEWORK INSULATION MATERIALS

Preformed pipe sections or tubing preferably of a closed cell insulation are recommended. Suitable products for cold insulation work are:

Expanded Polystyrene: To AS 1366 Class S or SL machine cut to form tubular sections of pipe insulation or board for insulating fittings. Also available with a factory applied foil laminate vapour Barrier.

Nitrile Foamed Rubber: (eg Armaflex)
Available in IT and FR Grade to suit applications to -40 ºC. These products have sealed outer skin that does not require vapour sealing.

Polyethylene Foam: (e.g. Thermobreak)
Available in long moulded pipe tubing sheets and rolls. Closed cell products have built in vapour barrier. Available with adhered foil covering to give improved early fire hazard ratings.

Phenolic Foam: Premoulded half pipe sections of minimum density 35kg/m³. Product has high compressive strength but vapour sealing is required.

Polyurethane: Premoulded half pipe sections of density 32kg/m³ used for temperatures to –60 ºC. Product needs to be covered with a high performance vapour barrier for low temperature applications.

Polyisocyanurate: Similar to Polyurethane but has superior early fire hazard indices. Again, a vapour barrier needs to be incorporated with this product.

Mineral Wool: Rockwool Pipe Sections are recommended for pipe penetration sealing to meet AS 1530 Part 4 fire rating requirements (as tested by TICA Queensland). Rockwool and Glasswool are to be used in conjunction with approved vapour barriers.

Mineral Wool can be used for filling air gaps around valves and fittings and for wrapping flexible connections to maintain flexibility.

3. VAPOUR BARRIERS

Cold insulation work requires an appropriate vapour barrier and appropriate vapour sealing of joins. The vapour barrier can take the form of foil laminate facings to AS/NZS 4200.1, Medium or Heavy Duty for vapour sealing of chilled water systems. For systems of higher performance (temperatures below 5 ºC) the use of higher performance mastic vapour barriers is recommended.

(i) Foil Laminate Vapour Barriers

Materials: Medium or heavy duty foil laminate to AS/NZS 4200.1

(ii) Site Applied Mastic Vapour Barriers

Materials: Interior or exterior mastic application to pipework as described in Foster Specification (published by H. B. Fuller) Guides No. 2 to 4.2. Eg Foster 30-90 mastic is applied in two coats to the pipe insulation with reinforcing scrim embedded into the first coat. A bedding sealant is recommended to secure pipe insulation to the pipe and for vapour sealing of butt joins. Typical maximum vapour permeance for mastic coatings should be:

0 ºC 0.010 g/ (S.MN)
-5 ºC 0.004
-10 ºC 0.002
-15 ºC 0.0015
-20 to -40 ºC 0.001

4. PRESSURE SENSITIVE TAPES

Used for sealing all joins in foil laminate facings.

MATERIAL: Pure aluminum or reinforced self adhesive aluminum foil tape, minimum 48 mm wide.

5. PIPE SUPPORT BLOCK REQUIREMENTS

(Supplied and Fitted by Mechanical Contractors)

For cold pipe systems: High density polyethylene “Ezybloc” 300 kg/m3.
Provide selected support blocks not less than twice the width of the support bracket and equal to the insulation wall thickness. The appropriate vapour barrier is to form an integral part of these 24

blocks. If metal sheathing is required, provide 0.5mm metal sleeve that terminates 10mm in from the outside edge of the support blocks so the vapour barrier can be maintained.

REQUIREMENT: Complete the insulation of the vapour sealed support block and metal sleeve at the construction stage to prevent removal of brackets at the insulation stage.

6. CONDENSATE DRAINS

Use Polystyrene (S or SL Grades), Armaflex or equal with a minimum wall thickness of 25mm for Polystyrene and 9mm for elastomeric insulation such as Armaflex. Polystyrene should be faced with an appropriate vapour barrier such as Heavy Duty foil laminate or mastic coating as described in Section 2. Where practical, install elastomeric insulation without slitting the tube. Where slitting is unavoidable, seal all joins with an adhesive recommended by the manufacturer.

7. EXTENT OF PIPEWORK INSULATION

REQUIREMENT: Insulate the following:
- Chilled water piping and associated fittings
- Refrigerant suction lines
- Refrigerant liquid lines exposed to sunlight
- Condensate lines

VAPOUR BARRIER: To be continuous over insulation on all piping carrying Fluids at below ambient temperature.

8. PIPEWORK INSULATION APPLICATION

REQUIREMENT: Use for pipes carrying fluids at temperatures below ambient.

SURFACE FINISH: Concealed pipework:
- Factory applied Aluminium Foil Laminate Heavy Duty Grade to AS/NZS 4200.1 or Foster 30-90 mastic coating or equal for areas not exposed to mechanical damage.

