Industry Standard: Technical Insulation

Thermal insulation of plumbing & cooling

Sweden
English version

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Preface

This is an industry standard for technical insulation developed by the Insulation Firms Association. One industry standard that will facilitate the entire construction industry - and especially the plumbing industry relevant to technical insulation, which in turn will lead to more durable and climate-smart buildings.

The standard should be a tool for clients, consultants, inspectors, plumbing, refrigeration and insulation contractors.

The standard deals with insulation of both pipe and ventilation ducts and equipment. One standard where different material choices and solutions can be accommodated. There, for example, can be taken into account insulated pipe hangers or so-called spacers.

Part of the purpose of the standard is to develop design tools in the form of tables which can be used during the design stage for new construction and ROT projects (Renovation, Remodeling, Extension) regarding pipe and ventilation systems. The goal is that the content of the tables should weigh both cost and environmental impact associated with a certain insulation product.

The ambition has been to develop a standard that needs to be revised less frequently and which is consistent with European standards in the field.

Our hope is that this industry standard for technical insulation will be able to show the benefits from insulating in an energy wise way. An energy-efficient philosophy in the planning stage, that pays off in the end.

We would like to thank everyone who helped with the development of the standard such as clients, consultants, insulation contractors, material manufacturers and industry colleagues.

The standard has been developed with financial support from **SBUF**, the Swedish Construction Industry Development fund.

The 2nd edition of the standard replaces the 1st edition dated 2020.03.30:

The following changes have been implemented:

☐ **Appendix A:** Proposals for insulation classes for pipe and air handling installations.

☐ **Appendix B:** Calculation process for pipes and ventilation ducts.

☐ **Appendix C:** Building information properties - BIP.

Introduction

The standard contains guidelines aimed at achieving good design and insulation workmanship of technical installations, limiting energy losses, risk of injury, and ensuring reasonable operating conditions and lifecycle perspectives for installations and insulation systems.

The standard assumes that the user has technical insight and knowledge of the legislation in references such as building regulations and the regulations on CE marking of construction products.

The normative part of the standard contains the technical requirements to be met in design and implementation of technical insulation. Appendix A, B and C to the normative text is informative, i.e. indicative.

The project manager is responsible for compliance with Industry Standard Technical Insulation - BTI, in applicable parts and that the documentation is available.

In order to ensure the proper result and function of the technical insulation, the insulation contractor should ensure all information is obtained before the start of the project in question.

Scope

The standard applies to thermal insulation of installations, e.g. heating, ventilation, cooling, solar, water and wastewater treatment plants. The standard applies to indoor and outside installation. For thermal insulation of industrial plants, including process and supply plants, we refer to standards within SSG (Standard Solution Group).

The standard covers all parts of the installation, including flat and curved surfaces of for example ducts and pipe systems, valves, fittings, mounting units and tanks. The standard also applies to pipes between buildings.

The standard does not apply to insulation of the building structure, cold rooms or to insulation of supply lines for district heating and district cooling. The boundary between district heating systems and remote cooling systems and building installation are located at the main system's stopcock.

The standard does not apply to insulation of boilers and heat pumps.

The standard does not deal with any fire requirements. For installations where there are fire requirements these must also be fulfilled.

The standard is designed for installations with operating temperatures between -40 °C and +120 °C.

References

SS-EN 12828: 2012 + A1: 2014 Heating systems in buildings - Design and installation of waterborne heating systems.

SS-EN ISO 12241: 2022 Thermal insulation of installations - Calculation rules.

SS-EN ISO 15758: 2014 Moisture and heat engineering properties of installations - Calculation of water vapor diffusion - Insulation on cold pipes.

DS 452 Issue 3 Thermal insulation of technical installations.

AMA VVS & Kyla 25. (Plumbing and cooling)

Building information properties - BIP: bipkoder.se

Edition and changes

Edition 1

1.01 - Change of D_y from mm to m at pages 10, 11 and 12 (2020.05.15)

Edition 2

Semantic changes in the standard:

Appendix A - Partially new proposals for insulation classes and media temperatures.

Appendix B - Calculation process for pipes and ventilation ducts.

Appendix C - Building information properties - BIP.

2.01 - Changed AMA VVS & Kyla 25 to AMA VVS & Kyla 25

3 - Terms and definitions

3.1 - Products

Product means the insulation itself as well as supplementary products included in the insulation solution.

3.2 - Insulated pipe support

Insulated pipe suspension with the same insulation thickness as the pipe insulation itself. The pipe support prevents heat and cold bridges at the pipe hangers of hot and cold pipes (and also condensation). It reduces thermal losses by 15 % indoors and 25 % outdoors. See also SS-EN ISO 12241: 2022. This type of suspension device should be taken into account in current circumstances. (see also 7.4).
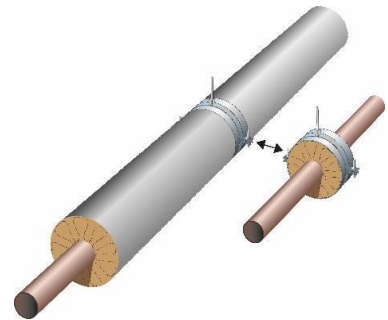
3.3 - Emissivity

Emissivity is a measure of how much an object or material reflects incoming radiation. If ε = 0, all incoming radiation is reflected and if ε = 1 all radiation is absorbed.

