Assets Planning and Delivery Group
Engineering

Strategic Product Specification

SPS 498
GRP Chemical Storage Tanks

VERSION 2
REVISION 2

APRIL 2025

FOREWORD

Each Strategic Product Specification has been prepared to inform Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project designer is required to document the supplementary project specific requirements in the 'Project Specific Requirements' Appendix of the Specification.

The text of a published Specification should not be directly modified. If a text variation is considered necessary to accommodate the needs of a particular project or application, then the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix.

Enquiries relating to the technical content of this Specification should be directed to the Senior Principal Engineer Water Treatment, Engineering Business Unit. Future Specification changes, if any, will be issued to registered Specification users as and when published.

Acknowledgment

Special thanks are expressed to Michael Leggett of Oceania Composites and to Peter Kirkwood of 'Resiglass' for their input to this specification.

Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

Users should use and reference the current version of this document.

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The revision status of this specification is shown section by section below:

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Strategic Product Specification
SPS 498
GRP Chemical Storage Tanks

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1 Scope and General

1.1 Scope

This Specification sets out requirements for the design, manufacture, production testing, handling and delivery of *Glass Reinforced Plastic (GRP) Chemical Storage Tanks*.

GRP tanks are commonly used by the Corporation for the storage of chemicals. The chemicals stored vary with the treatment process. The chemical storage tanks covered by this specification are limited to above ground use and are generally of a vertical, circular cross section configuration; however, there may be instances where horizontal tanks are desired.

Tanks may be located inside a treatment plant building or under cover where they are subject to normal ambient exterior temperatures but generally protected from solar radiation. For such tanks a design external surface temperature of 45°C would normally apply. Where located outdoors and exposed to solar radiation, a maximum external surface temperature of 60°C may occur.

The Specification also details how compliance with the Specification shall be demonstrated and the criteria for acceptance of Product.

The following chemicals are stored by the Corporation in GRP tanks; however, this Specification may also be applied to tanks used to store other chemicals with appropriate guidance to be provided by the Water Corporation Design Manager. Maximum intended product concentrations and maximum intended operating temperatures are included. Special requirements and considerations are numbered and listed in the notes below the list.

- Bulk Sodium Hypochlorite Solution 10% -15% @ 60°C **(ref. notes 2,3,4,5,8,9)**
- Dilute Sodium Hypochlorite Solution 0.5% -1.0% @ 60°C **(ref. notes 2,3,4,5)**
- Hydrogen Peroxide Max 30% @ 60°C **(ref. notes 2,3,4)**
- Aluminium Sulphate Solution @ 80°C
- Fluorosilicic Acid 20% - 25% Max 40°C **(ref. notes 1,2)**
- Sodium Chloride Solution, up to saturated (brine) solution strength @ 60°C
- Potassium Chloride Solution, up to saturation (brine) solution strength @ 60°C
- Acetic Acid up to 50% @ 60°C
- Ferric Chloride Solution 20% - 60% @ 60°C
- Hydrochloric Acid up to 20% @ 60°C **(ref. notes 5,6,7)**
- Phosphoric Acid 10% @ 60°C
- Sulphuric Acid up to 30% @ 60°C **(ref. note 7)**
- Sodium Hydroxide up to 50% @ 60°C **(ref. notes 1,2)**

Notes - specific requirements for chemicals listed above:

1. Double Synthetic veils

2. Post Cure.

3. BPO / Amine cure system.

4. Satisfactory up to maximum stable temperature for product.

5. Double C glass veil to be used in the corrosion barrier.

6. Double veil plus 5mm thick corrosion barrier.

7. Above 50°C ECR glass shall be used in the corrosion barrier and structural laminates.

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8. Use brominated resins Hetron 992 or Swancor 905-2 for the corrosion barrier

9. Consideration of a thermoplastic liner should be undertaken

The specification assumes that all tanks will be designed for static head duty unless specified in Appendix A: Project Specific Compliance Requirements (Normative).

1.2 Referenced Documents

The following documents are referenced in this Specification:

Corporation "Strategic Product Appraisal Process Manual" (Internally controlled)

Australian Standards

AS 4087	Metallic flanges for waterworks purposes
AS/NSZ 4020	Testing of products for use in contact with drinking water

AS/NZS AS/NZS ISO

9001	Quality management systems – requirements

ISO/IEC

17000	Conformity assessment – Vocabulary and general principles
17025	General requirements for the competence of testing and calibration laboratories

Standards Australia Guides

HB 18.23 (ISO/IEC Guide 23)	Guidelines for third-party certification and accreditation - Guide 23-Methods of indicating conformity with standards for third-party certification systems
HB 18.28 (ISO/IEC Guide 28)	Conformity assessment - Guidance on a third-party certification system for products

British and European Standards

BS EN 13121 Parts 1-4	GRP tanks and vessels for use above ground
EN1092.1	Flanges and their joints – circular flanges for pipes, valves and fittings and accessories, PN designated – PART1: STEEL FLANGES

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1.3 Definitions and Notation

The following definitions are intended to clarify the terminology used in this Specification.

1.3.1 Australian Standards®

Standards that are developed, published and maintained by Standards Australia

1.3.2 Certificate

A formal certificate issued by a Certification Body in accordance with the third-party product certification system described in HB 18.28, including associated Product license schedules.

1.3.3 Certification Body

An independent (or third party) organisation duly accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) to operate product Certification Schemes.

1.3.4 Certification Mark

A proprietary mark of product conformity issued in accordance with HB 18.23.

1.3.5 Certification Scheme

A third-party product certification system operated in accordance with HB 18.28.

> ***NOTE:*** *The effect of this is to require maintenance by the manufacturer of effective production control planning in addition to full type testing from independently sampled production and subsequent verification of conformity with specified standards.*

1.3.6 Compliant Product

Product that has been assessed, by means of Product Appraisal, as conforming with standards and specifications that are specified by the Corporation.

1.3.7 Corporation

The Water Corporation of Western Australia or its nominated representative.

1.3.8 Manufacturer

An entity or combination of entities that are responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

1.3.9 Notation

Statements governed by use of the word ‘shall’ are mandatory or ‘normative’ requirements of the Specification. Statements expressed by use of the words ‘should’ or ‘may’ are ‘informative’ but not mandatory and are provided for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated ‘normative’ contains mandatory requirements. An Appendix that is designated ‘informative’ is provided for information and guidance only. The term ‘specified’ includes requirements of the Specification and requirements stated or referenced in other project documentation.

1.3.10 Officer

A duly authorised representative or appointed agent of the Corporation.

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1.3.11 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment. This Specification and accompanying Purchasing Schedule define the nature and details of Product to be supplied.

NOTE 1: *An end product is most commonly an output of manufacturing processes that result in finished end products having the same features and characteristics and can be the result of a single or multiple production batches.*

NOTE 2: *Manufactured equipment and assemblies of Product components or materials are commonly procured for mechanical, electrical and civil infrastructure applications.*

1.3.12 Product Appraisal

A formal process whereby Product, including product design, is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate conformity of its production systems with specified standards and requirements. Product Appraisal includes verification of the extent of compliance in accordance with the requirements of a relevant 'Technical Compliance Schedule'.

1.3.13 Product Assessor

An organisation, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is appointed to evaluate Product, appraises the Product and issues one or more Product Verification Reports.

1.3.14 Product Certification

A formal process whereby the production and management systems for the manufacture of Product, are assessed by a Certification Body to evaluate compliance of these systems with specified product standards and tests, in accordance with Certification Scheme rules.

1.3.15 Product Verification Report

A formal report wherein a Product Assessor evaluates the extent of Product compliance with the specified product standards and specifications.

NOTE: *Verification may be on a project-by-project basis or at agreed intervals, as appropriate to the scope of a Purchasing Schedule and Product end use, subject to determination by the Corporation.*

1.3.16 Product Warranty

A formal express undertaking by a Supplier that indemnifies the Corporation against the consequences of supplied Product failure to comply with specified fitness for application and in-service life expectancy performance requirements.

1.3.17 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

NOTE: *The purchasing schedule of this specification is contained in Table 13-1 - Project Technical Requirements*

1.3.18 Quality System

A management system that establishes, documents, implements and maintains organizational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

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1.3.19 Standards Australia

The peak non-government standards development body in Australia which develops Australian Standards®.

1.3.20 Strategic Product

An essential infrastructure component whose performance is critical to the elimination of risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTE: *A Strategic Product is a component of permanent Corporation infrastructure. Ancillary operational and safety equipment that does not form part of permanent infrastructure but offers exceptional enhancements in operational performance or personnel safety may also be deemed strategic.*

1.3.21 Strategic Product Appraisal Process

The process described in the Strategic Product Appraisal Process Manual whereby manufactured products and equipment are evaluated and, where they comply with specified requirements, authorised for use in Corporation infrastructure.

1.3.22 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: *A Supplier may be a Manufacturer, owner, producer, distributor, vendor, agent, tenderer or contractor for supply of Product or Product related service.*

1.3.23 Inspection and Testing

The determination of Product characteristics by inspection and by the application of specified test procedures.

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2 Materials and Components

2.1 Materials

Each GRP Chemical tank shall be constructed from materials detailed in Table 2-1 below. Any materials not specified in the table must be in accordance with BS EN 13121 Parts 1-4. Any deviations will only be acceptable subject to being authorised for use by the Corporation.

