

THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

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**Above ground plastic tanks:
A guide to their specification, installation, commissioning,
inspection, maintenance, repair and disposal**

Publication 225

Edition 1

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Engineering Equipment and Materials Users Association

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Preface

Plastic tanks used in industrial heavy engineering applications have been typically regarded as “fit and forget” items, with lifetime based purely on manufacturers’ recommendations for nominal operating conditions. This often does not take into account the specific conditions of tank usage, leading both to tank failure in service, and the unnecessary scrapping of serviceable tanks.

EEMUA Publication 159 – “Users’ Guide to the Inspection, Maintenance, and Repair of Above Ground Vertical Cylindrical Steel Storage Tanks” has become the de facto standard for stakeholders in such equipment, worldwide, but there was no comparable guidance for users of plastic tanks. EEMUA formed a work group to produce EEMUA Publication 225, addressing the management of plastic tanks, from cradle to grave, including specification, inspection and maintenance, giving practical, pragmatic guidance for owners and operators of plastic tanks which will help reduce the risk of failure in service and enable the extension of service life where appropriate. This will also improve the image of plastic tanks, too often thought of as the “low cost, low quality” option, when the true issue has been the quality of the in-service care, rather than the quality of the equipment. The work group comprised experts from the user community, manufacturers, and wider industry, brought together and supported by EEMUA.

Contents

1 Scope.....	1
1.1 What is included?	1
1.2 Standards for thermoplastic tanks	1
1.3 Standards for Glass Reinforced Plastic (GRP) tanks.....	3
1.4 What is not included?.....	5
2 Materials	7
2.1 Group 1, Thermoplastics.....	7
2.2 Group 2, Glass Reinforced Plastic (GRP).....	7
3 Design issues	9
3.1 Information to be provided to the manufacturer.....	9
3.2 Tank procurement: selecting a manufacturer.....	10
3.3 Requirements for discussion/information to be exchanged between the end user and manufacturer	10
3.4 Information to be provided to the end user by the manufacturer.....	17
3.4.1 Information to be provided for thermoplastic tanks.....	18
3.4.2 Information to be provided for GRP tanks.....	20
3.5 Tanks with secondary containment.....	23
3.5.1 Bunded tanks	23
3.5.2 Close bunded tanks.....	23
3.5.3 Tanks with low-level nozzles.....	24
3.5.4 Tanks with “over the top” discharge systems	24
3.5.5 Integrally bunded tank.....	24
3.5.6 Thermal insulation.....	25
3.6 Vents	25
4 Nameplates, data book, and management of change	27
4.1 Tank nameplates.....	27
4.2 Tank data book.....	27
4.3 Management of change	28
5 Installation, commissioning, and operation within the design window	29
5.1 Pre-delivery/Factory acceptance testing (FAT).....	29
5.2 Transport and delivery.....	30

5.3 Offloading and installation.....	31
5.3.1 Vertical tanks.....	31
5.3.2 Horizontal tanks.....	34
5.4 Commissioning.....	36
5.5 Operation.....	37
5.6 Modification.....	37
5.7 Reuse, re-siting.....	38
6 Degradation mechanisms and failure modes	39
6.1 Degradation and failure modes of thermoplastics and thermoplastic-lined GRP	39
6.1.1 General.....	39
6.1.2 Chemical degradation	39
6.1.3 Thermal degradation.....	41
6.1.4 Weathering.....	41
6.1.5 Mechanical degradation.....	42
6.1.6 Failure modes	43
6.2 Degradation and failure modes of glass fibre reinforced plastic (GRP) tanks	44
6.2.1 General.....	44
6.2.2 Chemical degradation	45
6.2.3 Thermal degradation.....	48
6.2.4 Weathering.....	48
6.2.5 Mechanical degradation.....	49
6.2.6 Failure modes	49
7 Inspection methods and NDT techniques	53
7.1 The purpose of inspections	53
7.2 Safety and preliminary considerations for inspections.....	53
7.3 Type and frequency of inspection	53
7.4 What to inspect	54
7.4.1 Tank bases and supports.....	54
7.4.2 Tank shell/body.....	54
7.4.3 Tank bottom	55
7.4.4 Tank roofs.....	55
7.4.5 Paintwork.....	55
7.4.6 In-tank measurement and sampling devices	55
7.4.7 Connections and nozzles.....	55
7.4.8 Stairway, ladder, handrail system, walkways or platforms.....	56
7.4.9 Associated equipment/items	56
7.5 Inspection techniques	56
7.5.1 Visual inspection	56
7.5.2 Remote visual inspection.....	57