Emissivity of a surface layer is an important component in calculating surface temperature.

3.4 - U-value

Heat transfer coefficient U W / $(m^{2} \times K)$ for flat surfaces. Also available as linear heat transfer coefficient U_l W / (m × K) for example with pipes and circular ducts.

3.8 - Hidden spaces

Hidden spaces means spaces where installations cannot be easily accessed or inspected. For example, shafts, slots, in walls, joists, ceilings, above ceilings and the like.

4 - Symbols and units

Symbol	Designation	Unit
ε	Emissivity	
λ	Thermal conductivity	W / (m × K)
D_y	Outer diameter of pipe and duct	m
θ	Media temperature	°C
$θ_e$	Ambient temperature	°C
T	Temperature	°C
U	Heat transfer coefficient	U W / (m² × K)
U_l	Linear heat transfer coefficient	U_l W / (m × K)
R	Insulation classes for pipes	R0 - R7
V	Insulation classes for ventilation ducts	V0 - V6

5 - Insulation classes

5.1 - Determination of insulation level

The insulation level that limits the energy loss is determined based on the insulation classes in table 5.1.1 for pipes and according to table 5.1.2 for ventilation ducts. The mode of operation of the plant and design temperatures determine the choice of insulation class.

The insulation classes are used only to indicate the level of insulation in relation to limitation of energy loss for hot and cold installations. Lower thermal conductivity W/(mK) (lambda value, λ) of the insulation material decreases the insulation thickness. In determining the thickness of the insulation, one must also consider other factors, such as losses at pipe hangers, protection against condensation, fire, sound and microbial growth, etc. – see Chapter 6, installations.

Table 5.1.1 – Insulation classes for pipes and flat surfaces

Insulation Class	U-value requirements for pipes U_l W/(mK)	U-value requirements for flat surfaces U W/(m²K)
R0	No insulation	No insulation
R1	$3,3 \cdot D_y + 0,22$	1,17
R2	$2,6 \cdot D_y + 0,20$	0,88
R3	$2,0 \cdot D_y + 0,18$	0,66
R4	$1,5 \cdot D_y + 0,16$	0,49
R5	$1,1 \cdot D_y + 0,14$	0,35
R6	$0,8 \cdot D_y + 0,12$	0,22
R7	$0,7 \cdot D_y + 0,11$	0,21

The insulation classes are in accordance with SS-EN 12828 in addition to class R7 which is an addendum to this standard. Pipes include circular tubes with an outside diameter, D_y, up to 0,4 m. Flat surfaces include installation parts with flat and slightly curved surfaces and tubes outer diameter, D_y, greater than 0,4 m. The U-value is rounded to 2 decimal places for the requirement level.

Table 5.1.2 – Insulation classes for ventilation ducts and flat surfaces

Insulation Class	U-value requirements for circular ducts U_l W / (m × K)	U-value requirements for flat surfaces U W / (m² × K)
V0	No insulation	No insulation
V1	$1,53 \times D_y + 0,46$	0,70
V2	$0,86 \times D_y + 0,30$	0,37
V3	$0,85 \times D_y + 0,20$	0,32
V4	$0,77 \times D_y + 0,15$	0,27
V5	$0,55 \times D_y + 0,13$	0,19
V6	$0,47 \times D_y + 0,11$	0,16

Circular ducts include ducts with an outside diameter up to 1,0 m.

Flat surfaces include installation parts with flat and slightly curved surfaces as well as circular ducts with a diameter greater than 1,0 m.

The U-value is rounded to 2 decimal places for the requirement level.

5.2 - Calculation of heat emission

Calculation of the U-value for the construction is carried out in accordance with SS-EN ISO 12241: 2022.

Heat transfer coefficient U W / (m^2 × K) for flat surfaces. Also available as linear heat transfer coefficient U_l W / (m × K) for example with pipes and circular ducts.

The declared thermal conductivity of the insulation product W / (m × K) and the current surface layer emissivity, are used in the calculations.

In cases where there are thermal bridges, e.g. suspensions and other parts that penetrate the insulation layer, the increased heat loss from these is included in the installation's U-value. Standardly, the thermal losses increase by 15 % indoors and 25 % outdoors. The energy loss via thermal bridges can also be calculated according to SS-EN ISO 12241:2022.

The calculated U-value is rounded to 2 decimal places se appendix B.1 and B.2.

The U-value of the structure must be less than or equal to the level of requirements.

6 - Installations

6.1 - Purpose and dimension of insulation

Thermally insulated installations:

☐ To minimize energy losses.
☐ Against unintentional heating or cooling of room and installation parts.
☐ To prevent condensation formation.
☐ To prevent microbial growth (legionella).
☐ To prevent media freezing.
☐ To contribute to saving fresh water.
☐ For thermal protection of the media.
☐ Against risks, injuries and other inconveniences.

