Aalborg Forsyning

A2
TECHNICAL DESCRIPTION

TANK THERMAL ENERGY STORAGE

2021-12-17/2022-05-25
VERSION 3~~2~~

Aalborg Forsyning project no. 230810099

VERSION	**3~~2~~**
DATE	**2021-12-17/2022-05-25**
PREPARED BY	**CHTF/MHO**
CONTROLLED BY	**BKL**
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Developed: CHTF/MHO Controlled: BKL Approved: CHTF

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1. Orientation

Aalborg Forsyning, Aalborg Varme A/S (The client) is planning to phase out coal and all other fossil fuel producing units by the end of year 2028, by implementing a variety of different new heat producing units such as heat pumps and electrical boilers, as well as industrial surplus heat. A key element for this transition is to increase the heat storage capacity at "Nordjyllandsværket, Nefovej", with additional 200,000 m3 Tank Thermal Energy Storage (TTES).

The project with establishing 200,000 m3 TTES' are divided into 2 Lots which each involves the construction of 100,000 m3 TTES'. This document covers both Lots.

1.1 In general

The contractor's work shall include design, manufacturing, surface treatment and erection of the welded steel Tank Thermal Energy Storage (hereafter TTES) including stairs, ladders, platforms, cladding and insulation. Furthermore, the contractor's work shall include design, execution and surface treatment of the foundations and bitumen-sand coating.

The technical description has precedence over the General Description.

A project-specific description has precedence over the standard specification.

The following standard specifications will apply:

- bips B2.250, Standard Specification – steel general, Latest Edition

1.2 Definitions

A review is defined as an action where a written document is read and commented.

An approval is defined as an action where a document is reviewed and where it subsequently is declared whether the document is approved or discarded.

2. Scope of work

2.1 In general

The work shall include all the building elements mentioned in section 2.2 and other services described in the technical specification or shown at the drawings.

The contractor's offered contract sum shall include all the work and all the deliveries that are necessary for the actual work. The contractor's offered contract sum shall also include all temporary measures and secondary services that are necessary for the completion of the work. Even if the temporary measures and secondary services are not shown on the drawings or mentioned in the specifications, they shall be included in the contractor's offered contract sum if they are necessary for completion of the work.

The contractor's offered contract sum shall include delivery and maintenance of all necessary tools, machines, scaffolding, workmen's shelters, tool sheds, work light etc.

The work with the TTES shall in addition to the building elements mentioned in section 2.2 included the following items:

- Structural calculations including stability calculations
- All necessary drawings for building authority's approval (plane drawings, sectional drawings, and facade drawings)
- Documentation and quality assurance
- Filling of the TTES with treated water (osmosis treated and chemical treated water). The Client will deliver the water.

The foundations are included in the work.

Static calculations and static documentation must be drawn up in accordance with SBI-specification nr. 271, in which the contractor must be involved as the building designer

2.2 Building elements

The contractor's work shall include the complete delivery, erection, and commissioning of welded steel TTES with a total capacity of 100,000 m^3. The contractor's work shall include all measures and secondary services that are necessary for the full completion of the building elements. The welded steel TTES can be performed as 2 x 50,000 m^3 tanks, 3 x 33,000 m^3 tanks or 4 x 25,000 m^3 tanks.

All building elements that are not placed in a depository are considered as waste material. Those waste materials shall be removed from the site by the contractor. The waste materials shall be disposed according to the requirements of the authorities.

The work shall include the following building elements:

- Concrete foundations and bitumen-sand coating

- Welded steel TTES including bearings and consoles for cladding, stairs, ladders, and platforms etc.
- Cladding and insulation
- Lightning conductors
- Connections needed for instrumentation (Instruments and electrical installations are delivered by the Client).
- Case for instruments at roof
- Nitrogen pressure equalizing pipe connection

2.2.1 Foundation work

The work shall include all the concrete work at the foundation for the accumulation tanks. The work shall also include the following items:

- Excavation work, incl. groundwater lowering and sheet piles if necessary, for the work.
- Concrete foundations
- Bitumen-sand coating at top of the foundations according to DS/EN 14015, Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for storage of liquids at ambient temperature and above.

2.2.2 Steelwork

The work shall include all the steel work at the accumulation tanks. The work shall also include the following items:

- Structural calculations including stability calculations according to Eurocodes and other codes mentioned in chapter 3.2.2 and in bips B2.250, Standard Specification – steel general
- Structural drawings
- Welded steel tanks with spherical roof and welded bottom
- 2 pcs. of diffusers in each tank including piping to ball valves placed at the outer side of the cladding / insulation just above terrain
- Mounting/welding of ball valves for each diffusor – valves are delivered by the Client.
- DN250 branch at bottom to empty the tank. The studs shall include end flanges and overflow pipes
- Mounting of necessary branches for instrumentation, filling with nitrogen, safety valve and pressure and vacuum relief valve
- Delivery and mounting of safety valve and pressure and vacuum relief valve
- Delivery and mounting of stairs, ladders, platforms, railings and circumferential platform at top according to the CE requirements and must be approved by the client's HSE organization.
- Delivery and mounting of a waterproof cage for electrical instrumentation at roof and at bottom of tank.
- Delivery and mounting of a waterproof cage for valves and instrumentation at roof.
- Documentation and quality assurance according to DS/EN 1090-1, DS/EN 1090-2, DS/EN ISO 3834-3 and DS/EN 14015.

