HELLENIC GAS TRANSMISSION SYSTEM OPERATOR

357-359 MESSOGION AVE.,
15231 ATHENS, GREECE
Tel.: 210 6501258
Fax : 210 6501551

TECHNICAL JOB SPECIFICATION

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LIQUEFIED NATURAL GAS PLANTS

THERMAL INSULATION – COLD SERVICE FOR REFRIGERATED FULL CONTAINMENT TYPE STORAGE TANKS IN LNG SERVICE

QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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REFERENCE DOCUMENTS

ELOT EN 14620-1
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C. General]

ELOT EN 14620-2
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C. Metallic components]

ELOT EN 14620-3
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C. Concrete components]

ELOT EN 14620-4
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C. Insulation components]

ELOT EN 14620-5
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C. Testing, drying, purging and cool-down]

ELOT EN 14305
[Thermal insulation products for building equipment and industrial installations - Factory made cellular glass (CG) products – Specification]

ELOT EN 13169
[Thermal insulation products for buildings. Factory made products of expanded perlite (EPB). Specification]

ELOT EN ISO 13787
[Thermal insulation products for building equipment and industrial installations. Determination of declared thermal conductivity]

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[Flexible sheets for waterproofing. Bitumen damp proof courses. Definitions and characteristics]

ELOT EN 15599 –1
[Thermal insulation products for building equipment and industrial installations. In-situ thermal insulation formed from expanded perlite (EP) products. Specification for bonded and loose-fill products before installation]

ELOT EN 15599 –2
[Thermal insulation products for building equipment and industrial installations. In-situ thermal insulation formed from expanded perlite (EP) products. Specification for the installed products]

EU DIRECTIVES

CPD 89/106/EEC
[Approximation of laws, regulations and administrative provisions of the Member States relating to construction products]

1.0 SCOPE

1.1 This specification covers the requirements for design, materials and installation of thermal insulation for the base, shell interspace and suspended roof of full containment refrigerated storage tanks in LNG service.

1.2 This insulation shall be designed for placement between the inner and outer containers of the full containment tanks, comprising a metallic inner container with a metallic lined concrete outer container and a metallic lined concrete roof.

2.0 EUROPEAN STANDARDS AND EUROPEAN DIRECTIVES

The European and Standards referenced herein shall be as follows:

ELOT EN 14620 series "Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0 degrees C and -165 degrees C".

ELOT EN 14305 "Thermal insulation products for building equipment and industrial installations - Factory made cellular glass (CG) products – Specification"

ELOT EN 13169 "Thermal insulation products for buildings. Factory made products of expanded perlite (EPB). Specification]

ELOT EN ISO 13787 "Thermal insulation products for building equipment and industrial installations. Determination of declared thermal conductivity"

ELOT EN 14967 "Flexible sheets for waterproofing. Bitumen damp proof courses. Definitions and characteristics"

ELOT EN 15599 –1 "Thermal insulation products for building equipment and industrial installations. In-situ thermal insulation formed from expanded perlite (EP) products. Specification for bonded and loose-fill products before installation"

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EU DIRECTIVES

CPD 89/106/EEC
"Approximation of laws, regulations and administrative provisions of the Member States relating to construction products"

3.0 DESIGN

3.1 Within the parameters of this Technical Job Specification and the mandatory minimum width of the annulus between inner and outer containers, the CONTRACTOR shall be responsible for designing the insulation thickness to provide the specified heat leak-in rate.

3.2 Insulation thickness for tank bottoms shall be selected for the design condition listed on the data sheet or drawings. The insulation shall be installed on the under-side of the inner container. The specified dry sand surfacing layer must ensure that the cellular glass insulation is adequately protected from heat damage due to welding of the inner tank bottom plates.

3.3 For tanks in LNG service, the insulation materials shall be such that hydrocarbon vapor absorbed by the insulation is desorbed freely and easily, following purging of the external hydrocarbon source.

