



Set: 2020-03-30

Issue 1.01

- Industry Standard: Technical Insulation -
Thermal insulation of plumbing & cooling

Sweden

English version

Information on the substance of the standard is provided by the
Association of Insulating Companies, Sweden (**IF** - Isoleringsfirmornas Förening)
Phone: +46 8 762 75 37 | e-mail: info@tekniskisolering.se | www.tekniskisolering.se

Table of Contents	Page
Preface	5
Introduction	6
Scope	7
References	8
Edition and changes	8
3 Terms and definitions	9
4 Symbols and units	10
5 Insulation classes	11
5.1 Determination of insulation level.....	11
5.2 Calculation of heat emission	12
6 Installations	13
6.1 Purpose and dimension of insulation.....	13
6.2 Insulation against energy losses.....	13
6.3 Hot installations.....	13
6.4 Cold installations	13
6.5 Insulation against external condensation	14
6.6 Insulation against internal condensation	14
6.7 Insulation against unintentional heating and cooling of space.....	14
6.8 Insulation against freezing	14
6.9 Insulation to maintain the temperature of the medium.....	14
6.10 Insulation against microbial growth (legionella).....	14
6.11 Protective insulation	15
6.12 Insulation level and performance	15
6.13 Ambient temperature for installations	15
7. Products	16
7.1 Product durability - general.....	16
7.2 Insulation products.....	16
7.3 Surface coverings.....	16
7.4 Pipe clamps and insulated pipe supports.....	16
7.5 Installation instructions.....	16
8 Design - Space requirements for pipe and air treatment installations	17
8.1 General	17
8.2 Insulation space requirements for pipe insulation	18
8.3 Insulation space requirements for insulation of ventilation ducts	19

Appendix A 21

- A.1 Heating system..... 21
- A.2 DHW system..... 21
- A.3 Refrigerant system (comfort cooling) 21
- A.4 Tap cold water..... 22
- A.5 Groundwater and aeration pipes for wastewater 22
- A.6 Air treatment plant 22
- A7. Heat pump system 22
- A8. Solar collector 22
- A.9 Recommendation on insulation classes for pipe installations..... 23
- A.10 Recommendation on insulation classes for air treatment installations 25

Preface

The Association of Insulators has developed an industry standard for technical insulation. One industry standard that will facilitate the entire construction industry - and especially the plumbing industry relevant technical insulation, which in turn will lead to more durable and climate-smart buildings. The standard should be a tool for both 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 does not need to be revised every three years 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.

March 2020

The Association of Insulating Companies

Johan Gustafsson

Johan Sjölund

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 to the normative text is informative, ie indicative.

Building facilities are subject to building requirements, and the requirements for sizing of insulation are given in section 6, installations. The project manager is responsible for compliance with the standard 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 building 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, 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: 2008 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 Plumbing & Cooling 19.

Edition and changes

1.01 – Change of D_y from mm to m at pages 10, 11 and 12 (2020-05-12)

3 Terms and definitions

3.1 Products

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

3.2 Indoor

Spaces in all floors, attic and basement that are temperature controlled, intended to be heated to more than 16 °C and limited by the inside of the climate screen.

3.3 Secondary space

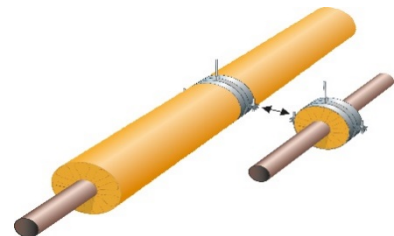
The category includes spaces heated to 5 - 16°C.

3.4 Outdoors

Includes placement of installations outdoors and in unheated spaces.

3.5 Insulated pipe support

Insulated pipe suspension with the same insulation thickness as the pipe insulation itself, see Chapter 5.1 and 5.2. 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 according to standard SS-EN ISO 12241: 2008. This type of suspension device should be taken into account in current circumstances.



3.6 Emissivity

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

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

3.7 U-value

Heat transfer coefficient U W/m²K for flat surfaces. Also available as linear heat transfer coefficient U_l W/mK 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/mK
D_y	Outer diameter of pipe and duct	m
θ	Media temperature	°C
θ_e	Ambient temperature	°C
T	Temperature	°C

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 $W/m \text{ }^{\circ}C$ (λ 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_i W/mK	U-value requirements for flat surfaces U W/m ² K
R0	No insulation	No insulation
R1	$3,3 \cdot Dy + 0,22$	1,17
R2	$2,6 \cdot Dy + 0,20$	0,88
R3	$2,0 \cdot Dy + 0,18$	0,66
R4	$1,5 \cdot Dy + 0,16$	0,49
R5	$1,1 \cdot Dy + 0,14$	0,35
R6	$0,8 \cdot Dy + 0,12$	0,22
R7	$0,7 \cdot Dy + 0,11$	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, Dy , up to 0,4 m.