2.2.3 Cladding and insulation

The contractor's work shall include all cladding and insulation at the accumulation tanks. The contractor's work shall also include the following items:

- Insulation of the tank roofs and the cylindrical shells
- Cladding of the cylindrical shells with trapezoidal sheets in a color agreed by the Client
- Roofing of spherical roofs with roofing felt
- Waterproof coverings and flashings of pipes, cables, stanchions and mountings penetrating the cladding, or the roofing felt

2.2.4 Lightning protection

The work includes the supply and installation of lightning conductors to secure the battery storage tank and installations therein. The contractor's work shall include installation:

- Collector
- Down conductors
- Earthing system
- Potential equalization
- Measurement report

Lightning protection of the tank system is carried out according to IEC 62305-3, LPS class II.
The earthing system/lightning protection system shall be designed as a type B system in accordance with DS/EN 62305-3 section 5.4.2.2. This is a ring earthing system which shall encircle the entire tank.

2.2.5 Instrumentation

All electrical instrumentation is delivered by the Client. The contractor's work includes the supply and installation of all necessary flanges, branches, pipe connections etc. for mounting of the following instrumentation:

- Temperature transmitters for recording temperatures throughout the tank – it's expected to be 3-4 down hanging chains from the top of the tank.
- Pressure transmitters and manometers and all equipment for controlling, regulating and monitoring the nitrogen buffer.
- Level transmitter for measuring the water level in the tank.
- Pressure transmitter at the bottom of the tank to measure the mass of water.
- Overflow alarm in overflow pipe from accumulation tank.

2.2.6 Electrical work

All electrical cabling is carried out by another contractor.

The contractor's work is to establish casing pipes from the top of the tank to the connection box at ground level and assist with the construction and mounting of smaller mounting plates etc.

The work includes electricity tracing of overflow pipes – the Client delivers the electrical connection.

2.2.7 Filling with water

The work includes filling with new treated water supplied by the Client. The Client can supply 50 m^3/h. After filling, the present contractor shall re-inspect the tank for leaks etc. Costs for water consumption, electricity consumption and chemical consumption in connection with the filling are to be paid by the Client.

2.2.8 Nitrogen plant – balancing connection

The capacity of the Client's existing nitrogen plant is assumed to remain adequate for future operation.
Nitrogen coverage of the proposed tanks is to be provided from a piped nitrogen line, from which at least 2 tanks are to be connected. Between the tanks, a nitrogen equalization connection must be established, which is routed together with the walkways.

2.3 Design

The work includes the complete detailed design of the storage tank and its associated parts including foundation.

Project material shall be delivered to the Client's construction management in 2 copies. The project material will to the extent possible be commented within 5 working days from receipt.

2.4 Construction site

According to appendix *A1 General description*.

The work includes all necessary protective measures for the protection of existing facilities and other works during execution.

Cladding sheets shall be thoroughly capped when stored on site.

2.5 Safety and Health

2.5.1 General

According to appendix *A1 General description*.

2.5.2 Temporary impacts

The project material considers the function of the building elements facing the effects and the impacts they are intended for in the finished structure. During construction, the function of the building elements and/or the impacts may be different from those in the finished structure, depending for example on the chosen sequence of execution and/or special impacts during the construction period.

The methods of execution envisaged must be well thought out and the necessary precautions must be taken to ensure safety at all times and to exclude unacceptable conditions during execution.

The site supervisor may require evidence that proof the above requirements will be met.

2.5.3 Risk specification

The following specific risks are highlighted:

- Deep excavations

- Groundwater
- Hot work
- Working at height
- Working with a crane
- Working with large quantities of water

The contractor must prepare a detailed risk specification and risk assessment prior to the work.

2.7 Quality management

2.7.1 General

The Contractor shall defray all costs, including inspection costs, associated to the requirements contained in these technical specifications.

It is the responsibility of the Contractor to plan, control and carry out the welding and control work in such a way that the required quality of the welding work is achieved and documented. All documentation shall be included in the final documentation and shall be present on site.

The basis for the execution and control of steel structures is DS/EN 14015, DS/EN 1090-1, DS/EN 1090-2 and the Eurocode EC3.

The tender shall include a detailed description of the form of quality assurance the Contractor intends to use for the execution of the project. In particular, it must be stated how the Contractor will organize and control the calculation, drawing and workshop work. It must also state how the Contractor intends to document the work carried out.

A copy of the QA folder must be handed over to the Client on completion of the construction of each tank at time of handover.

2.7.2 CE marking etc.

Supplies and services must generally be accompanied by the documentation specified in the regulations relevant to the supply, including the relevant harmonised standards.

