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UK Water Industry

SPECIFICATION FOR THE USE OF STEEL TANKS IN THE WATER INDUSTRY

FOREWORD

This Specification has been prepared by the Steel Construction Institute (SCI) under the guidance of Water UK's Standards Horizontal Group in consultation with representatives from the Water Industry, steel tank manufacturers and the steel industry.

The Specification covers the design and construction of rectangular and cylindrical steel tanks in open and closed operations.

Compliance with this Specification does not itself confer immunity from legal obligations.

The Specification does not purport to include all the necessary provisions of a contract. Users of this Specification are responsible for its correct application.

Reference to a European Standard, British Standard, Water Industry Specification or any other specification applies equally to any equivalent specification.

Purchasers are reminded that this Specification requires that the manufacturer shall operate a management system that ensures the products claimed to comply with this Specification consistently meet the required level of quality and are safe in both construction and use.

This Specification calls for procedures that may be injurious to health if adequate precautions are not taken. The Specification refers to technical suitability and does not absolve its user from legal obligations relating to Health & Safety at any stage.

It has been assumed in the drafting of this Specification that the execution of its provisions are

entrusted to appropriately qualified and experienced people.

Information contained in this Specification is given in good faith. The contributors, WRc, Water UK and The Steel Construction Institute cannot accept any responsibility for actions taken by others as a result of its use.

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1. SCOPE

This document specifies the requirements for the design, materials, fabrication, installation and testing of welded or bolted rectangular and cylindrical steel tanks. The tanks may be for open or closed operations in unpressurised conditions and may be in free-standing, buried or elevated situations.

It also covers helically wound corrugated tanks for use in buried applications.

The Specification is applicable to contracts for the supply of steel tanks under which the Supplier is responsible for the design, supply and installation of all steelwork, including the provision of a corrosion protection system and attachment of ancillary items.

2. DEFINITIONS

2.1 Purchaser

The Purchaser of the tank is as defined in the Contract for the supply of the tank.

2.2 Supplier

The Supplier of the tank is as defined in the Contract for the supply of the tank. The Contract shall specify if the tank is to be supplied with a base.

2.3 Welded cylindrical tank

A cylindrical tank with a vertical axis of revolution in which the walls are formed from singly curved steel plates welded together, edge to edge.

2.4 Bolted cylindrical tank

A tank formed of a series of cylindrical rings, each ring being made up of a number of singly curved panels. Panels in each ring are lapped and bolted one to another at their vertical edges, and from one ring to the next at their horizontal edges.

2.5 Welded stiffened rectangular tank

A tank formed by welding together flat steel plates onto which an arrangement of stiffening members (e.g. rolled steel angles, channels, I-beams, etc.) has been fitted.

2.6 Pressed steel sectional rectangular tank

A rectangular tank formed by bolting together hot pressed square steel panels. The panels are used as the walls and the base of the tank. The panels

conform to a standard modular size, which is normally either 1.22 m square or 1.0 m square.

3. QUALITY ASSURANCE

3.1 Quality Management System

The Supplier shall operate a Quality System acceptable to the Purchaser.

3.2 Quality Plan

The Supplier shall provide a Quality Plan for all aspects of the work relating to this Specification. The Plan shall include the identification of all responsibilities relating to interfaces with other works involved in the supply of the installed tank.

3.3 Design

The Quality Plan shall include a statement of the design methods to be used and the relevant Standards which are to be applied in the design of the structure. The checking procedures shall be identified.

3.4 Construction

The Quality Plan shall clearly define the procedures for all aspects of the construction work including:

- preparation of the site;
- construction of tank foundations;
- fabrication of tank parts;
- corrosion protection and coatings;
- transportation, handling and delivery;
- site storage;
- assembly and erection;
- connections between the tank or support steelwork and the foundation;
- connections between steelwork, tank and fittings;
- inspection and testing.

The Quality Plan shall include method statements and procedures for certification, testing and acceptance.