Exposed pipework: eg: plant rooms, tunnels
- Cover vapour barrier coating with 0.55mm zinc coated metal, taking care not to damage the vapour barrier.
- Alternatively, apply Foster 60-38 Monolar mastic or Foster 30-90 Vapour Safe Mastic over the insulation (no metal cladding is required.
- For external locations use 0.6mm aluminium or stainless steel.

APPLICATION*: Except for factory applied insulated pipe, do not apply insulation until pipe pressure testing is complete. Before installing insulation, ensure that scale, rust and grease have been removed from the pipe surface by the Mechanical

Contractor. The pipe should be dry and have a primer coating (see AS 4426: 1997 Section 6.4.1 for details). In order to prevent cold tracking and moisture travelling along the pipes, apply a coating of non-setting mastic such as Foster 30-45 Foamseal or equal to circumferential longitudinal butt joints of polystyrene pipe sections at support blocks and either side of valves. As an additional safeguard "bore" coat insulation sections at supports for a distance of 50mm either side of the blocks.

BENDS: Cut the insulation into segments to follow the contour of the bend, adhere together with adhesive recommended by manufacturer and fix to the pipe bend. Use mitred elbows where this is not possible.

Factory manufactured bends are an accepted alternative to the above.

Seal joints on the aluminium foil laminate with foil tape to complete the vapour barrier. The vapour barrier is to be continuous over all fittings, flanges and valves.

When all joints are sealed, apply one additional circumferential band of self-adhesive tape to the centre of each section.

VALVES AND PUMPS: Insulate all valves, unions, flanges and fittings with 25mm foam. Complete with factory applied Heavy Duty Foil Laminate (to AS/NZS 4200.1: 1994) cut to size with all joints sealed with self-adhesive foil tape 48mm wide. Fill all voids with mineral wool such as Bradford HT Loose Rockwool. Maintain vapour barrier between pipe and fittings. If required, metal sheath with 0.5mm zincalume or galvanized sheet. Serviceable fittings to have suitcase type clips or self-tapping screws dependent on size.

*AS 4426-1997 Section 6.4 has considerable detail of application systems for these insulation materials.

9. METAL SHEATHING

MATERIAL: Zincanneal, Galvanized Sheet or Aluminium

THICKNESS: 0.55mm

INSTALLATION: Provide pre-drilled lobster back bends containing at least three segments. Use mitred elbows where the size of the pipes or the radius of the pipe bend does not allow the use of segmental bends. Each segment is to have an inner and outer swage formed at the transverse edges, the longitudinal joint to be fixed using pop rivets of correct length ensuring the vapour barrier is not damaged.

FIXING: Sheathing to be clamped at 450mm maximum centres with 12 x 0.5mm galvanized or zincanneal bands.

WATER-PROOFING: Weatherproof external joints and fixings with approved silicone.

SERVICEABLE ITEMS:	Provide removable boxes or cover plates to allow ease of access for equipment requiring maintenance. Use proprietary support clips or self-tapping screws as applicable for all removable boxes.
REQUIREMENT:	All insulated strainers Valves at pump assemblies Control valves AS 4426: 1997 gives considerable detail on the full range of sheet metal options in Section 7.5 of this Standard.

10. BCA 2013 R-VALUE REQUIREMENTS FOR LOW TEMPERATURE VESSELS, HEAT EXCHANGES AND TANKS

BCA 2013 Specification J5.4 states that Insulation must achieve a minimum material R-Value of:

(a) R2.7 if the content is refrigerant low temperature brine or glycol that is not more than $2^{o}C$

(b) R1.8 if the content is refrigerant cooling water that is more than $2^{o}C$ but not more than $20^{o}C$

Note that any piping, vessels, heat exchangers and tanks containing chilled fluid must be protected by an appropriate vapour barrier of the correct perm rating on the outside of the insulation as detailed in Section 3. All joints in the vapour barrier should be sealed.

SECTION 4

BCA 2013 SPECIFICATION J5.2

PROVISIONS (VIC)

FOR HVAC DUCTWORK

THERMAL INSULATION

ALSO

ACOUSTIC INSULATION

FOR

DUCTWORK AND PLENUMS

1. DUCTWORK INSULATION MINIMUM MATERIAL R-VALUE BCA 2013

Deemed-to-Satisfy Provisions for BCA 2013 Specification J5.2 requires that ductwork and fittings must:

(i) Be thermally insulated to achieve the minimum Material R-Value specified, and

(ii) Use insulation that complies with AS/NZS 4859.1.

The minimum levels of insulation required for internal or external lining of ductwork are shown in Table 5.