Table 2-1: GRP Chemical Tank Material Requirements

Component	Material	Minimum Elongation	Notes
Thermosetting resin system: *Inner Surface*	V.E. Vinyl Ester (Crystic VE 671, Hetron 922 or equivalent)[1] Resin suppliers who do not provide certificates of compliance strictly in accordance with **EN 10204 and AS4020** shall not be considered or used.	4.5%	Heat distortion temperature (HDT) shall be no less than 20ºC higher than the design temperature. No pigments, dyes or colourants shall be used in the resin.
Thermosetting resin system: *Structural*	V.E. Vinyl Ester (Crystic VE 671, Swancor 901, Derakane 411–350, Hetron 922 , Dion 9100, Epovia RF1001, Sino MFE-11 or equivalent) Resin suppliers who do not provide certificates of compliance strictly in accordance with **EN 10204** shall not be considered or used.	4.5%	Heat distortion temperature (HDT) shall be no less than 20ºC higher than the design temperature. No pigments, dyes or colourants shall be used in the resin.
Thermosetting resin system: *Outer Surface layer/ final top coat*	I.P. Isophthalic Polyester Resin. (Crystic 272, Polylite 720-800, Epovia H-360 or equivalent) Resins suppliers who do not provide certificates of compliance strictly in accordance with **EN 10204** shall not be considered or used.	2%	Resin shall contain UV absorber/inhibitor. Unless specified no pigments, dyes or colorants shall be included in the resin.
Glassfibre Reinforcements	Chopped Strand Mat (CSM) Commercial grade type E (Electrical borosilicate) or ECR glass		Glass in non-continuous strands with coupling agent.
	Woven Roving (WR) Commercial grade type E (Electrical borosilicate) glass.		Warp and Weft to be equal.
	Filament Wound (FW) Commercial grade type E (Electrical borosilicate) or ECR glass Continuous Rovings		1100-2400 Tex with compatible coupling agent.
Surfacing Veils	C glass Tissue Glass veil shall be a minimum 25 g/ m^2 non-woven commercial grade "C"		Binder compatible with lay-up resins.

[1] Chemical tanks that are part of non-potable treatment plants may consider Crystic VE 671, Derakane 411–350 WSR, Hetron 922 , Dion 9100, Epovia RF1001, Sino MFE-11 or equivalent. Resin suppliers who do not provide certificates of compliance strictly in accordance with EN 10204 shall not be considered or used.

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Component	Material	Minimum Elongation	Notes
	glass with binder compatible to lay up resins. Synthetic veil Synthetic veils shall be a minimum 22 g/m² non-woven commercial grade type Polyacrylonitrile (PAC) or polyester with binder compatible to lay up resins.		
Alternative Reinforcements	The use of special reinforcements i.e. fabrics/ unidirectional /combination/ bi-axial mats, in varying masses are acceptable, provided the mechanical properties are known and used in the basic design calculations for the specific lay-up of the tanks, vessel or component. Subject to Corporation prior approval.		
Catalysts/Peroxides/ Initiators	A.A.P. Acetyl Acetone Peroxide B.P.O. Benzoyl Peroxide CuHP *(CMHP/CHP)* Cumene hydroperoxide CHP *(CHPO)* Cyclohexanone peroxide MEKP Methyl Ethyl Ketone Peroxide (Normal & Low Activity)		
Accelerators	Diethylaniline (DEA) Dimethylaniline (DMA) 100% solution		**Note:** D.E.A. or D.M.A. is a promoter when Benzoyl Peroxide is used as a catalyst.
Promoters	Cobalt Napthenate / Octoate		6% solution in Styrene
Additives / Solvents	Thixotropic Agent Cab-O-Sil M-5 or equivalent		Additives and Solvents to be used when specified
	Ultraviolet Absorber Tinuven P/326, or equivalent		
	Other Additives - Wax in Styrene (5% or 10% Wax in Styrene in Solution) - Styrene Monomer - Various Inhibitors - Various air release and wet out agents.		
	Solvents - Acetone		

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Component	Material	Minimum Elongation	Notes
Flanges	Stainless Steel Gr316		Full face flange c/w 6 mm minimum thick SS Gr 316 spreader ring drilled in accordance with AS 4087 unless otherwise specified. Reference is also made to Water Corporation's standard DS38-02 Flanged Connections.
Fasteners	Stainless Steel Gr316		
Gaskets	EPDM as standard.		See *Clause 3.14*
Thermoplastic Liner	PVC		See BSEN13121-2. Best option for sodium hypochlorite service.

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3 Design and Manufacture

3.1 General Design Requirements

The design of GRP Chemical Tanks shall comply with the requirements in BS EN13121-1 to 4.

The tanks shall be designed and manufactured to withstand, without structural degradation, distortion, excessive strain, leakage or cracking the operating conditions and loads as specified in Table 13-1 – Project Technical Requirements.

Tanks shall be designed for a minimum operating life of 25 years unless otherwise specified.

3.2 Design Acceptance

The manufacturer shall provide design calculations for all tank components, flanges, joints and equipment for comment and acceptance prior to proceeding with manufacture unless otherwise approved by the Corporation. Specific design requirements, detailed on data sheets shall be taken into consideration.

The "Basic" design method shall be used as described in BS EN 13121-3. The minimum design value for $K = 8$ and $F \geq 4$ shall be used.

The post cure factor A3 shall be calculated and increased by 0.05 regardless of whether a full post cure has been undertaken.

The minimum material property values of BSEN13121-3 Table 3 shall be used for design purposes irrespective of any test results being greater than those of BSEN13121-3 Table 3.

Tanks may be designed for construction using the Helical Winding, Hoop Winding, Contact moulded process or a combination of these.

Maximum allowable design strains shall be as per BSEN13121 Table 9 based on the manufacture process employed.

Tanks for installation outdoors shall be designed for the effect of wind loading and other environmental factors, e.g. seismic, solar, ambient temperature. Indoor tanks shall consider seismic loads.

The laminate shall consist of an inner surface layer and an interior backing layer, both of which comprise the internal chemical barrier. This shall be followed by a structural reinforcement layer and finally an exterior chemical barrier layer. The internal chemical barrier is to be excluded from any strength or stability calculation requirements. Thermoplastic liners shall follow the requirements of the BS EN13121 standard.

Tank design shall also consider physical loadings other than fluid head such as cyclic loading, side mounted equipment, violent agitation, unusually high flow rates, unsupported base area and nozzle loads. The fundamental design of the pipework connected to the tank shall be to minimise any nozzle loads.

Filament wound tanks shall have a longitudinal strength shall be verified by testing apart from hoop winding where the axial tensile strength shall be taken as zero.

The minimum required wall thickness of the tank shall be determined by design however this shall not be less than 3 mm (excluding the chemical barrier) for tanks under 1 m^3 and a minimum of 5mm (excluding the corrosion barrier) for tanks greater than 1 m^3.

The minimum corrosion barrier thickness shall be 2.5mm and comprise a veil inner surface and a minimum of 900gsm CSM or chopped glass backing with a maximum glass content of 35%. Corrosion barrier selection shall be supported in writing by the supplier of the corrosion barrier resin.

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3.3 Heads

3.3.1 General

Ends (Heads) may be designed and fabricated integrally with the tank wall or separately by contact moulding. Ends fabricated by contact moulding/ hand lay-up technique shall satisfy the mechanical property requirement of design. In either case, the inner surface of the head shall present the same corrosion resistant construction to the stored chemical medium as the tank cylindrical wall.

Refer to BS EN 13121-3 Clauses 10.5 and 10.6 for details of acceptable dished and flat bottom ends.

3.3.2 Top Heads

Top Ends may be integrally attached or removable as specified.

The top end shall be able to support a 120 kg load on a 100 mm by 100 mm area.

The minimum thickness of the dished top end shall be 5.5 mm, including the chemical barrier - Support of auxiliary equipment may require additional reinforcement or use of stiffener ribs, or both.

Flat top ends may be either fabricated integrally with the shell wall or may be separately moulded with a flange and subsequently bolted/ joined to the shell. Additional stiffening ribs may be required. All flat tops shall have provision for the prevention of water pooling where the tanks are installed outdoors.

3.3.3 Bottom Heads

For separately moulded ends, the minimum straight wall length shall be 75 mm.

Tanks with conical or rounded bottom ends shall have other means of support such as a cradle, skirt, or extension legs. The support of these tanks shall follow the design and limitations of BS EN13121.

The minimum bottom knuckle radius of a flat-bottomed tank shall be 30 mm.

The knuckle design of tanks shall follow the BSEN13121 Section 10.6; however, membrane designs are not permitted.

The flatness of the base shall meet the requirement of BSEN13121 Fig 67.

All efforts shall be made to ensure that the tank bedding material offers full uniform support and is able to accommodate the undulating profile of the tank bottom.

The knuckle tangent to the base shall meet the requirements of BSEN13121 Fig 67 and the concrete plinth or support frame shall be flat to within 2mm/m.

The use of scour/outlet nozzles fitted to the bottom, should be avoided wherever possible; however, if unavoidable, special consideration shall be given to the design of those unsupported bottom areas opposite the cut outs provided in the plinth.