7.5.3 Techniques for shell thickness measurement	58
7.5.4 Techniques to assess structural flaws.....	58
7.6 Reportong on inspections.....	60
8 Deciding end-of-life, repairs, modification and recommissioning	61
8.1 General considerations.....	61
8.2 Deciding end-of-life	61
8.3 Assessing whether to repair a tank	62
8.4 Modifying and repairing thermoplastic tanks.....	63
8.4.1 Types of damage.....	63
8.4.2 Planning for thermoplastic repairs	63
8.5 Modifying and repairing GRP and dual laminate tanks.....	64
8.5.1 Types of damage.....	64
8.5.2 Planning for GRP or dual laminate repairs.....	64
8.5.3 Steps in the repair process for GRP tanks.....	65
8.6 Recommissioning and returning tanks to service following repair	66
9 Decommissioning, mothballing, reuse and disposal	67
9.1 Introduction.....	67
9.2 Decommissioning.....	67
9.3 Re-siting and reuse	68
9.4 Disposal.....	68
Appendix 1: Example nameplates.....	69
Appendix 2: Example management of change form and checklist	71
Appendix 3: Recommended bolt tightening torques for flanges	79
Appendix 4: Example commissioning check list.....	81
Appendix 5: Risk-based inspection frequencies for tanks containing potentially aggressive contents	85
Appendix 6: Example Inspection Record Form.....	89
Appendix 7: Detectable defects, applicable inspection techniques, and possible actions	103
Bibliography.....	107

List of Figures

Figure 1:	Installed polypropylene and high-density polyethylene tanks	2
Figure 2:	Installed GRP tanks	4
Figure 3:	GRP tank showing outlets	11
Figure 4:	A tank being filled by discharge from a road tanker.....	13
Figure 5:	Bunded tanks.....	14
Figure 6:	Tank manway	15
Figure 7:	Tank showing access ladders, platforms and circular hand railing	16
Figure 8:	Illustration of spiral wound thermoplastic tank.....	18
Figure 9:	Illustration of sheet constructed thermoplastic tank	18
Figure 10:	GRP and lined-GRP flange sections	20
Figure 11:	GRP pipe section	21
Figure 12:	Lined GRP pipe section.....	21
Figure 13:	A thermoplastic tank insulated to 150mm above base level	24
Figure 14:	Example of damage to tank as a result of incorrect transport	30
Figure 15:	Tanks being offloaded.....	31
Figure 16:	Typical vertical tank transport arrangement	33
Figure 17:	Vertical tank offloading and installation	33
Figure 18:	Vertical tank installation arrangement.....	34
Figure 19:	Typical horizontal tank transport arrangement.....	35
Figure 20:	Horizontal tank offloading and installation	35
Figure 21:	Tank weathering.....	42
Figure 22:	Mechanical damage to a thermoplastic tank caused by misaligned agitator	42
Figure 23:	Cracking of internal welds on a thermoplastic tank	43
Figure 24:	Cracking on a thermoplastic tank due to chemical degradation.....	44
Figure 25:	Failure of an incorrectly specified GRP flange fitting due to attack by sodium hypochlorite.....	46
Figure 26:	Blistering on a GRP tank.....	47
Figure 27:	Weathering on a GRP tank.....	48
Figure 28:	Corrosion on a GRP tank caused by chemical attack	49
Figure 29:	Cracks on a GRP tank flange	50
Figure 30:	A pin-hole leak detected visually in the base of a tank using residual water in the tank base.....	57
Figure 31:	Flowchart to aid tank repair assessment	62