For each type of installation, the insulation method and insulation class are selected so that the requirements are met.

6.2 - Insulation against energy losses

Installations are insulated so that:

☐ Unintentional heat loss is avoided.
☐ Accidental cooling or heating of the medium is avoided.

6.3 - Hot installations

Hot installations are recommended to be insulated according to Appendix A, A.2 - A.10 (see overview in Tables A.9 and A10), so that the installation has a U or U_l value that does not exceed those listed in Chapter 5. Tables 5.1.1 and 5.1.2 only show the U values that apply to limit energy loss. Consideration must also be given to protection against condensation, freezing, fire, noise, microbial growth (legionella) and protective insulation etc.

6.4 - Cold installations

Cold installations means when the media temperature is below ambient temperature.

Cold installations are insulated according to Appendix A, A.2 - A.10 (see the overview in Tables A.9 and A.10), so that the installation has a U or U_l value not exceeding that specified in Chapter 5.

Installations that can alternately be hot and cold are insulated to meet the U-value requirement in both cases.

Tables 5.1.1 and 5.1.2 only show the U values that apply to limit energy loss. Consideration must also be given to protection against condensation, freezing, fire, noise, microbial growth (legionella) and protective insulation etc.

6.5 - Insulation against external condensation

Cold installations are insulated against external condensation, so no damage occurs to inconvenience the environment, the insulation or the installation. See also SS-EN 15758: 2014.

The insulation is dimensioned so that the surface temperature of the external cladding / vapour barrier is higher than the dew point temperature of the air. The calculation is done according to SS - EN ISO 12241:2022.The vapour diffusion resistance of the vapour barrier should meet the values in Table 6.5.1.

Table 6.5.1 - Minimum specific vapour resistance for vapour barrier on insulating material on cold installations

Media temperature	Minimum specific vapour diffusion resistance (Z)	
°C	m^2sPa/kg	Sd-value (m)
$\theta > 0$	250×10^9	50
$0 \geq \theta \geq -10$	500×10^9	100
$\theta < -10$	*Evaluated in each specific case*	

6.6 - Insulation against internal condensation

Installations for air and other gaseous media are insulated against internal condensation so that no damage to the environment, insulation or installation occurs. See also SS-EN ISO 15758.

6.7 - Insulation against unintentional heating and cooling of space

Hot and cold installations are insulated so that they do not hamper or hinder the control of the temperature in the spaces they pass through. Hot and cold installations are insulated so that they do not inadvertently give off heat or cold into spaces and thus in an unacceptable manner increase the need for cooling or heating.

6.8 - Insulation against freezing

Installations are insulated so that damage does not occur in the environment or in the installation as is, because the medium freezes. Observe protective insulation, see section 6.11. The insulation is dimensioned to protect against freezing for a specified time.

6.9 - Insulation to maintain the temperature of the medium

Installations are insulated so that unacceptable temperature changes in the medium that deteriorate installation function are avoided. Tap cold water and tap hot water pipes are insulated so that the flow time is minimized and so in both cases, the freshwater wastage is reduced.

6.10 - Insulation against microbial growth (legionella)

Tap cold water pipes are insulated so that the general advice in the Swedish National Board of Housing, Building and Construction regulations for microbial growth is met. See also industry regulations "Säker Vatteninstallation".

6.11 - Protective insulation

Hot installations are insulated …
- ☐ so that the surface temperature does not cause injury to persons or pets and does not carry the risk of ignition or other damage to other building components, installations and objects in the building.
- ☐ so that the surface temperature does not exceed 60 °C at any point, except for radiators and their connecting pipes.
- ☐ so that harmful condensation does not occur in e.g. flues.

Cold installations are insulated …
- ☐ so that the surface temperature does not cause cold damage.

6.12 - Insulation level and performance

All parts of the installation are insulated so that current functions of what is described in each Chapter are fulfilled (proposal can be found in Appendix A).

Where pipes and ducts are specified, this includes the entire pipe and duct system including suspensions, fittings and fixtures.

6.13 - Ambient temperature for installations

Ambient temperatures are defined during planning.

7 - Products

7.1 - Product durability - general

Products (see definition under point 3.1) that are included in an insulation solution must be durable with regard to the product's use in the insulation solution, the facility's operating conditions and lifespan. The standard calls for taking into account the products' sustainability performance from a life cycle perspective based on information in the products' EPDs (Environmental Product Declarations), which are also the basis for climate declarations.

7.2 - Insulation products

Insulation products must maintain their insulation properties which were assumed at dimensioning. Insulation products must be CE marked in cases where there is a harmonized product standard available. If such a harmonized standard does not exist, the properties of the insulation products are declared in accordance with the principles applicable to the corresponding CE-labeled products. For thermal properties, this means that the thermal conductivity in the actual temperature range must be verified by testing in an accredited laboratory.

7.3 - Surface coverings

In cases where the insulation product is clad with a cladding, it should be taken into account that any altered emissivity affects the risk of condensation and possible elevation of surface temperature (see 6.11 protective insulation).
See AMA VVS & Kyla, Chapter RC

7.4 - Fasteners

Tube clamps and supports (see 3.2) are only installed according to the manufacturers' instructions and recommendations.