Documentation of roof plates, roof supporting, stairs, ladders, and platforms etc.

-DS/EN 14015 section 10.3 prescribes that roofing and roof supporting structure shall be designed according to DS/EN 1993-1-1. Similarly, stairs, ladders, railings and platforms and bearings and consoles for cladding, stairs, ladders, and platforms etc. shall be designed according to DS/EN 1993-1-1. Those structures shall be delivered with a Declaration of Conformity and CE marking according to the requirements in DS/EN 1090-1 and DS/EN 1090-2 from a DANAK notified body.

Documentation of the requirements to Declaration of Conformity and fulfilling of the requirements to CE marking

The TTES shall be designed and manufacturing according to DS/EN 14015. The contractor shall as a minimum submit a Declaration of Conformity according to DS/EN 14015 for the tank bottoms and cylindrical shells. Furthermore, the contractor as a minimum shall submit a certificate from a notified body. This certificate shall document that the contractor will fulfill the conditions to CE-marking in DS/EN 1090-1 and DS/EN 1090-2. Thus, there is not a requirement for CE marking the tank bottoms and cylindrical shells. But there is a requirement for fulfilling the conditions to CE marking in DS/EN 1090-1 and DS/EN 1090-2.

2.7.3 Warranty statements

Warranty declarations for materials and products must be submitted to the Client's site management before installation.

The Client's site management shall be notified as soon as a guarantee statement covering both materials and products and workmanship is available.

Guarantee statements for workmanship shall be submitted within 5 working days after the work has been carried out.

2.7.4 Control documentation

The control documentation is as follows:

- Inspection forms
- Delivery notes
- Calibration certificates
- Qualifications of personnel subject to specific requirements
- Similar documents not relating to the quality of the finished work.

Where a single control document exceeds one page, the document shall be numbered.

The contractor shall draw up the relevant control plan.

QA-documentation folder for steel structures: In addition to the requirements of DS/EN 1090-1:2012, the following requirements apply: as evidence that the tank Contractor ensures and controls the quality of the steel works, the tank Contractor shall prepare a QA-documentation folder containing: workshop drawings with item no. and corresponding parts lists, declaration of conformity with certificate from a DANAK notified body for the tank Contractor's production control, material certificates, welding plan, welding procedures (WPS), welding coordinator, welding certificates, NDT reports incl. visual inspection of welds, vacuum test, pressure test, documentation for zinc layer thicknesses, documentation for paint products, paint layer thicknesses, climatic conditions during painting, foundation reactions and static documentation. Furthermore, section 20 - Documentation of DS/EN 14015:2004 shall be incorporated. A copy of the QA folder must be handed over to the Client on completion of the construction of each tank at time of handover.

Initial QA for steel structures: At least 10 working days before the start of the work, the tank Contractor shall submit the following information to the building contractor for acceptance: Project Basis, Table of Contents for QA Documentation

Folder, Contractor and Type of Bolts and Threaded Rods, Bolt Prestressing / Securing of Bolts, Welding Plan, Welding Procedures (WPS), Welding Certificates, Contractor of Grids and Steps, Painting Company and Painting System, hot dip galvanization, NDT Company for Welding Inspection, Essential Subcontractors. The table of contents for the QA documentation folder must contain at least the following: workshop drawings with item no. and corresponding parts lists, declaration of conformity with certificate from a DANAK notified body for the Contractor's production control, material certificates, welding plan, welding procedures (WPS), welding coordinator, welding certificates, NDT reports incl. visual inspection of welds, pressure test, vacuum test, documentation for zinc layer thicknesses, documentation for paint products, paint layer thicknesses, climatic conditions during painting, foundation reactions and static documentation. Furthermore, section 20 Documentation of DS/EN 14015:2004 shall be incorporated.

Final quality documentation: The Contractor shall deliver the required quality documentation in electronic form at the end of the work (at least 2 weeks before assessment of the construction made before the handover).

2.7.5 O&M-documentation

All documentation required to be provided to Client's construction management that is not control documentation is filed in the O&M documentation.

Product documentation shall contain the following:

- Subject
- Name, address, e-mail and telephone number of contractor's
- Material specification/manufacture/type
- Cleaning method and means
- Maintenance and repair instructions
- Suggested maintenance intervals
- Replacement procedure, if any
- Instructions for use.

O&M documentation to be submitted to the Client's site management for review 2 weeks before assessment of the construction made before the handover.

O&M documentation must be submitted in danish in 2 copies and electronically.

2.7.6 Authorisation documentation

Hot work

The contractor must document that the persons who will carry out the hot work are certified for this.

Certificate for and authorization form to perform hot work shall be provided to the Client's construction management review prior to commencement of work.

2.8 Work Planning

Participation in project review meetings and construction meetings must be counted on as necessary.

The following documents shall be provided for the approval of the Client's construction management in 1 sample copies:

- Complete project documentation.

Before commencing work, the necessary working documents in the form of working drawings, working instructions, descriptions, measurements, calculations, etc., must be prepared to show that the specifications given in the project documents will be complied with during execution.

