

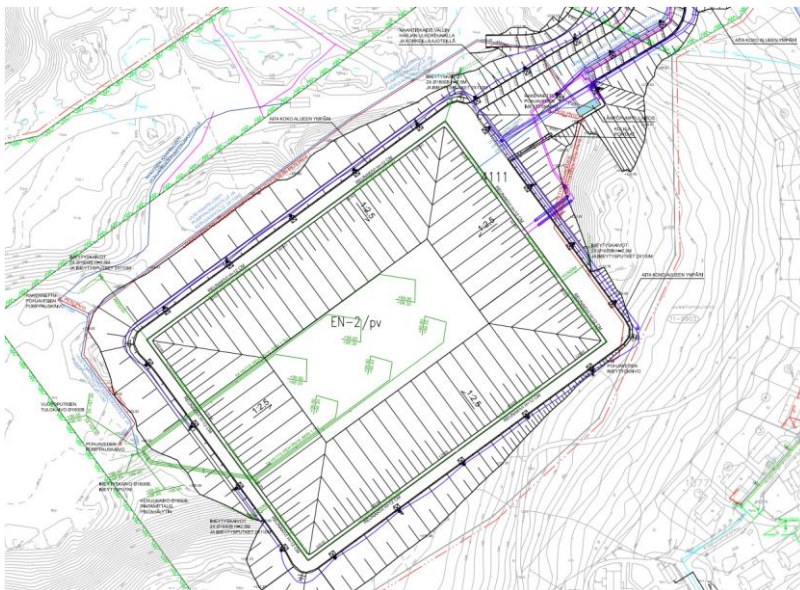
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Date

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MATERIAL AND WORKS SPECIFICATIONS FOR Installation and engineering works for welded ground- facing sealing and protective membrane structures of **PIT THERMAL STORAGE OF HYVINKÄÄ**



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1 GENERAL

1.1 Content of the guide and implemented structural layers

This work-specific work description covers the quality requirements and work instructions for the implementation of ground-facing geomembrane liner structure presented in the geotechnical construction plans for Hyvinkää heat storage (thermal storage pit).

Other earthworks related to the storage pool, as well as works related to surface structures and systems installed underground, are presented in a separate earthwork description GEO-001.

The ground-supported tightness and protective structures of the storage pool consist of the following structural layers made of geosynthetic materials (from bottom to top):

- Protective geotextile installation base (sand moraine layer, 1.0 m) according to the work description GEO-001
- Protective geotextile 1200 g/m²
- Lower layer high-temperature HT liner, min. 2.5 mm
- Drainage layer drainage mat (fiber fabric/network/fiber fabric) (drainage network in the bottom area)
- Upper layer high-temperature HT liner, min. 2.5 mm

The estimated amounts of the different structural layers calculated from the design drawings are as follows:

- Protective geotextile 1200 g/m², plus min. 2.5 m long anchoring strip in the upper edge excavation (total 41,370 m²)
- Lower layer high-temperature HT liner, min. 2.5 mm, total 8,130 m²
- Lower layer high-temperature HT friction liner (surface design choice up to supplier), min. 2.5 mm (slope areas 1:2.5), and plus min. 2.5 m long anchoring strip in the upper edge excavation (total 33,240 m²)
- Drainage mat, plus min. 2.5 m long anchoring strip in the upper edge excavation (total 33,240 m²)
- Drainage network, bottom area, total 8,130 m²
- Upper layer high-temperature HT liner, min. 2.5 mm, total 8,130 m²
- Upper layer high-temperature HT friction liner (friction surface only on the installation base side), min. 2.5 mm (slope areas 1:2.5), plus min. 2.5 m long anchoring strip in the upper edge excavation (total 33,240 m²)

The design target service life of all materials used in the above-mentioned structural layers and the structures made from them is at least 30 years. The long-term heat resistance of all these materials must be at least 90 °C.

The minimum requirement for the service life is 20 years, meaning that no solution can be accepted without a minimum of 20 years documented service life expectancy. A documented service life expectancy of more than 20 years will be awarded additional comparison points as specified in appendix "Evaluation criteria".

