

Technical Specifications (In-Cash Procurement)

Technical specification for thermal insulation of CWS in TKC

This technical specification provides the technical requirements for materials, manufacturing, and supply of thermal insulation for CCWS and CHWS pipes, valves and fittings in B11 from L2, B11 PCs, DTR and B14. For HCF and CCF material fire protection requirements are considered as well.

Fire wrapping without any thermal insulation function (PFP material) is out of scope of this supply as it will be managed by centralized procurement for all PBSs.

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1 Purpose

This technical specification provides the technical requirements for materials, manufacturing, and supply of thermal insulation for CCWS and CHWS pipes, valves and fittings in B11 (from L2 included and above levels in addition to Drain Tank Room and Port Cells) and B14 under IO scope of supply. It includes:

- Thermal insulation tagged as NBR: flexible elastomeric anti-condensation thermal insulation for CHWS-H2 (Chilled Water System H2), CHWS-1A (Chilled Water System 1A) and CHWS-1B (Chilled Water System 1B) pipes, valves, fittings and pressurizer in order to ensure that their anti-condensation requirements are met.
- Thermal insulation tagged as HC: mineral wool thermal insulation for CCWS-1 (Component Cooling Water System 1) and CCWS-1A (Component Cooling Water System 1A) pipes, valves and fittings in order to ensure that their hot conservation requirements are met.
- Thermal insulation tagged as HCF and CCF: microporous pyrogenic silica thermal insulation for pipes, valves and fittings of all CWS loops inside TKC to ensure that their fire protection requirements in addition to hot conservation requirement (for HCF) or anti-condensation requirements (for CCF) are met.

2 Scope of work

The work to be performed comprises the manufacturing, supply and delivery to IO site of thermal insulation for pipes, valves and fittings installed in TKC. The work under this specification shall be completed in every detail for the purpose required.

The Contractor shall:

1. Supply the thermal insulation material according to this technical specification.
2. Supply the cladding material according to this technical specification.
3. Supply installation instructions including how to realize the insulation of fittings and valves, the requirements for the attachments (collars, drawstrings, locking ties, etc.) and guidance about how to realize the external physical protection (i.e. cladding) of the thermal insulation with stainless steel sheet so that the contractor responsible for the installation will have the necessary information to install the material as required and as tested.
4. Supply the necessary documentation such as:
 - a. Product datasheet
 - b. Certificate of Conformity / Declaration of Performance (in accordance with Article 7(3) of Regulation (EU) No 305/2011 [R1]) (if available)
 - c. Type III Environmental Product Declaration according to ISO 14025 [R2] (if available)
5. Follow IO instructions regarding delivery to site of materials and components in accordance with section 10
6. Follow IO requirements regarding the tagging/marking of the supplied thermal insulation material in order to ensure a good traceability during installation (see section 10)
7. As an option, provide a quotation for the performance of the qualification for CCF and HCF thermal insulation in accordance with section 6.3.

The supplied material has the following classification:

Material supplied	Safety classification	Vacuum class	Remote Handling class	Tritium class	Quality class	Seismic class
NBR thermal insulation for CHWS-1A and CHWS-1B	SIC	N.A.	N.A.	N.A.	QC-1	SC-1
NBR thermal insulation for CHWS-H2	Non-SIC	N.A.	N.A.	N.A.	QC-2	NSC
HC thermal insulation	Non-SIC	N.A.	N.A.	N.A.	QC-2	NSC
HCF and CCF thermal insulation (including thermal insulation protecting fire sector boundaries)	SIC	N.A.	N.A.	N.A.	QC-1	SC-1

3 Definitions

TERM	DEFINITION
Customer	ITER International Fusion energy Organisation.
Certificate of Conformity	Certificate issued by the Supplier stating that the product concerned meets the requirements as specified in the Supplier's catalogue and/or this technical specification.
Deviation	A non-compliance with a defined requirement or non-compliance with a requirement set by the IO integrated management system that could affect the provisions of the Environment Code
Non-conformance	Any condition that does not comply with a specified IO requirement.
Nuclear Operator	The ITER Organisation (the IO)
Protection Important Activity	An activity which can impact a Protection Important Component.
Protection Important Component	A component important for protecting the interests of public security as defined in the INB Order [R17] and the Environmental Code.
Safety Important Class	Classification corresponding to the graduated approach of a PIC as defined in the Preliminary Safety Report.
Subcontractor	Any entity that performs work for the Supplier.
Supplier	Any entity that provides goods or services to the ITER Organisation.

4 Requirements for thermal insulation NBR (flexible elastomeric anti-condensation)

The thermal insulation material NBR shall be based on flexible elastomeric foam as specified in EN 14304 [R3].

The thermal insulation material NBR shall not contain harmful respirable fibres (e.g. asbestos) and has to be environmentally friendly. The material provided shall be halogen free in accordance with DIN / VDE 0472 part 815 [R13]. For outdoor installation only (i.e. thermal insulation for pressurizer), there is no need of halogen free properties.

The thermal insulation material NBR shall have high water vapour diffusion resistance and low thermal conductivity. In particular, the thermal conductivity of the anti-condensation thermal insulation should be below 0.040 [W/ m K] at a mean temperature of 0 [°C] in order to limit the required thickness and minimize the thermal losses. The thermal conductivity values are to be measured according recognized international standards such as ISO 8497 [R4], EN 12667 [R5] or ASTM C177 [R6]. The water vapour diffusion resistance factor (μ -factor) shall be higher than 6000 and shall be measured according to EN 12086 [R7] or equivalent. For the thermal insulation which is required to be halogen-free, a vapour diffusion resistance factor higher than 2000 may be accepted.

The thermal insulation material NBR shall be low-flammable, however flammability classes D and E according to EN 13501-1 [R8] may be accepted as well due to halogen-free requirements. If the flammability has been assessed according to other recognized international standards (e.g. NF P92-507 [R9], ASTM E84 [R10] or BS476 [R11]), the flammability performance shall be equivalent or better than the above mentioned classifications.

The service temperature range shall be at least 0 – 50 [°C]. The service temperature rating shall be tested according to EN 14706 [R12] or equivalent, considering the criteria of standard EN 14304 [R3].

The thermal insulation material NBR shall be compatible with stainless steel ASTM A 312 TP 304L / ASTM A358 GR 304L since the protected pipes and fittings are based on these materials. The thermal insulation material NBR shall be compatible with stainless steel AISI 304 as its cladding will be based on these materials. Cladding material is included in the scope of supply.