4. PURCHASER'S REQUIREMENTS

Prior to design and construction of the tank, the Purchaser shall provide the following information to the Supplier:

- description of the proposed tank site including all existing and proposed adjacent structures and

those on nearby sites, even if they are outside the Purchaser's property boundary;

- tank capacity;
- any constraints on tank dimensions;
- tank contents and range of pH and specific gravity of contents;
- details of tank foundation if provided by the Purchaser;
- site soils investigation data if the foundation is to be included in the supply;
- details of inlets/outlets (size; position; nozzle details; flow rate);
- tank characteristics (number/size of compartments; operating pressure/ temperature; maximum working pressure; normal working level; overflow level; freeboard above overflow, etc.);
- tank roofing requirements;
- test pressure (where applicable);
- details of provisions for equipment and other ancillaries (instrument tapplings; sumps; access holes; manholes; ladders or stairways, etc.);
- loading due to any equipment or fixtures;
- requirements for venting of closed tanks (limits on overpressure and negative internal (vacuum) pressure during emptying, etc.);
- the required lifetime (or period to first inspection) of the coatings and/or corrosion protection system;
- maximum and minimum temperatures for which the tank shall be designed;
- details of test fillings (source of water; disposal arrangements; test requirements);
- details of any constraints on design, construction sequence and programme;
- disinfection requirements and responsibilities;
- details of any adjacent structure or geography that could affect the wind loading or design of the tank.

Such details shall be provided on drawings or other contract documents issued by the Purchaser.

Appendix A gives a datasheet for typical purchaser's requirements for a steel tank.

5. GENERAL DESIGN REQUIREMENTS

5.1 Design basis

All tanks and supporting structures shall be designed either on an Allowable Stress Design basis (ASD) in accordance with 5.2 or on a Limit State Design basis (LSD) in accordance with 5.3. Alternatively, the strength of components and connections may be determined by testing in accordance with 5.4. The choice of design basis shall be at the Supplier's discretion unless otherwise specified by the Purchaser.

Design shall be in accordance with relevant European Standards and British Standards or equivalent. It shall also be in accordance with additional or alternative requirements given in this Specification.

NOTE: The choice of design basis is left to the Supplier's designer because UK design standards are presently in the process of change from ASD to LSD. Appropriate LSD standards do not always exist, or have only been recently introduced. All new Standards issued by BSI and CEN (the European Committee for Standardisation) for structural design will be based on LSD. Eurocode 3 *Design of steel structures* Part 4.1 *Silos* and Part 4.2 *Tanks* are currently being drafted and adopt a LSD basis. They are due to be issued as ENVs (pre-standards) by CEN in 1999.

5.2 Allowable Stress Design (ASD)

All parts of the tank and its supporting structure shall be capable of sustaining the applied loads without the consequent stresses exceeding the allowable stresses given in BS 449 or, for welded cylindrical tanks, the allowable stresses given in BS 2654.

The applied loads shall be taken as the nominal loads given in 6.2 and 6.7 of this specification.

5.3 Limit State Design (LSD)

5.3.1 General

Limit State Design of structural steelwork shall be in accordance with BS 5950: Part 1, except as varied or supplemented by this Specification. In this Standard, two limit states are considered:

- i) ultimate limit state; and
- ii) serviceability limit state.

5.3.2 Ultimate limit state (ULS)

The strength and stability of the tank and its supporting structure shall be such that the design resistance (or load capacity) of each element and its connections is greater than the design loads.

The design loads at ULS shall be taken as the nominal loads, as given in 6.2 to 6.7, multiplied by the relevant load factors given in 6.10.

The design resistances shall be as given in 5.3.5.

5.3.3 Serviceability limit state (SLS)

The deflection of the structure or part thereof, under the design loads at the SLS, shall not impair the strength or efficiency of the structure, nor cause damage to the finishes.

The design loads at SLS shall be taken as the nominal loads, as given in clauses 6.2 to 6.7, multiplied by a load factor of 1.0, as specified in BS 5950: Part 1.

5.3.4 Design strength of steel

The design strength of steel shall be taken as that given by BS 5950: Part 1 or BS 5950: Part 5, as appropriate, for the grade of steel material used for the structure.

5.3.5 Resistance of members and components

The design resistance of steel members and components shall be based on the design strength and the member properties (cross sectional area, effective length for buckling, etc.), in accordance with BS 5950: Part 1 or BS 5950: Part 5, as appropriate. The material factor on strength (γ_m) shall be taken as 1.0 for steel, in accordance with BS 5950: Part 1.

5.4 Strength determined by testing

As an alternative to calculation, the strength or resistance of steel components and connections may be determined by testing in accordance with either BS 449 or BS 5950: Part 1.

6. DESIGN LOADING

6.1 General

The nominal loads to be used in the design shall be those given in 6.2 to 6.7, as appropriate.

Loads shall be applied separately and in such realistic combinations as to cause the most critical effects on the elements and the structure as a whole.

6.2 Dead load

The dead load of all permanent construction and fittings shall be calculated from unit weights given in BS 648, or may be taken as actual measured weights.