TABLE 5: Ductwork and Fittings – Minimum Material R-Value

Location of Ductwork and Fittings	**Heating System or Cooling System (including evaporative System) for Victoria (Climate Zones 6 and 7)**
Within a Conditioned space	R1.2
Where Exposed To Direct Sunlight	R3.0
All Other Locations	R2.0

* For requirements in States other than Victoria visit www.abcb.gov.au

2. DUCTWORK INSULATION MATERIALS: EXTERNAL AND INTERNAL LINING

A wide range of insulation materials are available, selection is dependent on the thermal, acoustic and fire indices requirements of each particular application.

MATERIALS: Resin Bonded Mineral Wool (Glasswool or Rockwool)
Polyester
Phenolic Foam
Elastomeric Foam (external ductliner only)
Polyethylene Foam
Polyurethane and Polyisocyanurate (external ductliners only)

Performance specifications for internal and external ductliners are detailed in AS 4254.2-2012.

For specific physical properties of each of the above products consult manufacturer's data sheets.

3. EXTERNAL DUCT INSULATION

External insulation should have a minimum total R-Value as specified in Table 3 and 4 for Victorian conditions and be a flexible or semi-rigid Glasswool or polyester ductliner.

As thermal properties are paramount, an important criterion is the thermal conductivity of the thermal insulation product. Typical thermal conductivities for some products are:

	k-Value
Glasswool 18-24kg/m3	0.036 W/mK
Rockwool 60kg/m3	0.034
Polyester 20kg/m3	0.038-0.042
Phenolic Foam 40kg/m3	0.036
Polyurethane 35kg/m3	0.023
Polyisocyanurate 40kg/m3	0.023
Elastomeric Foam 96kg/m3	0.040
Polyethylene Foam	0.034

R-Value of External Duct Insulation (excludes foil component)

R1.0 38mm 18-24kg/m3 Glasswool Blanket
R1.1 38mm 32kg/m3 Glasswool Blanket/Board
R1.3 50mm 18kg/m3 Glasswool Blanket
R1.4 50mm 24kg/m3 Glasswool Blanket/Board
R1.5 50mm 32 or 40kg/m3 Glasswool Blanket/Board

4. INTERNAL DUCTLINERS

From the previous list of insulation products that provide reasonable sound-absorptive properties are used eg, Glasswool, Rockwool, and Polyester.

THERMAL CONDUCTIVITY: Typical thermal conductivity for internal ductliners is up to 0.036 W/mK 23ºC mean temperature). The required thermal or acoustic performance is achieved by using up to 75mm thick insulation dependent on ductwork location and system capacity.

SOUND ABSORPTION COEFFICIENTS: Internal ductliners provide a reduction of noise generated by fans. Manufacturers of these products publish Sound Absorption Coefficients (SAC's) at a particular frequency, and overall Noise Reduction Coefficients (NRC's) for each of their products.
SAC's and NRC's data is specific to the density, thickness and facing of the product. Most manufacturers also provide insertion loss data for lined ductwork of different dimensions. Sound absorption data is measured using AS ISO 354 "Measurement of Sound Absorption in a Reverberation Room".

Typical sound absorption coefficients for the following range of products can be sourced from manufacturer's data sheets for various densities, thicknesses and facings. Products are normally faced with perforated foil laminate (heavy

duty) to AS/NZS 4200.1 or other protective polymer based films which may achieve higher NRC's.

Glasswool 24 to 48kg/m3
Rockwool 60 to 80 kg/m3
Polyester 20 to 40 kg/m3
Phenolic Foam 50kg/m3

5. VAPOUR BARRIERS FOR EXTERNAL DUCTLINERS

It is necessary to face external insulation with an appropriate vapour barrier to eliminate the possibility of condensation in the insulation or at the metal surface.

MATERIAL: Shall be Medium or Heavy Duty Foil Laminate to AS/NZS 4200 Part 1.

6. PRESSURE SENSITIVE TAPES

Self-adhesive foil tapes are used to seal joins in external foil vapour barriers.

MATERIAL: Pure aluminum or reinforced self adhesive foil tape minimum 48mm wide

7. ELECTRIC HEATER DUCT INSULATION

REQUIREMENT: Provide ductwork housing electric duct heaters with 6mm minimum internal insulation Superwool (bio-soluble) as specified in AS 1668, Part 1, Clause 4.4.2.

8. DUCTWORK INSULATION FIXINGS

FIXING PINS: Welded pins with press on head or welded push through pins.

CHARACTER-ISTICS: Be corrosion resistant.
Indefinitely sustain a 25kg dead load test perpendicular to the duct wall. Be the correct length for the specified insulation thickness.

ANGLES AND CHANNELS: Manufacture angles, cover strips and channels from 0.5mm Galvanized Iron.

9. DUCTWORK INSULATION SELECTION SYSTEM

Extent and Types of Insulation.

The requirements for the extent, types and required thickness to be clearly shown on drawings or schedules in the specification. For additional background, consult AS 4254.2-2012 "Ductwork for air-handling systems in buildings - Rigid duct".

External Insulation of Ductwork.