3.4 The roof insulation shall be supported by the suspended deck.

3.5 The CONTRACTOR shall be fully responsible for the provisions which shall be made in double wall tank designs to compensate for the static head and compaction of perlite insulation.

3.6 Provision shall be made for purging the insulation spaces with inert gas. The purge system shall be provided by the CONTRACTOR in accordance with his proprietary design and shall terminate at the battery limits of the tank with standard pipe connections.

3.7 The design of the insulation system shall ensure that condensation or frost does not form on the outer surfaces of the tanks, tank nozzles and exposed portions of the pump columns while the tank is in the operating condition with a relative humidity of 90%.

3.8 A minimum safety factor of 3.0 shall be allowed in considering the compressive loading based on the nominal strength (average compressive strength) of the cellular glass base insulation material. A minimum safety factor of 1.8 shall be used in considering the compressive loading of perlite concrete blocks. The CONTRACTOR shall provide data to confirm that the specified base insulation complies with these requirements under both hydrotest and design seismic loading conditions.

3.9 The CONTRACTOR shall demonstrate that the tank design can readily accept the predicted maximum long term deformation of the base insulation material due to compressive creep and strain, including initial deformation as the load is first applied.

4.0 APPLICATION OF INSULATION

4.1 All insulation and accessory materials shall be stored in a dry place and shall be protected against water from the time they are dispatched to site until required for installation.

4.2 Outside the parameters specified in paragraphs 5.4, 5.10 and 5.17, adequate provisions shall be made to assure the complete absence of moisture in the insulation and in the zones where insulation is to be installed. The methods proposed for ensuring dryness shall be submitted for review by the OWNER.

5.0 BASE INSULATION

5.1 The base insulation shall be applied under protected conditions, preferably following essential erection of the outer tank including the roof and metallic vapor barrier lining and before commencement of inner tank erection. Under such protected conditions, the base insulation may alternatively be applied in two phases following installation of the outer tank bottom liner plates, as per sub-paragraphs 5.1.1 to 5.1.4 inclusive.

5.1.1 The area immediately beneath inner tank annular plates, including load bearing blocks and outer ring of cellular glass blocks shall be installed during Phase 1.

5.1.2 Following installation of inner tank annular plates all exposed stepped surfaces of cellular glass blocks in accordance with **ELOT EN 14305** and bitumen primed perlite concrete blocks shall be dust freed and weather protected with a 1.0 mm dried film coat of an elastomeric rubber bitumen emulsion. In addition, any gaps between the perlite blocks and the annular plates shall be stemmed with a high solids butyl sealant. The exposed edge of the sand topping layer shall in addition be adequately stemmed by the insertion of a flexible and completely watertight sealing strip, capable of being easily removed during Phase 2.

5.1.3 Between Phases 1 and 2 during the inner tank erection period, fully effective mechanical protection shall be provided over the exposed surfaces of the cellular glass blocks and Perlite blocks and the requirements of para 4.2 followed to ensure complete absence of moisture.

5.1.4 The remaining area of cellular glass blocks beneath the inner tank bottom shall be applied during Phase 2. The insulation previously installed during Phase 1 shall be inspected and where necessary, repaired, before proceeding with Phase 2.

5.2 Where, as a result of the tank erection sequence, it is necessary to proceed with all or part of the base insulation prior to erection of the outer tank roof, such alternative means as are necessary shall be adopted to ensure that the base insulation is carried out under completely dry conditions and is subsequently kept dry until such time as the tank is essentially weather tight and erection of the outer tank roof has been completed. For this purpose, use shall be made of inflatable protective tent enclosures capable of enveloping the overall diameter of the base working area.