The minimum structural laminate thickness (excluding chemical barrier) for a flat, fully supported bottom shall not be less than the following:

Up to and including 2,000 mm tank diameter – 5.0 mm

Over 2,000 mm and including 3,500 mm tank diameter – 7.2 mm

Over 3,500 mm and including 4,500 mm tank diameter – 10.0 mm

Over 4,500 mm tank diameter – 14.0 mm

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3.4 Joints / Circumferential Seams

Refer to BS EN 13121-3 Clauses 10.7 for details of Joints / Circumferential seams.

Joints / Seams between tank wall sections and heads shall be laminated to a thickness with the appropriate strength value for the type of construction, at the applicable joint height level.

If it is necessary to undertake joints to tanks and vessels on site, then an additional design factor of 1.2 shall be applied to the design loading for the site joints.

No joint shall have a thickness less than 5 mm, excluding the chemical barrier.

The minimum ultimate shear strength, peel strength and pull off strength shall be no less than that given in BS EN13121-3, all values shall be supported by testing as per the standard.

The width of the first layer of joint lay-up shall be 75 mm minimum. Successive layers shall uniformly increase in width.

The reinforcement laminate shall be centred on the joint and the joint widths are to be determined in accordance with BS EN 13121.

All fully cured resin surfaces to be joined shall first be roughened by sanding or grinding. The roughened/ abraded area shall extend by at least 25.0 mm, beyond each side of the final intended joint width, so that no lay- up is applied onto a -moulded surface. Surfaces shall be cleaned and dried before application of the lay-up. The entire roughened/ abraded area shall be neatly sealed with a waxed resin rich topcoat (“hot coat”) after the joint has been made.

The internal laminate shall be centralised /scaled on either side of the joint line. This laminate shall correspond to the chemical barrier layer of a minimum of two layers of 450 g/m² mat overlayed with the appropriate surface veil/s. Under no circumstance must the internal laminate extend beyond the internal joint abraded surfaces.

The total width of the internal corrosion barrier laminate shall be no less than 100 mm wide and not greater than 150 mm wide. At the joint line the thickness of the internal laminate shall not be less than 2.5 mm.

Joints shall be as crevice-free as is commercially practicable. Crevices between joined pieces shall be filled with resin or thixotropic resin paste leaving a smooth surface for lay-up.

All cut edges shall be coated with a waxed resin rich layer so that no glass fibres are exposed, and all voids are filled and sealed.

3.5 Vents

Closed-top tanks shall have a dedicated vent nozzle for venting to atmosphere. The minimum vent size shall be calculated for worst case condition with consideration of tank filling, emptying, draining, thermal in/out breathing and any other normal or emergency operating conditions. The vent size shall also comply with the requirement of any Australian Standards relevant for the chemical to be stored in the tank (e.g. AS/NZS 3780). The vent nozzle and line size shall be a minimum of 1.5 times the fill line diameter.

Vents shall be fabricated from either contact moulded, integrally moulded, or machine-made pipe and shall be of a swan neck shape. Vents connected to long vent lines may result in partial vacuum or positive pressures being created. These pressures are exacerbated when the vent is passed through a seal pot or similar. Where this occurs, the tank shall be designed for both positive and negative pressure resulting from the induced pressure caused by the vent line as well as the seal pot where fitted. This consideration

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shall also be applied where insect or vermin screens are fitted on vents (The screens shall be regularly inspected by Operators for blockage).

3.6 Overflow

All tanks shall be fitted with an overflow nozzle that is conservatively sized for the maximum design filling rate of the tank and be a minimum of 1.5 times the size of the fill line.

For some chemicals the overflow pipe may include a liquid trap to prevent vapour emissions or to prevent air or moisture ingress. The inclusion of a trap could increase the tank operating pressure due to hydrostatic head at the trap. The liquid height in the trap shall be kept to a practical minimum and the increase in pressure or vacuum created shall be considered in the design of the tank.

This consideration also applies where insect or vermin screens are fitted. The screens shall be regularly inspected by operators for blockage.

3.7 Flanged Connections / Nozzles

Flanged connections shall be compatible with and capable of providing an effective drip-tight seal when mating with an equivalent size and pressure rated flange. Mating flanges shall generally be to AS 4087. The required flange standard is specified in Project Specific Compliance Schedule at Appendix A. All flanges shall be flat faced. Where the flanges are required to be connected to raised face flanges, stub and backing ring flanges shall be fitted.

The manufacturer shall provide details of required gaskets and bolt torques for all flanged connections and shall remain responsible for ensuring a drip-tight seal between all tank flanges and mating flanges. Recommended bolt torques shall consider effective gasket compression, bolt tension and flange strength.

Care shall be taken to ensure flange flatness to achieve a seal. If necessary, flange faces are to be machined and a new chemical barrier re-applied by the “wet setting” technique.

Standard flanged nozzles shall be fabricated from either contact moulded pipe and a suitable flange; integrally moulded pipe and flange; or from machine-made pipe and suitable flange. Adhesively bonded on flanges are not permitted.

All bolt holes shall be drilled after full cure of the laminate has been achieved. The backs of flanges are to be smooth, flat and suitable for backing ring acceptance and/or correct washer seating. Special attention shall be paid to the hub area to facilitate torque wrench and socket access when tightening up bolts.

The BSEN13121 minimum requirements for additional laminate for internal overlays and minimum compensation thickness shall be followed.

3.7.1 Flange Material

Flanges shall be flat faced GRP contact moulded from chopped strand mat for sizes up to 250NB and CSM and woven rovings minimum ratio of 2:1 for nozzles greater than this, excluding manways, impregnated with thermosetting resin to suit the stated design conditions. The minimum design pressure for flanges is 200kPa. Table 3-1 below specifies the minimum acceptable flange structural laminate thicknesses (i.e. ex CB) for all tanks:

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Table 3-1 - Minimum Acceptable Flange Structural Thickness

DN 50 to DN 150	16 mm
>DN 150 to DN 250	20 mm
>DN 250 to DN 350	22 mm

No flanged nozzle smaller than DN 50 shall be used[2] unless otherwise specified.

Tank nozzles greater than 350NB shall be a minimum 32mm ex CB.

The flanges are to be constructed with the required corrosion barrier; this shall be a minimum thickness of 2.5 mm.

The design of flanges may be to BSEN13121 method (not including the tables) or as an alternative ASME RTP-1 may be used where the design uses the calculated design properties using the BSEN13121 method. The calculated flange thickness shall be the structural thickness onto which the corrosion barrier thickness will be added.

3.7.2 Flange Hub

The thickness of the flange hub reinforcement measured at the top of the fillet radius shall be at least one half the flange thicknesses (ex CB) and shall taper uniformly over the length of the hub reinforcement.

The minimum flange hub shear length shall be four times the flange thickness.

The thickness of flange hub reinforcement measured shall be at least one half of the flange thickness Ex CB.

The fillet radius, where the back of the flange meets the hub, shall be in accordance with the design method used.

3.7.3 Flange Installation

At assembly, the minimum nozzle standoff from the external tank wall to the back of the flange shall be 150 mm to enable suitable access for laminating up the flange body.

Special consideration shall be given to nozzles inserted into a tank with a particularly thick wall thickness or to nozzles that do not penetrate perpendicular to the tank's centreline.

Where angular loadings are anticipated, nozzles shall be supported by a suitable gusseting technique; the standard requirement is a conical gusset.

Standard orientation shall have bolt holes straddling principal centre lines of the tank unless otherwise specified.

The shell area around all nozzles shall be adequately reinforced in accordance with compensation pad design requirements. The reinforcement diameter shall be calculated as per the BSEN13121 Section 10.8 but in no case less than the sum of the nozzle outside diameter plus 200 mm ex tapers.

Edge tapers of compensation pads shall not be steeper than 1:6 grades.

[2] Rationale for the minimum nozzle size of DN50 is to provide mechanical integrity; hence, even though smaller diameter pipework may be connected (via a reducer), the weakest point will be the small diameter pipework (which is more readily replaced) rather than the tank nozzle.

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Attachment laminates shall have the same OD as the compensation (ex tapers).

Nozzles on the tank shall be within the specified tolerance BSEN1312 Fig 64 to Fig 67, unless otherwise agreed upon by the manufacturer and the Corporation.

The flange face shall be perpendicular to the centre line of the tank with angular tolerance within ±1°.

3.8 Scours

The minimum diameter of a scour nozzle shall be DN 50 mm, unless otherwise specified.

Special consideration shall be given to scour nozzles which penetrate the tank through the bottom to ensure that there is continuity of the chemical barrier and a suitable seal at the nozzle/ tank wall intersection.

Where specified (refer to section 3.9), the tank shall be provided with an internal floor slope to the scour nozzle.

3.9 False Floor

The installation of false floors shall only be installed where essential[3]. False floors are outside of the BSEN13121 standard and shall rely on successful historical design by the fabricator. In all cases, the false floor shall be built inside a compliant base design. The minimum compressive strength of the foam (or similar) core material shall be a minimum of 4 times the maximum internal pressure including any overpressure from filling activities.

3.10 Stiffeners

Open top vertical tanks should be constructed with a flange or a stiffening ring bonded to the top of the shell. Alternatively, the shell shall be over-wound or over-laid to provide sufficient rigidity for retaining the shape of the tank.

Side wall stiffeners used to increase the radial buckling capacity of the tank shall be closed in top hat or similar design.