The thermal insulation NBR for piping shall be compatible with indoor as well as outdoor installation since the protected pipes and equipment are located inside and outside buildings.

The thermal insulation NBR for pipes shall be provided in blankets (continuous sheets) or tubes depending on the pipe DN: tubes are recommended up to DN100 included, blankets for larger sizes. For pipe fittings (elbows, bends, etc.) it is recommended to provide the thermal insulation in preformed shapes, whenever possible. The thermal insulation for the pressurizer shall be provided in blankets. Further information how to realize thermal insulation for valves are in Appendix C.

The thermal insulation NBR shall be dimensionally correct, completely dry and in an undamaged condition. Edge damages, surface distortions or thickness irregularities (beyond the allowed tolerance according to EN 14304 table 1 [R3]) in the cross section are not allowed. Technical details about piping and fittings can be found in [R14].

The Supplier is responsible to follow and meet the requirements set in sections 4, 4.1 and 4.2 and to apply the proper engineering practice, so that the whole quantity of thermal insulation NBR will meet the applicable norms and standards, together with the specific requirements of this technical specification and of the design documentation provided by IO in the list of applicable document to the contract.

The Supplier may suggest alternative insulating materials meeting the performance requirements and the intent of this specification. In such cases, the Supplier shall provide justification for using alternative materials. The suggested material shall be subjected to approval of IO.

4.1 Expected NBR max thickness – indoor piping

The thickness of the thermal insulation NBR for indoor piping should not exceed the values stated in Table 1.

Table 1: Thermal insulation NBR - max thickness for piping

Pipe DN range	Max insulation thickness (including product tolerance)
DN10 – DN65	27 [mm]
DN80 - DN800	34 [mm]

The Supplier shall confirm the thickness considering that the allowed maximum temperature measured on the external surface of the thermal insulation shall not exceed 26 [°C] for a surrounding air temperature of 35 [°C] and relative humidity of 60 [%] considering:

- Fluid inner temperature (min/max): 6 [°C] / 12 [°C]
- Pipe material: Stainless steel ASTM A 312 TP 304L / ASTM A358 GR 304L
- Flowing medium inside pipes: demineralised water
- Cladding material: stainless steel with 0.5 [mm] thickness

4.2 Expected NBR max thickness – pressurizer

The thickness of the thermal insulation NBR for pressurizer should not exceed the values stated in Table 2.

Table 2: Thermal insulation NBR - max thickness for pressurizer (outdoor)

Pressurizer outer diameter	Halogen free requirement	Max insulation thickness (including product tolerance)
766 [mm]	N	42 [mm]

The Supplier shall submit a calculation demonstrating that the thickness of the offered material is able to limit the temperature measured on piping surface below 35.4 [°C] for a surrounding air temperature of 45 [°C] and relative humidity of 60 [%] and considering the following input:

- Fluid inner temperature: 6 [°C]
- Pressurizer material: Stainless steel
- Flowing medium inside pipes: demineralised water
- Cladding material: stainless steel with thickness 0.5 [mm]

5 Requirements for thermal insulation HC (mineral wool)

The thermal insulation HC material shall be based on mineral wool as per EN 14303 [R15].

The thermal insulation HC material shall not contain harmful respirable fibres (e.g. asbestos) and has to be environmentally friendly. The material provided shall be halogen free in accordance with DIN / VDE 0472 part 815 [R13]

The thermal conductivity of the thermal insulation HC should be below 0.042 [W/ m K] at a mean temperature of 100 [°C] in order to limit the required thickness and minimize the thermal losses. The thermal conductivity values are to be measured according recognized international standards such as ISO 8497 [R4], EN 12667 [R5] or ASTM C177 [R6]. The thermal insulation HC shall be water repellent and tested for water absorption and retention.

The thermal insulation HC shall be low-flammable. The minimum classification in terms of flammability is B s3 d0 according to EN 13501-1 [R8]. For the thermal insulation which is required to be halogen-free, flammability classes D and E according to EN 13501-1 [R8] may be accepted as well. If the flammability has been assessed according to other recognized international standards (e.g. NF P92-507 [R9], ASTM E84 [R10] or BS476 [R11]), the flammability performance shall be equivalent or better than the above mentioned classifications.

The service temperature range shall be at least 0 – 100 [°C]. The service temperature rating shall be tested according to EN 14706 [R12] or EN 14303 [R15] or equivalent.

The thermal insulation material shall be compatible with stainless steel ASTM A 312 TP 304L / ASTM A358 GR 304L since the protected pipes and fittings are based on these materials.

The thermal insulation HC shall be compatible with stainless steel AISI 304 as its cladding will be based on these materials.

The thermal insulation HC shall be compatible with indoor installation since the protected pipes are located inside buildings.

The thermal insulation HC shall be provided in blankets (continuous sheets) or preformed shapes. Further information how to realize thermal insulation for valves are in Appendix C.

The thermal insulation HC shall be supplied with wire mesh on both sides.

The density of thermal insulation HC shall not exceed 150 [kg/m³].

The thermal insulation HC shall be dimensionally correct, completely dry and in an undamaged condition. Edge damages, surface distortions or thickness irregularities (beyond the allowed tolerance according to EN 14303 table 1[R15]) in the cross section are not allowed.

Cladding material is included in the scope of supply (see section 7).

Technical details about piping and fittings can be found in [R14].

The Supplier is responsible to follow and meet the requirements set in section 5 and 5.1 and to apply the proper engineering practice so that the whole quantity of thermal insulation HC will meet the applicable norms and standards, together with the specific requirements of this technical

specification and of the design documentation provided by IO in the list of applicable document to the contract.

The Supplier may suggest alternative insulating materials meeting the performance requirements and the intent of this specification. In such cases, the Supplier shall provide justification for using alternative materials. The suggested material shall be subjected to approval of IO.

5.1 Expected HC max thickness

The thickness of the thermal insulation HC should not exceed the values stated in Table 3.