1.1.1 Clarification of scope

The contract includes a turn-key delivery of the design, materials, and all installation works needed for a full functioning sealing of the pit thermal energy storage. Soil works, heavy

equipment and certain other measures are provided by other contractors as specified in appendix X - Contract Programme. Any other equipment needed for the turn-key supply must be included in this contract.

1.1.2 *Design responsibility*

It is clarified that generally detailed design is the responsibility of the contractor. This means that the contractor has the freedom to select materials for the lining-, protection-, and drainage-layers according to the contractor's own design if the requirements stated in this document as well as other tender documents are fulfilled.

Detailed design of penetrations and connections between geomembranes and other devices is also the responsibility of the contractor. Design descriptions and drawings in the tender material are non-binding design proposals and the contractor is responsible for the design in any case, no matter if the contractor uses the design proposals included in the tender material or its own design.

1.1.3 *Design review*

Before starting the project, it is expected to carry out a design review. The purpose of the design review is to include ideas and experience from the client and client's consultants in relevant design details. The contractor shall participate in the design review with an open mind and be willing to adjust design details according to commonly accepted design improvements.

1.2 Guideline documents to be followed in construction work

In addition to this work description, the construction work also follows, as applicable:

- InfraRYL General quality requirements for infrastructure construction (InfraRYL online version 2023/2 or a published newer version)
- InfraRYL 2015 Part and project nomenclature. Measurement instructions
- Thermoplastic pipes installed in soil and water. Installation instructions (RIL 77-2013)

In addition to the above-mentioned publications and this work description, the following guidelines and regulations are followed:

- Regulations from Finnish occupational safety authorities and occupational safety legislation
- Instructions and regulations given by material suppliers regarding materials, their storage, and installation work

In the planning, execution, and arrangement of the work, the following must also be considered:

- The client provides all necessary information to the contractor for the location of installed channels and cables. The contractor checks the information provided by the client.
- From the start of the work until the work is handed over to the client, the contractor is responsible, at their own expense, for the protection arrangements of the areas belonging to the contract and the maintenance of the roads they use for their work performance.
- Preparation of detailed drawings is included in the contract. Drawings and other documents verifying the project's plans must be made and delivered to the client in digital form (dwg and pdf format).

- All quality control documents must be delivered to the client in a compiled format and documents agreed with the client must be delivered electronically.
- The contractor is responsible for preparing the necessary plans needed for the execution of the work, such as measurement, traffic arrangement, protection, etc.
- Requirements for installation, including quality control and testing will generally follow the DVS guidelines (when applicable).

2 SITE MANAGEMENT AND ARRANGEMENTS

2.1 Inspections

Before starting construction work, an inspection is carried out at the construction site during which the client provides the contractor with information and instructions that could not be included in the plan documents in sufficient detail. The inspection covers, among other things:

- Construction areas,
- Locations of temporary roads and structures,
- Protection measures,
- Locations of existing cables and pipelines and consideration of them during excavation work,
- Other construction work near the work areas.

If deemed necessary, a plan review is also arranged by the client.

Before the start of the work, a start-up inspection (start-up meeting) is carried out where work methods are clarified as needed, and requirement levels and other contract-related matters raised by the contractor are discussed.

During the work, other stage-specific and structure-specific inspections are done as needed. Inspections are carried out according to the inspection document presented in the quality control plan.

When construction work is completed, a final inspection (completion inspection) is carried out. The inspection ensures that construction has taken place according to the plans and that quality assurance work has been performed acceptably and the requirements set for the structures have been met.

Final inspection records must be handed over to the client before the acceptance inspection. Any damage and repairs must be resolved before the financial final settlement of the contract.

The following parties are present depending on the inspection item:

- The client's representative,
- The main contractor's representative,
- The subcontractor's representative,
- The quality controller for geosynthetic work,
- The representative of the authority monitoring the compliance with the environmental permit of the site (if deemed necessary),
- The designer (if deemed necessary).

If deficiencies are found during inspections or checks, they must be corrected before final approval and covering the structure. If the structure is found to not meet the set requirements, correction is primarily done by removing the faulty structure and rebuilding it. A report must be created for all inspections.

2.2 Reporting of structures

The contractor prepares their quality assurance plan according to section 3.2.1.