3.11 Hold Down Lugs

Hold down lugs shall be provided on all tanks for outdoor service and when specified by the Corporation. The design of the hold down lugs shall follow the requirements for spacing as per BSEN1321-3, the design of the lugs themselves shall be as per RTP-1 using the BSEN1321 safety factors.

3.12 Manufacturer's Information Plate

A manufacturer's information plate shall be mounted, at a clearly visible location on the chemical tank, providing all the information required by BS EN13121-3.

3.13 Design for Drinking Water Use

Where the chemical tank is used as part of a potable water treatment process, all materials that may encounter the contents of the tank shall be compliant with AS4020. Materials without AS4020 approval but recognised to an equivalent international standard (e.g. NSF-61) will only be accepted if listed as Approved Materials in Schedule 5 of the WA Department of Health document Materials, products and substances in contact with drinking water.

[3] Unless essential to operational requirements, false floors are generally not preferred because of the high risk of failure due to seemingly minor deficiencies in the fabrication process.

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3.14 Gaskets / O-Rings

Gaskets/ O rings shall be EPDM (UV Stabilised) unless default gasket material is incompatible with the designated chemical that the tank is to contain, in which case the designer shall specify the alternative gasket material. For sodium hypochlorite the gasket material shall be FPM (carbon black stabilised Viton) or expanded PTFE depending on the required design temperature.

Reference should also be made to the Water Corporation's standard DS 38-02, Flanged Connections.

If flanges with O-ring seals are being provided, then the seal groove shall be 'off-mould' finish or machined and suitably resin sealed, ensuring that the O-ring contact surfaces are smooth, uniform and free of resin "runs". Seals shall be drip-tight under all operating conditions.

3.15 Nozzles, Manholes and Inspection Openings

Attention is brought to the requirements of BS EN 13121-3 regarding opening and branch diameter restrictions. Generally. any opening in a tank shell should not be greater than one third of the tank diameter.

Where the manway diameter is too small for entry or the tank is insufficiently large for a standard size manway, the inspection nozzle in the cylindrical shell or roof shall be provided at an ergonomic height to permit camera entry. Drawings showing the location of all such openings are to be provided for review and acceptance by the Principal.

An opening shall be provided to allow inspection (from outside the tank) and for access to hose out the tank through this nozzle, but there is no operational requirement for entry because the intent is that Operators and Maintainers will never enter a chemical tank. However, GRP tank fabrication is compromised if the inspection opening is not sized as a manhole to enter the tank to do the final seal/joint of the roof to wall internally. Inspection nozzle (minimum) size requirements are:

- For tanks smaller than 1,800 mm diameter, a DN 300 mm inspection opening shall be provided unless specified otherwise in Appendix A: Project Specific Compliance Requirements (Normative).
- Tanks 1,800mm diameter and above should have a DN 600 mm manhole where the chemical storage building space allows (roof manholes to be considered where building space is limited, such as in pre-fabricated buildings) and tanks 2,000mm diameter and above shall have DN 600 mm manhole[4]s fitted.

The minimum pressure rating for the inspection nozzle/manway shall be 100kPa. Other manway designs shall be negotiated between manufacturer and the Corporation.

Inspection nozzle height shall provide ergonomic access for inspection and hose out, and orientation of the inspection nozzle shall suit requirement to hose out towards the scour outlet.

3.16 Lifting Lugs / Trunnions /Tailing Lugs

The tank shall be equipped with a minimum of two suitably designed lifting/handling devices where required to facilitate lift of the tank. Design shall comply with BS EN 13121.

Unless specifically designed and rated for other than vertical lifting loads (e.g. designed for lifting the tank from a horizontal position to a vertical position during installation), a clear label stating that the lifting lugs are "Rated for vertical lift only" shall be fixed near the lifting lug when applicable. The SWL load of the lugs shall be indelibly marked next to each lug.

[4] Manholes are important to allow application of the internal chemical barrier resin joint on the roof to wall joint inside the tank during manufacture. This practice only applies to GRP fabrication and therefore is not required on HDPE tanks.

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Lifting lugs/ trunnions/ handling devices that are bolted through the tank wall are not permitted.

3.17 Internals

Internal structural elements (e.g. baffles, supports brackets, dip pipes, etc.) having edges exposed to the chemical contents shall be sealed with the same corrosion barrier laminate and surface veil as the main tank. All voids are to be filled and cut edges coated with a waxed resin coat, leaving no glass fibres exposed.

Any overlay or attachment laminate shall present the same corrosion resistant construction to the chemicals as specified for the GRP tank or equipment.

All structural laminates for any internals shall be constructed from the same resin as the corrosion barrier.

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4 Protective Coatings

4.1 Tank Colour

The tank colour shall be "natural" (opaque) unless an alternative colour is specified in Table 14-1: Technical Compliance Schedule.

Note. An alternative colour may be preferred to provide both a degree of reflection (to limit tank wall temperature rise) and a UV barrier to reduce the potential for UV degradation or algal growth for certain chemicals. Colour coding of tanks is not required.

4.2 Corrosion Barriers

All tanks shall be constructed with an internal and an external corrosion barrier as detailed below and where appropriate, as required by Clause 1.1.

Internal corrosion barrier - minimum thickness = 2.5 mm

- 1 x 25 g/m² "C" glass veil (or 2 x 22 g/m² Synthetic veil when required)
- Min 900 g/m² Chopped Strand Matt (CSM)
- Resin -- Vinyl Ester
- Resin: glass ratio 25-35%

If specified above in Section 1.1 Scope, a resin rich liner layer consisting of two layers of an organic synthetic veil, shall be used in the makeup of the internal corrosion barrier i.e. for Fluorosilicic Acid and Sodium Hydroxide containment. Any other specific requirements for the chemical barrier makeup i.e. increased chemical barrier thickness or cure system required for a particular chemical shall be noted and addressed. The selected resin suppliers shall provide a written recommendation based on the application service conditions. Where the resin supplier requirement exceeds the above it shall be followed[5].

External corrosion barrier - minimum thickness = 0.3 mm

- 1 x 25 g/m² "C" glass veil (90% Resin)
- 1 x waxed resin rich top-coat layer (with ultraviolet absorber)
- Resin -- Iso-NPG Polyester Resin pigmented with the specified colour

No wax or pigment shall be added to the resin used in the initial tank structural and chemical barrier layer construction to ensure improved secondary bonding and visual inspection. Pigment, ultraviolet absorber and wax shall only be added to a final resin rich top coat ("hot coat") after tank inspection and hydro testing has been completed and accepted. The final waxed resin rich top coat is required to provide exterior corrosion and UV protection of the structural layers beneath.

Final waxed resin rich resin coats (hot-coats) shall be formulated strictly in accordance with the resin manufacturer's recommendations. Care shall be taken to ensure that the resin's exothermic reaction is adequate: to drive the wax to the surface, forming a thin wax film, preventing oxygen inhibition of the surface cure and ensuring that it is tack free. (The acetone sensitivity test shall be used to check surface cure). The coating shall be thick enough to prevent light penetration[6].

4.3 Post Cure

Resin cure systems that require post cure as recommended by the resin manufacturer for specific chemical containment duties i.e. Sodium Hypochlorite (refer to Scope Section 1.1) shall be carried out

[5] Resins change and historical performance may require different constructions. To minimise risk, the resin supplier should advise.
[6] Light penetration may degrade chlorine-based chemicals.

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in accordance with the following procedure. Note: This procedure is only for improving the condition of the corrosion barrier and does not post cure the structure of the tank.

4.3.1 Preparation Prior to Post Curing

All apertures and openings are first blanked off using suitable materials that will offer adequate insulation for the intended post cure temperature and duration. Plywood and or Polyurethane foam are generally acceptable for this purpose.

Nozzles, through which temperature probes will be inserted for temperature monitoring, shall be provided with blanks that have small apertures drilled in the centre for acceptance of the measuring devices.

The internal surface of the equipment must be clean and free of all dust prior to commencement of the post cure process. GRP dust is highly combustible and can ignite if drawn onto the heater elements.

4.3.2 Procedure and Heating Equipment

A suitable electrical infrared heater of adequate power complete with a circulating fan is to be used to heat up the air within the GRP equipment that is being post cured. The heater and fan must be capable of heating the air in the GRP tank to the recommended temperature within a 4-hour period. The use of open flame heater devices is not recommended and poses a fire risk.[7]

4.3.3 Post Cure Temperature and Duration

The tank shall be post cured at the recommended temperature and maintained at this temperature for a minimum period of 4 hours once the internal air temperature has reached the post cure temperature and has stabilised.

4.3.4 Barcol Hardness and Acetone Solvent Cure Tests

Prior to post cure, Barcol hardness readings shall be taken of representative, specific areas of the internal surfaces of the GRP equipment. Note excessive use of a Barcol hardness indenter can cause permanent damage to the resin rich surface and resultantly could reduce the chemical resistance and life expectancy of the GRP equipment.

Barcol hardness readings are repeated, after the post cure process has been completed, in the same locations as those recorded previously.

If the hardness readings have not reached 80% of the resin published value, the tank shall be quarantined and the cure of all the areas of the tank investigated to determine if any areas are subject to undercure requiring the laminates to be repaired or replaced.

Acetone solvent tests shall be carried out on both the internal and external surfaces to ensure that they are cured tack free and that they have not suffered from oxygen inhibition.