MATERIAL: Be of a flexible ductwrap insulation of density 20-24kg/m3 having a maximum thermal conductivity of 0.035W/mK at 23 Celsius with an R-Value to meet BCA Specification J5.2.

VAPOUR BARRIER: Factory applied foil laminate vapour barrier, Medium or Heavy Duty Foil Laminate to AS/NZS 4200 Part 1.

10. INTERNAL INSULATION APPLICATION

For additional detail refer to AS 4254.2-2012 "Ductwork for air-handling systems in buildings - Rigid duct" and AS4426 "Thermal Insulation of Pipework, Ductwork and Equipment – Selection, Installation and Finish". Ductliners should also comply with AS1530 Part 3.

A wide range of internal ductliner products are available to meet the particular thermal and acoustic requirements required, contact suppliers listed at the beginning of this guide for product information.

REQUIREMENT: Place the insulation so that the faced surface is exposed to the airstream. Use only single pieces per duct side. If more than one piece is required, tape joins with 72mm tape. Fix metal strip over taped joint.

FIXINGS: Fix the ductwork using steel welded pins and speed clips at 300mm centres and within 300mm of end channels. Install 25 x 25mm corner angles for ducts up to and including 300mm and 50mm x 50mm angles for larger ducts. Finish ends of insulation with "U" channels pop riveted to ductwork. When cover strips are used, fix to corner angles with pop rivets.

Internal insulation application (metal sheathed)

FIXING: Where subject to mechanical damage or high velocity air install 0.6mm Z Sections to ductwork with pop rivets at 600mm centers with a minimum of one row per duct side. Cover with perforated sheathing mechanically fastened at a maximum of 60mm centers with a minimum of one row per duct side.

11. EXTERNAL INSULATION APPLICATION

REQUIREMENT: Install flexible ductwrap (18-24k/m3 Glasswool or equal) to the outside of ducts requiring thermal insulation accordingly to the BCA. Square and butt together the edges of adjacent pieces of insulation, ensure that all surfaces are completely covered and joints are kept to a minimum of one row per side.

Galvanized or zinc coated pins of the correct length for the insulation thickness should be used.

Horizontal ducts less than 400mm will not require pinning, ducts 40 to 750mm are to have one row of pins spaced at no more than 300mm centers along the centre line of the bottom of the duct. Horizontal ducts greater than 750mm shall have pins installed to the sides and bottom of the duct at 300mm centers.

Vertical ducts shall have pins installed at 300mm centers to all surfaces. Speed clips shall be used to secure the insulation to the pins.

HANGERS: Ensure the insulation passes continuously over the entire surface of the duct maintaining unbroken insulation coverage through the hanger.

FLANGES AND PROTRUSIONS: Ensure that flanges and other protrusions are completely covered by the insulation and foil system as a single continuous cover.

Insulation stopped short of flanges and protrusions, leaving them exposed or just foiled over could lead to cold bridging, which is unacceptable.

12. CONDITIONERS, ACOUSTIC WALLS AND PLENUMS

REQUIREMENTS: Insulate the complete conditioner housing (excluding the dividing panels around the heating and cooling coils). Return air mixing plenums on fan coil multi zone units.

Floors not insulated unless specified.

Plenums and acoustic treatment to walls as specified or as detailed on tender drawings.

MATERIAL: Semi rigid batt or board or Acoustic Phenolic Foam nominal thickness 50mm.

FACINGS: Perforated zincanneal sheet 0.6mm with 10% acoustic perforations.

FIXING: Use 50mm x 50mm Z sections manufactured from 0.6mm galvanized steel fixed to walls and/or ceilings at 600mm centers with expandable anchors, ramset, pop rivets or equal depending on the surface to be insulated.

Cut the insulation batts or boards to fit between the Z sections.

Perforated sheeting shall be fitted to the Z sections with a minimum overlap of 20mm at joints in the direction of the air flow. Fix perforated metal at 150mm centres with pop rivet

13. ACOUSTIC TREATMENT OF WASTE WATER PIPES

REQUIREMENTS: Acoustically treat waste water pipework located in ceiling or wall voids as detailed in the tender documents.

MATERIAL: Foil faced loaded vinyl faced with convoluted foam or glasswool insulation. The weight per square metre of the loaded vinyl and thickness of the backing insulation thickness should be as detailed in the tender documents to achieve the required acoustic performance.

FIXING: Cut the acoustic material to the required width to wrap around the pipe, allow an additional 25 mm width to give an overlap. Trim the backing insulation from the lap to ensure a neat overlap. Bend the loaded vinyl around the outside of the pipe allowing the insulation to retain its thickness. Secure the loaded vinyl around the pipe by banding around the outside at 300mm centres with reinforced foil tape or other strong banding material. Tape all butt circumferential and longitudinal joins with reinforced foil tape ensuring there are no gaps between the acoustic material.