5.3 A reinforced concrete leveling course shall be applied over the outer tank bottom liner plates to a thickness of 100mm. The course shall have a smooth surface parallel to the theoretical shape of foundation within +/-6mm (12mm max. difference) up to 9.0m in any direction +/-12mm (24mm max. difference) over the entire base surface. The CONTRACTOR shall submit details of the concrete proposed for this purpose for Owner's review. Such details shall include density after drying out and any inclusions such as air entraining agents considered necessary.

5.4 The leveling course shall be allowed a 28 day drying period before commencement of insulation and shall be sealed with a cut back priming solution.

5.5 Insulation shall comprise cellular glass blocks of additional High Load Bearing (HLB) grade, laid in the required number of courses to achieve the designed overall thickness. The blocks shall typically have dimensions of 600mm x 450mm with a maximum thickness of 100mm and a minimum thickness of 50mm. The layers shall be arranged so that as far as possible vertical joints in successive insulation courses are staggered by 50% in both directions and that in no case are joints staggered by less than 100mm.

5.6 Foamglas blocks shall be tightly butted with gaps between blocks not exceeding 2.0mm. Each successive course shall be level to the extent that surface irregularities shall not exceed ±3 mm (6 mm difference) in a distance of up to 2.0m in any direction. Any discrepancy in level must be corrected before proceeding with the next course. Cellular glass blocks that have become cracked or damaged during installation shall be rejected / replaced. Blocks that have become cracked or damaged in transit or storage shall not be used other than where sound portions can be used as make up blocks in locations where they can be employed following cutting and fitting.

5.7 Where the cellular glass blocks in each layer butt up to the inside perimeter of the annular ring beam, they shall be carefully cut 20mm short to allow for tightly butting up to the glass fibre blanket (para. 5.17) when compressed from 50mm to 20mm thick. Under no circumstances shall the glass blanket be applied progressively as a packing out material.

5.8 To enable individual courses of cellular glass blocks to achieve their ultimate average compressive strength, comparable to **ELOT EN 14305** Quality Assurance test results carried out during block manufacture, a surfacing medium shall be introduced above, below and/or between each layer of cellular glass blocks as work proceeds in accordance with one of the following methods:

a) The underside of the first layer shall be coated with hot bitumen and bonded to the concrete leveling course, then subsequent layers shall be bonded with hot bitumen applied to upper face of the preceding layer until the final layer is reached, which shall then be mop coated with hot bitumen on the upper face.

The bitumen shall be applied at a nominal coverage of 4.0 kg/m^2 as a molten liquid at an application temperature of from 150°C to 180°C. This coverage shall partially fill the open surface cells between layers of cellular glass blocks sufficient to obtain an effective capping.

The bottom of the block being placed shall achieve at least 95% bonding to the preceding layer. This shall be verified by an inspection procedure to be submitted by the CONTRACTOR for review and prior approval of the OWNER.

b) Alternatively the blocks shall be laid dry but interleaved with layers of D.P.C felt complying with **ELOT EN 14967** (BS 6398 class A equal) type 3,8 kg/m^2. The interleaving shall commence with a layer of D.P.C felt laid on to the sand leveling layer and shall finish with a layer of D.P.C felt applied over the top of the final layer of cellular glass blocks. Each layer must be laid to form a completely level surface with due provision being allowed between adjoining edges, so that following settlement, the edges are closely butting. Overlapping of the felt which may create high spots, shall not be permitted. The joints between the final layer of felt shall be sealed by means of a 76mm wide adhesive backed PVC tape.

Due to difficulties associated with restraint/moisture ingress during the first phase and with alignment/levels during the second phase, this method shall not be used if base installation is carried out in two phases as per paragraph 5.1.

5.9 Where DPC felt interleaving as per paragraph 5.8 (b) is employed, the cellular glass insulation layers shall be provided with means of purging out any residual vapor or liquid from each layer independently. Where hot bitumen as per paragraph 5.8 (a) is employed, means of purging of any residual vapor or liquid from the sand topping layer shall be provided.