List of Tables

Table 1:	EN13121 Group 2(a) resin types and characteristics.....	7
Table 2:	EN13121 Group 2(b) thermoplastic lining (TPL) polymer types and characteristics.....	8
Table 3:	Design information to be provided to manufacturer	9

Acknowledgements

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1 Scope

1.1 What is included

This Publication is aimed at owners and operators of above-ground plastic tanks, which are typically cylindrical in shape. The document's content is aimed mainly at tanks being operated at atmospheric pressure or at pressures above the liquid head up to 0.5 barg. It is not therefore intended for tanks which would be classed as pressure vessels under the Pressure Equipment Directive (PED), although some of its content may still be relevant and useful to users operating plastic pressure vessels in what are usually quite specific applications.

The publication covers a range of topics, from how to specify the design, through inspection, maintenance, and repair, to decisions at end-of-life and safe disposal.

1.2 Standards for thermoplastic tanks

Some standards commonly used to design thermoplastic tanks are described below:

EN 12573: *Welded static non-pressurised thermoplastic tanks*.

This European standard comprises the following parts:

Part 1 – General principles

Part 2 – Calculations for vertical cylindrical tanks

Part 3 – Design and calculations for single skin rectangular tanks

Part 4 – Design and calculations for flanged joints

This European standard covers tanks with a capacity of 0.45m³ and above. Because unreinforced thermoplastics are limited at increased temperatures, much of the design data in this standard is derived from EN 1778, which gives characteristic values for welded thermoplastic constructions, determination of allowable stresses, and moduli for the design of thermoplastic equipment.



Figure 1: Installed polypropylene and high-density polyethylene tanks

Part 2 establishes rules for the design and calculations of welded static, non-pressurised, cylindrical, flat-bottomed tanks. The calculations take into account short-term and long-term active pressures as well as the hydrostatic loading. The following values are long-term pressures and represent the limiting values:

- Positive pressure – 5mbar (0.0005N/mm²)
- Vacuum – 3mbar (0.0003N/mm²)

This standard applies to tanks fabricated in polyethylene (PE), polypropylene (PP), unplasticised polyvinyl chloride (PVCU), and polyvinylidene-fluoride (PVDF).

The standard does not take into account wind or snow loadings, nor does it combine axial loadings in the vertical shell. If these operational parameters are required, additional calculations are necessary, which are available in the German Technical code, DVS 2205-2.

DVS2205- DVS Technical Codes on Plastics Joining Technologies – “Technical section DVS 2205 – 2 “Calculation of tanks and apparatus made of thermoplastics. Vertical round, non-pressure.”

Here, non-pressure means a pressure rating below the threshold where the European Pressure Equipment Directive (PED) applies, which is 0.5bar. This standard applies to tanks fabricated in PE, PP, PVCU, chlorinated polyvinyl chloride (CPVC), PVDF, and ethylene chlorotrifluoroethylene (ECTFE).

This comprises the following parts:

DVS 2205-1: Characteristic values for strength of materials, safety concept, reduction coefficients, welding factors, and creep moduli for materials.

DVS 2205-2: Calculations for tanks and apparatus made from thermoplastics. Vertical, round, non-pressurised tanks with flat bottoms. It also includes parallel supported diagonal (sloping) bottoms and ring-supported conical bottoms.

DVS 2205-3: Design of thermoplastic tanks and apparatus – Welded joints

DVS 2205-4: Calculation of thermoplastic tanks and apparatus – Flanged joints

DVS 2205-5: Calculation of thermoplastic tanks and apparatus – Rectangular tanks

The standard is more extensive in terms of detailed tank design than EN 12573. It is generally recognised that unreinforced thermoplastic and fluoroplastic tanks are used for non-pressure duties and rarely come within the scope of the PED. The standard gives no specific parameters with regard to scope for operating conditions. Within the design process the operating temperatures, pressures, chemical resistances (reduction factors), safety concepts, creep moduli and capacities, and other factors, control the overall operating and design parameters of the finished product.