Table 3: Thermal insulation HC- max thickness

Pipe DN	Inner fluid temperature	Max temperature on thermal insulation external surface	Max insulation thickness (including product tolerance)
DN80	64 [°C]	45 [°C]	20 [mm]
DN250	41 / 43 [°C]	37 [°C]	30 [mm]
DN500	80 [°C]	59 [°C]	25 [mm]
DN1600	80 [°C]	59 [°C]	25 [mm]

The Supplier shall confirm the thickness considering that the allowed maximum temperature measured on external surface of thermal insulation shall not exceed the values stated in Table 3 for a surrounding air temperature of 35 [°C] and considering the following input:

- Inner fluid temperature: according to Table 3
- Pipe material: Stainless steel ASTM A 312 TP 304L / ASTM A358 GR 304L
- Flowing medium inside pipes: demineralised water
- Cladding material: stainless steel
- Stainless steel cladding thickness: 0.5 [mm]

6 Requirements for thermal insulation HCF and CCF (microporous pyrogenic silica)

The thermal insulation material HCF and CCF shall be based on microporous pyrogenic silica. In addition, the thermal insulation CCF shall be water repellent / hydrophobic, as it has to be suitable in applications as anti-condensation thermal insulation. For HCF there is no need of having hydrophobic properties.

The thermal insulation material HCF and CCF shall not contain harmful respirable fibres (e.g. asbestos) and has to be environmentally friendly. The material provided shall be halogen free in accordance with DIN / VDE 0472 part 815 [R13].

The thermal conductivity of the HCF and CCF thermal insulation should very low even at high temperatures and shall be sufficient to meet the criteria for temperature rise of pipe and maximum thickness provided in section 6.1 and 6.2. Thermal conductivity values are to be measured

according recognized international standards such as ISO 8497 [R4], EN 12667 [R5] or ASTM C177 [R6].

The thermal insulation material HCF and CCF shall be non-combustible. The minimum classification in terms of flammability is A_{2L} s₃ d₀ according to EN 13501-1 [R8]. If the flammability has been assessed according to other recognized international standards (e.g. NF P92-507 [R9], ASTM E84 [R10] or BS476 [R11]), the flammability performance shall be equivalent or better than the above mentioned classifications.

The service temperature range shall be at least 0 – 100 [°C]. The material shall be resistant up to 1050 [°C] considering that it shall ensure adequate protection during a 2 hours ISO-834 nominal temperature fire curve.

The thermal insulation material shall be compatible with stainless steel ASTM A 312 TP 304L / ASTM A358 GR 304L since the protected pipes and fittings are based on these materials.

The thermal insulation material shall be compatible with stainless steel AISI 304 as its cladding is based on these materials. Cladding material is included in the scope of supply (see section 7).

The thermal insulation shall be compatible with indoor installation since the protected pipes are located inside buildings.

The thermal insulation shall be provided in blankets (continuous sheets) or preformed shells. Further information how to realize thermal insulation for valves are in Appendix C. Technical details about piping and fittings can be found in [R14].

The thermal insulation shall be dimensionally correct, completely dry and in an undamaged condition. Edge damages, surface distortions or thickness irregularities (beyond the allowed tolerance) in the cross section are not allowed.

The Supplier is responsible to follow and meet requirements set in section 6, 6.1 and 6.2 and to apply the proper engineering practice, so that the whole quantity of thermal insulation will meet the applicable norms and standards, together with the specific requirements of this technical specification and of the design documentation provided by IO in the list of applicable document to the contract.

The Supplier may suggest alternative insulating materials meeting the performance requirements and the intent of this specification. In such cases, the Supplier shall provide justification for using alternative materials. The suggested material shall be subjected to approval of IO.

6.1 Expected CCF max thickness

The thickness of the thermal insulation CCF should not exceed the values stated in Table 4.

Table 4: Thermal insulation CCF- max thickness

Pipe DN	Max insulation thickness (including product tolerance)
Up to DN25 included	75 [mm]
From DN32	50 [mm]

The Supplier shall confirm the thickness considering that:

- a. The allowed maximum temperature measured on pipe wall after exposure to 2 hours ISO-834 standard temperature time curve does not exceed 190[°C] for CHWS-1A and CHWS-1B, 185[°C] for CHWS-H2; for this analysis the pipe is considered empty and the pipe wall thickness is according to standard schedule 40.
- b. The allowed maximum temperature measured on the outer surface of the thermal insulation shall not exceed 26 [°C] for a surrounding air temperature of 35 [°C] and relative humidity of 60 [%] and considering the input data provided in section 4.1.

6.2 Expected HCF max thickness

The thickness of the thermal insulation HCF should not exceed the values stated in Table 5:

Table 5: Thermal insulation HCF - max thickness

Pipe DN	Max insulation thickness (including product tolerance)
Up to DN40 included	50 [mm]
From DN50	25 [mm]

The Supplier shall confirm the thickness considering that:

- a. The allowed maximum temperature measured on pipe wall after exposure to 2 hours ISO-834 standard temperature time curve does not exceed 220 [°C] for CCWS-1 pipes, 210 [°C] for CCWS-1A pipes, 200 [°C] for CCWS-2A pipes, 190 [°C] for CCWS-2B pipes; for this analysis the pipe is considered empty and the pipe wall thickness is according to standard schedule 40.
- b. The allowed maximum temperature measured on external surface of thermal insulation shall not exceed 37 [°C] for a surrounding air temperature of 35 [°C] and considering an inner fluid temperature of 43 [°C].

6.3 Qualification requirements

As an option, the Supplier shall provide a quotation for the qualification activities for HCF and CCF thermal insulation. The qualification can be performed either by design, by reference to existing qualification certificates, by analysis or by qualification testing. In case additional qualification testing to demonstrate compliance with the requirements will be necessary, IO and the Contractor shall share the ownership of the resulting certification (procès-verbal) for any such tests. The typical means of qualification expected for various technical requirements is given in Appendix B. The Contractor may propose alternative means for demonstrating compliance, to be agreed with the IO

7 Requirements for cladding

Thermal insulation cladding shall be provided by the Supplier. The cladding shall be delivered in coils. The material shall be stainless steel grade AISI 304 with a minimum thickness of 0.6±0.1 [mm].

For the removable sections of valves and flanges, stainless steel AISI 304 sheet with minimum 0.6±0.1 mm thickness shall be used.

For some specific locations with radiation issues (e.g. port cells, B11-L3 shielded), the impurities inside the steel used for cladding shall be within the limits set in [R32], namely:

- Cobalt = max 0.05%
- Niobium = max 0.10%
- Tantalum = max 0.0%

It is estimated that the impurities limits for stainless steel cladding are applicable for around 15% of the total amount of cladding to be procured.