On request, working documents shall be made available for inspection by the Client.

Working documents will to the extent possible be commented on within 5 working days of receipt.

2.9 Investigations

Investigations, including sampling, that are common practice and/or required by codes and standards are not listed but expected to be conducted by the Contractor.

The following tests shall be performed:

- Geotechnical feasibility study
- Tightness testing
- Fill water quality check
- Levelling of tank foundation during water filling

Weld inspection (NDT) is delivered by the Client, but planning is included in the work of the Contractor.

2.10 Samples

Samples of materials and products (product samples) shall be submitted in sufficient time to avoid delays due to possible discarding and obtaining of new samples. These samples must be labelled with the name of the construction company, the name of the project and the contractor, their address, e-mail and telephone number.

Tests for the determination of performance requirements (reference fields) shall be carried out at such an early stage that any discarding and carrying out of new reference field does not delay the work.

Product tests and reference fields shall, after approval by the Client's site management, form the standard for the work.

The following samples of materials and products shall be submitted to the Client's site management for approval:

- Trapezoidal sheets for cladding

Samples will to the extent possible be commented on within 10 working days of receipt/notification that the sample has been carried out.

2.11 Lead-ins, installations, and retrofits

All penetrations, attachments and retrofits shall be included in the work.

2.12 Cleaning

All visible parts of the structure must be cleaned when the work is handed over for subsequent work/before the handover.

Metal shavings and metal dust in the workplace must be continuously removed and/or washed down.

Regarding waste disposal, please refer to the appendix *A1 General description.*

2.13 Contract scope

Piping up to the branch on the bottom of ball valves is carried out by another contractor. Ball valves for main connection pipes are delivered by another contractor. Mounting and welding of ball valves to piping on both sides of valves is included in this work. Secondary valves, bottom drain nozzles etc. is included in the work of the tank.

Electrical installation for components from IP65 box to heating plant is provided under electrical for machine installation. The present contractor shall provide complete documentation for the installed components, so that another contractor can establish the necessary control and monitoring. Wiring from the components to the IP65 box at ground level belongs to the present contractor.

3. General specifications

3.1 General

3.1.1 CE-markning, etc.

Supplies and services falling within the scope of one or more directives implemented in Denmark must be marked accordingly. The marking must include both the CE marking and any other marking requirements.

Documentation must be provided to the Client's construction management.

3.1.2 Construction site

3.1.2.1 General

Please refer to appendix *A1 – General description*.

3.1.2.2 Protective measures

Protective measure covers any form of covering, enclosing, covering, dust walls and similar interim measures.

Materials for protective measures shall be suitable for the purpose.

Protective measures must be removed immediately before handover of the work for each tank individually as a basis for subsequent work/before handover.

Protective measures must be disposed after use and in such a way it does not damage permanent building elements.

Protective measures must be installed before work commences.

Protective measures must be carried out in such a way that adjacent building parts are not damaged.

Protective measures shall be maintained on a regular basis.

3.1.2.3 Transport and storage

Materials are the responsibility of the contractor. The location of materials on the construction site is agreed with the Client and any other contractors.

3.1.2.4 Scaffolding

Scaffolding is defined as a temporary structure that can either act as a support, bracing, fixing, etc. for the permanent structures until they can support themselves, and/or act as an access route for personnel, transport of materials, etc. and platform on and from which work is carried out.

A working scaffold is defined as a scaffold whose primary function is the performance of work on and/or from the scaffold.

Technical aids attached to working scaffolds are to be considered as part of the working scaffold if they are anchored to the working scaffold. This applies, for example, to total covers, access routes, stairways, and fall-arrest devices.

Working scaffolds must be designed in a safe and healthy manner.

Scaffolding must be erected in accordance with general practice, for example as set out in the scaffolding supplier's instructions and relevant industry guides.

The following applies only to scaffolding which serves as support, bracing, fixing, etc. for permanent structures until such time as they can support themselves.

Scaffolding must be designed and documented in accordance with the relevant Eurocodes, DS/EN 12811 and DS/EN 12812 and DS 2427 - EN 13670, chapter 5.3.

Concepts used for load and safety are in accordance with DS/EN 1990 and DS/EN 1991.

For the dimensioning the rules of DS 2427 - EN 13670, Annex C apply.

The static documentation shall be drawn up and checked in accordance with the provisions of DS 2427 - EN 13670, Chapter 5.3.

A specification shall be drawn up for the construction of the scaffolding. The specification shall contain all relevant information and checks for the execution.

The Client's construction management may request the static documentation and the specifications for the execution.

The geotechnical parameters specified in the geotechnical investigation report and the geotechnical design report apply to the site.

3.1.3 Work planning

Work shall not commence until comments or declarations have been made by the Client's site management in connection with a review or approval.

Unless otherwise specifically stated, comments or statements from the Client's construction management will be available within 5 working days of receipt.

3.2 References

3.2.1 General

Where basic descriptions have been applied to the present work, the references in those basic descriptions apply to the parts of the work which are referred to in those basic descriptions and are therefore not repeated in the present description.