7.5 - Installation instructions

It is the responsibility of the supplier of the product to provide mounting instructions which ensures a consistent and satisfactory result in the finished installation.

8 - Design - Space requirements for pipe and air treatment installations

8.1 - General

Insulation of technical installations is performed according to the supplier's documented installation instructions and considering the properties of the materials, installation method and the impact of the environment. See also 7.1 Product durability – generally.

Control and documentation of the control of the insulation is carried out according to AMA VVS & Kyla 25, chapter Y. In documents that connect to AMA VVS & Kyla 25, or another edition, this must be prescribed in section YHB.5.

In order to ensure the proper result and function of the technical insulation, the insulation contractor should ensure all information is obtained before the start of the project in question.

Which gives the following benefits …

- ☐ Pipe hangers can determine the thickness of the insulation.
- ☐ Approved fire insulation solutions for pipes and air treatment installations require different suspension distances etc. depending on the choice of insulation product.
- ☐ Any adjustments to holes, fire seals etc. can be considered.
- ☐ Insulation of embedded pipes and ducts can be considered.
- ☐ Insulation of valves and flanges can be considered.

Procuring full insulation contract information in good time is both economically and practically advantageous.

8.2 - Insulation space requirements for pipe insulation

Pipelines which are to be insulated shall be mounted so that the distance between insulated pipes and other piping, as well as between fully insulated piping and wall, floor and ceiling surface, is large enough that the insulation work can be carried out. Dimensions of room for pipe installations. When installing insulation and surface cladding one must always have one side of the channel fully accessible to the installer. Take into account obstacles such as crossing pipes, ventilation ducts and cable trays. When insulating consider fire, sound and condensation.

In case of fire insulation follow the manufacturer's instructions.

Space requirements for pipe insulation. The table below is taken from AMA VVS & Kyla 25, table AMA PN/1.

Finished outside diameter after insulation (mm)	a (mm)	b (mm)
- 160	50	50
(160) - 300	100	50
(300) - 500	150	50
(500) - 800	200	100
> 800	300	100

The (b) dimension also applies to the distance to the floor.
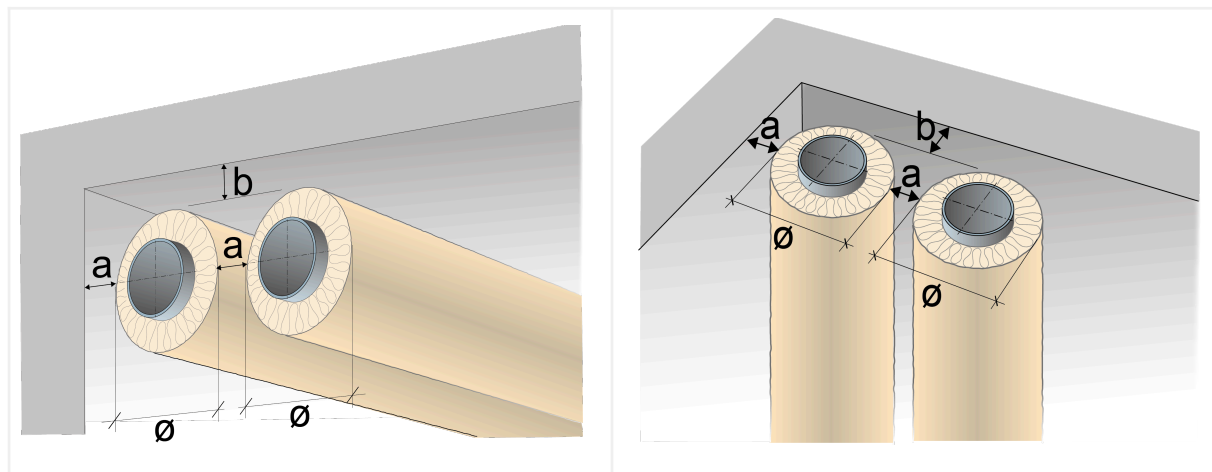
Tap water shaft

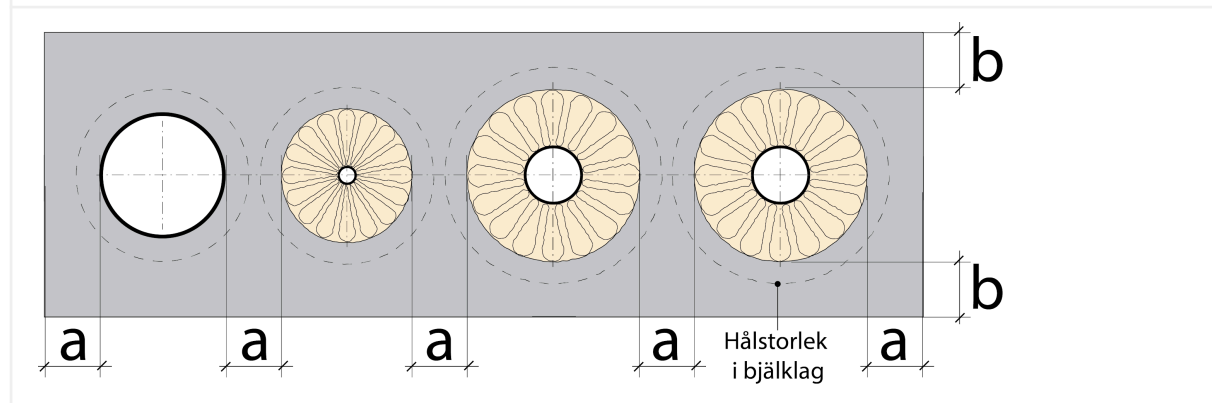## 8.3 - Insulation space requirements for insulation of ventilation ducts