6.3 Fluid load

The fluid load shall be the weight or hydrostatic pressure of the liquid contents of the tank, when filled to normal maximum working level, to the level of the overflow or to such other level specified by the Purchaser, as appropriate. The load shall be calculated on the basis of the maximum specific gravity of the contents given by the Purchaser.

In annular, compartmented or cellular tanks, where there may be a hydraulic pressure difference across internal walls, the loading shall be that due to wholly filled, partly filled or empty compartments, whichever produces the greatest effect on the elements of the structure.

6.4 Imposed roof load

The imposed roof load shall be taken to be that produced by environmental effects (other than wind) and by the use of the roof for access or maintenance. The minimum values given in BS 6399: Part 3 shall be used, unless otherwise specified by the Purchaser. In addition to this loading, any localized loads from lifting frames for equipment retrieval during maintenance shall be taken into account.

NOTE: This clause allows the application of the imposed load given by BS 6399, rather than that specified in BS 2654, unless otherwise specified by the Purchaser.

6.5 Wind load

For tanks above ground, wind loads shall be calculated in accordance with BS 6399: Part 2 or BS CP 3: Chapter V: Part 2 (until it is withdrawn by BSI), taking account of the locality and situation of the tank. The possible effects on the wind load of the proximity

of other structures shall be taken into account. The Purchaser shall provide details of the local geography and of any adjacent structures which might affect the wind loads on the tank.

6.6 Internal pressure

For closed tanks, account shall be taken of the load due to internal pressure in the space above the fluid level. Such pressures shall include any possible overpressure, which may be limited by venting arrangements; or negative internal (vacuum) pressure, created during draw-down of fluid level during emptying.

For sludge tanks, additional loading factors in accordance with BS 5502: Part 50 may be required but these should be viewed in conjunction with BS 5502: Part 22 which allows a reduction in partial factors in consideration of the building (usage) classification.

6.7 Ground pressure load

For tanks which are partly or wholly buried, pressure on the external walls shall be calculated on the basis of the characteristics of the soil or backfill, the level of the groundwater table and on the surcharge conditions upon the surrounding ground.

6.8 Thermal effects

The tank structure shall be designed to accommodate any expansion or contraction effects due to changes in temperature of the external environment in relation to the temperature of the contents. If the structure or parts are restrained in any way, then the design shall allow for induced loading due to these thermal effects.

6.9 Loads due to equipment and fixtures

The loads due to any non-structural fixtures and any equipment either fixed to the tank or which may come into contact with the tank shall be taken into account. The Purchaser shall provide the Supplier with details of the loads due to any such items which are not part of the Contract.

6.10 Load factors at ultimate limit state (ULS)

Table 1 gives the relevant load factors for LSD at the ULS.

Table 1 Load factors at ULS

| Loading | Factor, γ_f | |
|--|-----------------------|-----------------------|
| | No wind | With wind |
| Dead load | 1.4 ⁽¹⁾ | 1.2 ⁽¹⁾ |
| Loads due to equipment and fixtures | 1.6 ⁽¹⁾ | 1.2 ⁽¹⁾ |
| Fluid load | 1.4 ⁽²⁾ | 1.4 ⁽²⁾ |
| Imposed roof load | 1.6 ⁽²⁾ | 1.2 ⁽²⁾ |
| Wind load on elements causing adverse effect | - | 1.4 ⁽¹⁾ |
| Internal pressure (positive or negative) | 1.4 ⁽²⁾ | 1.2 ⁽²⁾ |
| Loads due to restraint of thermal effects | 1.2 ⁽²⁾ | 1.1 ⁽²⁾ |
| Ground pressure | 1.4 ⁽¹⁾⁽³⁾ | 1.4 ⁽¹⁾⁽³⁾ |

Notes:

(1) These factors shall be reduced to 1.0 when the appropriate loads are relieving to the effect being considered (e.g. the dead load of the roof when designing the holding down bolts to resist internal pressure).

(2) Any or all of these factors shall be taken as zero if by so doing the effect being considered is made more severe.

(3) A factor of 1.4 shall be used for design ground pressures to the Civil Engineering Code of Practice No.2 (CECP2) or 1.2 for design ground pressures to BS 8002.

7. SPECIFIC DESIGN REQUIREMENTS (STRUCTURAL ELEMENTS)

7.1 Tank walls - general

The walls of the tank shall be designed to resist the greatest value of the fluid load, together with any other loads which may be coexistent.

Where the tank is closed, the fluid pressure shall be increased by an equivalent water gauge value of the overpressure. The overpressure shall be taken to act over the full height of the structure.

The tank walls shall also be designed to resist the design wind load when the tank is empty.