References containing building legislation are included in the following lists only where appropriate; the listing of building legislation is therefore not exhaustive.

The instructions, notes, recommendations, advice, etc. given in the references are to be regarded as requirements which may be departed from only if this is stated in the work description or on drawings/building models or agreed with the Client's construction management.

When referring to a reference in the statement of work, the full title of the reference is not necessarily used, but often an abbreviated title or other unique identification such as publication number.

When referring to a Eurocode or standard, this is also a reference to the related Danish national annex/national provision.

3.2.2 References in general

- DS 452: Thermal insulation of technical service and supply systems (Danish Standards)
- SBI 271 Documentation and inspection of load-bearing structures (in Danish)
- DS/EN ISO 14122 "Safety of machinery".

3.2.3 References for specific parts of work

The following is a list of the references used in the technical description. The references listed, or parts thereof, are specifically indicated in the places in the technical description to which the reference relates. The references shall be in latest edition and with national annexes (DK NA).

Foundation

The concrete foundations are designed and manufacturing according to:

- Eurocode 2: Design of Concrete structures
  Part 1-1: General rules and rules for buildings
  DS/EN 1992-1-1 (Danish Standards)

- Eurocode 7: Geotechnical design
  Part 1-1: General rules and rules
  DS/EN 1997-1-1 (Danish Standards)

- DS/EN 13670 Execution of concrete structures
- DS 2427 - EN 13670 Concrete execution – Rules for application of EN 13670 in Denmark
- The Bitumen-sand coating at top of the foundations is designed and manufacturing according to: DS/EN 14015, Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for storage of liquids at ambient temperature and above

Tank

TTES are designed and manufacturing according to:

Tank bottoms and cylindrical shells

- DS/EN 14015
  Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for storage of liquids at ambient temperature and above (Danish Standards)

Roofing, roof supporting, stairs, ladders, railings and platforms and bearings and consoles

- Eurocode 3: Design of Steel structures
  Part 1-1: General rules and rules for buildings (Danish Standards)
  DS/EN 1993-1-1
  Eurocode 3: Design of steel structures:
  Part 1-1: General rules and rules for buildings (The Danish Enterprise and Construction Authority)

DS/EN 1993-1-1 DK N

- DS/EN 1090-1
  Execution of steel structures and aluminum structures
  Part 1: Requirements for conformity assessment of structural components (Danish Standards)
- DS/EN 1090-2
  Execution of steel structures and aluminum structures
  Part 2: Technical requirements for steel structures (Danish Standards)
- DS/EN ISO 3834-3
  Quality requirements for fusion welding of metallic materials
  Part 3: Standard quality requirements (Danish Standards)
- DS/EN ISO 1461
  Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (Danish Standards)
- DS/EN ISO 2063
  Thermal spraying – Zinc, aluminum and their alloys (Danish Standards)

Scaffold / Falsework

- Falsework - Performance requirements and general design
  DS/EN 12812 (Danish Standards)
- Temporary work equipment – Scaffolds
  DS/EN 12811 (Danish Standards)

Design Basis in general

- Eurocode 0: Basis of structural design
  DS/EN 1990
  Danish Standards.

- Eurocode 0: Basis of structural design, National Annex
  DS/EN 1990 DK NA
  The Danish Enterprise and Construction Authority.

Actions

- Eurocode 1: Loads for the design of structures.
  Part 1-1: General actions – Densities, self-weight, imposed loads for buildings
  DS/EN 1991-1-1
  Part 1-2: General actions – Actions on structures exposed to fire
  DS/EN 1991-1-2 b)
  Part 1-3: General actions – Snow loads
  DS/EN 1991-1-3
  Part 1-4: General actions – Wind actions
  DS/EN 1991-1-4
  Part 1-5: General actions – Thermal actions
  DS/EN 1991-1-5
  Part 1-6: General actions – Actions during execution
  DS/EN 1991-1-6
  Part 1-7: General actions – Accidental actions
  DS/EN 1991-1-7
  Danish Standards.

- Eurocode 1: Actions on structures, National Annexes:
  Part 1-1: General actions – Densities, self-weight, imposed loads for buildings
  DS/EN 1991-1-1 DK NA
  Part 1-2: General actions – Actions on structures exposed to fire
  DS/EN 1991-1-2 DK NA
  Part 1-3: General actions – Snow loads
  DS/EN 1991-1-3 DK NA
  Part 1-4: General actions – Wind actions
  DS/EN 1991-1-4 DK NA
  Part 1-5: General actions – Thermal actions
  DS/EN 1991-1-5 DK NA
  Part 1-6: General actions – Actions during execution
  DS/EN 1991-1-6 DK NA
  Part 1-7: General actions – Accidental actions
  DS/EN 1991-1-7 DK NA
  The Danish Enterprise and Construction Authority.