4.3.5 Recording and Verification of Post Cure

A precise record of post cure, including temperature and durations shall be included in the Material Data Records (MDR). The use of standard temperature recorders and thermal temperature indicator strips with the appropriate range shall be used for verification of post cure.

Positions of thermal indicators, thermometers and thermal probes shall be marked on the main general arrangement drawing for inclusion in the MDR.

[7] The issue is that you can have a VE with a HDT of 105C backed by an Iso with a lower HDT closer to 80 ºC. So, heating to 90 ºC is not good practice as deformation may occur.

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5 Inspection and Testing

5.1 General

Product shall be tested in accordance with the inspection and test requirements of this Specification and BSEN13121. Inspection and testing shall be deemed acceptable when the outcomes have been formally verified by a Certification Body or witnessed by an inspection and testing Officer.

The requirement for Third Party Verification is case specific. The Water Corporation Design Manager, or the Corporation's Design Consultant where nominated, is to complete the schedule in Appendix A: Project Specific Compliance Requirements (Normative). Product for which inspection criteria and/or test requirement has not been met shall be classified as non-compliant Product.

NOTE 1: *Inspection and testing should preferably be carried out by an organisation accredited by NATA or in accordance with ISO/IEC 17025.*

NOTE 2: *An Inspection and Testing Officer should normally be an independent Officer who has specialist knowledge of or training in product or materials inspection and testing appropriate to the Product characteristics to be tested.*

NOTE 3: *An independent inspector/ testing officer shall be someone who has credibility and is acceptable to the Corporation and should be involved throughout the manufacturing process in accordance with the approved control points detailed on the Inspection and Testing Plan. (ITP)*

5.2 Notification of Inspection and Testing

The Corporation shall be notified in writing of each formal inspection and test proposal. A minimum of 5 working days' notice shall be provided for tests of tanks or vessels manufactured in WA and a minimum of 20 working days' notice for tanks or vessels manufactured interstate. This notification is required to enable the Corporation to make all necessary arrangements including appointment of an inspection and testing Officer in a timely manner.

5.3 Access to the Place of Manufacture

The testing Officer shall be afforded access, at all reasonable times, to all places of manufacture of Product or product components and shall be authorised to arrange or undertake such testing there as the Corporation deems appropriate to the testing regime specified.

5.4 Place of Manufacture Other Than WA

Where any Product or product component is being manufactured other than in Western Australia the Corporation may appoint a local inspecting Officer to undertake inspections and witness testing as required. The testing Officer shall be provided with all due authority and permits required to carry out testing at the place of manufacture.

NOTE 1: The cost of witnessed testing arranged by the Corporation will normally be borne by the Corporation unless otherwise negotiated.

5.5 Performance Test Requirements

5.5.1 Production Tests

Each Product item shall be tested during production in accordance with the test requirements of BS EN 13121 and the Inspection and Test Plan approved prior to commencement of manufacture.

The Supplier shall retain all cut outs / coupons used in the tests for a minimum period of 7 years.

The following tests listed in Annex D of BS EN 13121 shall be carried out on the cut outs where applicable. Test criteria defined in BS EN 13121 shall apply, as appropriate to the values used in the

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design:

D.1.1 Tests Methods
D.2 Loss on ignition
D.5 Ultimate unit tensile strength of laminates by ply type
D.6 Unit tensile modulus of laminates by ply type
D.7 Inter laminar shear strength of laminates by ply type
D.8 Lap shear strength of bond between laminates.

D.9 Peel strength of bond between laminate layers and or TPL
D.11 Barcol hardness
Minimum acceptable Barcol hardness test shall be 80% of the resin manufacturer's recommendations.
D.14 Acetone test

5.6 Qualifications

All laminators shall be trained, tested and certified in accordance with the applicable requirements of the design standard in use and shall have at least 3 months experience in this particular field of work and be suitably supervised.

5.7 Test Results, Inspection and Certificates

For the purposes of acceptance, each test certificate shall, as a minimum, document the laminate construction being tested and shall certify that the Product item has complied with the specified test method and requirements.

Photographic records shall be provided for each stage of manufacture of the tank.

All testing shall be reviewed, verified and signed off by the appointed independent 3rd party inspector whose credentials and experience are acceptable to the Corporation.

5.7.1 Hydrostatic Testing in the Manufacturer's Works

All products are to be hydraulically fill tested in accordance with the specification requirements after installation. Unless otherwise stated, products are filled with clean water (pH range 6.5 -7.5) to a maximum possible head (i.e. overflow) and held for a minimum of twelve (12) hours. They are to be drained slowly with top manholes / vents open to avoid pulling a vacuum.

The test shall be a 'witness' test with the Corporation's nominated representative invited to attend. A minimum of 7 days' notice of test shall be provided for tanks manufactured in WA, and minimum of 14 days' notice for tanks manufactured interstate.

Where, in the sole opinion of the Corporation's representative, the test has resulted in undue strain or deformation of tank components, the manufacturer shall repeat the test using strain measurement in the area(s) of concern. The manufacturer shall demonstrate that the tank is not subjected to strains greater that those listed in Section 8.2.5 in BS EN 13121-3 "Allowable Test Strain" based on the laminate design and the direction in which the strain is recorded. This test shall take into account that the density of water used for test may be less than the intended medium and as such the difference in resulting strain shall be taken into account. For hydrostatic tests the strain measured[8] and factored for density shall be directly compared to that specified in the design. The strain in the design shall not be factored for hydrostatic test purposes. Where over pressure is part of the test process then the allowable test strain

[8] Strain measurement needs to be kept in context of the loads being placed on it. In addition, the stiffness used in the calculations can sometimes be 30% less than what is achieved in testing of the actual laminate, and as strain varies with ply stiffness this becomes a complex issue. If deformation is noticed it would be better to do a structural survey i.e. thickness etc. than to test the tank again and take strain measurements.

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may be factored as per the standard where appropriate.

Any leakage from the tank, or from flanged or threaded connections, shall result in failure of the test.

5.7.2 Visual Defect Acceptance Test

The tank(s) shall be inspected by the Corporation's nominated representative. All visual defects shall be in accordance with the BS EN 13121-3 Table 32.

5.7.3 Tolerances

Tank manufacturing tolerances shall be checked by the manufacturer and compared to the tank design, in the presence of the testing Officer. The Corporation may reject the tank if measured dimensions and angles are not within tolerance.

The following tank tolerances shall apply during the inspection:

- BS EN 13121-3 Section 17.3.3

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6 Marking and Packaging

6.1 Marking

All GRP tanks and associated components shall be clearly and permanently marked for identification and traceability purposes. The markings shall remain legible under normal handling and installation practices.

Each tank shall include the following information provided in characters at least 5mm high, clearly marked by casting on the body, or displayed by stamping or engraving on a corrosion resistant plate which shall be permanently secured using corrosion resistant fasteners:

- Manufacturer's name or identification mark
- Design and manufacturing standard
- Manufacturer's serial number
- Date of manufacture
- Hydrostatic Design pressure
- Over pressure Maximum Service temperature
- Capacity (volume kL and weight kg)
- Contents (main) and design specific gravity
- Material/ Resin types
- Suitability for potable water contact (if required by the client)
- Inspection authority mark (if applicable)
- Purchase order number
- Tare weight of the tank
- Warranty Expiry

6.2 Packaging

6.2.1 General

The tank shall be packaged with appropriate protection, which shall prevent damage or defects as a result of handling, storage or transportation. Flexible packaging material shall have a minimum expected life in outside storage conditions of 12 months from the date of delivery.

Tanks and any other associated components shall be thoroughly cleaned before transportation. Particular attention shall be paid to the presence of GRP grinding dust and production residue.

The tank shall be suitably braced and protected against deterioration and damage during transportation.

Nozzles shall be covered and sealed against contamination. All flanged branches and pipe ends shall be blanked and protected by fitment of at least 9 mm thick plywood blanks. Blanks may be secured with black bolts and nuts or heavy-duty cable ties spaced at every second hole.

Adequate internal and external stiffening or supporting devices, timber spiders, sandbags, saddles, soft cushioning material or any other provisions shall be provided as necessary for internal parts which are vulnerable to damage to ensure that the manufactured product remains free from accidental mechanical damage during transportation to site.

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6.2.2 Identification Tag

Each tank shall be identified using a weatherproof marking pen on a corrosion resistant metal identification tag securely wired to the Product in a conspicuous position using a galvanised tie wire. The tag shall include the following information from the purchasing document:

a) Identification name/number of tank

b) Site or Location

c) Contract number

d) Purchase order number

6.2.3 Marking of Packaging

Where the tank is wrapped for transportation, it shall be additionally identified by marking on the outside of any protective packaging, the same information as shown on the identification tag.

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7 Transportation, Handling and Storage

7.1 Transportation

Transportation, handling and storage facilities shall be designed to prevent damage to the tank and to maintain the tank free of deleterious matter. The tank shall not be dropped off elevated vehicle platforms or sites. Mechanical handling equipment shall be in accordance with AS 2550.1, AS 2550.3, AS 2550.5 and AS 2550.11 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia. Product restraint during transportation shall be in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia.