1.3 Standards for Glass Reinforced Plastic (GRP) tanks

Note: For the purposes of this guide, and in the context of plastic tanks, the term glass reinforced plastic (GRP) is assumed to mean the same as fibre reinforced plastic (FRP). While fibre reinforced plastic has a broader application as a term, in cases where the fibre used is glass, such as plastic tanks, the terms can be used interchangeably.

Some standards commonly used to design GRP tanks are described below:

British Standard 4994: *Design and construction of vessels and tanks in reinforced plastics*

This standard is no longer current, but many tanks in operation have been manufactured to it. The standard is a specification for the design, materials, construction, inspection, testing and erection of tanks in reinforced plastics. It covers tanks with a polyester, vinylester, epoxy or furane resin system, reinforced with glass fibres, which have been manufactured by the wet layup process. Constructions both with and without a lining of thermoplastic or fluoroplastics are included.

EN 13121 “GRP tanks and vessels for use above ground”

This standard covers tanks for above ground use that are subject to temperatures between -40°C and 120°C, and to pressures between 10bar and full vacuum. To comply with the PED, vessels designed to operate at pressures greater than 0.5bar must be subject to a third party inspection.



Figure 2: Installed GRP tanks

EN 13121: *Parts 1, 2, 3 and 4: above ground GRP tanks*

This European standard comprises the following parts:

Part 1 – Raw materials – Specification conditions and acceptance conditions

Part 2 – Composite materials – chemical resistance

Part 3 – Design, workmanship, inspection and testing

Part 4 - Delivery, installation, and maintenance

It specifies requirements for tank specification, the acceptance conditions for raw materials, the chemical resistance of composite materials, and the requirements for the design, fabrication, inspection, testing, and verification for pressure and non-pressure GRP tanks, with or without linings of thermoplastic or fluoroplastic for the storage and processing of fluids for above ground use. Glass lining may also be used for tanks containing aggressive liquids.

GRP composite materials include glass fibre reinforced unsaturated polyester resins, vinyl ester resins, vinyl ester urethane resins, epoxy resins, furane resins and phenolic resins. Glass fibre reinforcements include chopped strand mats, woven fabrics and woven roving fabrics, and rovings for winding and chopping applications.

ASME RTP-1: *Reinforced Thermoset Plastic Corrosion-Resistant Equipment*, American Society of Mechanical Engineers. This standard applies up to pressures of 1 barg.

ASME BPVC: *Section X - Fiber-Reinforced Plastic Pressure Vessels*, American Society of Mechanical Engineers. This standard applies to pressures over 1 barg; RTP-1, above, covers pressures lower than this.

DIBt 40-B1 *Calculation recommendations for vertical storage containers made of glass fibre reinforced plastics*, DeutschesInstitutfürBautechnik., DeutschesInstitutfürBautechnik. This standard has been largely superseded by EN 13121.

DIBt 40-B2 *Calculation recommendations for glass fibre reinforced plastics vessels mounted on saddle supports*, DeutschesInstitutfürBautechnik. This standard has been largely superseded by EN 13121.

1.4 What is not included

This is a general guide, and not a design code. Relevant local and international design codes should be followed, but the reader is assumed to be an owner and operator rather than a manufacturer. For this reason, fabrication and manufacturing techniques are not covered.

Only tanks where plastic provides the primary structure are considered; lined steel tanks are not included.

Also excluded are tanks for transport containment, intermediate bulk containers (IBCs) and similar containers, spherical tanks, buried tanks, and irregular shaped tanks.

The effect of radioactivity is a specialist area which is not addressed in this document. Also omitted are the requirements for grounding on ancillaries, and extraneous metalwork, as well as issues to do with any connected pipework.

Thermoplastic tanks manufactured by rotational moulding techniques to EN 13341 intended for domestic use and the storing of heating oils, kerosene and diesel fuels, and tanks manufactured to EN 13575 are also excluded.

2 Materials

2.1 Group 1, Thermoplastics

This group comprises tanks constructed predominantly of high-density polyethylene (HDPE) or polypropylene (PP). The grades normally selected for the manufacture of tanks include:

HDPE – PE 100 – which gives excellent chemical resistance, impact and mechanical properties.