5.10 A final 50mm thick bedding layer of dry sand with a maximum moisture content of 1%, shall be spread over the final layer of cellular glass blocks to finish level with the annular ring beam. Sand shall be leveled progressively with laying of the inner tank bottom plates and kept in a dry condition.

5.11 The cellular glass insulation and perlite concrete blocks shall be adequately protected from heat damage during welding of the inner tank bottom plates. In the event of the specified dry sand surfacing layer proving insufficient for protection of cellular glass, or the perlite concrete blocks being vulnerable, the CONTRACTOR shall advise the OWNER his proposal for providing additional protection.

5.12 The installed thickness of cellular glass blocks shall be such that mandatory levels of the inner tank bottom plate and any intermediate seal plates forming a part of the CONTRACTOR'S design are maintained after taking into account the sand and/or concrete bedding/topping layers, interleaving materials etc.

5.13 A perlite concrete annular ring beam shall be installed to form an enclosure around the base insulation and shall be positioned beneath the inner tank bottom annular plates. Because of the high conductivity of this material, the width of the beam shall be kept to a minimum commensurate with design loading conditions, but with sufficient projection beyond the intersection with the inner tank shell plates to ensure stability under these conditions. The ring beam shall be designed so as not to be overstressed both under hydrotest conditions and under seismic conditions at line loading.

5.14 The ring beam shall be installed in the form of perlite concrete base blocks manufactured from a mix of light weight perlite aggregate, ordinary Portland cement and admixtures, as factory manufactured by an approved manufacturer.

5.15 Perlite blocks shall have a depth equivalent to the base insulation thickness plus the sand/concrete bedding/topping layers. The blocks shall have a width to meet the requirements of para. 5.13 and a handleable length segmented to suit the tank radius. The blocks shall be oven dried after manufacture and immediately sealed with two coats of a cut-back bitumen solution. Any damage to the bitumen coating that may have occurred during transit shall be repaired immediately on arrival at site with a compatible cut-back bitumen solution. Such damage to the coating as may subsequently take place during field handling, including damage to the base of the blocks, shall be similarly reinstated without delay.

5.16 Perlite blocks shall have a manufacturer's declared maximum thermal conductivity of from 0.17 W/(mK) for a density of 500 kg/m3 up to 0.27 W/(mK) for a density of 1,000 kg/m^3 based on perlite concrete having 5% moisture content by volume at $20^{O}C$ mean temperature. The CONTRACTOR shall be responsible for ensuring that the installed perlite blocks achieve optimum performance conditions and that the foundation heating system in the area of the ring beam is capable of meeting the design loading. Data shall be submitted to the OWNER to demonstrate that all design requirements can be fulfilled.

5.17 Perlite blocks shall have a manufacturer's declared maximum thermal conductivity of from 0.17 W/(mK) for a density of 500 kg/m3 up to 0.27 W/(mK) for a density of 1,000 kg/m^3 based on perlite concrete having 5% moisture content by volume at $20^{o}C$ mean temperature. The CONTRACTOR shall be responsible for ensuring that the installed perlite blocks achieve optimum performance conditions and that the foundation heating system in the area of the ring beam is capable of meeting the design loading. Data shall be submitted to the OWNER to demonstrate that all design requirements can be fulfilled.

5.18 The blocks shall be laid in hot bitumen as para. 5.8(a) on to the 100mm thick reinforced concrete leveling course. To prevent thermal bridging, a 25mm thick glass fibre blanket shall be installed between adjacent blocks compressed to approximately 11mm.

5.19 A continuous layer of glass fibre blanket, 50mm thick, shall be securely adhered to the inside perimeter of the installed ring beam prior to commencement of cellular glass base insulation.

5.20 In cases where intermediate seal plates form a part of the CONTRACTOR'S design, these shall be laid over the dry sand topping layer, para 5.10, and ring beam, para. 5.13. A further concrete leveling course shall in such cases, be then applied in way of the inner tank to a thickness of 100mm and to the requirements of para. 5.3 and 5.4. The concrete leveling course shall be left ready to receive inner tank bottom plates.