> ***NOTE:*** *Where wire ropes or chains are used for loading and unloading, they should not come into direct contact with the tank. Lifting elements in direct contact with the tank should be of a non-abrasive design e.g. elastomeric or fabric webbing straps. During transportation, tank restraints should be checked for tension at regular intervals of travel and should not be released until the transporting vehicle is resting in a secure stable disposition on level ground. The restraints should be placed at hard points wherever possible to prevent excessive deformation of the tank.*

Extreme care should be taken during transportation and handling of GRP tanks and equipment.

Tanks transported horizontally shall be mounted on a skid, cradle or supported with sandbags. All contact areas shall be padded and suitably protected from point loading and abrasive damage. Fixing ropes and straps should be of hemp or fabric. If metallic, they are to be properly lagged to prevent abrasion.

No loose items may be shipped inside tanks or equipment.

Loose items are to be removed and packed in suitable containers for handling separately.

The tank shall be fully protected against damage throughout transport to destination. Where weather conditions are a consideration, suitable protection against the elements shall be provided.

7.2 Handling

Sound rigging practices shall always be adopted. If lifting lugs/ trunnions are fitted, they shall be used (with suitable spreader beams if necessary). Where lifting lugs are not provided, properly placed soft slings are to be used. Under no circumstances shall fitted nozzles, branches or clips be used for lifting.

Only non-metallic or very well protected metal slings or hooks are to be used. Wherever possible, hemp rope or fabric webbing, strap slings are preferred. Chain or wire ropes shall not be used.

When lifting, care shall be taken to ensure that no shock loads are applied to the lugs or elsewhere on the tank. The use of any lifting device or practice that involves high point loading on any GRP surface or is likely to result in high distortion stresses in the structure, is expressly forbidden.

It is mandatory that a control rope be attached to the tank during lifting to prevent unnecessary swing and potential damage.

Lifting operations shall be to an agreed lifting plan.

Righting of the tank shall be undertaken using the supplied Lifting Plan. The following practices are expressly forbidden for GRP tanks:

- Striking or permitting to strike any obstruction.

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- Sliding unless mounted on a sledge (sled) and supported by suitable soft packaging.
- Rolling, unless the carrying surface is smooth, soft and flat and rolling over flanges, nozzles and other protrusions can be avoided.

7.3 Preservation of Tank in Storage

The tank shall be stored in original protective packaging in accordance with the published requirements of the manufacturer, prior to installation. Sensitive component materials shall be protected from extended exposure to direct sunlight and high temperatures e.g. elastomeric components shall be stored in accordance with the general principles of AS 1646. Designated storage areas shall be of sufficient size to accommodate tank deliveries and shall be flat, reasonably level and free of combustible vegetation, sharp stones or projections that could cause damage or defects.

A suitable storage location should be selected that will minimise the risk of accidental impact damage from construction vehicles and activities.

Possible movement due to wind must be considered and temporary anchors provided when necessary.

8 Installation

8.1 General

All tanks must be given a thorough visual examination to check for signs of damage during transit and/or installation. Particular attention is to be paid to the internal surface.

Protective/ soft-soled footwear is always to be worn inside a product to avoid damage to the interior surface.

All tanks shall be placed upon their supports in such a way as to ensure that loads are distributed as intended in the design. Care must be taken to ensure that all bolts are an easy fit in mating holes, so that no loads due to misaligned holes are imparted to the laminate. The use of drifts or bars is strictly prohibited.

Nozzles are not designed to take pipe loads, and piping should be fitted and supported so that back loads are minimised. It is prohibited to use branches and clips on GRP fabrications as footholds during installation.

Ladders or scaffolding are not to be supported against an installed GRP tank unless contact points are well cushioned to prevent damage. Care must be taken when crossing the head of the tank, as the surface finish of GRP is slippery, especially when wet. Access to the top of any tank must be kept to an absolute minimum unless it has been specifically designed for this purpose.

8.2 Support Base

It is the responsibility of the manufacturer to provide the methodology and details of installation and the support bedding requirements for the tank.

The top surface of the foundation/plinth, whether it is flat screed concrete or steelwork, should be flat, level and free from any local irregularities. It should not vary more than 2 mm in any 1 m, or a total of 6 mm in any 6 m, measured laterally or diagonally.

Intermittent supports under the base of the tank shall have a suitably solid plate installed unless the tank has been specifically designed for discrete support locations.

Any tank foundation should be constructed so that when the tank is full, the support deflection should not exceed 1/500th of the tank diameter.

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As most GRP tanks do not have perfectly flat bottoms, it is recommended that they be placed on a suitable medium that will offer the necessary full support.

This can be a suitable grout or cushioning material (minimum 12 mm thick) with < 50% compression that covers the entire tank/vessel footprint to ensure even load distribution and limit point loading. It is important that the cushioning material thickness exceeds the undulations of the tank base by a minimum of 50%, so that point loading does not occur.

Tanks that have the reinforced knuckle have laminates that extend around the bottom and result in a step in the base of the tank. As a result, the bottoms are not flat and these tanks require the underside of the tank base to be supported. Consideration shall be given to infilling the recessed area to create a flat base.

There are a number of acceptable methods of supporting larger diameter tanks, namely the use of a wet grout, bitumen sand premix compound or a retained sand base.

Both epoxy and cementitious grouts are acceptable, provided they are suitable for the chemical duty, alternatively a protective membrane should be fitted around the perimeter of the tank. Tanks should be placed on the wet grout base and allowed to bed in properly prior to curing.

If the bitumen sand premix alternative is chosen, then the procedure requires that the entire base is covered with a uniform and similar thickness layer of premix, prior to tank placement. This does necessitate the orientation, placement and partial filling of the tank immediately afterwards in order to prevent premature setting of the bitumen and formation of voids and unsupported areas under the bottom.

If the sand alternative is chosen, then it is recommended that a 25 mm average thickness bedding base layer of selected and slightly damp, river sand be placed first on the solid plinth foundation. The sand should be placed so that it is approximately 25-30 mm higher in the centre of the plinth base and tapered evenly to the outside diameter of the tank base. This is to allow for the “tin can effect” and deflection of the tank bottom and providing full and uniform support. The installer should use discretion with regard to determining the actual depth of sand required, by first checking the tank’s actual deflection, prior to tank placement. The tank should then be orientated and placed in position and partially filled with water to bed it down.

To prevent the sand or bitumen sand premix from erosion by rain, chemical degradation, wind or pressure cleaning, the space between the bottom outside radius of the tank and base or plinth should be filled with bitumen/sand mix and tamped down to a 45° chamfer (see sketch below).

The premix may be softened by addition of a small quantity of water if difficulty is found in tamping smooth. An alternative to the use of the premix surround is the use of a silicone rubber compound that offers flexibility and superior chemical resistance.

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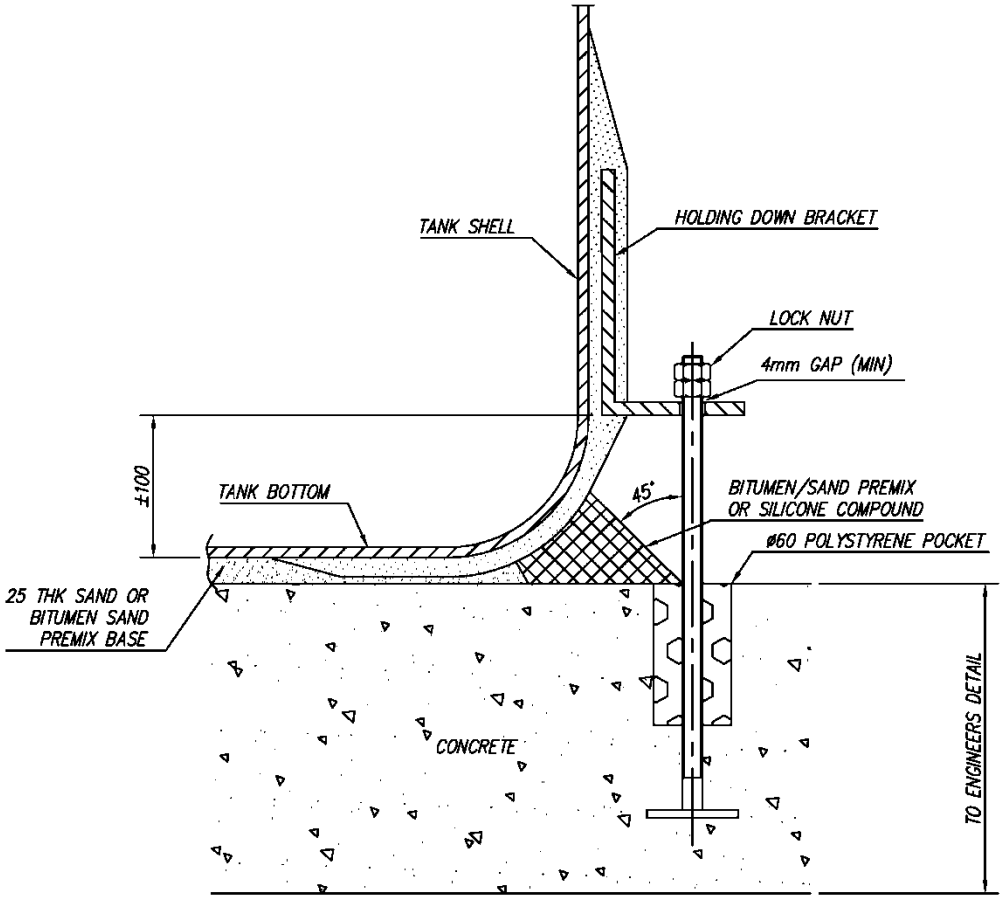

SKETCH X - CROSS SECTIONAL VIEW OF TYPICAL TANK BOTTOM AND BASE

Premix. The bitumen and premix is prepared using One (1) part of Table 60 bitumen together with five (5) parts of selected river sand and thoroughly mixed together.
The sand should be sieved and free from stones or other debris.
The premix should be pre-packed into suitable 20 kg plastic bags for storage and transport to site.