8 Regulatory Requirements

ITER is a licensed nuclear facility as defined in the Decree of Authorisation of Creation of ITER-INB-174 [R16] and consequently IO, the Nuclear Operator, must comply with the French Order of 7th February 2012 [R17] establishing the general rules for licensed nuclear installations (INB-Order).

Certain components, structures and systems of ITER are classified as important for the interests of public safety as defined under Article L 593-1 of the French Environmental Code and are further classified according to the area or service (i.e. their function). Specific quality assurance requirements must be applied which are proportional to the importance of what they protect.

The components specified in these technical specifications will perform/contribute to some safety functions and hence, under the scope of the INB-Order, these are classified as Protection Important Components.

The IO as Operator is responsible for ensuring that Protection Important Components are qualified, supplied, and applied to meet their safety functions in compliance with their associated safety requirements and under the requirements of the INB-Order [R17].

The Supplier must demonstrate compliance with the provisions for the implementation of the INB Order [R17] including the defined requirements (articles 2.5.1 and 2.5.2) in their organisation and in the chain of subcontractors. All external actors of the ITER project shall implement the requirements set in [R31] in order to satisfy the requirements of the INB Order.

9 Quality Assurance Requirements

9.1 Quality Management

The Supplier's Quality Assurance Programme (QAP) is subject to approval by the IO in accordance with the ITER QA Programme and shall be applied to all work carried out as a result of any contract arising from this specification.

The ITER QA Programme is based on IAEA Safety Standard GS-R-3 and on conventional QA principles and integrates the requirements of the French Order dated 7th February 2012 [R17] on the quality of design, construction and operation of Licensed Nuclear Installations. For this purpose, the Supplier shall ensure that any subcontractors carrying out work placed under the prime contract are in compliance with the QA requirements under the relevant QA classifications.

The general requirements are detailed in ITER Integrated Safety, Quality and Security Policy [R23] and ITER Procurement Quality Requirements [R19] whilst the specific requirements for the supervision of the supply chain for Protection Important Components, Structures, Systems and Activities is detailed in [R20].

9.2 Quality Plan

Prior to commencement of the work, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the qualification and experience of the named individuals involved including who will act as Independent Reviewer(s) and any anticipated sub-contractors. Curricula Vitae shall be provided.

The Quality Plan shall demonstrate how the work will be controlled and shall include a Test Plan Procedure.

9.3 Protection Important Components and Activities

For Protection Important Components, structures and systems and Protection Important Activities, a specific management system must be implemented by the Supplier and any subcontractor working on protective important activities, on the basis of activities defined and executed by the Supplier and Subcontractor.

This system could be included in the Quality Plan. This management system will include the evaluation of Non-Conformance Reports whether major or minor [R21].

The use of computer software to perform a safety based task or activity such as analysis and/or modelling shall be reviewed and approved by the IO prior to its use, in accordance with [R22].

9.4 Deviations and Non-Conformances

A deviation is defined in the Order [R17] as a non-compliance with a defined requirement or non-compliance with a requirement set by the licensee's integrated management system that could affect the provisions of the Environment Code. Deviations must follow the ITER procedure for management of deviation request [R24], while non-conformances must follow the ITER procedure for management on nonconformities [R25].

9.5 Additional Surveillance Requirements

ITER Organisation is the Nuclear Operator and has the ultimate responsibility for the application of the INB Order [R17] within the IO and in its chain of suppliers. IO must undertake additional surveillance for those components which are classified as Protection Important Components. The Supplier shall therefore grant access to the IO and ASN representatives to its facilities and records and those of its subcontractors for the purposes of surveillance.

9.6 Documentation

All safety related documentation developed as a result of this work shall be provided to the IO. Any other documentation developed as a result of this work shall be retained by the Supplier for a minimum of 5 years and then it may be discarded at the direction of the IO.

10 Labelling, Cleaning, Packaging and Shipment requirements

10.1 Labelling and Traceability

All components shall be clearly marked in a permanent way and in a visible place with the IO official numbering system according to [R33].

10.2 Cleaning

During cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter, particularly from the coolant passages and sealing surfaces. Final cleaning shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the materials. The Supplier shall submit to the IO the proposed cleaning procedure for approval/acceptance. The demonstration of meeting the above cleaning requirements represents a Hold Point (HP).

10.3 Packaging and Handling

The supplier shall design and supply appropriate packaging, adequate to prevent damage during shipping lifting and handling operations. Shock absorbing material shall be used. Each shipment shall be accompanied by a Delivery Report prepared by the Supplier, stating as a minimum:

- The packing date;
- The full address of the place of delivery and the name of the person responsible to receive the package, as well as of the Supplier's name and full address;
- Bill of Materials
- Security Measures
- Contractor Release Note in accordance with [R34];
- Packing List [R37];
- Material Safety Sheet;
- Safety classification of the material delivered;
- The declaration of integrity of the package;
- The declaration of integrity of the components;
- Any additional relevant information on the status of the components.

The Delivery Report shall be signed by a representative of the IO and its Supplier. The signature by the IO of the Delivery Report prior to shipment represents a Hold Point (HP).

10.4 Shipment, Transportation and Delivery to the ITER Site

The components shall be delivered to IO site as DAP Cadarache. Before the shipment, a Release Note shall be prepared in accordance with [R35] and approved by the IO. The Release Note together with the delivery report [R36], the packing list reflecting the content of the release note [R37] and the equipment storage and preservation requirements form [R38] shall be submitted to logistic.data@iter.org at least 15 working days prior to the planned shipment date.

Upon receipt of the package, the IO shall open the package and make a visual inspection of its content to check:

- The integrity of the package, including identifying visible damage;
- The number and type of components contained in the shipment;
- The enclosed documentation;
- The integrity of the components.

In the case of anomalies the IO shall make any additional relevant remark on the inspection. A decision on acceptance of the delivery of the components will be made by the IO. If the components are in an acceptable condition, the IO will sign the Delivery Report. The signature of the Delivery Reports is an IO Hold Point. The original of the Delivery Report shall be kept by the IO and a copy of it shall be kept by the Supplier.