7.2 Walls of cylindrical tanks

7.2.1 Welded cylindrical tanks

Welded cylindrical tanks shall be designed in accordance with BS 2654, except where varied by this Specification or by the Contract.

7.2.2 Bolted cylindrical tanks

A bolted cylindrical tank shall be designed to transmit the forces in the walls through the bolted joints between panels.

The vertical joint between adjacent panels shall be designed to resist the forces induced by a fluid pressure which is uniform over the height of the panel and equal to the design fluid pressure (including internal pressure, where appropriate) at the lower edge of the panel.

The horizontal joint between adjacent panels shall be designed to resist vertical forces due to weight, internal pressure and wind loading, as appropriate.

The bolted joints shall either be designed on an ASD basis in accordance with BS 449 and 5.2 herein, or on a LSD basis in accordance with BS 5950: Part 1 and 5.3 herein. In either case, any subsequent slip at the plate interface shall be prevented in service or at the ultimate limit state by fully expanding the bolted joint during construction. To ensure this condition is met, the Supplier shall supply and/or advise on the tools and methodology to be adopted for fully expanding the bolted joint, prior to tightening the bolts to their specified torque.

Alternatively, the joint strength may be determined by test to failure and the design capacity of the joint calculated in accordance with clause 7.3.5 of BS 5950: Part 1. For design on an ASD basis, the allowable design strength of the joint shall be taken to be no greater than this calculated design capacity divided by 2.0. For design on a LSD basis, the design capacity of the joint shall be taken to be no greater than this calculated design capacity divided by 1.4.

7.2.3 Design of cylindrical walls against wind loads

The walls of cylindrical tanks, whether welded or bolted, shall be of sufficient thickness and stiffened at suitable intervals to provide adequate resistance to the inward pressures due to wind when the tank is empty.

For welded cylindrical tanks, ring girder stiffening in accordance with BS 2654 may be taken to comply with the above requirement.

For bolted cylindrical tanks, ring girder stiffening in accordance with either BS 5502: Part 50, DIN 11622 or AWWA D103 may be taken to comply with the above requirement. Alternatively, a stiffening arrangement may be taken to provide sufficient support if it limits the horizontal deflection under wind load when empty to not more than $D/1000$, where D is the outside diameter of the tank. This may be demonstrated by suitable Finite Element Analysis or other means.

The thickness and stiffening shall also be sufficient to resist vertical compressive forces consequent on the overturning moment caused by the wind load. The Supplier shall ensure that potential geometrical imperfections are fully understood and allowed for in vertical or horizontal buckling calculations. These imperfections may result from tolerances occurring during the manufacture of the steel plate, during fabrication of the elements or during assembly of the configuration on site.

7.2.4 Reinforcement of holes in cylindrical tanks

Holes in cylindrical tanks for openings, nozzles, inlets, manholes, etc. shall be provided with adequate reinforcement that is sized according to rigorous analysis and calculations.

For welded cylindrical tanks, provision of reinforcement around holes in accordance with BS 2654 may be taken to comply with the requirements of this clause.

For bolted cylindrical tanks, provision of reinforcement around holes in accordance with AWWA D103 may be taken to comply with the requirements of this clause.

The tensile resistance of the walls of bolted tanks is determined by the net section at the bolted joint; modest sized openings within a panel may not require any reinforcement.

7.2.5 Design of cylindrical walls against inward pressures

Cylindrical walls which are wholly or partly buried and inner cylindrical walls of annular tanks are subject to radially inward pressures which give rise to compressive circumferential forces in the walls. For a cylindrical wall subject to inward pressure, the compressive design forces in the wall shall not exceed the buckling capacity of the wall.

The buckling capacity may be determined by appropriate analysis which takes account of the elastic critical buckling stress of a cylindrical shell, the strength of the material and the assumed initial geometrical imperfections. For ASD, the allowable

buckling stress is calculated by dividing the elastic critical buckling stress by a safety factor of 1.2.

7.3 Walls of rectangular tanks

7.3.1 Welded stiffened rectangular tanks

Plate panels between stiffeners shall be designed to resist fluid loads and any other coexistent loading that imposes transverse loading on the panel. The design shall be in accordance either with BS 449 or with BS 5950: Part 1, treating the panels as elements in bending. Plastic analysis may be used.

Stiffeners shall be designed to resist the forces imposed on them by the plate panels and to transmit those forces either to other supporting members or to external supports. The design shall be in accordance with either BS 449 or with BS 5950: Part 1. Elastic analysis shall be used.

An effective section of stiffener plus a width of plate to which it is attached may be assumed in the design of the stiffeners. The effect of stresses parallel and perpendicular to the plane of the plate element shall be considered.