The contractor compiles material, research, measurement, and test results from the construction, and presents the final report content for the construction work involving the geosynthetic structural layers to the client and supervisors before the completion inspection so they can comment on its content.

The contractor must hand over the final documentation of the work performance to the client and store it in the project bank before the acceptance of the tightness structure contract and the financial final settlement.

2.3 Site arrangements

2.3.1 Working conditions

The working conditions at the construction area are consistent with a typical construction site.

2.3.2 Consideration of operations in the work area and adjacent areas

In the planning and execution of the work, the contractor must take into account the location of the work area and, in cooperation with the client, plan all their work so that operations in adjacent areas are disturbed as little as possible during construction. The contractor must sufficiently familiarize themselves with the equipment, construction sites, and traffic conditions in and around the work area.

2.3.3 Site plan

The contractor prepares the site plan, which presents the location of the base camp, storage areas, traffic arrangements, temporary structures, water and waste management arrangements, the starting and progression order of the work, etc. The plan must be prepared within 21 days of signing the contract and presented for acceptance by the client together with the quality assurance plan.

2.3.4 Site and base camp areas

The contractor is responsible for marking their site area. The client designates the location of social facilities and the site office near the work areas or another suitable area close to the work site. The client also indicates the electricity connection point near the designated location. Water and sewer availability are agreed upon separately. The contractor must prepare for the delivery of a dry toilet to the site.

2.3.5 Site traffic and traffic arrangements

Site traffic and material transports to the site must be done via existing road connections. The contractor must ensure guidance to their work site. This is further discussed at the start-up meeting and site meetings.

2.3.6 Restrictions, points and areas to be noted

The client provides instructions regarding the organization of traffic leading to the site and internal site traffic, parking, restrictions, prohibited areas, etc.

2.3.7 Moving pipes and cables

The protection, potential underpass, cutting, moving, and rejoining of all pipes and cables indicated in the plan documents and present in the work areas are part of the contract.

2.3.8 Site maintenance

Water, sewage, cleaning, waste management, electricity, and other maintenance related to the work performance are the contractor's responsibilities. Wastewater must not be discharged into the environment. There must be at least one portable container on-site for waste generated from the work.

3 CONSTRUCTION AND QUALITY CONTROL

3.1 Placement and measurements of the structures

The contractor may choose to present their own construction and quality control for placement and measurement of structures (Section 3.1.) or alternatively indicate they will comply with the following procedures:

The client indicates the fixed points to be used, from which measurement work is the contractor's responsibility. The contract includes performing implementation and detailed measurements as well as measurements for checking work performance according to Table 3.1.

Table 3.1 Levels to be measured and minimum density of X, Y, and Z measurement points.

	Structure/level to be measured	Measurement density	Note.
1	Base structure		
1.1	Current surface of the work area (after surface levelling)	grid 5 m x 5 m	initial data for measurements on the work area
1.2	Edges of the area where protective geotextile	break lines at intervals of a maximum of 5 m	edge measured as break lines
1.3	Seams and edges of the lower tightness liner application area	as break lines at intervals of a maximum of 5 m	before the installation of the drainage mat
1.4	Edges of the drainage mat and drainage network application areas	as break lines at intervals of a maximum of 5 m	before the installation of the upper tightness liner
1.5	Seams and edges of the upper tightness liner application area	as break lines at intervals of a maximum of 5 m	
1.6	Locations of constructed wells and passages		water runs in pipes measured from wells and passages
1.7	Quality control points	1 measurement per point	location of all quality control points (including client quality control)

Before starting the work involving geosynthetic structural layers, the work area is measured onto a grid of approximately 5 meters (see Table 3.1). The upper surface of each completed

structural layer is measured onto a grid of 5 meters. The contractor prepares implementation drawings based on their measurement results. The implementation drawings must show the locations of the constructed layers, wells, and passages.

The contractor must have their measurement performers, methods, and equipment approved by the client. In implementation and detailed measurements, the performance and output of the measurement work must be suitable for the formation of terrain models.