Ventilation ducts which are to be insulated shall be installed so that the distance between the insulated duct and another duct, and between the insulated duct and the wall and ceiling surface, is large enough that the insulation work can be carried out.

Dimensions of space for ventilation ducts. When installing insulation and surface cladding one must always have one side of the duct fully accessible to the installer.
Take into account obstacles such as crossing ducts and cable trays.
When insulating, consider fire, sound and condensation.

In case of fire insulation, follow the manufacturer's instructions.

Space requirements for insulation of circular ducts (refers to duct systems)

Finished outside diameter after insulation (mm)	a (mm)	b (mm)
- 160	50	50
(160) - 300	100	100
(300) - 500	200	100
(500) - 800	300	100
> 800	500	150

The (b) dimension also applies to the distance to the floor.
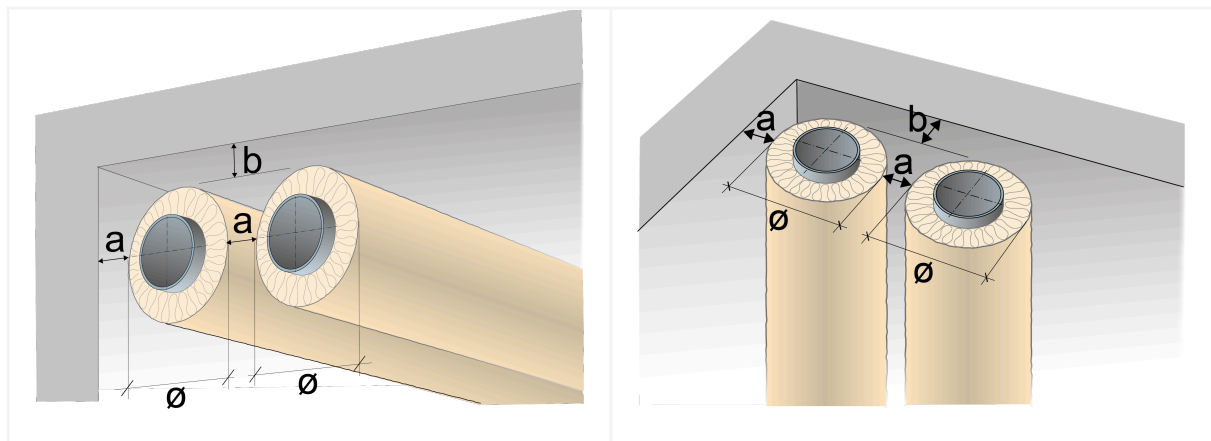
Space requirements for insulation of rectangular ducts (refers to duct systems)

Insulation 2 sides *Channel side < 700 mm* a ≥ 400 mm b = max 30 mm *Channel side ≥ 700 mm* a ≥ 600 mm b = max 30 mm	
Insulation 3 sides *Channel side < 700 mm* a ≥ 400 mm b = max 30 mm *Channel side ≥ 700 mm* a ≥ 600 mm b = max 30 mm	
Insulation 4 sides horizontally *Channel side < 700 mm* a ≥ 400 mm b ≥ 150 mm *Channel side ≥ 700 - 1200 mm* a ≥ 600 mm b ≥ 200 mm. *Channel side ≥ 1200 mm* a and b ≥ 600 mm	
Insulation 4 sides vertically *Channel side <700 mm* a = 400 mm *Channel side ≥ 700 mm* a = 600 mm	
The (b) dimension also applies to the distance to the floor.	
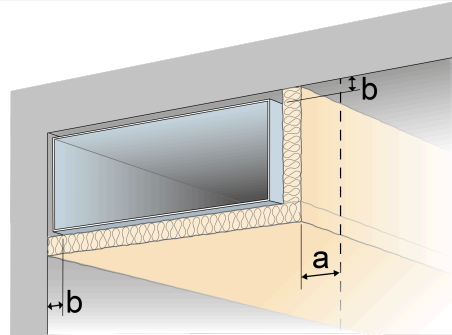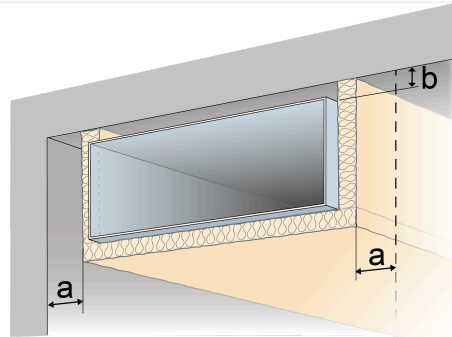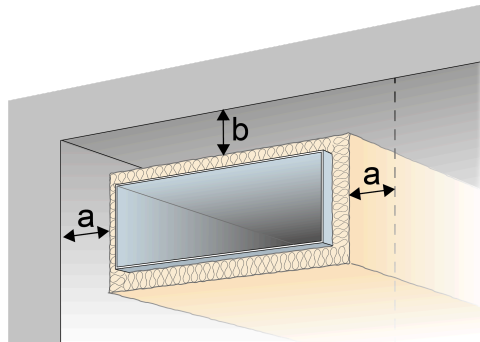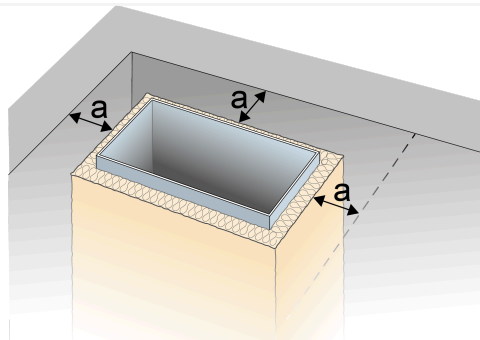
Appendix A