11 Contract management - responsibilities

The IO shall nominate a representative (IO Responsible Officer, or IO-RO) who is responsible for all matters relating to the execution of this contract. The IO is responsible for providing all of the input data to the Contractor in a complete and timely manner. The Contractor shall nominate a representative who is responsible for all the matters relating to this contract.

12 Deliverables schedule

Final deliverables schedule is given separately for each supply order. An estimation of the schedule is provided in Table 6.

Table 6: Estimated deliverable schedule

Deliverable	Due Date
Quality plan	2 weeks after contract signature
Documentation stated in section 2	4 weeks after contract signature
Material delivery	The material will be delivered in several batches using Supply Orders starting from second quarter of 2021 and ending in 2024. The material will be delivered with monthly/bimonthly frequency depending on construction activity schedule. Material delivery will be expected to commence 3 to 5 weeks after signature of each Supply Order, however the precise delivery schedule will be included in the Supply Request for the specific Supply Order.
Delivery report	2 weeks before each material batch delivery
Qualification	If necessary, expected to start in 2021 and ending latest in 2022.

13 Acceptance criteria

ITER IO will perform proper inspections after the delivery of this material for checking:

- the delivered quantities according to the packing list;
- the required documentation in section 2
- the specification requirements

At the end of the inspection, IO will sign the handover documentation.

14 Estimated BOQ - Bill of Quantity

An estimation of the quantity of each thermal insulation material needed is provided in the tables below. More accurate BOQs and isometrics will be given separately at each supply order.

Table 7: Estimated BOQ for NBR halogen free thermal insulation for CHWS-1A

Element	DN	Quantity thermal insulation type NBR HF	Unit
Pipe	15	60	m
Pipe	20	8	m
Pipe	25	1	m
Pipe	40	23	m
Pipe	50	17	m
Pipe	65	69	m
Pipe	80	196	m
Pipe	100	22	m
Reducer	20 / 15	3	pc
Reducer	25 / 15	6	pc
Reducer	40 / 15	4	pc
Reducer	65 / 50	3	pc
Valve	15	10	pc
Valve	20	3	pc
Valve	25	3	pc
Valve	40	6	pc
Valve	65	3	pc
Valve	80	6	pc
Elbow 45deg	15	6	pc
Elbow 45deg	40	8	pc
Elbow 45deg	65	7	pc
Elbow 45deg	80	7	pc
Elbow 90deg	15	30	pc
Elbow 90deg	20	8	pc
Elbow 90deg	25	3	pc
Elbow 90deg	40	26	pc
Elbow 90deg	50	13	pc
Elbow 90deg	65	25	pc
Elbow 90deg	80	62	pc
Tee	40	3	pc
Tee	50	2	pc
Tee	65	4	pc
Reducing Coupling	40 / 25	3	pc
Half Coupling	100	2	pc
Thredolet	40	2	pc
Thredolet	80	3	pc
Weldolet	80	9	pc
Weldolet	65	4	pc
Weldolet	80	6	pc
Weldolet	100	2	pc
Instrument	15	10	pc
Latrolet	40	3	pc

Table 8: Estimated BOQ for NBR thermal insulation for CHWS-1B pressurizer

Element	DN	Quantity thermal insulation type NBR	Unit
Pressurizer	-	8	m ²

Table 9: Estimated BOQ for NBR thermal insulation halogen free for CHWS-1B

Element	DN	Quantity thermal insulation type NBR HF	Unit
Pipe	15	270	m
Pipe	25	99	m
Pipe	40	199	m
Pipe	65	34	m
Pipe	80	16	m
Pipe	100	105	m
Pipe	150	287	m
Pipe	200	319	m
Reducer	40 / 15	4	pc
Reducer	40 / 25	10	pc
Reducer	100 / 80	3	pc
Reducer	200 / 100	6	pc
Valve	15	26	pc
Valve	25	12	pc
Valve	40	8	pc
Valve	65	3	pc
Valve	80	3	pc
Valve	150	6	pc
Valve	200	11	pc
Elbow 45deg	15	15	pc
Elbow 45deg	25	17	pc
Elbow 45deg	40	12	pc
Elbow 45deg	80	3	pc
Elbow 45deg	100	3	pc
Elbow 45deg	150	16	pc
Elbow 45deg	200	10	pc
Elbow 90deg	15	78	pc
Elbow 90deg	25	39	pc
Elbow 90deg	40	91	pc
Elbow 90deg	65	13	pc
Elbow 90deg	80	10	pc
Elbow 90deg	100	21	pc
Elbow 90deg	150	71	pc
Elbow 90deg	200	46	pc
Tee	15	6	pc
Tee	40	8	pc
Tee	65	3	pc
Tee	100	3	pc
Tee	150	3	pc
Tee	200	6	pc
Blind flange	25	2	pc
Thredolet	25	2	pc
Thredolet	40	6	pc
Thredolet	80	2	pc
Weldolet	100	2	pc
Weldolet	150	4	pc
Weldolet	200	16	pc
Instrument	15	13	pc
Reducing Coupling	25 / 15	3	pc
Half Coupling	100	3	pc
Half Coupling	150	6	pc
Half Coupling	200	3	pc

Table 10: Estimated BOQ for NBR thermal insulation halogen free for CHWS-H2

Element	DN	Quantity thermal insulation type NBR HF	unit
Pipe	15	30	m
Pipe	20	4	m
Pipe	25	23	m
Pipe	40	1681	m
Pipe	50	726	m
Pipe	80	475	m
Pipe	100	165	m
Pipe	150	327	m
Pipe	200	3	m
Pipe	250	352	m
Pipe	300	159	m
Pipe	400	33	m
Pipe	500	11	m
Reducer	25 / 15	2	pc
Reducer	40 / 25	3	pc
Reducer	50 / 40	133	pc
Reducer	80 / 40	11	pc
Reducer	80 / 50	23	pc
Reducer	100 / 40	71	pc
Reducer	100 / 50	8	pc
Reducer	100 / 80	16	pc
Reducer	150 / 80	16	pc
Reducer	150 / 100	11	pc
Reducer	200 / 150	3	pc
Reducer	250 / 150	3	pc
Reducer	300 / 200	3	pc
Reducer	400 / 300	3	pc
Reducer	500 / 300	3	pc
Valve	15	56	pc
Valve	20	12	pc
Valve	25	32	pc
Valve	40	143	pc
Valve	50	52	pc
Valve	80	14	pc
Valve	150	3	pc
Valve	300	7	pc
Valve	500	6	pc
Elbow 45deg	40	150	pc
Elbow 45deg	50	28	pc
Elbow 45deg	80	75	pc
Elbow 45deg	100	26	pc
Elbow 45deg	150	41	pc
Elbow 45deg	250	7	pc
Elbow 45deg	300	11	pc
Elbow 90deg	15	43	pc
Elbow 90deg	20	3	pc
Elbow 90deg	25	45	pc
Elbow 90deg	40	775	pc
Elbow 90deg	50	231	pc
Elbow 90deg	80	25	pc
Elbow 90deg	100	3	pc
Elbow 90deg	150	38	pc