3.3 Design and calculation

3.3.1 In general

Height Overflow piping (Fixed)	**36.1**	**kote**	
Level top diffusor (Fixed)	**33.5**	**kote**	
Level bottom diffusor above bottom (Fixed)	**0.1**	**m**	
Level top foundation (Fixed)	**2.5**	**kote**	
Tank type	**25,000**	**33,000**	**50,000**
Internal diameter [m]	32.0	37.0	45.3
Gross vol. [m^3] (below overflow tank)	27,090	36,120	54,180
Number of tanks	4	3	2
Total net vol. [m^3] (for the tanks)	100,000	100,000	100,000
Total gross vol. [m^3] (for the tanks)	108,360	108,360	108,360
Design flow – Diffusor [m^3/h]	2,500	2,500	2,500
Min. pipe diameter for the diffusors	DN 600	DN 600	DN 600

Water temperatures:
Supply ..... 70-98 ^{0}C
Return .....
35-45 ^{0}C

Designed for max. ..... 99 ^{0}C

3.3.2 Documentation

A full set of project documentation shall be provided to the Client's construction management. The project material shall be submitted to the Client's construction

management early enough to allow review and any necessary revisions to be made before construction commences.

The project material shall be in such a form that it can be incorporated directly, or with only minor editorial changes, into the material supplied to the authorities.

The project documentation shall include, in addition to the statement of work, the necessary additional specifications for manufacture and execution.

If comments etc. lead to changes in the above project documentation, a revised version must be submitted.

The Contractor shall for commenting submit all arrangement and principal drawings and drawings of major components to the Client and the Client's consultant.

By handover of each tank at the latest, the Contractor shall deliver 2 hard copies of all arrangement drawings as well as of all drawings necessary for operation and maintenance.

Until the end of the guarantee period, the Contractor must immediately correct and submit all drawings relating to any modifications carried out by the contractor.

3.3.3 Steel tanks

Corrosion supplement
The calculated plate thicknesses in bottoms, cylindrical shells and roofs shall be added a corrosion **supplement** of minimum 1 mm. The roof supporting's are performed without corrosion **supplement**.

Man holes
1 x ø 900 mm manhole in top of tank.

1 x ø 600 mm manhole inside of tank, maximum height from bottom of manhole to inner bottom 500 mm.

Design and calculations
Above the top diffuser there must be an expansion volume to absorb the water expansion in the tank and in the district heating network.

3.3.4 Stairs, ladders, railings, and platforms

Two spiral or tower staircase with access to the top of the tanks, one at each end of the tank yard, is required by the Client. This means, that the Contractor needs to include one spiral or tower staircase in the offer.

The top of all tanks included in the contract must be internally connected with walkways/platforms.

The contractor shall submit proposal for design of stairs, ladders, railings, and platforms inclusive design basis.

All external steel items shall be hot dip galvanized in accordance with DS/EN ISO 1461.
Welding on hot dip galvanized steel is not allowed. Repair of hot dip galvanizing shall be performed according to DS/EN ISO 2063.
Bolts in dimension M12 and smaller shall be in stainless steel quality A4.
All stairs, ladders, railings, and platforms shall be performed with non-slip steps and gratings.

Stairs, railings, and platforms
Stairs, railings, and platforms shall be designed and manufacturing in accordance with DS/EN ISO 14122 "Safety of machinery". All platforms shall be performed with external railings. Platforms connecting the top of two tanks shall be performed with oblong bolt holes at the supports - to allow horizontal differential movements of the tanks.
Layout must be approved by the Client's HSE organization.

3.3.5 Diffusors

Water velocity at diffusor outlet must be max 0.03 m/s. The velocity must be the same throughout the cylindrical outlet of the diffuser.

The performance of the diffusor design must be documented in the tender.

All nozzles/diffusers shall be fixed.

Pipes inside the tank from the tank shell to the diffusers must be watertight insulated with at least 50 mm insulation material.
The nozzles shall be placed side by side at the height indicated in the description and terminated with ball valves.

The pipes shall be smooth steel pipes according to DIN 2448/1629.

3.3.6 Overflow and drainage

A pipe for overflow from the tank top to the drain at the tank foot is to be provided. The overflow shall be designed to maintain the nitrogen pressure in the tank top. The overflow must be equipped with a level gauge for alarm purposes.

For draining and filling, the tank is supplied with a pipe near the bottom. The pipe shall be terminated visibly and fitted with a ball valve and a blind flange.

For sampling, a ¾" branch with bend shall be provided, terminating approximately 20 mm above the bottom and at a distance of 3000 mm from the shell.

The outlet shall be provided with a valve and a blind flange.

All steel parts placed in the open shall be hot-dip galvanized in accordance with the requirements of the Directive. DS/EN ISO 1461, K.1.B.

3.3.7 Fittings

Shut-off valve shall be full weld steel ball valves with reduced bore and weld ends designed for district heating. The valve shall be maintenance-free ball valve with all-welded valve body and stainless-steel polished valve ball in spring-loaded Teflon seats, which make the valve tight even at low pressures.

Pressure and vacuum relief valve to protect the tank, it must be equipped with a pressure relief valve (Pmax = 100 mm V.S.) and a vacuum relief valve (Pmin = 25 mm V.S.). The pressure and vacuum relief valve shall be adjusted to fit the max. emptying capacity of the accumulator tank. Reference is made to section 3.3.1.