7.3.2 Profiled welded rectangular tanks

The individual panels in each corrugation shall be designed to resist fluid loads and any other coexistent loading which imposes transverse loading on the panel. The design shall be in accordance with either BS 449 or with BS 5950 : Part 1, treating the panels as elements in bending, spanning as beam elements between the bend lines. Plastic analysis may be used.

The corrugated profile sections shall be designed to resist the forces imposed on them by the plate panels and to transmit those forces either to other supporting members or to external supports. The design shall be in accordance with either BS 449 or with BS 5950: Part 1. Elastic analysis shall be used.

Restraint shall be provided at the top of the wall by ties, by the tying action of the roof structure, by edge beams running along the top of the wall or by a combination of these means. Intermediate restraint shall be provided as necessary.

7.3.3 Pressed steel sectional rectangular tanks

Except as described below, pressed steel sectional rectangular tanks shall be designed to BS 1564, Type 1, with bolted joints, mastic sealant and internal ties acting as wall panel support members. Such tanks shall not be used for wall heights greater than 4.88 m.

Pressed steel sectional rectangular tanks may alternatively be designed as above but with external supports, in place of internal ties. External supports shall be designed to resist the forces imposed on them by the panels and to transmit those forces either to other supporting members or to external supports. The design of the external supports shall be in accordance either with BS 449 or with BS 5950: Part 1. Elastic analysis shall be used.

As an alternative to the use of bolted joints and sealant, pressed steel sectional rectangular tanks may be designed with welded joints which also act as a watertight seal. The design of the welded connection shall be in accordance either with BS 449 or with BS 5950: Part 1.

Pressed steel sectional rectangular tanks with external supports and welded joints may be designed with wall heights in excess of 4.88 m.

7.4 Attachment of walls to base

The connection between the tank wall and the tank base shall be designed to transmit to the foundation the vertical forces in the tank walls and horizontal shear forces due to wind loads, and forces due to fluid loads and internal pressure. The design forces shall include any forces acting upward as a result of overturning moment due to wind load or due to internal pressure.

Fixing bolts cast into a reinforced concrete base shall be made from either plain or deformed bars or may be a fixing of a proprietary nature. Such bolts shall be not less than 16 mm diameter.

7.5 Tank roof

7.5.1 Application of design loading

Inward and outward acting pressures on the roof shall be taken into account.

For outward pressures, the design pressure is the greater of the test pressure specified by the Purchaser or the working pressure combined with the maximum outward pressure due to wind loading. Dead load shall be applied in conjunction with this design outward pressure; for LSD, the partial factor on dead load for this loading condition shall be taken as 1.0.

For inward pressures, the roof shall be designed for the worst condition of imposed roof loading over part or all of the roof, combined with dead load and negative internal (vacuum) pressure.

The roof of the tank may be designed as either:

- i) self-supporting steel plating, or
- ii) steel plating or other covering, supported by a steel framework.

Self-supporting steel plating shall only be used on cylindrical tanks.

7.5.2 Roof plating

Roof plating of a cylindrical tank designed as self-supporting shall be in accordance with BS 2654.

Note: This is termed a "membrane roof" in BS 2654.

When roof plating is supported by a framework of structural members, it shall be designed to carry the wind loads and any other loads on the roof, spanning between the supporting members. Plastic analysis may be used.

7.5.3 Supporting framework

A supporting framework may span unaided between the walls of the tank or may be supported by the walls and by columns inside the tank. The supporting structure (framework and columns) shall be designed in accordance either with BS 449 or with BS 5950: Part 1. Where the tank is rectangular, the framework shall be designed to transmit the tying forces at the tops of the walls.

7.5.4 Other roof covering

As an alternative to steel plating, the roof covering may be of another material, subject to the agreement of the Purchaser. The Supplier shall be responsible for demonstrating the adequacy of such covering in terms of both strength and durability.

7.6 Tank bottom

7.6.1 General

The tank bottom may be formed either by steel plating (stiffened plating or pressed steel sectional panels) or may be formed by a reinforced concrete slab.

The provision of support to a steel bottom, or the design and construction of a reinforced concrete bottom, may not be part of the contract for the supply of the tank. Where such support or slab base is not part of the tank supply, the Supplier shall provide the Purchaser with details of loads on the supports or slab from the tank, and the Purchaser shall provide the Supplier with details of the supports or base slab.

Where the Supplier is responsible for the complete design and supply of the tank including supports or base slab, the Purchaser shall provide site soils investigation data, in accordance with BS 1377: Parts 1 to 9 as appropriate.

