Grupa LOTOS S.A.	**TECHNICAL SPECIFICATION**	Spec. nr **1191**
	Thermal insulation	

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1 Subject of specification

This specification and other documents referenced herein establish the minimum requirements for the design, fabrication, installation, inspection and tests of piping and equipment.

2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts concerning new investments and modernization projects planned by LOTOS Group S.A.

It shall also be a basis for preparing both detailed specifications and inquiries for individual or package unit supplies.

2.1 Deviations

Any deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and / or technically superior solutions must be submitted in writing for review and approval by Grupa LOTOS S.A. Non-approved exceptions are not acceptable by Grupa LOTOS S.A.

The supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS S.A. or non-compliance with the referred documents / standards and obtain a written explanation from Grupa LOTOS SA.

2.2 Order of Precedence

In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

1. The current Polish legislation
2. Terms of purchase order / contract and other requirements agreed in writing Grupa LOTOS S.A.
3. Data Sheets approved by Grupa LOTOS S.A.
4. This specification
5. Other Specifications
6. Drawings and other documents
7. Standards

3 General

Pipelines and equipment requiring insulation shall be marked:

- in piping and instrument diagrams (P&ID) – with an appropriate graphic symbol
- the piping list contains the type (see the table with markings) and thickness of insulation

Marking	Types of lagging
H	Thermal insulation, economical
PP	Thermal insulation as a personal protection (safety insulation)

ST	Lagging for steam-traced piping
ET	Lagging for electrically traced piping
HT	Lagging for oil-traced piping

For piping, vessels and equipment that do not require heat insulation, protective insulation should be designed for all exterior surfaces of piping, vessels and equipment of a temperature in excess of 60 ^{o}C wherever there is a possibility of personnel touching such surfaces.

Insulation-protected area shall extend 2 m above the service level and 0.5 m on each side of a service space, platform, ladder or communication route.

Where personnel protection against burns is required and insulation is not allowed, screens or covering nets shall be provided.

4 Basic materials for making pipelines, vessels and equipment insulation

4.1 Mineral wool mats on a glass veil or on aluminium foil

Basic technical parameters:

- density up to 80 kg/m^3
- thermal conductivity at a temperature of +20°C - λ=0,043 W/mK

Application:

- insulation of pipelines, vessels and equipment of surface temperature of up to 200°C

4.2 Industrial boards of mineral wool

Basic technical parameters:

- density 60-150 kg/m^3
- thermal conductivity at a temperature of +20°C - λ=0,043 W/mK

Application:

- insulation of flat horizontal and vertical surfaces of large vessels of a temperature of up to 250ºC

4.3 Cylindrical covering of mineral wool without an envelope or with an envelope of reinforced aluminum foil

Basic technical parameters:

- density 140 kg/m^3
- thermal conductivity at a temperature of +20°C - λ=0,043 W/mK

Application:

- insulation of pipelines of a temperature up to 200°C, (as a standard not heated by satellite heaters)

4.4 Mineral wool mats on wire mesh, galvanized, with or without aluminum foil between wool and the mesh

Basic technical parameters:

- density 80-105 kg/m^3
- thermal conductivity at a temperature of +10°C - λ=0,038 W/mK
- absorbability: not absorbable
- combustibility: not combustible

Application:

- insulation of pipelines, vessels and equipment of a surface temperature between 200°C and 950°C

4.5 Cylindrical covering of Rockwool mineral wool

Basic technical parameters:

- density 120 kg/m^3
- temperature of application 650 °C
- thermal conductivity at a temperature of +20 °C - λ=0,043 W/mK

Application:

- insulation of pipelines of a temperature of 650 °C

4.6 Aluminum sheet A1Z4R

Aluminium sheets in accordance with wg PN-87/H-92741

Application:

- 0.8 mm in thickness – for insulation mantles of piping of a diameter up to Dn 200mm
- 1.0 mm in thickness – for mantles of vessels and equipment of a diameter exceeding Dn 200 mm

4.7 Galvanized steel sheets 1.5 – 2mm thick

Application:

- Vessel and tank insulation support structure components, for temperatures of up to 400°C

4.8 Galvanized hoop steel

Application:

- of dimensions 20 mm×2mm – for insulation-supporting structure for piping of a diameter from 100 mm to 300 mm and components of vessel structure of surface temperature up to 400 °C
- of dimensions 30 mm×3 mm – for insulation-supporting structure for piping of a diameter exceeding 300mm and vessels of surface temperature up to 400 °C

4.9 Self-adhesive glass fabric type TSS125g/cm^2

Basic technical parameters:

- temperature of application up to 400 °C

Application:

- insulation separator between insulation support structure made of hoop iron and the mantle made of aluminium sheets

4.10 Galvanized wire mesh 20×20×0.5mm

Application:

- thickening of multilayer insulation made from mineral wool mats on a glass veil of a density up to 60 kg/m^3
- covering of process pipelines heated by steam satellite heaters insulated with mats on a glass veil

4.11 Stainless steel screws, self –piercing, for sheets, diameter 3.9×16mm

Application:

- joining aluminum insulation-protecting mantles

4.12 Steel rivets of a diameter of 4×12mm

Application:

- joining insulation-supporting structures

4.13 Silicone cement of an application temperature of 150-200°C

Application:

- sealing of flashings within connector pipes, brackets and similar elements penetrating the insulation mantle

4.14 Cement Terostat VII or equivalent

Application:

- sealing the joints of the protective mantle of insulation subject to penetration of precipitation or other liquids from the environment

4.15 Aluminum foil in accordance

Aluminium foil in accordance with PN-EN 546-1

Application:

- covering of process piping heated by steam satellite heaters insulated with mats on a glass veil

4.16 Galvanized steel wire of a diameter of 1.2 to 1.5 mm

Application:

- for bands for fixing lagging and mat insulation without steel mesh

4.17 Hood fasteners

Application:

- for fixing insulation made from hood segments

4.18 Bending steel out of stainless steel

Bending steel in accordance with PN-EN 10038-1, PN-EN 10038-2

Application:

- for fixing of insulation on piping and equipment made out of s.s.

4.19 Nonasbestos stealing sheets FA-O

Application:

- Insulating spacer of jacket supportive construction.

5 Insulation thickness

Table No.5.1. Thickness of heat insulation of mats and lagging

Nominal diameter of pipeline Dn		Operating temperature range (max operating permanent work) in °C				
		20 –150	151 – 200	201 – 350	351 – 400	401 - 550
[cale]	[mm]	Insulation thickness in mm				
11/2”	40	40	40	50	60	90
2”	50	40	40	50	60	90
3”	80	40	50	60	70	90
4”	100	40	50	70	80	100
6”	150	50	50	80	90	120
8”	200	50	60	90	100	140
10”	250	60	70	90	100	140
12”	300	60	70	100	110	140
14”	350	60	70	100	110	150
16”	400	60	70	100	110	150
18”	450	60	80	110	110	160
20”	500	70	80	110	120	160
24”	600	70	80	120	120	170
26”	650	70	80	120	130	170
28”	700	70	80	120	130	180
30”	750	70	90	120	130	180
32”	800	70	90	120	130	180
34”	850	70	90	120	130	180
36”	900	70	90	120	130	180
Equipment	>900	70	90	120	130	180

Notes:

1. For equipment diameter less than 36” insulation thickness as for pipelines shall be used.
2. For insulation thickness larger than the thickest available in the product range, insulation should be arranged in layers, by putting together layers of a suitable thickness to obtain the total thickness of combined layers not less than specified in the table.
3. It shall be allowed to make the comparison of insulation thickness vs. heat loss on the basis of insulation thickness selection programs possessed by suppliers.