3.3.8 Electrical work

Potential equalization

All metal parts in the accumulation tank must be potential equalization bonded to earth electrode. Lead is connected at top and bottom to lightning conductor.

Instrumentation

All electrical instruments are delivered by the Client.

Valves, studs, blind flanges, instrument tubes, sensor pockets etc. are included in the delivery of the contractor.

3.3.9 Nitrogen plant

A nitrogen buffer is to be established above the water level to prevent oxygen transport to the district heating water. Between the tanks, a nitrogen equalization connection must be established, which is routed together with the walkways. The dimension of the pipe connection must be designed/calculated by the Contractor.

The connecting pipe must be insulated with min. 100 mm insulation with same properties as the tank insulation.

Sectioning ball valves is to be installed in each connecting pipe by the Contractor.

3.3.10 Water treatment plant

For the initial filling of the accumulation tanks, a temporary softening plant will be supplied and installed by the Client with a total capacity of min. 50 m3/h.

Temporary connections from the water treatment plant to the tanks is to be delivered and installed by the Contractor.

3.4 Investigations

3.4.1 General

Notice of sampling shall be given to allow the Client's site management to observe the sampling.

3.4.2 Documentation

The investigation documentation must have a quality for basis for decision by the Client.

3.4.3 Levelling of the tank foundation

The tank foundation shall be levelled according to the requirement in DS/EN 14015 during water filing of the tanks.

The foundation is leveled at the following intervals:
When empty tank.
At 50% water-filled.
At 75% water-filled.
At 100% water-filled.
Leveling / earthing brackets must be fitted to the tank for this purpose.

There are requirements for difference theorems. If the tank settles at an angle, it must be out of position with maximum 1/200 of the tank height and a maximum of 50 mm.

3.5 Materials and products

3.5.1 General

The required documentation for materials and products used shall be submitted to the Client's site management for review.

The following materials and products shall not be delivered to the site until the Client's construction management has commented on the documentation:

- Trapezoidal sheets for cladding and screws for fixing them. Trapezoidal sheets including stainless steel screws for fastening of the trapezoidal sheets

The documentation will to the extent possible be commented within 10 working days of receipt.

All materials and products included in the permanent structure must be free of defects and/or deficiencies and not previously used.

All materials and products included in the permanent structure shall be delivered to the site in original packaging.

3.5.2 Insulation and cladding

The insulation shall be performed with staggered joints to avoid thermal bridges. The insulation shall be performed according to DS 452 "Thermal insulation of technical service and supply systems".

Cylindrical shell

Rockwool Industribatts 50 or equivalent in a total thickness of 400 mm on the cylindrical shells:
λ-value max. 0.043 W/m K at 50 °C.

The insulation shall be fastened to the tank sides with circumferential Ø 8 mm ropes in synthetic materials or equivalent per 0.5 m in height.

The insulation shall be performed with staggered joints to avoid thermal bridges.

The offer shall include a surface treatment of the outer side of the steel tanks. Max/min surface temperature according to water temperatures section 2.3.1. The tank shall be surface treated to prevent corrosion due to condensation on the lower part of the tank (1 m).

Roof
The roof shall be insulated with 400 mm insulation with the same insulating properties as the shell.

Roofing felt
The tank roof shall be covered with two layers of roofing felt in accordance with instructions in PTM-instructions from Phønix Tag Materialer (former denoted TOR)

Cladding
The sheets must be delivered free of defects and, after installation, must appear undamaged. Damage will result in the discarding of the damaged sheets.

The plates shall be performed with rubber sealing band in all horizontal and vertical joints.

To avoid contact corrosion between the plates and the rigging, Flash-band, bitumen tape with aluminum foil shall be used.

All coverings shall be made in such a way that there is free movement between the tank and the plate covering.

All joints shall be waterproof.

Trapezoidal sheets shall be with a corrosion protecting layer(s), painted and with 200 µm coating thickness, available in standard Ral colours and with guarantee and certification for 40 years durability. Colours shall be presented to and approved by the Client and the supervisor. Sheet quality must be specified in the tender. Vfz - paint treated steel sheets as per architect.

Fastening: The trapezoidal sheets shall be fastened with stainless steel self locking screws in quality A4 with vulcanized rubber and stainless steel washers.

Spacers and mounting rings must be corrosion treated.

The insulation and spacer material fitted must not impede cladding expansion.

The trapezoidal sheets shall have a fixed point for vertical movements at the top of the tanks. The vertical expansion of the

trapezoidal sheets shall be free. The contractor shall submit a proposal for design of the bearings and consoles to ensure this expansion.

Penetration:

All penetration of cladding and roofing felt shall be performed waterproof. The contractor shall submit a proposal for design of the penetrations to ensure this waterproofing. Where possible, penetrations should be terminated with bellows and a stainless-steel clamping band designed for saline atmospheres.