Element	DN	Quantity thermal insulation type NBR HF	unit
Elbow 90deg	250	16	pc
Elbow 90deg	300	12	pc
Tee	40	104	pc
Tee	50	49	pc
Tee	80	65	pc
Tee	100	26	pc
Tee	150	13	pc
Tee	200	3	pc
Flange	40	7	pc
Flange	50	3	pc
Flange	80	11	pc
Flange	300	13	pc
Blind flange	40	2	pc
Blind flange	300	2	pc
Threadolet	40	2	pc
Threadolet	50	2	pc
Threadolet	80	2	pc
Threadolet	150	2	pc
Threadolet	300	2	pc
Cap	40	3	pc
Weldolet	50	3	pc
Weldolet	80	29	pc
Weldolet	100	6	pc
Weldolet	150	16	pc
Weldolet	250	3	pc
Weldolet	300	6	pc
Instrument	15	13	pc
Instrument	40	41	pc
Instrument	50	7	pc
Instrument	150	4	pc
Instrument	300	2	pc
Nipple	15	3	pc
Nipple	20	26	pc
Nipple	25	16	pc
Half Coupling	80	11	pc
Half Coupling	100	78	pc
Half Coupling	150	12	pc
Half Coupling	250	16	pc
Half Coupling	300	8	pc
Half Coupling	500	6	pc
Bend	40	0	pc
Bend	50	0	pc
Bend	150	2	pc
Bend	300	0	pc
Reinforcing pad	250	3	pc
Reinforcing pad	500	3	pc

Table 11: Estimated BOQ for HC thermal insulation for CCWS-1

Element	DN	Quantity thermal insulation type HC	unit
Pipe	25	1	m
Pipe	250	76	m
Pipe	500	45	m
Pipe	1600	40	m
Valve	25	2	pc
Valve	250	3	pc
Elbow 45deg	250	2	pc
Elbow 90deg	250	26	pc
Elbow 90deg	500	12	pc
Flange	250	3	pc
Blind flange	25	2	pc
Weldolet	250	4	pc

Table 12: Estimated BOQ for HC thermal insulation for CCWS-1A

Element	DN	Quantity thermal insulation type HC	unit
Pipe	250	85	m
Valve	250	4	pc
Elbow 90deg	250	30	pc
Flange	250	3	pc
Weldolet	250	8	pc

Table 13: Estimated BOQ for HCF thermal insulation for CCWS-1

Element	DN	Quantity thermal insulation type HCF	unit
Pipe	15	4	m
Pipe	250	30	m
Pipe	500	15	m
Valve	15	3	pc
Valve	250	4	pc
Valve	500	8	pc
Elbow 90deg	15	7	pc
Elbow 90deg	250	12	pc
Weldolet	250	3	pc

Table 14: Estimated BOQ for HCF thermal insulation for CCWS-1A

Element	DN	Quantity thermal insulation type HCF	unit
Pipe	15	4	m
Pipe	25	1	m
Pipe	250	32	m
Valve	15	3	pc
Valve	25	2	pc
Valve	250	4	pc
Elbow 45deg	250	3	pc
Elbow 90deg	15	10	pc
Elbow 90deg	250	22	pc
Half Coupling	250	2	pc
Weldolet	250	3	pc

Table 15: Estimated BOQ for CCF thermal insulation for CHWS-1A

Element	DN	Quantity thermal insulation type CCF	unit
Pipe	15	54	m
Pipe	20	12	m
Pipe	25	48	m
Pipe	40	32	m
Pipe	50	40	m
Pipe	65	50	m
Pipe	80	78	m
Pipe	100	122	m
Reducer	20 / 15	6	pc
Reducer	40 / 25	6	pc
Reducer	50 / 25	2	pc
Reducer	65 / 50	3	pc
Reducer	80 / 40	3	pc
Reducer	100 / 40	3	pc
Reducer	100 / 80	3	pc
Valve	15	4	pc
Valve	20	8	pc
Valve	25 / 25	15	pc
Valve	25 / 50	15	pc
Valve	50	8	pc
Valve	65	6	pc
Valve	80	6	pc
Valve	100	12	pc
Elbow 45deg	15	2	pc
Elbow 45deg	25	6	pc
Elbow 45deg	40	6	pc
Elbow 45deg	50	8	pc
Elbow 45deg	65	4	pc
Elbow 45deg	80	8	pc
Elbow 45deg	100	13	pc
Elbow 90deg	15	25	pc
Elbow 90deg	20	18	pc
Elbow 90deg	25	12	pc
Elbow 90deg	40	15	pc
Elbow 90deg	50	12	pc
Elbow 90deg	65	21	pc
Elbow 90deg	80	34	pc
Elbow 90deg	100	41	pc
Tee	25	3	pc
Tee	40	3	pc
Tee	80	3	pc
Tee	100	8	pc
Half Coupling	100	3	pc
Reduce Coupling	20 / 15	3	pc
Blind flange	25	2	pc
Threadolet	50	2	pc
Threadolet	80	2	pc
Weldolet	50	3	pc
Weldolet	65	3	pc
Weldolet	80	6	pc
Weldolet	100	10	pc
Instrument	15	10	pc

Table 16: Estimated BOQ for CCF thermal insulation for CHWS-1B

Element	DN	Quantity thermal insulation type CCF	unit
Pipe	15	6	m
Pipe	25	12	m
Pipe	40	4	m
Pipe	50	2	m
Pipe	100	80	m
Valve	15	2	pc
Valve	25	6	pc
Valve	40	3	pc
Valve	50	2	pc
Valve	100	12	pc
Elbow 45deg	25	2	pc
Elbow 45deg	100	8	pc
Elbow 90deg	15	6	pc
Elbow 90deg	25	12	pc
Elbow 90deg	40	2	pc
Elbow 90deg	50	6	pc
Elbow 90deg	100	20	pc
Tee	40	7	pc
Tee	100	3	pc
Flange	40	2	pc
Flange	100	6	pc
Reducing Coupling	25 / 15	3	pc
Thredolet	40	2	pc
Thredolet	100	8	pc
Weldolet	100	8	pc
Instrument	15	8	pc