Table No.5.2. Thickness of insulation protecting against burns, made from mats and lagging

Nominal diameter of pipeline Dn		Operating temperature range (max operating permanent work) in °C				
		20 –150	151 – 200	201 – 350	351 – 400	401 - 550
[cale]	[mm]	Insulation thickness in mm				
11/2”	40	30	30	40	60	80
2”	50	30	30	50	60	80
3”	80	30	30	50	60	90
4”	100	30	30	50	60	90
6”	150	30	40	50	80	90
8”	200	30	40	50	80	100
10”	250	30	40	50	80	100
12”	300	30	40	50	80	100
14”	350	30	40	50	80	100
16”	400	30	40	50	80	100
18”	450	30	40	60	80	110
20”	500	30	40	60	90	110
24”	600	30	40	60	90	110
26”	650	30	40	60	90	110
28”	700	30	40	60	90	110
30”	750	30	40	60	90	110
32”	800	30	40	60	90	110
34”	850	30	40	60	90	110
36”	900	30	40	60	90	110
Equipment	>900	30	40	60	90	110

Notes:

1. For equipment diameter less than 36” insulation thickness as for pipelines shall be used.
2. For insulation thickness larger than the thickest available in the product range, insulation should be arranged in layers, by putting together layers of a suitable thickness to obtain the total thickness of combined layers not less than specified in the table.
3. It shall be allowed to make the comparison of insulation thickness vs. heat loss on the basis of insulation thickness selection programs possessed by suppliers.

6 Requirements concerning the execution of insulation

6.1 General requirements:

- The contractor shall comply with the safety regulations in force at LOTOS Group S.A.
- Insulation work shall be performed by qualified personnel and in compliance with the best practice of this type.
- The contractor shall be responsible for protecting the site from pollution and all generated waste shall be the contractor's property and shall be removed at his cost.
- All preceding insulation works shall be finished and inspected with positive result.
- Insulation works shall be commenced after acceptance testing and final inspection of piping and equipment is finished, and their hand over for insulation works shall be confirmed with approved record in construction log.

6.2 Requirements concerning insulation materials:

- The physical properties of materials should fulfill the requirements of the standard specifications, and in lack of such specifications they should comply with the supplier's certificate.
- Materials used for the insulation of vessels and piping must not contain asbestos.
- Mechanical properties of materials shall ensure stability of shape and surface as well as resistance to long –lasting vibrations.
- Physical-chemical properties of isolation materials shall ensure their durability at operation, i.e. then can not melt burn, demurely react with insulation surface.
- Insulation materials to be applied for insulation of surfaces made out of austenitic s.s. shall be requirements of ASTM C795 and ASTM C929.

6.3 Requirements concerning the insulated surface:

- Surfaces under insulation should be protected against corrosion in compliance with technical specifications No.1190.
- Insulation must not be laid over dirty, wet, corroded, oilyr frozen surfaces.

6.4 Requirements concerning atmospheric conditions:

- Insulating materials should be stored on pallets and protected against moisture; materials showing any dampness must be rejected.
- Outdoor insulating work may be performed only during dry weather.
- Insulation made during one day should be gradually protected with a protective mantle. Performed incomplete insulation (without a mantle), if exposed to atmospheric conditions, should be protected all the time from getting damp.
- Damp insulation must not be covered with a protective mantle. Damp insulation should be removed and replaced.

6.5 Requirements concerning the execution of vessel and piping insulation:

- The thickness of executed insulation should not differ from the thickness specified in the design by more than:

  5mm and +10 mm for insulation thickness up to 100 mm

  5mm and + 10% of the insulation thickness, for insulation thickness exceeding 100mm
- Insulation density should not differ from the required density by more than ±10%.
- Prior to installing the protective mantle insulation should be inspected, paying special attention to the occurrence of spaces between the contact edges of insulation mats, empty spaces, fractures. The above mentioned faults should be completed with insulating material.
- The temperature of the outer surface of insulation should not be higher than + 50 °C at an ambient temperature of +40 °C.
- External reinforcing rings of vessels and piping must have insulation of the same thickness as the vessels and piping on which they are installed.