Measurement plan:

Before starting the work, the contractor must prepare a measurement plan. The measurement plan must present (who performs and how):

- personnel
- measurement equipment
- used fixed points and coordinate system
- source and method of collecting/transfer plan information
- coding/list of codes for measurements, drawing rules
- measurement densities and quantities § marking methods in the field
- data processing tools
- processing and checking of measurement results
 - tools used for processing
 - printing of measurements
 - schedule for processing and printing
 - storage and archiving of measurement results
- graphical presentation and markings of results; explanations of symbols
 - outputs must be viewable as black and white copies
- what documents are delivered, to whom, when and in what form
 - what is delivered during the work in paper or electronically and in what format
 - outputs to be included in the final report

The measurement results must be compiled in a format that quality control can use to analyze the measurement and positional accuracy of the structures so that they can be used later as initial data for future area plans.

The measurement data is delivered coded according to, for example, the Vid-code list. The measurement data must include a note on which code list has been used.

3.2 Quality control and work reporting

3.2.1 Contractor's quality control

Quality control shall minimum apply with requirements in DVS guidelines.

Quality control measurements and sampling of the protective layer (protective geotextile 1200 g/m²), both tightness layers (HT liners, min. 2.5 mm), and the drainage layer between the tightness liners (drainage mat/drainage network) are part of the work.

The contractor must prepare their preliminary work method and work order proposal for the implementation of the construction project and present it in the preliminary quality assurance plan attached to the bid.

The contractor updates their preliminary quality assurance plan from the bidding stage to a quality assurance plan encompassing all tasks included in the contract, which must be approved by the client and independent quality controller at least 1 week before the work starts.

The quality assurance plan includes the contractor's procedure for material approval. The plan presents:

- plan for the implementation of different structural layers of the base structure, considering available work, and traffic areas,
- quality control measurements in different stages of work,
- field and laboratory methods used,
- measurement densities and
- acceptance criteria used in the work.

The quality assurance plan also names the contractor's responsible personnel, subcontractors, and subcontractors.

The contractor maintains a site diary and, if necessary, a separate quality control log, to record all quality control measures. All quality deviations, corrective actions, and subsequent re-measurements are documented carefully. Product information is also collected and presented as part of the final documentation.

The contractor promptly delivers all their quality control measurement results electronically to the client and independent quality controller.

At the end of the work, the contractor prepares a final report, which includes all product information, quality control measurement results, and correction reports.

3.2.2 *Client's quality control*

Local supervisor and geosynthetic work quality controller: The client assigns a local supervisor and geosynthetic work quality controller to the site. The local supervisor acts as the client's representative and oversees the daily operations of the site.

The geosynthetic work quality controller makes site visits as needed, participates in site meetings and inspections, approves the contractor's plans and products, and performs or arranges parallel quality control measurements if necessary. The geosynthetic work quality controller reviews the quality control results provided by the contractor and the final report, then prepares a summary based on their observations, measurement results, and the contractor's final report.

4 PROTECTIVE GEOTEXTILE

4.1 Weight and material

A protective geotextile is applied as the installation base and lower protective layer for the lower HT-HDPE/PP liner. Its mass is at least 1200 g/m² (using average minimum area masses determined by production quality control).

The protective geotextile material is needle-punched and needle-free polypropylene (PP) or polyethylene (PE). The product must not contain recycled fibers except for recycling material from the manufacturing process. The protective geotextile is approved with product information and performance declarations that present the required CE marking information according to the product standard SFS-EN 13257. The standard-compliant product information includes:

- raw material
- area mass, EN ISO 9864

- thickness, EN ISO 9863-1
- tensile strength and elongation at break, EN ISO 10319
- static puncture strength (CBR test), EN ISO 12236
- dynamic penetration resistance (cone drop test), EN 13433
- damage during installation, EN ISO 10722
- protection efficiency, EN 13719 and EN 14574
- long-term durability (service life)
- weather resistance, EN 12224
- heat resistance, high-temperature resistance to be demonstrated ($T_{max} = 90 \text{ }^{\circ}\text{C}$)
- chemical resistance, EN 14030+A1 or EN ISO 13438, EN 12447
- microbiological resistance, EN 12225
- sufficient friction at material interfaces to be demonstrated by the inclined surface test (load <50 kPa) according to EN ISO 12957-2 or straight shear test according to EN ISO 12957-1.