Installations are insulated against energy loss and temperature change of media depending on type of plant and if they are located outside or in heated spaces.

Sections A.1 to A.8 contain the types of installations that the standard deals with.

Tables A.9 and A.10 give suggestions for insulation classes for energy-efficient construction for pipe and air handling applications.

The insulation classes are adapted to common temperatures and operating times. Other conditions require calculating each individual case. Starting from specific conditions such as media temperature, ambient temperature and installation conditions, operating time and location.

The designer indicates the insulation class, R0 - R7 for pipes and V0 - V6 for ventilation ducts,and the calculated insulation thickness in millimetres for different pipe and duct dimensions.

A.1 - Heating system

This group includes the following installations in connection with a (central) heating system i.e. liquid-based installation with heat emitters in the form of radiators, or underfloor heating, as well air heating systems.

- ☐ Main lines, distribution lines and connection lines.
- ☐ Containers such as accumulator tanks.
- ☐ Heat exchanger.
- ☐ District heating plant.

The installations are insulated against energy loss taking into account:

- ☐ The location of the installations and ambient temperatures
- ☐ Operating temperatures (i.e. supply temperatures).
- ☐ Control.
- ☐ Operating time.

Supply and return lines are insulated in the same insulation class.

A.2 - DHW system

The following installations are included:

- ☐ Main lines, distribution lines and connection lines.
- ☐ Fittings (fittings, valves)

The installations are insulated against energy loss in heated spaces regardless of location, operating time and regulatory conditions. Tap hot water pipes are insulated to minimize the flow time (see 6.9).

A.3 - Refrigerant system (comfort cooling)

This includes:

- ☐ Pipe in cooling panels.
- ☐ Pipe for ceiling cooling.
- ☐ Pipes for fan convectors and circulation air coolers.
- ☐ Pipes for coolant tanks.
- ☐ Pipes for coolant recycling systems etc.

A.4 - Tap cold water

Tap cold water pipes are insulated against condensation in heated rooms and against freezing outside. In shafts and joists, the pipes are also insulated so that the risk of microbial growth (legionella) is minimized. Note that the insulation thickness is dependent on pipe diameters, shaft design and temperatures.Tap cold water pipes are insulated so that the flow time is minimized (see 6.9 and 6.10).

A.5 - Groundwater and aeration pipes for wastewater

Groundwater pipes passing through heated spaces are insulated against condensation and accidental cooling of the space. Also includes aeration pipes for wastewater venting. Also take into account any need for sound insulation.

A.6 - Air treatment plant

Installations are insulated against energy loss and temperature change of media depending on type of plant and if they are located outside or in heated spaces. The industry standard provides proposals for insulation classes for air treatment plants in table A.10. Air has a low heat capacity so it is important to design correctly for conditions (temperature and air velocity) and then determine the insulation class. This is especially true for variable flow systems, VAV systems, where temperature change usually is the driver.

Exhaust air ducts in heated rooms are not normally insulated against energy losses.
Duct outlets located in the room they serve can usually be uninsulated.
Supply air ducts in systems without added cooling, air temperature between 15°C and 23°C, located in heated rooms, may have minimal or no insulation for energy loss reasons.

Ventilation ducts in exhaust air systems without heat recovery can be uninsulated. However, they should be insulated against condensation where necessary.

Ventilation ducts for outdoor air intake and exhaust air in heat recovery plants, can be uninsulated against energy loss when placed where the air temperature of the duct is equal to the ambient temperature. Ventilation ducts for outdoor air intake and exhaust air in heated rooms are insulated against condensation and unintentional cooling of the space.