The supports or the top of the base slab shall be located accurately at the correct elevation.

Fixing bolts, when required, shall be designed and furnished by the Supplier to suit the connection to the base slab.

7.6.2 Site preparation

The Purchaser shall provide details about how the ground around the foundations will be prepared by others.

Note: Normally the site should be regraded sufficiently to permit efficient tank erection and to prevent ponding of surface water in the foundation area.

7.6.3 Steel bottom

Where the bottom is of unstiffened welded plate, it shall generally be designed and constructed in accordance with BS 2654. For rectangular tanks, the geometrical disposition of the plates shall suit the size and shape of the tank and the plating shall be designed to transmit the horizontal tying forces at the base of the walls.

Where the bottom of the tank is of bolted steel plating, it shall be fully bolted along all the seams. The bolting of the bottom to the wall shall be continuous around its entire perimeter. The design shall not transfer vertical loads from the bottom into the wall. The bottom and its connection to the tank shell shall be fully waterproofed by the application of a sealant compatible with the contents of the tank.

Where the bottom is of unstiffened plating, the plating shall be supported over its full area by a suitable foundation. The transmission of the vertical hydraulic load from the tank contents to the foundations shall be taken to be uninterrupted by the bottom membrane.

Where the bottom is of stiffened plating or pressed steel sectional panels, support shall be provided to the stiffeners or along the seams of the pressed panels.

7.6.4 Foundations

Where the design of the foundations or base slab is part of the Contract, the Supplier shall design the foundation or slab in accordance with BS 8004 and the *Civil Engineering Specification for the Water Industry* (CESWI 5).

7.7 Ancillary items

7.7.1 Manholes

Hatches or manholes may be of circular, square or elliptical aspect, as specified by the Purchaser. Where a manhole is square, the corners of the manhole shall be radiused so as to avoid excessive stress concentration in the steel walls.

Where a manhole is provided in the wall of the tank, the cover and its connection to the wall shall be designed to AWWA D103 to withstand the fluid load (including any overpressure) at that location. Reinforcement to the tank wall shall also be designed to AWWA D103. See also clause 7.2.4.

7.7.2 Ladders and platforms

The design of stairways, ladders and platforms shall comply with BS 4211 or BS 5395, as appropriate.

The loads applied by ladders, platforms or walkways on the walls, roof or floor of the tank shall be taken into account in the design of the structure.

Stays and supports shall not cause deflection in the tank wall that would damage the coating or result in a total deflection that is greater than the allowable deflection for the tank design.

If stairways are preferred, the Purchaser shall state his requirements including the space allowed to accommodate them adjacent to the tank. Any

requirement for platforms or walkways to be freestanding shall also be stated as part of the Purchaser's requirements to the Supplier in accordance with clause 4 herein.

7.8 Helically-wound corrugated tanks for use in buried applications

The structural design of helically wound corrugated steel tanks for stormwater storage or non-potable water shall be in accordance with the Highways Agency's Standard BD 12/95: *Design of Corrugated Steel Buried Structures* that is published as part of the *Design Manual for Roads and Bridges*.

In addition, all helically wound corrugated tanks shall comply with the *Water Test for Non- Pressure Pipelines*, given in Section 6 of CESWI 5.

8. QUALITY CONTROL REQUIREMENTS

8.1 General

All materials shall be new and shall comply with the requirements of this Specification.

8.2 Effect of materials on water quality

When used under the conditions for which they are designed, all materials in contact with, or likely to come into contact with, water for public supply shall be introduced in accordance with the requirements of Regulation 25 of the Water Supply (Water Quality) Regulations 1989. [Water Supply (Water Quality) (Scotland) Regulations 1990 in Scotland].

For products not approved under the former voluntary system, and not eligible for use under regulation 25(1) (b) or 25(1) (c), Secretary of State Approval shall be obtained via submission of the product to the Committee on Chemicals and Materials of Construction for Use in Public Water Supply and Swimming Pools for consideration. Products shall also comply with the requirements of BS 6920: Part 1:1996; evidence of compliance shall be submitted to the above committee by the manufacturer.

NOTE 1: The Committee, operated by the Drinking Water Inspectorate, undertakes toxicological assessments of products and may require leaching tests for substances of concern. A list of approved

substances and products is published annually and is available from: The Drinking Water Inspectorate, Ashdown House, 123 Victoria Street, London, SW1E 6DE.

NOTE 2: Regulation 25 applies only to products used by water companies in the treatment and distribution of public water supplies; it does not apply to use of fixtures and fittings on consumers' own premises. Approval under the Water Regulations Advisory Scheme and listing in the Water Fittings and Materials Directory is desirable.