If weather resistance is not demonstrated, the products must be covered on the installation day.

4.2 Installation

The protective geotextile is installed manually.

The protective geotextiles are overlapped using:

- a minimum overlap length of 0.3 m or
- an overlap length of 0.15 m + welding every 0.5...1 m.

No impurities are allowed between the protective geotextile and the tightness liner installed over it.

Each protective geotextile roll must visibly show the manufacturer's name, product type, mass per unit area (g/m^2 etc.), and roll serial number. The product manufacturer and type markings must be visible on the surface of the protective geotextile. *The quality requirements for protective geotextiles are presented in table 4.1.*

After the acceptance inspection, the contractor shall take one sample per each starting 10,000 m^2 (in accordance with InfraRYL 142514.1.2 appendix 20) for testing purposes, and the independent quality controller will send said samples to an independent testing laboratory for testing. At minimum, the samples of protective geotextile will be tested for mass per unit area (EN ISO 9864) and tensile strength (EN ISO 10319).

The average of the results must meet the requirements specified in the table. The individual minimum requirement is -10%. The individual minimum for mass per unit area is determined according to EN ISO 9864 (the individual minimum requirement is not one sample piece but a series of samples, e.g., a sample the width of the roll is cut into a sample series of e.g., 10 pieces, then the average weight of these 10 individual pieces constitutes one measurement result).

Table 4.1. Minimum average values (MARV values) of protective geotextile properties.

Property	Test method	Unit	Value threshold
Mass per unit area (average of 10 test samples), taken from each roll	ISO EN 9864	g/m^2	≥ 1200
Thickness at 2 kPa load	EN ISO 9863-1	mm	value to be reported
Tensile strength (md/cmd)	EN ISO 10391	kN/m	$\geq 36 / 36$

Strain corresponding to tensile strength	EN ISO 10391	%	≥ 50
Static puncture strength	EN ISO 12236	kN	≥7,6
UV resistance	ISO 12959 or EN 12224	%	≥ 70

Broken needles are removed during manufacturing through an automatic continuous needle detection and removal system. The needle absence in the protective geotextile must be examined on site according to the contractor's quality control plan.

5 SEALING LAYER (MATERIAL HT-HDPE- OR HT-PP-LINER)

5.1 Material and storage of liner rolls

High Temperature High Density Polyethylene (HT-HDPE) or equivalent polypropylene (HT-PP) liner with a long-term heat resistance of at least 90°C is used for the sealing structure of the basin bottom and slopes 1:2.5 (lower and upper sealing liner). Resistance properties of the liners should cover the cyclical operational thermal loading (10°-90°C) of the pit storage. The nominal thickness of the material is minimum 2.5 mm.

Design target for the service life is 30 years. The tenderer must provide required documentation, that the expected service life fulfills the minimum requirements of 20 years expected service life (Please see document "Evaluation Criteria").

Friction liner must be used on the slopes 1:2.5, where the lower sealing liner must have a rugged or textured surface on both sides to improve friction properties. The upper seal liner must have a friction surface at least on one side (surface against drainage mat). The contractor has the design responsibility and must choose a material suited for the purpose. The high temperature (90°C) and the high pressure from the water table shall be considered in the design.

Liner rolls must be stored off the ground on new pallets and covered. Liner rolls may not be temporarily stored on the work area or structures. Regarding work safety, special care must be taken to ensure that liner rolls do not start moving independently on the slopes.

5.2 Installation Instructions

Before starting installation work, the contractor prepares installation and quality assurance plans for both sealing liner layers which must be approved by the client and independent supervisor.

The installation plan for liners includes:

- Detailed spreading plan (location, installation direction, and locations of seams of all liners to be installed)
- Contractor's quality assurance program: i.e., description of how the installation is documented
- Plans for repairing holes, damages, cuts, etc.
- Plans and drawings designated to be performed by the contractor
- Transport, storage, handling, and protection of geomembrane at the site

The contractor must consider stability during installation work and the final situation. The equipment and working method used by the contractor must take into account stability during work.