A.7 - Heat pump system

This includes:

- ☐ Liquid for water heat pumps.
- ☐ Air to water heat pumps.
- ☐ Air to air heat pumps.
- ☐ Pipes and hoses connecting outer and inner parts.

A.8 - Solar collector

This includes:

- ☐ Thermal solar panel pipelines.

A.9 - Proposal of insulation classes for pipe installations

The standard calls for calculating each individual case and then choosing the insulation class. Assume specific conditions such as media temperature and the operating time of the installations and location. The insulation classes below are adapted for common occurrence temperatures and operating times. **The insulation classes do not consider fire.**

Plumbing connections - Ambient temperature ≥ 10 °C indoors		
Type of installation	Installation part	Insulation Class
Heating System (VS)	Media temperature max 35 °C	**R4**
	Media temperature max 60 °C	**R5**
	Media temperature max 90 °C	**R6**
	Media temperature max 120 °C	**R7**
	Fittings (fittings, valves, flanges etc.)	**R2**
	Pipes cast in concrete (VS)	**R3**
	Visible pipelines located in the same room as the heat emitter	**R0**
Tap Water		
Domestic hot water (VV)	Distribution and connection lines located in other spaces than the tap	pipe outer diameter **≤ 22 mm R6[2]** **> 22mm R5[2]**
	Visible pipelines located in the same room as the tap	**R0**
Hot water circulation (VVC)	Pipes for hot water circulation.	pipe outer diameter **≤ 22 mm R6[2]** **> 22mm R5[2]**
Co-located heating pipes (VV + VVC)	Co-located heating pipes, in case of co-insulation (insulation thickness is based on pipe outer diameter VV)	**R5[2]**
Tap cold water (KV)	Pipes for cold water. Separate shafts (KV separated from VV)	**R4[1] [2]**
	Pipes intended for cold water. Combined shaft (VV and KV)	pipe outer diameter **≤ 22 mm R7[1] [2]** **> 22mm R5[1] [2]**
	Visible pipelines located in the same room as the tap	**R0[1]**
	Pipes cast in concrete (VV, VVC and KV)	**R3[1] [2]**
	Fittings (fittings, valves, flanges etc.)	**R2[1]**
Sewerage system	Internal pipes	**R2[1]**
Refrigerant system	Coolant (KM) piping to the cooler	**R3[1]**
	Coolant circuit 13 - 15 °C (dry cooling)	**R2[1]**
	Coolant circuit 5 - 13 °C (wet cooling)	**R2[1]**
Solar collector	Pipes from thermal solar panel	**R5**
Heat pumps	Earth and rock heat (hot connection pipes)	**R5**
	Air - air and air - liquid, hot pipes to the outdoor unit	**R5**
	Air - air and air - water, cold pipes to the outdoor unit	**R4[1]**

[1] *Insulate against condensation precipitation according to conditions (see 6.5 and 7.1).*
[2] *Consider microbial growth (legionella), choose an insulation class according to pipe diameter, shaft size and other conditions.*

A.10 - Proposal on insulation classes for air treatment installations

The standard calls for calculating each individual case and then choosing the insulation class. Assume specific conditions such as media temperature and the operating time of the installations and location.

Air has a low heat capacity which is why it is important to dimension with regard to temperature drop under the right conditions (temperature and air velocity) and thereafter determine insulation class. This is especially true for variable flow systems, VAV systems, where the temperature change usually is the driver.

The insulation classes below are adapted for commonly occurring temperatures and operating times. **The insulation classes do not consider fire.**

Air handling installations		
	Ambient temperature	
Installation part	< 10 °C outside incl. cold attic	≥ 10 °C indoors
	Insulation class	
Outdoor air	V0[1]	V2[1]
Exhaust	V0[1]	V0[1]
Exhaust air during heat recovery	V1[1]	V2[1]
Ducts insulated with loose wool	V4[1]	V1[1]
Supply air ducts in systems without added heating or cooling, air temperature between 15 °C and 23 °C.	V4[1]	V1[1]
Supply air ducts in systems with added heating or cooling, air temperature between 15 °C and 23 °C.	V4[1]	V2[1]
Ventilation ducts in exhaust air systems without heat recovery	V0[1]	V0[1]
Extract air ducts with heat recovery	V4[1]	V1[1]
Duct outlets located in the room they serve	-	V0[1]

[1] *Insulate against condensation according to conditions (see 6.5 and 7.1)*

Appendix B

An insulation class specifies the minimum requirement for how much the installation parts must be insulated. For each insulation class, a maximum U-value W / (m² × K) is defined for surfaces and a maximum linear U_l-value W / (m × K) for pipes and circular ducts. The insulation class is selected with regard to operating conditions.

B.1 - Calculation procedure for pipe insulation.