Flat surfaces include installation parts with flat and slightly curved surfaces and tubes outer diameter, Dy , 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_i W/mK	U-value requirements for flat surfaces U W/ m²K
V0	No insulation	No insulation
V1	$1,53 \cdot D_y + 0,46$	0,70
V2	$0,86 \cdot D_y + 0,30$	0,37
V3	$0,85 \cdot D_y + 0,20$	0,32
V4	$0,77 \cdot D_y + 0,15$	0,27
V5	$0,55 \cdot D_y + 0,13$	0,19
V6	$0,47 \cdot D_y + 0,11$	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: 2008.

The declared thermal conductivity of the insulation product W/m °C (λ) 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. The energy loss via heat bridges can be calculated in accordance with SS-EN ISO 12241:2008, Annexes A and B. By default, thermal losses increase by 15% indoors and 25% outdoors.

The calculated U-value is rounded to 2 decimal places.

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 media.
- Against risks, injuries and other inconveniences...

...to an extent such that the requirements of this chapter are met.

For each type of installation, the insulation method and insulation class are selected so that the requirements 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_i 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 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 A10), so that the installation has a U or U_i 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 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.

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)	
	m ² sPa/kg	Sd-value (m)
°C		
θ > 0	250 * 10 ⁹	50
0 ≥ θ ≥ -10	500 * 10 ⁹	100
θ < -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.

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 injuries.

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 (recommendations 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

Temperatures are defined in Chapter 3.

7. Products

7.1 Product durability - general

Products (see definition under 3.1) included in an insulation solution shall be resistant to use in the insulation solution, in regard to the plant's operating conditions and service life.

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 Plumbing & Kyla 19, Chapter RC

7.4 Pipe clamps and insulated pipe supports

Tube clamps and supports (see 3.5) 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 taking into account the properties of the materials, installation method and the impact of the environment.

Inspection of the insulation is carried out according to AMA HVAC & Cooling 19, Chapter Y.

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 distance 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

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 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 and cable trays.

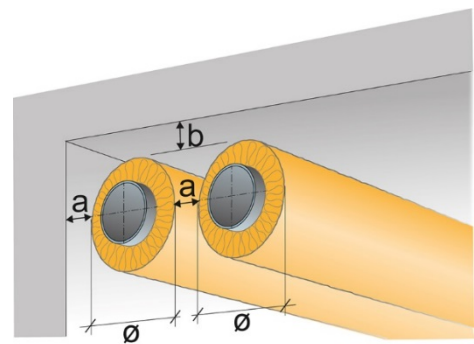
When insulating, consider fire, sound and condensation

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

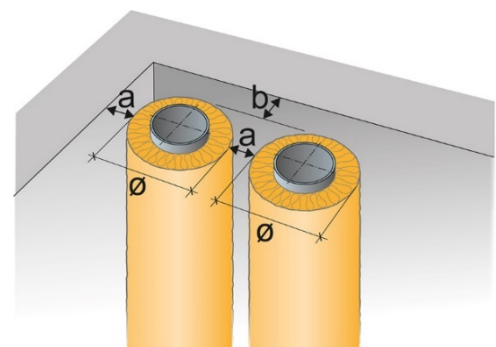
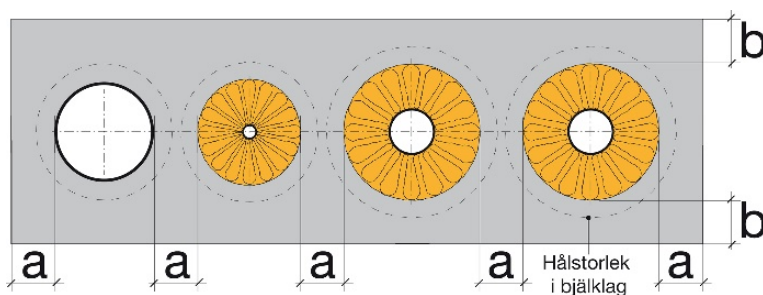
For insulation of pipes see AMA HVAC & Cooling 19, Table PN / 1.

Space requirements for pipe insulation (pipes)

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



Tap water conduit



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.