The lower sealing liner is installed directly on top of the protective geotextile and the upper sealing liner is directly on top of the drainage mat (drainage network) following the instructions of section 142524.3.1 of InfraRYL online version 2023/2.

Penetrations and seams in the liner are made as gas-tight structures. Seams between liner strips are welded using pressure-tested double seam.

Penetrations of wells and pipes, repair points for damaged liners, etc., are welded using extrusion welding. *Penetrations of wells and pipes are implemented with penetration structures according to the contractor's plans*, to which the contractor attaches the sealing liners. The design will need to be approved by the client supervisor.

The integrity and tightness of all seams must be checked no earlier than 0.5 hours after welding.

From the welding machines, real-time proof must be received either in the form of a paper strip or electronic record, showing temperatures, progress, seam thickness reduction, etc. In addition to the output from a wedge welder, all double seams must be checked with a pressure test. The operational parameters of the welding machine are adjusted according to welding conditions before the start of each seam day or whenever there are significant changes in weather conditions.

The adjustment is done by welding a test seam and measuring the compression of the sample piece and conducting strength tests (peel and tensile tests).

The contractor takes sample pieces (2 pcs) from each of the double seams welded with a wedge welder. Sample pieces are numbered and positioned on the map. The first seam-specific sample pieces are tested by the contractor with peel and tensile tests, results documented and handed over to the developer. The other seam-specific sample pieces are documented and handed over to the developer. Faulty seams are immediately repaired, and the repaired seam is retested immediately.

A map is drawn for the completed work, identifying all used liners and completed repairs. The liner must not be installed at temperatures below +5°C, in rain, or in strong wind. Movement on the sealing liner should be avoided. Movement with heavy machinery on the liner is prohibited.

A competent and experienced contractor and installation and seam purpose-made operational tools and equipment must be used for the installation of the sealing liner and seaming. To demonstrate competence and experience, the contractor must present references from previous similar projects and a description of the training and experience of installers and supervisors and perform a test before starting the work. The welders' competence must be demonstrated with a valid welder's certificate according to SFS-EN 13067 standard or DVS 2212-3 guidelines (additional requirements in the contract program).

If the membrane installation work is part of the main contract, the developer approves the liner contractor before the start of membrane work.

In the installation and covering of the liners, the temperature must be considered so that the liner surface is straight during spreading and does not get wrinkles due to thermal expansion

5.3 Seam work and liner quality control

Before starting the liner membrane work, the contractor's installers perform a test where the success of the seam work is examined under site conditions. Preliminary tests/test works are carried out with all the welding machines used; each machine being individually identified. The length of the test seam for wedge welding machine will be the width of the liner. The test seam undergoes a pressure test and a sample taken from the test seam undergoes strength tests (peel and tensile tests). Additionally, the test must include at least one T-seam, and one penetration welded. The tightness of these seams must also be verified.

In the pressure test, the pressure drop from the initial pressure must not exceed 10% within 10 minutes. For extrusion seams, a spark test is performed where no breaks may occur.

In the preliminary tests/test works, complete ASTM D6392 series of 5 pcs tensile tests and 5 pcs peel tests are conducted. Daily before work starts, one peel and tensile test are conducted, and during the work, one tensile and one peel test are conducted for each seam. The test piece width 25 mm (or 20 mm).

Tensile tests for 2.5 mm friction liner material must achieve 876 N/25 mm tensile strength and 661 N/25 mm peel strength for wedge seam and 876 N/25 mm tensile strength 570 N/25 mm peel strength for extrusion seam. Strength requirements are reduced in proportion to test piece width, i.e., a 20 mm wide test piece must achieve 80% strength in relation to the values presented above. Requirements are adjusted according to the liner material thickness. Eg. for 3 mm material the strength value requirements are increased by 20%.

A separate written report (seam and test report), presenting test results and seam parameters (seam outputs) is made from the preliminary tests/test works and the in-work test results. The report is handed over to the client and geosynthetic works quality controller at the acceptance inspection.

Material and roll information and information on manufacturer's quality assurance for all liner rolls installed must be provided to the client according to the installation plan.

The properties and condition of the sealing liner are visually inspected during installation. The thickness of the liner is checked with a micrometer from the edge of the liner roll (one measurement/liner roll). The measurement results are recorded in the quality control reports.