8.3 Temporary Tying Down of the Tank in Position

If it is not possible to bolt down the tank immediately after erection, then precautions against movement should be taken by securely tying down the tank.

The lifting lugs shall be used to secure the tank to any substantial anchor or stack positions.

8.4 Bolting Down Hold Down Lugs

Under no circumstances should the hold down brackets be firmly bolted down, nor should a nut be fitted under the bracket or spacers fitted between the bracket and solid foundation, as this will restrict movement during settlement of filling and could result in damage to the tank. This practice could impose

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undue stressing to the laminate behind the brackets.

The nuts on the anchors shall be finger tight only. A "Nyloc" nut is preferable for this purpose, alternatively the use of a second lock nut, is also acceptable.

8.5 Bolting

The manufacturer shall be responsible for providing the maximum acceptable torque values that the flanges can be subjected to when bolting up to tanks, piping or equipment.

Bolts must be tightened up in the correct dynamometric bolting sequence. This should be carried out in small torque steps (minimum of 4 increments per flange) to ensure uniform pressure is applied by all the bolts.

Particular attention and care must be made to those full-face flanges that match up to raised face valves and equipment.

After torquing, the torque shall be checked again 24hrs later, prior to filling.

8.6 Hydrostatic Test After Site Installation

All tanks are to be hydraulically re-tested in accordance with the specification requirements after installation. Unless otherwise stated, tanks are filled with clean water (pH range 6.5 -7.5) to the maximum level and held for a minimum of twelve (12) hours. They are to be drained slowly with top manholes/ vents open to avoid pulling a vacuum.

The test shall be a 'witness' test with the Corporation's nominated representative invited to attend.

Any leakage from the tank, or from flanged or threaded connections, shall result in failure of the test.

9 Manuals

9.1 Format and Language

The tank shall be supplied complete with appropriate installation, operation and maintenance instructions or manuals, in clear diagrammatic and text format, in English.

9.2 Content

The manuals shall contain all the relevant information required to commission, operate and maintain the tank in service, including the following:

a) Details of tank features

b) Installation and commissioning instructions

c) Preventative maintenance requirements and intervals

d) Testing procedures

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9.3 Documentation

9.3.1 Quotation Submittals

The following information will be required to be submitted by the Supplier on request for quotation:

a) A general arrangement drawing of the tank(s) with sufficient dimensions to confirm the tender requirements have been understood.

b) Estimate of the weight of tank, and fixing details to the foundation.

c) Any applicable datasheets.

d) An outline program for the proposed execution of the works.

e) List of all comments or exceptions to this Specification.

f) Generic Inspection and Test Plan (ITP)

g) Details of the tank and equipment warranty.

9.3.2 Pre-fabrication Submittals

The Supplier shall prepare and submit the following documentation to the Corporation's Representative for approval. No manufacturing shall proceed until all required information has been submitted and accepted in writing by the Principal's Representative.

a) Specific Inspection and Test Plan.

b) Detailed shop drawings with sufficient dimensions and details of construction of the tank for review together with installation requirements.

c) Evidence that the design has been checked and approved in accordance with an approved Quality Assurance system.

9.3.3 Final Submissions

Upon completion of fabrication of the tank, the Contractor shall compile and submit a Manufacturer's Data Report (MDR) which shall include the following:

a) ITP with support documentation completed and approved.
b) As-Built drawings
c) Laminating records
d) Material Certificates
e) Certificates of compliance and analysis
f) Consumable Certificates
g) Inspection Reports
h) Testing Certificates
i) Design Calculations
j) Design Third Party verification Certificate
k) NDT Reports
l) Hydrostatic Test Report
m) Painting Report
n) Name Plate Rubbing/ Photo
o) Declaration of conformity/ certificate of compliance
p) Calibration Certificates as appropriate

In addition to the MDR, the Contractor shall supply an Operation and Maintenance Manuals if any valves and accessories are to be supplied with the tank. The Contractor shall furnish one hard copy and one electronic copy in pdf format of the MDR and any Operation and Maintenance Manual. All documents shall be written in English and clearly legible.

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10 Manufacturer's Drawings

10.1 General

The Supplier shall supply manufacturing drawings which are required for the construction of the tank and once complete the final As-constructed drawings.

Drawings shall be submitted to the Corporation for review and comment. The Supplier shall not proceed to obtain Design Verification (if required) until the drawings have been accepted by the Corporation. The Supplier shall submit a complete design summary report, design calculations and design verification certificate to the Corporation prior to commencing fabrication works.

The manufacturer shall prepare Manufacturing Drawings of sufficient detail to enable the tank to be constructed, installed and maintained effectively by competent tradespersons; they shall include details of all appurtenances, internal components, fixings and any valves supplied.

10.2 Drawing Practice

All Manufacturer's Drawings produced shall be in accordance with the latest version of the Corporation's "Guidelines For Planset Creation, Drawing Registration And General Drawing Reference", a copy of which will be made available to the Contractor free of charge for the period of the Contract.

Manufacturer's Drawings shall be produced using the latest AutoCAD release, with original sheet size A1 metric. The Corporation's standard base drawing sheet shall be used for all general drawings. The Corporation's standard AutoCAD drawing default layering scheme and process symbols as defined in their "General Drawing Reference Guidelines" shall be used on all drawings.

The Manufacturer's Drawings shall be of a standard ensuring the content can be easily read and understood when reproduced at A3 size. The first sheet shall comprise the dimensioned GA of the tank with all design notes, manufacturing notes i.e. resins, reinforcements, nozzle labelling and nozzle description. No fabrication details shall be included on the first sheet of the drawing.

10.3 Approval of Manufacturer's Drawings

The Corporation's Representative will examine the drawings submitted for approval and will return one copy to the Supplier marked either 'Accepted', 'Accepted with Corrections as Noted', or 'Returned for Correction'. Drawings returned to the Supplier for correction shall be resubmitted within fifteen (15) working days for approval as outlined in this clause. The Supplier shall not commence any manufacture until the drawings in clause 9.3.2 are accepted.

The drawings shall become the property of the Corporation and shall not be varied prior to or during manufacture without the approval of the Corporation's Representative. The Supplier shall rectify, at the Supplier's cost, all errors and omissions in the drawings, provided such errors and omissions have not resulted from incorrect information supplied by the Corporation.

Following manufacture and prior to acceptance, the Supplier shall supply a complete set of *As constructed* drawings of the same size as corresponding drawings submitted as per Clause 9.3.3. All a*s constructed* drawings shall be signed by the Supplier as a revision to certify their accuracy. *As Constructed* drawings shall be supplied in CAD format and A3 size hard copy.

Supply under the Contract shall be regarded as incomplete until all drawings, including final *as constructed* drawings, have been supplied.

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11 Spare Parts and Special Tools

11.1 General

No spares shall be provided unless specifically listed in the Contract specification or drawings. Special tools required for normal operation or regular maintenance shall be supplied by the Manufacturer.

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12 Quality Assurance

12.1 Certification

12.1.1 Certification of Product

The tanks shall be self-certified by the manufacturer with 3rd party certificates included i.e. design verification, inspection, material testing etc.

12.1.2 Quality System

The processes for manufacture, testing, supply, transportation, handling, delivery and storage of Product to be supplied in accordance with this Specification shall form part of a documented Quality System. The System shall be certified by a Certification Body as complying with the requirements of AS/NZS ISO 9001 and shall provide for identification and traceability, control of production and delivery to the specified destination, customer verification and control of documents and records.

12.1.3 Product Re-verification

Compliance with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed supply period, there occurs any:

- substantive change in the tank performance
- The tank fails in operational service

Re-verification shall require the reason for failure to be investigated and a plan to re-instate the tank to service supplied to the Corporation for approval. Where deemed necessary the works shall be undertaken to the same standard as required by this specification and the same level of oversight in terms of QA/QC and 3rd party inspection.

12.2 Compliance and Acceptance

12.2.1 Means of Demonstrating Compliance

Compliance with this Specification shall be demonstrated by means of a self-issued Certificate of Compliance which has to include the 3rd party inspector sign off.

12.2.2 Acceptance Criteria

For acceptance, the tank shall be supplied as specified in the Purchasing Schedule.

Prior to the implementation of any arrangement to supply a tank, the Supplier shall, in accordance with specified requirements:

- supply the required documentation and inspection certificates, design verification etcetera demonstrating compliance
- detail that any non-compliances have been rectified to the satisfaction of the designer and design verifier and the 3rd party inspector.

12.3 Non-Compliant Tank

12.3.1 General

A tank whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-compliant and shall be subject to rejection for return to and remediation or replacement by the Supplier.

Where the Specification includes a ‘Technical Compliance Schedule’, the tank shall be deemed non-compliant except where a Supplier has demonstrated compliance in accordance with the requirements

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of the 'Technical Compliance Schedule' Appendices of the Specification.