8.3 Protection against galvanic corrosion

Where dissimilar metals are used in a tank, suitable electrical insulation shall be provided between them to ensure that a corrosive 'cell' is not established.

8.4 Steel plate, sheet and strip

Appendix B lists the relevant current British, European and International material standards for steel plate, sheet and strip.

8.5 Bolts

Nuts, bolts and washers shall normally be to BS EN 24014, BS EN 24016, BS EN 24017, BS EN 24018, BS EN 24032, BS EN 24033 or BS EN 24034 as appropriate.

Vitreous enamelled panel tanks utilise specially designed bolts to BS 1768.

NOTE: An unusually onerous operating condition may require the Supplier to consider the use of materials other than carbon steel for bolts.

8.6 Seals and gaskets

For tanks containing potable water, the materials for sealants and gaskets (and for any associated primers or adhesives) shall comply with clause 8.2. Gaskets shall be prepunched to size.

NOTE: Some sealant materials require the use of a primer for maximum adhesion. Some of these primers contain a volatile solvent. After evaporation of the solvent, the primer shall comply with the requirements of the DWI regulations.

Sealants and gaskets shall remain flexible when in continuous operation over the operational temperature range specified by the Purchaser.

Sealants and gaskets shall be resistant to degradation by ozone, ultraviolet light and the effects of the tank contents and shall not be subject to shrinkage due to weathering.

9. COATINGS

9.1 Durability

Where a coating is required for corrosion protection, the Supplier shall select an appropriate type, subject to the Purchaser's agreement, that will be durable over the design life specified in the Contract. Where a design life in excess of the durability life of the coating is required, the coating shall be inspected to judge whether any maintenance is necessary.

In accordance with BS 5493 and clause 9.4 herein, the Supplier shall advise the Purchaser of full details of any maintenance that may be necessary during the durability life period to ensure that the required lifetime of the coating and the tank are achieved. The Supplier shall also state what level of inspection shall be carried out at defined intervals to check for any onset of coating breakdown in order to assist in identification before any more extensive breakdown develops. By such means it will be possible to extend the durability life of the coating to meet that required for the tank.

9.2 Coating system

The coating system shall be selected in accordance with BS 5493 or BS 7793: Part 2 (for vitreous enamel coatings).

9.3 Suitability for use

Coatings for helically corrugated steel stormwater retention tanks as covered by a British Board of Agrément Certificate are deemed to comply with this Specification.

Coatings for potable water applications shall comply with 8.2.

9.4 Maintenance

The Supplier shall provide the Purchaser with documentation describing the procedures for inspection, maintenance and repair of coatings.

10. FABRICATION AND INSTALLATION

10.1 General

The procedures for all aspects of construction shall be identified in the Quality Plan, in accordance with 3.4.

10.2 Foundations

Where the construction of the tank foundation or base slab is part of the Contract, the Supplier shall carry out the work in accordance with CESWI 5 and BS 8004.

10.3 Fabrication, transport and installation of steelwork

The fabrication, transport and installation of steelwork shall be in accordance with relevant nationally recognised specifications, such as BS 5950: Parts 2 or 7, the National Structural Steelwork Specification, BS 2654 or BS 1564. The relevant standards to be used, including those for bolting procedures, welding procedures, etc., shall be identified in the Quality Plan.

The particular requirements for flange drilling and tapped sockets given in 10.3.1 and 10.3.2 shall be taken into account.

10.3.1 Flange drilling

Flange drilling shall comply with the requirements of BS 4504: Part 3.1 for steel flanges and BS EN 1092-2 for cast iron flanges unless otherwise specified by the Purchaser.

10.3.2 Tapped sockets

Tapped sockets shall comply with the requirements of BS 1387 unless otherwise specified by the Purchaser.

10.3.3 Sealing of bolted joints

Only recommended sealants shall be used for bolted joints and they shall be applied according to the tank manufacturer's instructions.

The procedures for making bolted joints, particularly those in bolted cylindrical tanks, shall be such that there will be no significant slip under load which could lead to damage of the sealing at the joints (see clause 10.3.4).

10.3.4 Bolting

Bolts shall be torqued to the manufacturer's recommendations.

For bolted cylindrical tanks, joints shall first be expanded fully before finally tightening the bolts. The bolted joint is stretched to the point where the bolts are fully in bearing with their holes so that the hoop load is taken up immediately when the tank is filled.

10.4 Accuracy of workmanship

The dimensional accuracy of the completed tank shall be consistent with the accuracy of construction assumed in the design of the tank.