Table B.1.1 - U-value requirements for insulation classes for pipes and flat surfaces

	Calculated U-value requirements for pipes according to table 5.1.1						
	Insulation class						
Outer diameter	R1	R2	R3	R4	R5	R6	R7
mm	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)
12	0,26	0,23	0,20	0,18	0,15	0,13	0,12
15	0,27	0,24	0,21	0,18	0,16	0,13	0,12
18	0,28	0,25	0,22	0,19	0,16	0,13	0,12
22	0,29	0,26	0,22	0,19	0,16	0,14	0,13
28	0,31	0,27	0,24	0,20	0,17	0,14	0,13
35	0,34	0,29	0,25	0,21	0,18	0,15	0,13
42	0,36	0,31	0,26	0,22	(0,19)	0,15	0,14
48	0,38	0,32	0,28	0,23	0,19	0,16	0,14
54	0,40	0,34	0,29	0,24	0,20	0,16	0,15
60	0,42	0,36	0,30	0,25	0,21	0,17	0,15
70	0,45	0,38	0,32	0,27	0,22	0,18	0,16
76	0,47	0,40	0,33	0,27	0,22	0,18	0,16
89	0,51	0,43	0,36	0,29	0,24	0,19	0,17
108	0,58	0,48	0,40	0,32	0,26	0,21	0,19
114	0,60	0,50	0,41	0,33	0,27	0,21	0,19
Flat surface W/(m²K)	1,17	0,88	0,66	0,49	0,35	0,22	0,21

Example for pipe insulation:

Outer diameter: **42 mm**, media temperature: **55 ºC**, ambient temperature: **20 ºC**, insulation class: **R5**.

U-value requirements according to **Industry Standard Table 5.1.1:** 1.1 × 0.042 + 0.14 = 0.1862 which gives U_l requirement 0.19 W / (m × K). See table B.1.1.

The difference between media temp and indoor temperature = 35 °C. This means that the permitted heat loss for insulation class R5 is 35 × 0.19 = **6.7 W/m**. The insulation thickness can then be calculated, for example, with the material producers software.

B.2 - Calculation procedure for ventilation duct

Tabell B.2.2 – U-value requirements for insulation classes for ventilation ducts and flat surfaces

| Outer diameter | Calculated U-value requirements for ventilation ducts according to table 5.1.2 | | | | | |
| | Insulation class | | | | | |
	V1	V2	V3	V4	V5	V6
mm	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)
100	0,61	0,39	0,29	0,23	0,19	0,16
125	0,65	0,41	0,31	0,25	0,20	0,17
160	0,70	0,44	0,34	0,27	0,22	0,19
200	0,77	0,47	0,37	(0,30)	0,24	0,20
250	0,84	0,52	0,41	0,34	0,27	0,23
315	0,94	0,57	0,47	0,39	0,30	0,26
400	1,07	0,64	0,54	0,46	0,35	0,30
500	1,23	0,73	0,63	0,54	0,41	0,35
630	1,42	0,84	0,74	0,64	0,48	0,41
800	1,68	0,99	0,88	0,77	0,57	0,49
1000	1,99	1,16	1,05	0,92	0,68	0,58
Flat surface W/(m²K)	0,70	0,37	0,32	0,27	0,19	0,16

Example for duct insulation:

Duct outer diameter: **200 mm**, Media temperature: **20 ºC**, Ambient temperature: **0 ºC**, Insulation class: **V4**.

U-value requirements according to **industry standard table 5.1.2:** $0.77 \times 0.200 + 0.15 = 0.304$ which gives U_l requirement 0,30 W / (m × K). See table B.1.2

The difference between media temperature and ambient temperature = 20 °C. This means that the permitted heat loss must be 20 × 0,30 = **6 W/m** in the current case. The insulation thickness can then be calculated, for example, with the material producers software.

Appendix C

C.1 - Building Information Properties - BIP

BIP - Building Information Properties, is a system for properties and designations for objects in buildings. With the help of BIP, builders, installers, architects, other designers and property owners can use the same designations and characteristics. Communication in the projects is significantly facilitated.

BIP satisfies a need to have standardized names for the properties that are set on objects during BIM planning. You want to be able to use the properties, or parameters, that are set on objects in CAD files in many different contexts during the project. With a consistent name, it is easier to build systems and functions that can be reused in all projects.

Industry standard Technical Insulation is mentioned in and has codes in BIP.

BIP covers construction and installations and can be found in a common database that is freely available at bipkoder.se

Discipline and main category in BIP that refers to Industry standard technical insulation	
Discipline	**Main category**
Insulation class (k)	Insulation class R0 - R7 according to BTI for pipes
Insulation class (k)	Insulation class V0 - V6 according to BTI for ventilation ducts
VS	Composite thermal insulation of installations
VS	Thermal insulation of pipeline
Ventilation	Thermal insulation of ventilation duct
Where k is insulation class from BTI R0 to R7 and V0 to V6.	

BIP code example

VS21-42-R6DF60-C

VS2	Heating system, secondary, radiators
1	Sequence number for the system VS2x where x = 1
42	Pipe diameter in mm
-R6	Insulation class R6 according to BTI
D	Suspension with pipe support
F	Pipe section of mineral wool with surface layer of reinforced aluminum foil
60	Insulation thickness in mm
-C	Surface layer with plastic sheet

Information on the substance of the standard is provided by the

Association of Insulating Companies, Sweden (IF - Isoleringsfirmornas Förening)

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