3.5.3 Electrical materials

All measuring equipment shall be easily accessible from stairs/galleries.

3.6 Execution

3.6.1 General

Manufacturer and/or supplier instructions for selected or prescribed materials and products for proper use and installation shall be followed. The instructions, notes, recommendations, advice, etc. given in the instructions shall be considered as requirements which may only be deviated from if indicated in the technical description or on drawings/building models or agreed with the Client's site management.

The Client's site management shall be kept informed of planned and ongoing offsite production.

3.6.2 Dimensions and tolerances

Only dimensions that are of particular importance for assembly or special use requirements are marked with tolerances. Other dimensions must be observed with an accuracy taking into account the size of the dimension and adjacent/succeeding building components.

The individual building components must be positioned according to measurement guidelines so that error accumulations are avoided.

Measurement markings shall be made in such a way that, when removed, they do not cause any damage to building components or deterioration of visible surfaces.

Measurement markings shall be removed at the end of the work.

Measurements for exterior building parts may be indicated on drawings/building models and in the description. Such dimensions shall be verified on site.

3.6.3 Mounting etc.

The Contractor shall provide information on the amount of storage space, shed space, etc. required and on the power required during the mounting period.

For the management, coordination and control of the mounting work, a person who is familiar with and fully qualified for the work in question is required at the assembly site.

The supervisor reserves the right to check the quality of the work carried out. In particular, the supervisor's representative must be present during the leak test.

The Contractor must be involved in health and safety work.

The Contractor shall notify the work to the Danish Working Environment Authority.

3.7 Relation to other work

3.7.1 General

Before work commences, the Client's site management must be informed if the conditions for conditional work are found not to be present.

3.7.2 Preliminary work

The planting in the project area will be removed by the client prior to the commencement of the works.

3.7.3 Coordination

Other contractors, where required, shall be able to carry out their works as specified.

The present contractor shall keep himself informed at all times of the status of execution of his own and other works so that the works belonging to the contract can be carried out in due time.

The Client's site management must be kept informed of the current status of the work so that other contractors can be informed in good time.

3.8 Working environment

If work with hazardous substances cannot be avoided, it must be carried out by persons with appropriate training.

Workers other than those carrying out the work must not be so close to the workplace as to expose themselves to harmful effects.

The work area must be cordoned off as necessary.

Warning signs shall be posted as necessary.

Reduced air quality in enclosed spaces due to emissions from the work must be reduced by ventilation and/or temperature and humidity control.

3.9 Control

3.9.1 General

Neither an inspection nor an approval relieves the contractor from carrying out his own checks.

If, during inspection, defects are found within an inspection section, the inspection frequency is doubled. If defects are subsequently detected within the inspection

section, the inspection frequency shall be extended as instructed by the Client's site management.

3.9.2 Project design control

The project material must be checked before submission to the Client's construction management.

3.9.3 Control of investigations

The material shall be checked before submission to the Client's site management.

3.9.4 Material and product control

The materials and products to be used shall be checked for conformity with the specifications and shall be adequately documented.

Material and product control also includes the production control carried out by the Contractor.

3.9.5 Receipt control

If no material and product control has been carried out, materials and products shall be controlled on receipt in accordance with the requirements of *2.9.4 Material and product control.*

Materials and products checked in accordance with point *2.9.4 Material and product* checks shall be checked on receipt to ensure that they are identical to the documentation provided.

3.9.6 Execution control

As a general rule, a visual check shall be carried out to verify compliance with performance requirements. If there is doubt as to whether these have been complied with, the performance requirements shall be checked by measurement.

If the measurement shows that the performance requirements are not met, the Client's construction management shall be informed.

3.9.7 Weld inspection

Quality control of welding shall be carried out in accordance with DS/EN ISO 3834-3. Welding Procedures (WPSs) shall be prepared in accordance with DS/EN ISO 15609 and DS/EN ISO 15613 or DS/EN ISO 15614 and shall also specify tack welds.

Welds shall meet the requirements of EXC2 "Standard quality demand " in DS/EN 1090-1.

Inspection of welds in accordance with DS/EN ISO 17635 shall be coordinated by the contractor but test company will be contracted by the Client.

The testing organization will be organized independently of production and a utilization rate of more than 50 % shall be assumed for transverse butt welds. Butt and T-joints with partial penetration welding will be examined for internal defects by ultrasonic or radiographic means according to DS/EN 17635 Table 3. Both edge seams and butt seams shall be examined for surface defects in accordance with

Table 1 in DS/EN ISO 17635. All butt welds shall be made with a minimum of 2 strands.

All welders shall hold a valid certificate in accordance with DS/EN 17635 Annex II. DS/EN ISO 9606-1 or DS/EN ISO 14731. During a transitional period, DS/EN 287-1 and DS/EN 1418 shall also apply.

Welding signatures are specified according to: DS/EN 22553 where dimensions for edge seams are a-dimensions.

3.9.8 Final inspection

Before delivery of the work as a basis for subsequent work/before delivery a final inspection shall be carried out. It must be visually checked that the work has been carried out correctly.