6.0 RESILIENT GLASS BLANKET SYSTEM FOR INNER TANK SHELL

6.1 In compliance with the requirements of para. 3.5, a resilient glass blanket system shall be provided to form a compression cushion on the inner tank shell.

6.2 The glass blanket material shall provide the required resistance to compression as imposed by the perlite insulation and tank shell plates respectively under cycles of operation.

6.3 The system shall employ glass fibre insulation developed for cryogenic service in the form of blankets as manufactured under the Garnett or Air Float process such as Industrial Resilient Blanket by Certain-Teed Corporation or equal. The material shall be manufactured from long continuous textile type glass fibres chopped into 50 mm to 100 mm lengths and firmly bonded in random orientation with an inert thermosetting resin. The blanket shall have a nominal density of 16 kg/m^3.

6.4 Where supplied in roll form the material shall be of even thickness throughout the roll. The tolerance on 50mm thickness shall be + 15mm/- 1mm.

6.5 The blanket shall be installed adjacent to the inner tank shell in not more than two drops using a method approved by the OWNER involving either a blanket suspension system or an impaled blanket system.

6.6 The resilient glass blanket shall have a nominal density of 16 Kg/m^3 and shall be applied in a minimum of two layers of such thickness as is required to comply with para. 3.5 and 6.2.

6.7 The outermost blankets shall be provided with a high tensile facing designed to prevent blanket failure resulting from the loading and friction imposed during perlite filling and subsequent thermal cycles of tank operation/shutdown. The CONTRACTOR shall provide evidence in the form of test results to this effect.

6.8 The blanket shall be subject to an approved qualification and production tensile testing procedure to ensure that it has sufficient tensile strength capacity for construction loads and for local stresses in service.

6.9 The blanket system shall be securely held against the tank wall and adequately sealed between joints to ensure stability during perlite filling and to prevent the perlite from infiltrating between the blanket layers.

6.10 The blanket shall have compression characteristics to meet with test requirements, in that, when loaded from a preload value of 0.48 kN/m^2, the test results shall indicate a mean percentage reduction of the original thickness before preload of at least 28.0 per cent, with no individual samples producing a reduction of less than 23.0 per cent.

Before compression testing commences, the blanket shall be subjected to two conditioning load cycles from 0 to 2.4 kN/m^2, applied and removed in increments of 0.24 kN/m^2.

6.11 The CONTRACTOR shall be responsible for the integrity of the blanket within their contractual obligations.

6.12 For impaled method of glass fibre blanket erection contractor shall provide and install securing pins Stic-Klip type 'N' insulation anchors complete with Type'S' adhesive or equal.

7.0 PERLITE INFILL WITHIN TANK INTERSPACE

7.1 Insulation for the remainder of the annular space between the inner and outer tank shells shall comprise loose fill expanded perlite having a compacted density greater than 48 Kg/m^3 but not exceeding 65.6 Kg/m^3.

7.2 The powder insulation shall be manufactured on site by means of expanding a natural volcanic glass ore, comprising sodium potassium aluminium silicates of variable composition under properly controlled furnace conditions in order to produce the type of powder material known by the name Perlite.

7.3 The Perlite shall conform to the requirements of **ELOT EN 13169**.

7.4 The filling shall be carried out via adequately sized manholes located on the outer tank roof. The manholes shall be of sufficient dimension to permit entry of all materials including shell and roof blanket.

7.5 During the filling operation, every care shall be exercised to ensure that the level of the perlite in the interspace is kept as level as possible. The differential between maximum and minimum heights of the perlite shall not exceed 4.00m at any stage.

7.6 The perlite installation shall be the subject of a quality control procedure, the minimum requirements for which are given under Section 11.0.