6.6 Requirements concerning the execution of pipeline insulation:

- Galvanized wire bands should be used to mount insulating lagging on vessels. Fastening on the edges and one in the middle should be used on one-meter lagging.
- Insulation made of cylindrical lagging should be mounted allowing for displacement of longitudinal adjacencies for single-layer insulation, and longitudinal and circumferential adjacencies for multilayer insulation.
- Multilayer insulation made from insulating mats should be made separately for each layer, with shifting of all contact edges.
- Insulation of insulating mats without a mesh should be fixed with galvanized wire bands, using 3 bands for every 1 meter length of insulation.
- Pipeline insulation before flanges or fittings should end with protective sheet flanges, at a distance from the flanges allowing for easy removal of nuts and bolts without damaging the insulation.
- Insulation of flanges and valves should be made in the form of easily dismounted and reinstalled hoods. Use hood fasteners to fasten the hoods.
- Mantle elements should be mounted allowing for longitudinal and circumferential overlaps 40-50 mm each. Mantle connections should be made with stainless steel screws.
- Insulation connections subject to penetration by liquids should be sealed with an adequate sealant.
- Electrical heating cable shall be covered with aluminum sheets before insulation is applied.
- Any welding to piping / equipment is strictly forbidden. Other ways to fix insulation elements shall be used, e.g. fattening with tables or teeing with wires.
- Insulation thickness for straight piping legs. Insulation shall be fitted to curviness of elbow

6.7 Requirements concerning the execution of vessel insulation

- Insulation should be provided with a supporting structure with a span of 950 mm; if a pressure test was made for the vessel, insulation-supporting structure may not be welded to the pressure surface. For pressure vessels, unwelded two-ring design is allowed.
- Insulation of low-density mats (up to 60kg/m$^{3)}$ should be provided with an additional structure made of pins, placed among the hoop-iron structure. Pins should also be used on large-diameter vessels (> 2220) with a vertical main centreline. Pressure-welded pins are allowed. For pressure equipment fusion- or pressure-welded pins shall not be used, but only non-weldable ones or a vertical design riveted to the horizontal rings.
- Each insulation layer should be installed separately and fastened with galvanized wire bands.
- Insulation-supporting rings should be insulated.
- Sheet mantle should be attached to the supporting structure and the sheets should be joined with one another. Connection overlaps: 40-50mm each.
- Equipment elements requiring access should be left uncovered and finished with flashing and sealed with a sealant.
- Manholes and connection pipes requiring access should be insulated with dismountable hoods fastened with hood fasteners.
- One –layer insulation shall not be thicker than 100mm. Thicker insulation shall be applied by layers one by one
- When long piping legs are being insulated dilatation shall be used. Dimension and frequency of dilatation shall be depended on media temperature and pipeline elongation
- For heat exchangers, where flange connection is nor to be insulated shall be applied with protective sheet flanges, at a distance from the flanges allowing for easy removal of nuts and bolts without damaging the insulation
- Protective jacked joint shall be due to water ingress possibility
- Insulated surfaces out of s.s. and or nicely alloys shall be protected from contact with zinced elements.

7 Safety and fire-protection requirements

- When erecting vessels and pipelines, both general regulations and specific regulations valid in LOTOS Group's plants must be complied with.
- All work performed within an active plant must be performed on the basis of detailed instructions of the Plant Fire Brigade and under its supervision.

8 Relevant documents

Any “Technical Specification” issued by Grupa LOTOS S.A. listed in Contract Files.

9 Technical execution and acceptance criteria

Insulation works shall be carried out and accepted in accordance with the requirements specified in the following:

- PN-B-02421: 2000 Heating and district heating-Heat insulation of piplines, vales and equipment-Specification and reception tests
- Specifications of the workmanship and the receipt of the construction and assembling works.Vol II sanitary and industrial installations

Following insulation components shall be subject to quality acceptance:

- Main insulation materials
- Supportive construction
- Insulation application
- Thickness of applied insulation and its quality
- Protective jacket assembly
- Final acceptance of insulation.