As the inspection authority is responsible for the assurance of the tank's compliance, the Inspection Authority shall be reviewed for the thoroughness of the inspection process and subject to an improvement notice and or removal from the project.

12.3.2 Manufacturing Repairs (In-process)

Any identified defect which the Manufacturer considers can be repaired; together with details of proposed repair procedures shall be submitted in writing for determination by the Corporation.

The Manufacturer shall make provision in its production Quality System and in the appropriate ITPs for sufficient hold points whenever defects or deficiencies are encountered. Production work on non-compliant components shall cease and repair work shall not commence until the following details have been confirmed by the Corporation in writing:

(a) that repair of the non-compliant components in lieu of their replacement is acceptable; and

(b) that proposed repair procedures are acceptable; and

(c) that any proposal to vary the terms of the original Product Warranty as a consequence of the in-process repair is acceptable.

(d) The repairs have been subject to design and verification scrutiny to assess their appropriateness.

12.3.3 Tank Warranty

The Supplier shall replace or repair (where possible) any non-compliant tank with a replacement tank that conforms to the acceptance criteria or shall repair or rectify all faults, in the defective tank. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all losses suffered by the Corporation as a result of non-compliant tank for a period no less than 24 months after Product delivery or 12 months after Product installation, whichever period elapses first.

12.3.4 Tank Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of tank defects shall not void or otherwise diminish the provisions of the Product Warranty. Any repair that has an influence on the structural integrity of the tank shall be supported with a design assessment and agreed repair procedure.

12.4 Compliance Plate

A permanently affixed corrosion resistant compliance plate shall be provided on the outside of the tank as described in section 6.1. This plate is best located at eye level and positioned so it can be read without stepping down into the bunded area.

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13 Appendix A: Project Specific Compliance Requirements (Normative)

13.1 General

Project specific information and requirements, not included elsewhere in this Strategic Product Specification, shall apply as specified in the following Clauses.

13.2 Revisions to Specification Text

Notwithstanding the content of sections 1 to 12 of this Specification, the following amendments to the Specification shall apply and shall prevail in the event of conflict with section 1 to 12 content.

INSERT ANY TANK OR PROJECT SPECIFIC AMENDMENTS HERE

13.3 Technical Requirements

Table 13-1 details project specific requirements for the tanks to be procured.

The Table 13-1 – Project Technical Requirements table below shall be completed by the Designer or Corporation (Principal's Representative), as applicable.

Table 13-1 – Project Technical Requirements

	Item	Requirement
	Number of tanks required:	
	Site Location:	
1.	Tank Contents - Liquid	
2.	Maximum Tank Surface Temperature	Indoor 45C / Exposed 60C
3.	Corrosion Barrier Type	SPL / TPL
4.	Exposed to Solar Radiation	Yes / No
5.	Required Design Operating Life	Min 25 years / Max 50years
6.	Imposed nozzle loads (if any):	
7.	Top Head Type and Loading	Fixed / Removable/ kPa (min 2.5kPa)
8.	Bottom Head Type	Flat / Conical / Rounded / Other (specify)
9.	Internal Fall to Scour on Flow Bottom Tanks	Not Required or Specify Slope
10.	Support Method for Non-Flat Bottom Tanks	Skirt / Legs
11.	Vent with Screen required	Yes/No
12.	Filling Overpressure	
13.	Discharge Overpressure	
14.	Overflow	Yes/No
15.	Seal trap on overflow	Yes/No
16.	Flange Standard	AS 4087 / Other (specify)
17.	Third Party Design Verification	Yes / No

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	Item	Requirement
18.	Manufacturers Information Plate Required (mandatory)	Yes
19.	Scour Nozzle Size	DN 50mm
20.	Drinking Water Compliance Required	Yes / No
21.	Gasket / O-Ring Material	
22.	Nominal inlet nozzle size:	
23.	Nominal outlet nozzle size:	
24.	Top Manway	Yes / Not Required
25.	Shell Manway	Yes / Not Required
26.	Tank Colour	.
27.	Hydrostatic Water Fill Test (Factory)	Yes
28.	Hydrostatic Water Fill Test (Site)	Yes

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14 Appendix B: Technical Compliance Schedules (Normative)

14.1 Compliance Schedules

Suppliers shall demonstrate compliance with the Specification by completing Table 14-1: Technical Compliance Schedule as shown in Table 14-1 on an item-by-item basis. For acceptance, the extent of scheduled technical item compliance shall be supported by verifiable documentary evidence. Each scheduled item nominates a Specification clause number with which the extent of the compliance shall be demonstrated.

The Supplier shall denote compliance of an item by ticking the unshaded 'Yes' column appropriate to that item. Where the item does not comply with specified requirements, the Supplier shall tick the 'No' column and shall detail the reasons for non-conformance and any proposed alternatives in the 'Comments' column. The Supplier shall denote acceptance and understanding of a Specification clause by ticking the corresponding 'Noted' column wherever unshaded.

Failure to notify the Corporation of all non-compliant components, including the extent of non-compliance, may void an accepted offer to supply or may result in rectification of all non-compliant elements, at the Supplier's cost.

Table 14-1: Technical Compliance Schedule

GRP Storage Tanks					
		Noted	Compliance		Comments
			Yes	No	
1 Scope and General					
1.1	Scope				
1.2	Referenced Documents				
1.3	Definitions and Notation				
2. Materials and Components					
2.1	Thermosetting Resin System				
2.1	Glass fibre Reinforcements				
2.1	Surfacing Veils				
2.1	Alternative Reinforcements				
2.1	Catalysts/Peroxides/ Initiators				
2.1	Accelerators				
2.1	Promoters				
2.1	Additives/Solvents				
2.1	Flanges				
2.1	Fasteners				
2.1	Gaskets				
2.1	SPL (Corrosion Barrier) / TPL				
3. Design and Manufacture					
3.1	General Design Requirements				
3.2	Design Acceptance				
3.3	Heads				
3.3.1	General				
3.3.2	Top Heads				
3.3.3	Bottom Heads				
3.4	Joints / Circumferential Seams				
3.5	Vents				
3.6	Overflow				
3.7	Flanged Connections / Nozzles				
3.7.1	Flange Material				
3.7.2	Flange Hub				
3.7.3	Flange Installation				
3.8	Scours				
3.9	False Floor				
3.10	Stiffeners				
3.11	Hold Down Lugs				
3.12	Manufacturer's Information Plate				
3.13	Design for Drinking Water Use				
3.14	Gaskets / O-Rings				
3.15	Nozzles, Manholes and Inspection Openings				

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GRP Storage Tanks					
		Noted	Compliance		Comments
			Yes	No	
3.16	Lifting Lugs / Trunnions /Tailing Lugs				
3.17	Internals				
4. Protective Coatings					
4.1	Tank Colour				
4.2	Corrosion Barriers				
4.3	Post Cure				
5. Inspection and Testing					
5.1	General				
5.2	Notification of Inspection and Testing				
5.3	Access to the Place of Manufacture				
5.4	Place of Manufacture Other Than WA				
5.5	Performance Test Requirements				
5.5.1	Production Tests				
5.6	Qualifications				
5.7	Test Results, Inspection and Certificates				
5.7.1	Hydrostatic Testing in the Manufacturer's Works				
5.7.2	Visual Defect Acceptance Test				
5.7.3	Tolerances				
6. Marking and Packaging					
6.1	Marking				
6.2	Packaging				
6.2.1	General				
6.2.2	Identification Tag				
6.2.3	Marking of Packaging				
7. Transportation, Handling and Storage					
7.1	Transportation				
7.2	Handling				
7.3	Preservation of Tank in Storage				
8. Installation					
8.1	General				
8.2	Support Base				
8.3	Temporary Tying Down of the Tank in Position				
8.4	Bolting Down Hold Down Lugs				
8.5	Bolting				
8.6	Hydrostatic Test After Site Installation				
9. Manuals					
9.1	Format and Language				
9.2	Content				
9.3	Documentation				
9.3.1	Quotation Submittals				
9.3.2	Pre-fabrication Submittals				
9.3.3	Final Submissions				
10. Manufacturer's Drawings					
10.1	General				
10.2	Drawing Practice				
10.3	Approval of Manufacturer's Drawings				
11. Spare Parts and Special Tools					
11.1	General				
12. Quality Assurance					
12.1	Certification				
12.1.1	Certification of Product				
12.1.2	Quality System				
12.1.3	Product Re-verification Product Re-verification				
12.2	Compliance and Acceptance				
12.2.1	Means of Demonstrating Compliance				
12.2.2	Acceptance Criteria				
12.3	Non-Compliant Tank				
12.3.1	General				
12.3.2	Manufacturing Repairs (In-process)				

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GRP Storage Tanks					
		Noted	**Compliance**		**Comments**
			Yes	**No**	
12.3.3	Tank Warranty				
12.3.4	Tank Repair				
12.4	Compliance Plate				
13 Appendix A: Project Specific Compliance Requirements (Normative)					
	Revisions to Specification Text				
	Technical Requirements (Table 13-1)				

Name of Supplier:

Signature: Date:

When requested by the Corporation, the Supplier shall provide the information required by Technical Compliance Schedule as shown in Table 14-1**.**

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END OF DOCUMENT

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