7.7 The design shall allow a perlite hopper volume no less in capacity than 2 1/2% of the perlite volume within the annulus itself. Perlite filling nozzles positioned above the tank interspace shall perform the dual function of topping up nozzles for which purpose they shall be positioned at no greater than 6.0m intervals around the circumference.

7.8 The perlite installation shall incorporate a system of tank vibration with a view to effecting an average overall compaction of 10% of the initial installed filling. For individual lifts, a permissible tolerance of +/- 2% is allowed on this percentage, provided that the overall 10% average compaction is achieved.

7.9 Full details of the method of tank vibration proposed shall be submitted to the OWNER by the CONTRACTOR for review. In view of externally mounted vibrators being unsuitable for a concrete outer tank, the vibrators shall with this type of design be of an internally applied type, installed in the lower area of the interspace before filling, and raised following cycles of vibration progressive with filling operations.

7.10 Final topping up without vibration shall be affected including filling of the hopper volume.

8.0 ROOF DECK INSULATION

8.1 The CONTRACTOR shall submit details of his proposed suspended deck system for approval by the OWNER.

8.2 Insulation for the suspended deck shall comprise one of the following alternatives:

1. Glass fibre blanket Insulation applied in layers having a maximum thickness of 100mm and a minimum thickness of 50mm to achieve the designed overall thickness.
2. Loose fill expanded perlite to the general requirements of Section 7.

8.3 The roof deck shall have been effectively seal welded before commencement of perlite or glass blanket installation.

8.4 Installation shall be delayed until all other requirements for access to the roof deck have been effectively completed. Any damage to the roof insulation attributable to the CONTRACTOR prior to commissioning shall be made good by the CONTRACTOR.

8.5 The CONTRACTOR shall be responsible for allowing in his design for any compaction of the roof insulation both prior to and following erection and shall install additional thickness to compensate and to ensure that design requirements of para. 3.1 are fully complied with.

8.6 Blanket material shall have a minimum density of 12 kg/m^3. Blankets having a greater density may be used provided this is within the roof design load.

9.0 TRANSIT PROTECTION OF METALLIC SURFACES

9.1 To prevent widespread corrosion of metallic plate surfaces during transit, storage and following erection, the plates shall receive the following protective treatment.

a) Blast clean to SA 2 1/2 in shop.

b) Prime coat with inorganic zinc weldable preconstruction primer 25 microns dried film thickness in shop,

c) Coat all plate edges with Deoxaluminite protection or equal.

9.2 The transit protection shall be left intact after tank erection with the exception of the inside of the inner tank shell and floor plates which shall be blast cleaned to Sa 2 1/2 and cleaned free of all contaminants prior to commissioning.

9.3 The inorganic zinc transit protection primer applied to the inside of the outer shell plates shall be of a type chemically compatible with the secondary insulation system, i.e. polyurethane foam and any associated secondary priming coat application, or cellular glass and any associated adhesives.

10.0 SECONDARY INSULATION ON INSIDE OF OUTER CONTAINER

10.1 The CONTRACTOR shall put forward proposals for providing an insulating layer extending for a vertical distance of 3.0m up the inside face of the outer container to reduce vapor evolution due to liquid contact with the warm outer wall in the event of an inner container rupture, or resulting from overflow of LNG liquid from the primary container.

10.2 The purpose and the requirements governing the design of the secondary insulation to the inside of the outer containment shall be as follows:-

a) The system shall minimize the vapor generation rate resulting from a spill of product into the perlite filled annular space and shall protect the steel liner and bottom joint from thermal shock by maintaining at a temperature not colder than -30°C, allowing the steel liner to remain intact and the outer tank fully functional as a liquid and vapor container

b) Insulation shall be suitable for staying in contact with liquid without absorbing liquid.

c) Insulation shall be capable of being gas freed in a relatively short period of time.

d) The system shall possess mechanical strength at designed deflections, and shall have been tested to withstand the dynamic load in the event of an inner tank failure equivalent to 2.5 x liquid head in an inner tank (approx. 3.0 Kg/cm^2) without damage.