Results of performed test shall be recorded in the protocol

10 Norms and standards

Standards listed below form part of this specification. Each publication shall be the latest revision and addendum in effect at the Contract award, unless otherwise specified:

- PN-B-02421
  Ogrzewnictwo i ciepłownictwo - Izolacja cieplna przewodów, armatury i urządzeń - Wymagania i badania odbiorcze
- PN-EN 13162
  Wyroby do izolacji cieplnej w budownictwie. Wyroby z wełny mineralnej (MW) produkowane fabrycznie – Specyfikacja
- PN-EN 13467
  Wyroby do izolacji cieplnej wyposażenia budowli i instalacji przemysłowych. Określenie wymiarów, prostokątności i liniowości otulin
- PN-EN 13468
  Wyroby do izolacji cieplnej wyposażenia budowli i instalacji przemysłowych. Oznaczanie śladowych ilości rozpuszczalnych w wodzie jonów chlorkowych, fluorkowych, krzemianowych, sodowych oraz pH
- PN-EN 13470
  Wyroby do izolacji cieplnej wyposażenia budowli i instalacji przemysłowych. Określenie gęstości pozornej otulin
- PN-EN-ISO 13787
  Wyroby do izolacji cieplnej wyposażenia budynków i instalacji przemysłowych. Określanie deklarowanej przewodności cieplnej

- PN-EN 14707+A1
  Wyroby do izolacji cieplnej wyposażenia budowli i instalacji przemysłowych. Określenie maksymalnej temperatury stosowania otulin
- PN-EN 609+A1
  Wyroby do izolacji cieplnej w budownictwie. Określanie krótkotrwałej nasiąkliwości wodą metodą częściowego zanurzenia
- PN-B-23118+Ap1
  Wyroby do izolacji cieplnej w budownictwie-Otuliny z wełny mineralnej
- PN-EN 12087+A1
  Wyroby do izolacji cieplnej w budownictwie-Określenie nasiakliwości wody przy długotrwałym zanurzeniu
- PN-EN 485-1+A1
  Aluminium i stopy aluminium - Blachy, taśmy i płyty – Część 1: Warunki techniczne kontroli i dostawy
- PN-EN 485-2
  Aluminium i stopy aluminium –Blachy- Część 2 Własności mechaniczne
- PN-EN 485-3
  Aluminium i stopy aluminium –Blachy, taśmy i płyty-Część 3: Dopuszczalne odchyłki wymiarów i kształtu-Wyrobów walcowanych na gorąco
- PN-EN 485-4
  Aluminium i stopy aluminium –Blachy, taśmy i płyty-Tolerancje kształtu i wymiarów wyrobów walcowanych na zimno
- PN-EN 546-1
  Aluminium i stopy aluminium-Fola –Część 1: Warunki techniczne kontroli i dostawy
- PN-EN 10088-2
  Stale odporne na korozję-Część 2: Warunki techniczne dostawy blach i taśm ze stali nierdzewnych ogólnego przeznaczenia
- PN-EN 10327
  Taśmy i blachy ze stali niskowęglowych powlekane ogniowo w sposób ciagły do obróbki plastycznej na zimno-Warunki techniczne dostawy
- PN-EN 10346
  Wyroby płaskie stalowe powlekane ogniowo w sposób ciągły - Warunki techniczne dostawy
- ASTM C795
  Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- ASTM C929
  Standard Practice for Handling, Transporting, Shipping, Storage, Receiving, and Application of Thermal Insulation Materials for Use in Contact with Austenitic Stainless Steel
- ASTM C449
  Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing CementASTM-C-592
  Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
- ASTM-C-547
  Standard Specification for Mineral Fiber Pipe Insulation

- ASTM-C-612
  Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- Warunki techniczne wykonania i odbioru robót budowlano-montażowych. TOM II Instalacje sanitarne i przemysłowe.

11 Record of changes

No.	Date	Description	Introduced by
0		This specification replaces in whole the earlier LOTOS Group's standard No. PR 07 270 titled identically	B. Kowalewski
1	30-11-2013 (rev.1)	Review, update, standardize and changes to the Standard within scope of order No. OK/990/2012	Editorial board coordinated by T.Wróbel
-	31-08-2015	Page layout corrections, no contents changes.	T. Wróbel