PP (PPC) – Copolymer polypropylene which gives excellent chemical resistance, impact and mechanical properties. It has better temperature resistance than HDPE.

PP (PPH) - Homopolymer polypropylene is only selected where extra heat resistance and stiffness is required. It has a lower impact strength than copolymer polypropylene and becomes fragile at temperatures below 0°C.

2.2 Group 2, Glass Reinforced Plastic (GRP)

This group covers laminated materials with some form of glass reinforcement and a thermoset resin matrix. The chemical and mechanical properties of the laminates are very dependent on the type of glass fibre and resin selected.

Laminates may include an inner corrosion barrier of a resin rich layer reinforced with Type C glass fibre tissue or a synthetic reinforcement such as polyester, or a polyacrylonitrile (PAN) or carbon fibre veil with an external structural (load-bearing) GRP laminate. The table below gives the most commonly used resins.

Group 2(a)

Resin Type (Group from EN13121)	Characteristics
Vinylester (7, 8)	Excellent chemical resistance, good impact resistance and higher strain resistance. High heat distortion temperature (HDT).
NGP (neopentylglycol) isophthalic polyester (4)	Very good chemical resistance. High HDT and good mechanical properties.
Isophthalic polyester (2)	Good chemical resistance and mechanical properties.
Orthophthalic polyester (1)	A general purpose material for undemanding applications; not normally considered for chemical tank manufacture.

Table 1: EN13121 Group 2(a) resin types and characteristics

Group 2(b)

This subgroup comprises dual laminate composites, where the corrosion barrier, referred to in EN 13121 as the chemically resistant layer (CRL), is a thermoplastic or fluoroplastic liner, 2.3mm to 6mm thick, with an external structural (load-bearing) GRP laminate. While the external load-bearing structure is not in contact with the contents, it is good practice to select a high-quality resin with good mechanical properties and some degree of chemical resistance to the contents. Further details on these materials are given in EN13121-1, Table 6.

Polymer – inner tank thermoplastic lining (TPL)	Characteristics
Polypropylene	Good resistance to most chemicals, and resistant to impact.
PVCu (unplasticised polyvinyl chloride)	Good resistance to most chemicals, particularly in strongly oxidising environments; low impact strength and low-temperature resistance.
CPVC (chlorinated polyvinyl chloride)	Similar to PVCu but can operate at higher temperatures.
PVDF (Polyvinylidene-fluoride)	Excellent resistance to most chemicals and can operate at higher temperatures.
ECTFE (ethylenechlorotrifluorethylene)	Generally increased chemical resistance compared with PVDF and can operate at higher temperatures.
Fluoropolymers such as FEP (fluorinated ethylene propylene), PFA (perfluoroalkoxy alkane) and MFA (perfluoro methyl alkoxy).	Used in highly specialised applications that require strong chemical resistance and can operate at high temperatures.

Table 2: EN13121 Group 2(b) thermoplastic lining (TPL) polymer types and characteristics

3 Design issues

3.1 Information to be provided to the manufacturer

The information the end user will need to provide to the manufacturer to establish the necessary design and build parameters required is shown below. Note: this is not exhaustive and end users must ensure that all of their specific requirements are communicated to the manufacturer.

Information	Details Required
Intended duty (blended products or single product)	• Concentrations • Volumes • Possible blend variances • Trace contaminations • Relevant MSDSs
Product characteristics	• Relative density • Product pH • Freezing point • Flammability
Contents characteristics	• Fuming • Exothermic • Endothermic • Oxidising, etc.
Temperatures	• Design temperature • Incoming liquid temperature • Maximum operating temperature • Minimum operating temperature
Pressure	• Design pressure • Maximum operating pressure • Minimum operating pressure
Volume and fill requirements	• Working volume • Anticipated fill/empty cycles (for example, 25,000l filled and emptied twice weekly) • Intended method of delivery/filling (for example, 2bar air pad/fixed transfer pump/gravity) • Anticipated fill rate • Anticipated draw rate

Table 3: Design information to be provided to manufacturer

3.2 Tank procurement: selecting a manufacturer

Selecting a suitable manufacturer is a key step in the design process. While an end user may have a clear idea and specification for the tank(s) required, the value of such precision can only be realised if the tank's manufacturer can deliver the tank, manufactured to high quality and according to the specification. Plastic tanks can be critical items of plant, and taking time to select a suitable manufacturer should be a priority.