11. REFERENCES

This Specification incorporates undated references to the British and European Standards and other publications listed below.

Where reference is made to a Standard or other publication, it shall be taken to apply to the version which is current at the date of the Contract, unless specifically stated otherwise.

British Standards

| | |
|---------|--|
| BS 449 | Specification for the use of structural steel in building |
| BS 648 | Schedule of weights of building materials |
| BS 1377 | Methods of test for soils for civil engineering purposes |
| BS 1387 | Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads |
| BS 1564 | Specification for pressed steel sectional rectangular tanks. |

Buried Structures, published by
The Stationery Office for the
DETR

| | |
|-----------|--|
| NSSS | National Structural Steelwork Specification for Building Construction, British Constructional Steelwork Association Ltd. |
| DIN 11622 | Silage and Manure Liquid Containers. Parts 1 to 4. |
| ANSI/AWWA | D103 American Water Works Association Standard for Factory Coated Bolted Steel Tanks for Water Storage |
| CESWI 5 | Civil Engineering Specification for the Water Industry. 5th Edition. |

APPENDIX A TYPICAL DATASHEET FOR PURCHASER'S REQUIREMENTS FOR A STEEL TANK

| | | Purchaser's requirements |
|----------------------|--|--------------------------|
| Tank site | Description of proposed tank site | |
| | Details of foundations to be provided by the Purchaser | |
| Service requirements | Tank capacity | |
| | Tank contents; Range of specific gravity of contents | |
| | Specific dimensional requirements | |
| | Tank characteristics (number/size of compartments; operating pressure/temperature; maximum working pressure; normal working level; overflow level; freeboard above overflow, etc.) | |
| | Details of inlets/outlets (size; position; nozzle details; ladders, etc.) | |
| Tank roof | Tank roofing requirements (if any) | |
| | Test pressure (where applicable) | |
| | Requirements for venting of closed tanks (limits on overpressure and vacuum during emptying, etc.) | |
| Coatings | Durability life of coatings and/or corrosion protection system | |
| Commissioning | Chlorination requirements and responsibilities | |
| | Details of test fillings (source of water; disposal arrangements; test requirements) | |
| Other matters | Details of any constraints on construction sequence and programme | |

**APPENDIX B MATERIAL STANDARDS FOR STEEL PLATE,
SHEET AND STRIP**

| | |
|---|--|
| BS1449 | Steel plate, sheet and strip Part 1 Section 1.1 General specification Part 1 Section 1.8 Specification for hot rolled narrow strip based on formability Part 1 Section 1.14 Specification for hot rolled narrow strip supplied in a range of Conditions for heat treatment and general engineering purposes Part 1 Section 1.15 Specification for cold rolled narrow strip supplied in a range of Conditions for heat treatment and general engineering purposes |
| BS EN 10025 ⁽¹⁾ | Hot rolled products of non-alloy structural steels – technical delivery conditions |
| BS EN 10111 | Continuously hot-rolled low carbon steel sheet and strip for cold forming – technical delivery conditions (<i>replaces BS 1449: Section 1.2</i>) |
| BS 10113 | Hot rolled products in weldable fine grain structural steels |
| BS EN 10130 | Specification for cold rolled low-carbon steel flat products for cold forming – technical delivery requirements |
| BS EN 10131 | Cold rolled uncoated low carbon and high yield strength steel flat products for cold forming |
| BS EN 10137 | Plates and wide flats made of high yield strength structural steels in the quenched and tempered or precipitation hardened conditions |
| BS EN 10139 | Cold rolled uncoated mild steel narrow strip for cold forming – technical delivery conditions (<i>replaces BS 1449: Section 1.9</i>) |
| BS EN 1042 ⁽²⁾ | Specification for continuously hot-dip zinc coated low carbon steel sheet and strip for cold forming – technical delivery conditions |
| BS EN 10147 | Specification for continuously hot-dip zinc coated structural steel sheet and strip-technical delivery conditions |
| BS EN 10149 | Specification for hot rolled flat products made of high yield strength steels for cold forming (<i>replaces BS 1449: Section 1.4 and 1.10</i>) Part 1 General delivery conditions Part 2 Delivery conditions for thermomechanically rolled steels Part 3 Delivery conditions for normalized or normalized rolled steels |
| ISO 4997 | Cold reduced steel sheet of structural quality |
| <p>NOTES (1) Hot rolled sections for stiffeners, support systems etc, shall be to BS EN 10025. (2) Strip for helically-wound corrugated tanks shall be to BS EN 10142.</p> | |