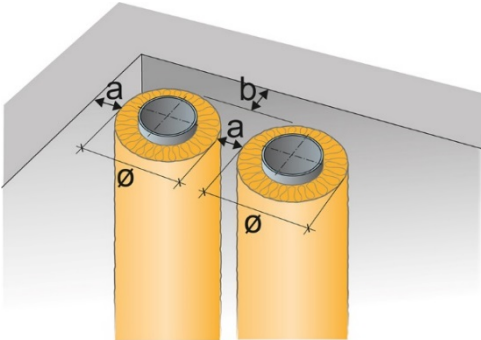
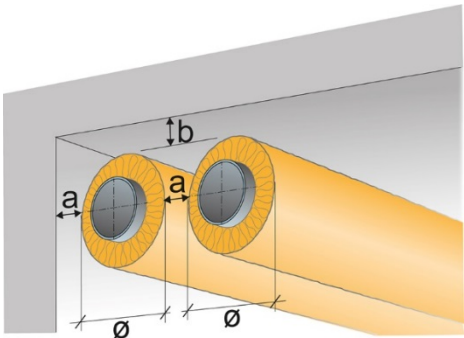
Take into account obstacles such as crossing ducts and cable trays.

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, etc., mm	a mm	b mm
-160	50	50
(160) -300	100	100
(300) -500	200	100
(500) -800	300	100
> 800	500	150



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

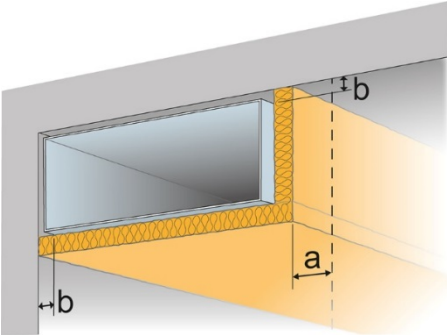
Insulation 2 sides

Channel side <700 mm

- a ≥ 400 mm
- b = max 30 mm

Channel side ≥ 700 mm

- a ≥ 600 mm
- b = max 30 mm



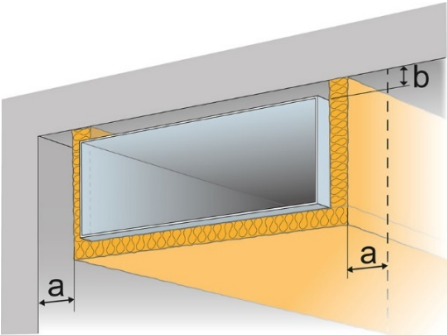
Insulation 3 sides

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

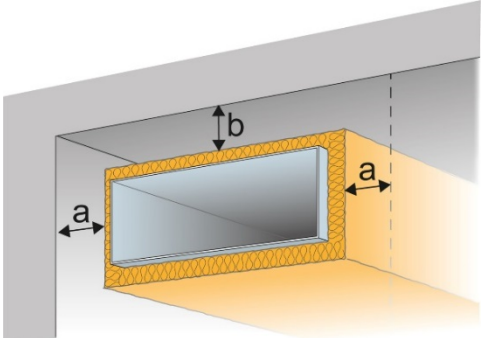
- a ≥ 400 mm
- b ≥ 150 mm.

Channel side ≥ 700 - 1200 mm

- a ≥ 600 mm
- b ≥ 200 mm.

Channel side ≥ 1200 mm

- a and b ≥ 600 mm



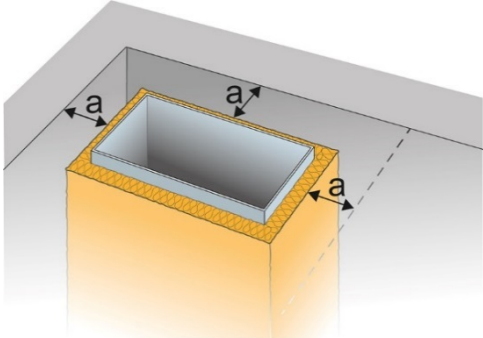
Insulation 4 sides vertically

Channel side <700 mm

- a = 400 mm

Channel side ≥ 700 mm

- a = 600 mm



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 recommendations for pipe and air treatment applications with insulation classes for an energy efficient construction.

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

A.1 Heating system

This group includes the following installations in connection with a (central) heating system ie 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, outdoors, bi-spaces or indoors.
- 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
- Fan coil devices
- 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. Tap cold water pipes are insulated so that the flow time is minimized (see 6.9).

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.

Supply air ducts (for supply air devices) in the space they serve can usually be uninsulated. Supply air ducts with air temperature between 15-23°C, in heated rooms, are not normally insulated against energy loss.