5.4 Anchoring of sealing liners and other geosynthetics

The anchoring of the sealing films and other geosynthetic layers related to ground-based sealing structures are implemented at the upper edge of the basin slope. RAK design plan drawing RAK 2 (structure type, principle details) shows the principles of the anchor trenches.

The contractor is responsible for the design of the anchor trenches to secure the sealing membranes in the embankments. The design shall consider any requirements related to the properties of the membrane materials to ensure sufficient anchoring, as well as mechanical, and environmental (weather) protection.

The earth works related to construction of the anchor trenches is in the scope of the main contractor.

The design needs to be approved by the client supervisor.

5.5 Checking the integrity of completed sealing liner layers

The liner contractor must also verify the integrity of at least the lower sealing liner using a suitable electronic leak detection method (e.g., arc testing method, Arc Testing Method). The integrity of the upper sealing liner should also be verified, if the suitable leak detection method can be technically arranged.

Any holes and other damages found during integrity tests are repaired according to the contractor's work plan.

5.6 Penetration structures

There are no specific pipe penetrations related to the sealing liner in the construction plans. However, the supplier has design responsibility, and the design needs to be approved by client supervisor. For the leaking well, the sealing structures are implemented according to section 6.4. On top of the diffuser foundations, a so-called casting liner is installed, to which the upper sealing liner of the bottom area is attached using extrusion welding. Installation instructions for said casting liner and sealing liner are provided in separate installation plan drawings for diffuser foundations.

Possible other penetrations are implemented according to the contractor's implementation plans.

related to the penetration of the liners, the supplier has design responsibility, furthermore the design needs to be approved by client supervisor

5.7 Repair of sealing liners

Any damages found in the sealing liner must be examined and repaired. Patch and repair points must be documented.

Commented [MB1]: Just a note: We should discuss this design detail with the contractor.

6 DRAINAGE MAT AND LEAK WATER MANAGEMENT BETWEEN SEALING LINERS

6.1 Drainage mat for basin slopes 1:2.5

A drainage mat is installed on top of the lower sealing liner on slopes 1:2.5 for draining leak water, which has an incompressible PP or HDPE core (minimum thickness of at least 5.0 mm) and geotextile on both sides (e.g., FabriNet ST-E, Double-Sided 200 g/m²). The drainage mat must be bidirectional water-draining horizontally, and there must be filter fabrics on both sides of the mat (e.g., filter fabric 200 g/m²).

The contractor must demonstrate that the product used is suitable for the application (high-temperature resistance must be demonstrated ($T_{\max}=90^{\circ}\text{C}$) and additionally convincingly demonstrate by calculations the long-term functionality of the drainage mat and that the drainage mat meets the water permeability requirement, which is at gradient 0.1 and 200 kPa load at least 0.05 l/m*s at 90°C.

6.2 Drainage network installed on the basin bottom

On the bottom area defined by the lower edge of the slopes 1:2.5, an incompressible drainage network is installed instead of a drainage mat on top of the lower sealing liner, with a core thickness of at least 6.0 mm and material PP or HDPE (e.g., HyperNet HF-E).

The contractor must demonstrate that the product used for the drainage network is suitable for the application (high-temperature resistance must be demonstrated ($T_{\max} = 90^{\circ}\text{C}$) and additionally convincingly demonstrate by calculations the durability of the drainage network and that the drainage network meets the water permeability requirement, which is at gradient 0.1 and 200 kPa load at least 0.45 l/m*s at 90°C.

6.3 Quality control and work instructions

Construction of drainage mat (and drainage network) in accordance with InfraRYL section 142515.3.2 and demonstration of suitability of the finished structure in accordance with InfraRYL section 142515.5.

The contractor must prepare a spreading plan for the installation of drainage mats and drainage networks, which must be approved by the client and geosynthetic works quality controller before the start of work. The spreading plan must be updated as necessary.

The drainage mat and drainage network are installed directly on top of the lower sealing liner following the manufacturer's installation instructions.

The drainage mat on the slopes 1:2.5 ends at the lower edge of the slope, where the drainage layer continues as a drainage network in the basin bottom area.