Table 17: Estimated BOQ for CCF thermal insulation for CHWS-H2

Element	DN	Quantity thermal insulation type CCF	unit
Pipe	300	6	m
Valve	150	2	pc
Valve	300	2	pc

15 References

- [R1] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC Text with EEA relevance
- [R2] ISO 14025 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures
- [R3] EN 14304 - Thermal insulation products for building equipment and industrial installations. Factory made flexible elastomeric foam (FEF) products. Specification
- [R4] ISO 8497 - Thermal insulation -- Determination of steady-state thermal transmission properties of thermal insulation for circular pipes
- [R5] EN 12667 - Thermal performance of building materials and products. Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance
- [R6] ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- [R7] EN 12086 Thermal insulating products for building applications. Determination of water vapour transmission properties
- [R8] EN 13501-1 - Fire classification of construction products and building elements. Classification using test data from reaction to fire tests
- [R9] NF P92-507 - Building — Interior fitting materials - Classification according to their reaction to fire
- [R10] ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- [R11] BS476-7 - Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products
- [R12] EN 14706 Thermal insulation products for building equipment and industrial installations. Determination of maximum service temperature
- [R13] DIN VDE 0472-815 - Testing of cables, wires and flexible cords - non-halogen verification
- [R14] Piping Material Specification for CCWS, CHWS and HRS (ITER_D_7GYNDL)
- [R15] EN 14303 - Thermal insulation products for building equipment and industrial installations - Factory made mineral wool (MW) products – Specification
- [R16] Decree No.2012-1248 dated 9 November 2012 authorising IO to create a licensed nuclear facility called <<ITER>> - EN ([ITER_D_CZK7M5](#)).

- [R17] Order dated 7 February 2012 relating to the general technical regulations applicable to INB – EN ([ITER_D_7M2YKF](#))
- [R18] IAEA Safety Standards Series No. GS-R-3 - The Management System for Facilities and Activities
- [R19] ITER Procurement Quality Requirements ([ITER_D_22MFG4](#))
- [R20] Overall supervision plan of external interveners chain for Protection Important Components, Structures and Systems and Protection Important Activities ([4EUQFL](#))
- [R21] Requirements regarding contractor's deviations and non-conformities ([22F53X](#))
- [R22] Quality Assurance for ITER Safety Codes ([ITER_D_258LKL](#))
- [R23] Policy on Safety, Security and Environment Protection Management ([43UJN7](#)).
- [R24] Procedure for the management of Deviation Request ([ITER_D_2LZJHB](#))
- [R25] Procedure for management on Nonconformities ([ITER_D_22F53X](#))
- [R26] NF T30-900 – Paints and varnishes - Paints for the nuclear industry – Behavioural test under controlled accident conditions and reparability of paint systems (PWR)
- [R27] Arrêté du 22 mars 2004 relatif à la résistance au feu des produits, éléments de construction et d'ouvrages
- [R28] Arrêté du 5 février 1959 portant agrément des laboratoires d'essais sur le comportement au feu des matériaux
- [R29] Load Specification for Cooling Water System located in B11, B13, B14, B15 and annex, B21, B23, B24, B37 and annex, B74 ([ITER_D_XLTXGR](#))
- [R30] Technical specification for thermal insulation - installation ([ITER_D_WVPJSP](#))
- [R31] Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners ([ITER_D_SBSTBM](#))
- [R32] Chemical composition and impurity requirements for materials ([REYV5V](#))
- [R33] ITER Numbering System for Components and Parts ([ITER_D_28QDBS](#))
- [R34] Requirements for Producing a Contractors Release Note ([ITER_D_22F52F](#))
- [R35] ITER_D_X3NEGB - Working Instruction for the Delivery Readiness Review
- [R36] Delivery Report Template ([WZPYVZ](#))
- [R37] Package & Packing List Template ([XBZLNG](#))
- [R38] Template - Equipment Storage & Preservation Requirements Form ([WU9636](#))

Appendix A – ISO-834 standard temperature time curve

The standard temperature-time curve ISO-834 is defined by the following formula:

$$T = 20 + 345 \log_{10} (8 t + 1) \text{ [}^{\circ}\text{C]}$$

where t is the time in [min].

Table 18: Temperature at different time steps calculated according to the nominal time-temperature curve ISO-834

Time [min]	Temperature [°C]
0	20
1	349
5	576
10	678
30	842
60	945
90	1006
120	1049