10.3 The CONTRACTOR shall provide evidence to show that the secondary insulation system has been specifically designed and successfully tested to cover all aspects of double integrity side wall insulation as detailed in para. 10.2.

10.4 The insulation system shall be selected from the following:

1. Spayed polyurethane insulation incorporating a crack arresting glass reinforced epoxy facing.
2. Cellular glass blocks installed in an inner and an outer laminated layer employing adhesive(s) suitable for cryogenic service and incorporating a glass fabric crack arresting membrane within the second layer.

11.0 QUALITY CONTROL

11.1 The CONTRACTOR shall submit to the OWNER for approval, his proposed quality control and testing procedures covering all phases of the field installation of insulation systems for the tank base, shell and roof respectively.

11.2 COMPRESSION BLANKET

11.2.1. Tests for quality of the glass fibre compression blanket shall include the following:

(1) Resilience properties by load deflection tests. The blanket shall have compression characteristics per para. 6.10.

(2) Density

(3) Tensile strength calculations supported by tensile load tests.

(4) Minimum failure load on suspension (if suspension system used).

(5) Length and extension characteristics of elastic suspension (if elastic suspension system used).

(6) Dimensional tolerances

(7) Consistency of thickness throughout glass fibre roll. (Testing required in factory and reconfirmed in field prior to installation).

(8) Integrity of facing materials, including tests to show drag imposed by friction during perlite filling is within acceptable limits.

(9) Failure of pins under tank design conditions (if impaled system used).

11.3 PERLITE

Perlite shall be in accordance with **ELOT EN 13169**. For quality of perlite ore prior to shipment, all tests in accordance with **ELOT EN 13169** shall be performed after preparation of perlite samples by Vendor and the product shall bear CE mark as per **EU Directive CPD 89/106/EEC**.

11.4 CELLULAR GLASS BLOCKS

11.4.1 Test for cellular glass blocks at the manufacturers' works shall include tests for the following in accordance with the manufacturer's established quality control procedure for applications involving cryogenic service:

(1) Density

(2) Compressive strength

(3) Dimensional tolerance

(4) Thermal conductivity W/(mK)

11.4.2 The CONTRACTOR shall provide test certificates of the physical properties of the specified Foamglas base insulation material.

11.5 PERLITE CONCRETE BLOCKS

11.5.1 Tests for perlite concrete blocks at the manufacturers' works shall include:

(1) Density

(2) Compressive strength

(3) Moisture content : maximum 3% by volume

(4) Dimensional tolerance

(5) Thermal conductivity W/(mK)

(6) Visual inspection for cracking: cracks in excess of 0.5 mm in width and in

excess of 75 mm in length shall not be acceptable. This shall be carried out immediately after removal from drying oven and prior to bitumen coating.

11.5.2 Perlite concrete blocks shall be subjected to tests prior to installation in the field for:

Installed moisture content: maximum 5% by volume. The test method shall comprise drilling 25mm diameter x100 mm deep holes at one high point and one low point in each block being tested. Cuttings shall be carefully collected, identified and weighed before and after drying at 110°C (± 5^0C) in a laboratory oven for a minimum of 2 hours. Frequency shall be one block in every 25 installed, this being increased at the discretion of the OWNER if blocks consistently fail to meet specified requirements. Test holes shall be plugged with cork and sealed with bitumen equivalent to the original application as per para 5.15.

11.5.3 Should any circumstances arise wherein perlite concrete blocks become wet after installation, further testing as per 11.5.2 shall be carried out and any blocks having a moisture content in excess of 5%, replaced.

11.5.4 Perlite concrete blocks shall be of a type specifically constructed for load bearing purposes having an average compressive strength to meet the requirements of para. 3.8.