6.4 6.4 Leak Water Management Structures in Sealing Structures

6.4.1 Leaking Wells

In the center of the shallow depressions (6 pcs) in the bottom area of the basin shown in the grading plan, leaking wells (prefabricated PP or PEH-well, pipe material PN 16, 40-ton grating cover) are installed for collecting and draining possible leaking water from the drainage layer, the type drawing of which is shown in the design drawing GEO-19.

The flange at the top of the well is extruded-welded to the well after the well installation work is completed when the surrounding fills of the well have been implemented to the fixing level of the flange.

Material compatibility between leaking wells and sealing liner is the responsibility of the supplier to ensure that the service life of the wells and connections are the same as the sealing liner.

The supplier has design responsibility of leaking wells, and the design needs to be approved by client supervisor.

6.4.2 Work Instructions for Sealing Structures and Well Connection Works

The supplier has design responsibility of sealing structures and well connection works. However, the design needs to be approved by client supervisor.

1. The lower sealing liner is extrusion-welded to the PP or PEH flange at the top of the installed well.
2. The drainage network is installed on top of the grated well.
3. The upper sealing liner is installed on top of the drainage network and connected to the other upper sealing liner structure of the bottom area.

7 CLEANLINESS, TEMPORARY PROTECTIVE LINER AND WATER FILLING PROCESS

7.1 Cleanliness and installation of temporary protective liner

To protect the water in the storage from dirt and contamination during water filling, a temporary protective liner is required. The protective liner could be a 1.5 mm geomembrane installed on top of the geomembrane covering the bottom and slopes of the pond. Water is filled in below the temporary protective liner, which shall float upwards together with the increasing height of the water table. The design and installation of the temporary protective liner, to ensure a minimum of dirt being able to enter the water, is the responsibility of the supplier. This includes:

- Installation and welding of protective liner
- Installation of montage opening around diffuser device
- Installation of all necessary flotation devices and weight pipes
- Anchoring and wind protection of protective liner
- Design of the protective liner, including montage openings, flotation devices and weight pipes

During installation of the geomembranes, it is unavoidable to get dirt onto the surface of the geomembrane. To ensure a clean surface and a minimum of contamination of the water being

filled into the storage, the geomembrane surface must be cleaned after installation. The contractor must include in the offer a cleaning of the entire surface with a pressure washer or alternative method to ensure the same level of cleanliness. Removal of dirt and liquid from the surfaces is the responsibility of the contractor. The cleaning procedure shall be done in a continuous process section by section immediately before installation of the protective liner to ensure a clean surface below the protective liner.

7.2 Water filling process

Contractor has full responsibility of arranging and supervising the filling process of the pit. In filling process special attention must be paid during filling process:

- to protect the water from any impurities, e.g. such as dust, vegetation, animals and microbes
- to protect all structures from mechanical damages within the pit and construction area
- to protect temperature sensitive materials from freezing and or mechanical impacts

Filling water is led to the pit storage trough Diffusor piping system. The Client provides filling water from Hyvinkää freshwater network. Available filling water flow varies between 80 m³/h (daytime) – 120 m³/h (nighttime), depending freshwater demand in Hyvinkää area. Estimated time for filling the pit storage is 6 months. Temperature of the filling water varies between appr. 2° - 10°C.

Contractor shall preset filling plan and at least principles for precaution actions as part of tendering phase. Filling plan needs to be approved by Client supervisor.

7.3 Maintenance and protection of geomembranes during installation and water filling

The supplier has full responsibility of all necessary precautions to protect the liner and other materials during the installation and water filling period. If special precautions need to be taken due to low temperatures, wind load or other impacts, these precautions shall be included in the contract and designed and carried out by the Contractor. The Contractor shall carry out detailed design of the precautions within an agreed design schedule.

General maintenance related to weather impact and removing of rainwater from protective liner during water filling of the storage is the responsibility of the supplier and therefore they are included in this scope. The contractor shall act as a supervisor for the maintenance of the filling and geomembranes to ensure that the maintenance is in line with the requirements from the Client. The contractor is also responsible for any needed adjustments of the protective liner during water filling (e.g. openings or protective sleeves around diffuser pipes).

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