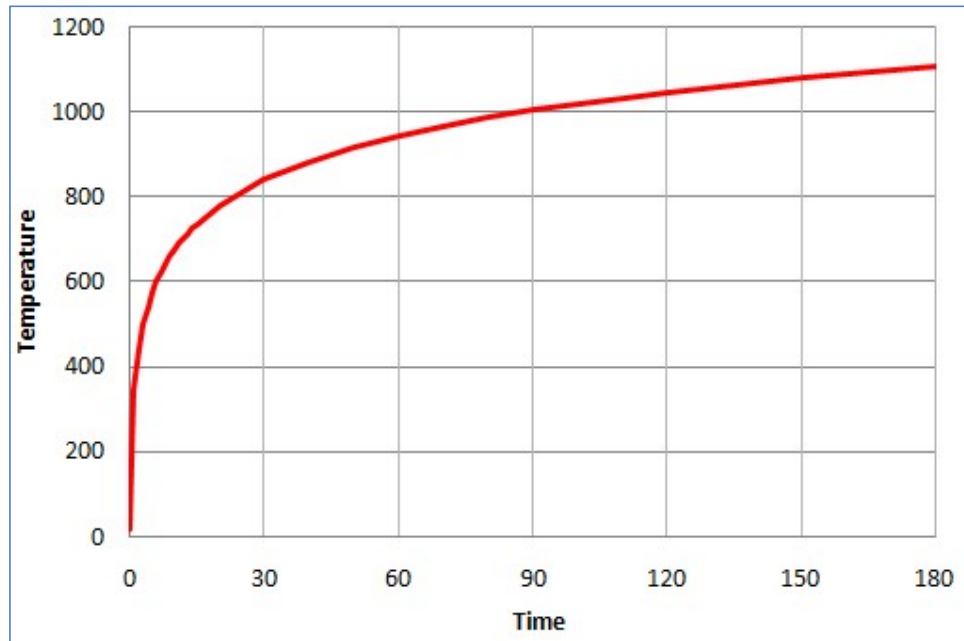


Figure 1: ISO-834 nominal time-temperature curve

Appendix B – Qualification guideline for CCF and HCF thermal insulation

Technical requirement	Description	Applicable standard / typical means of qualification
Resistance to ageing (temperature, humidity)	<p>CCF and HCF material shall withstand the normal environmental conditions over the 40 year operating lifetime without significant degradation for:</p> <ul style="list-style-type: none"> • Temperature range: 18 – 35 [°C] • Relative humidity range: 20 – 60 [%] <p>Ageing tests to demonstrate resistance cumulative dose: the material shall be compatible with a cumulative dose at the end of the life of 3349 [kGy] (specific test or demonstration that the requirement is met is needed). The ageing qualification shall be performed in sequence and prior to accident qualification tests.</p>	Accelerated ageing tests
Thermal performance in case of fire	<p>The thermal insulation material CCF and HCF shall be able to limit the temperature of the protected element below the allowed maximum temperature after exposure to 2 hours ISO-834 standard temperature time curve. The allowed maximum temperature is:</p> <ul style="list-style-type: none"> • 220 [°C] for CCWS-1 piping • 210 [°C] for CCWS-1A piping • 200 [°C] for CCWS-2A piping • 190 [°C] for CCWS-2B, CHWS-1A and 1B. • 185 [°C] for CHWS-H2 piping <p>For this analysis the pipe is considered empty and the pipe wall thickness is according to standard schedule 40.</p>	Qualification by analysis, e.g. by using FEM (Finite Element Method) codes and/or tests.
Thermal shock test 1	<p>The thermal insulation material CCF and HCF shall preserve its integrity after a thermal shock due to a loss of coolant accident in the port cell described as:</p> <ul style="list-style-type: none"> • Maximum room temperature: 145 [°C] • Maximum room humidity: 100 [%] • Maximum room pressure: 60 000 [Pa] • Event duration: 10 [hours] 	NF T 30-900 [R26] or PMUC (Produits et Matériaux Utilisés en Centrale nucléaire).
Thermal shock test 2	<p>The thermal insulation material CCF and HCF shall preserve its integrity after a thermal shock due to a loss helium leak in galleries described as:</p> <ul style="list-style-type: none"> • Minimum room temperature: -170 [°C] • Maximum room pressure: 20 000 [Pa] 	NF T 30-900 [R26] or PMUC (Produits et Matériaux Utilisés en Centrale nucléaire).
Seism	<p>The thermal insulation material CCF and HCF shall stay in place when exposed to seismic load SL-3 as it has to be guaranteed that it will perform its function in case of fire following an earthquake. In accordance with [R29], SL-3 is considered as 1.5×SL-2 at the same damping factor: the maximum peak horizontal acceleration is 27 m²/s.</p>	Qualification by analysis and/or qualification by shaking table test.

In accordance with the applicable regulation [R27] and [R28]:

- either the qualification tests shall be performed by an accredited French laboratory, or;
- the qualification tests shall be accepted / certified by an accredited French laboratory.

Appendix C – Thermal insulation of valves

For the thermal insulation of valves, section 6.4.1 of [R30] applies. In particular the valves shall be insulated by removable pre-moulded insulation shapes. It is reminded that only the valve body shall be insulated up to the level of the packing gland with the hand/lever remaining free. The thickness of the thermal insulation material shall be identical with that of the pipe the respective component is installed on and the casings are then lined with bulk wool by the company installing the thermal insulation. An example of how the thermal insulation of valves is to be realized can be found in Figure 2.

For each valve DN, Table 19 provides the valve width and length to consider for enveloping the entire valve body.

Table 19: Valve width and length to consider for enveloping the whole valve body with thermal insulation

Valve DN	Valve width	Valve length
DN15	Ø85 [mm]	110 [mm]
DN20 / DN25	Ø105 [mm]	170 [mm]
DN32 / DN40	Ø130 [mm]	200 [mm]
DN50	Ø150 [mm]	240 [mm]
DN65 / DN80	Ø190 [mm]	360 [mm]
DN100	Ø230 [mm]	400 [mm]
DN150	Ø280 [mm]	450 [mm]
DN200	Ø430 [mm]	460 [mm]
DN250	Ø550 [mm]	300 [mm]
DN300	Ø600 [mm]	330 [mm]
DN350	Ø650 [mm]	370 [mm]
DN400	Ø760 [mm]	390 [mm]
DN450 / DN500	Ø850 [mm]	450 [mm]
DN600	Ø1000 [mm]	500 [mm]

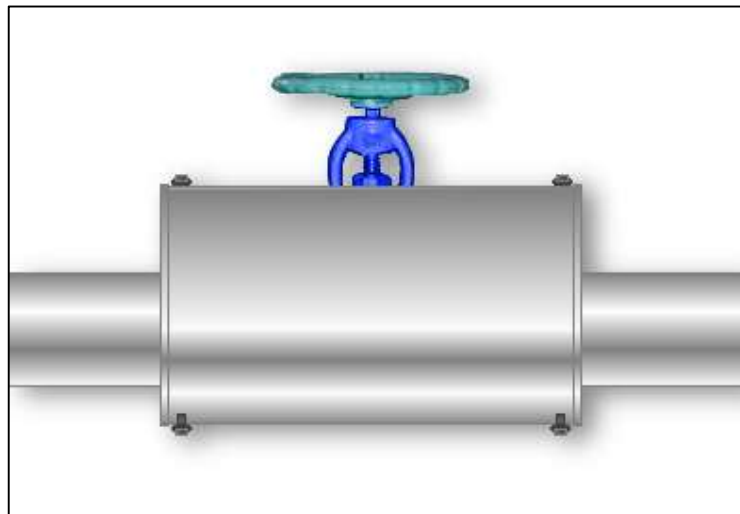


Figure 2: Example showing how the valves are to be protected with thermal insulation