Ventilation ducts in exhaust air systems without heat recovery can be uninsulated. However, they should be insulated against condensation if the ducts are located in the bi-spaces (see 3.3).

Ventilation ducts for outdoor air intake and exhaust air in heat recovery plants, can be uninsulated against energy loss when placed in auxiliary spaces (see 3.3). Ventilation ducts for outdoor air intake and exhaust air in heated rooms are insulated against condensation and unintentional cooling of the space.

A7. 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

A8. Solar collector

This includes: thermal solar panel pipelines

A.9 Recommendation on 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			
Type of installation	Installation part	Ambient temperature	
		Secondary S 5 - 16°C	Indoor >16°C
		Insulation Class	
Heating System (VS)	Visible pipes in the same room as a heat emitter	R0	R0
	Pipes and distribution lines in heating systems, with outdoor compensation, max 55°C	R6	R5
	Pipes and distribution lines in heating systems, with outdoor compensation, max 35°C	R5	R4
	Pipes and distribution lines in heating systems, with constant temperature, 55 - 60°C	R7	R6
	Other cases including district heating within the building and distribution lines between buildings (culverts)	R7	R7
	Fittings (fittings, valves, flanges etc.)	R2	R2
	Pipes cast in concrete (VS)	R3	R3
Tap Water			
Domestic hot water (VV)	Distribution and connection lines located in other spaces than the tap.	R7 ²⁾	R6 ²⁾
	Visible pipelines located in the same room as the tap.	R0	R0
Hot water circulation (VVC)	Pipes for hot water circulation.	R7 ²⁾	R6 ²⁾
	VVCi, (VVC in VV) - co-insulation	R5 ²⁾	R4 ²⁾
Tap cold water (KV)	Distribution and connection lines located in other spaces than the tap, shared conduit (hot and cold)	R6 ^{1) 2)}	R5 ^{1) 2)}
	Distribution and connection lines located in spaces other than the tap, separate conduits (hot and cold)	R5 ^{1) 2)}	R4 ^{1) 2)}
	Visible pipelines located in the same room as the tap.	R0 ¹⁾	R0 ¹⁾
	Fittings (fittings, valves, flanges etc.)	R2 ¹⁾	R2 ¹⁾
	Pipes cast in concrete (VV, VVC and KV)	R3 ^{1) 2)}	R3 ^{1) 2)}

Sewer system	Internal pipes	R2 ¹⁾	R2 ¹⁾
Refrigerant system	Coolant (KM) piping to the cooler.	R3 ¹⁾	R3 ¹⁾
	Coolant circuit 13 - 15°C, dry cooling	R2 ¹⁾	R2 ¹⁾
	Coolant circuit 5 - 13°C, wet cooling	R2 ¹⁾	R2 ¹⁾
Solar collector	Pipes from thermal solar panel	R6	R5
Heat pumps	Earth and rock heat (hot connection pipes)	R5	R5
	Air - air and air - water, hot pipes to the outside	R6	R5
	Air - air and air - water, cold pipes to the outside	R0 ¹⁾	R4 ¹⁾

¹⁾ Insulate against condensation precipitation according to conditions (see 6.5 and 7.1).

²⁾ Consider microbial growth (legionella) – choose insulation class according to conditions.

A.10 Recommendation 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			
Installation part	Ambient temperature		
	Outside	Secondary space 5 - 16°C	Indoor >16°C
	Insulation Class		
Outdoor air	V0 ¹⁾	V2 ¹⁾	V3 ¹⁾
Exhaust	V0 ¹⁾	V0 ¹⁾	V0 ¹⁾
Exhaust air during heat recovery	V1 ¹⁾	V1 ¹⁾	V2 ¹⁾
Ducts insulated with loose wool	V5 ¹⁾	V3 ¹⁾	V1 ¹⁾
Supply air ducts in systems without added cooling, air temperature between 15°C and 23°C	V5 ¹⁾	V3 ¹⁾	V1 ¹⁾
Supply air ducts in systems with added cooling, air temperature between 15°C and 23°C	V5 ¹⁾	V3 ¹⁾	V2 ¹⁾
Ventilation ducts in exhaust air systems without heat recovery	V0 ¹⁾	V0 ¹⁾	V0 ¹⁾
Extract air ducts with heat recovery	V5 ¹⁾	V4 ¹⁾	V1 ¹⁾
Duct outlets located in the room they serve	-	V0 ¹⁾	V0 ¹⁾

¹⁾ Insulate against condensation according to conditions (see 6.5 and 7.1).