It is essential that the user has a process in place to establish trust with potential manufacturers, for example, by inviting them to make site visits. There should also be a strong emphasis on manufacturer verification to mitigate the risks associated with procurement. The best overall approach is for users to engage fully with an experienced manufacturer who can demonstrate long-term applications. More detailed information can be found in EEMUA Publication 224, "A guide to risk-based procurement".

Good suppliers typically use questionnaires to assess users' requirements. Such questionnaires can be used as a check for any elements of design information that might have been overlooked and should be incorporated in the scope of use.

3.3 Requirements for discussion/information to be exchanged between the end user and manufacturer

To ensure the best possible design, durability and safe operation of the tank, it is important that the end user provides the manufacturer with the necessary detailed information on which to base the design, even where the tank procurement and installation is being handled by a third party. Providing information that could have a bearing on safety is particularly important. Points to bear in mind here include:

- Nozzles, venting requirements, and other fittings, to ensure correct initial design
- Access and manway requirements to ensure safe access and egress
- Information on fill, draw and dilution operations, especially where the contents are oxidising or highly corrosive chemicals

Questions and requirements that should be discussed, or the subject of information exchanged, between the end user and manufacturer, may include, but are not limited to, those shown below:

What is the design standard to which the tank will be designed and built?

- Are there any specific requirements that need to be considered to satisfy local standards or local laws?

What are the options for design life?

- For example, 10 years, 15 years, 20+ years
- What is the intended location of the tank?
- Will it be located indoors or outdoors?
- Geographical considerations: climate extremes, for example, the effects of wind on design calculations. Will the tank be exposed or sheltered; and at ground level or elevated?
- Is there a requirement to incorporate adequate design parameters to cater for earthquake loadings?



Figure 3: GRP tank showing outlets

What nozzle sizes & nozzle orientations are required?

- Inlets
 - Splash fill or dip pipe?
 - If dip pipe, ensure siphon breaker hole is provided in pipe
- Outlets/level switches/probes
- Temperature gauges/probes
- Overflow (including maximum height from liquid level)/venting/recirculation
- Mixing, process and transfer lines

- Wash water lines, water dilution lines, etc.
- Flange standards and types

What venting arrangements are required?

- The size of vent must be suitable for the intended loading method
- Will the vent need to be open? Mist eliminator type?
- Where should the vent terminate, top of tank/fume scrubber/into bund/other?

Are there any additional requirements to control fumes?

- Fume scrubber, fume eliminator for vent line?
- Vapour recovery line from fume scrubber to road tanker
- Seal/lute pots for overflow; recommended medium for seal/lute pot

Is an inert gas & pressure relief system required?

- For example, a nitrogen blanket. JOIFF (the Joint Oil and Industry Forum) provides guidance on secure nitrogen and CO₂ blanketing.

What will the tank contents be?

- Will the tank contain an oxidising/highly corrosive chemical, for example sulphuric acid or sodium hypochlorite?
- Will the tank contain a liquid liable to produce corrosive vapours/fumes which could be present in the tank atmosphere above the contents? Could these present any degradation risk?
- Will the tank be used for storage only, or will it be used to perform other operations relating to the contents?
- Will the contents be diluted as part of the tank's operational cycle; if so, what are the details?
- Will the tank's contents be alternated?
- Might the tank's contents be liable to deposit solids, for example, as a result of precipitation or other changes. These have the potential to accumulate in the form of a sludge, or other solid deposit, and the design of the tank should take account of this possibility.

What are the fill/empty requirements?

- What is the method that will be used to fill the tank; for example, pumped or blown discharge from a tanker
- Overfill prevention. API 2350, Overfill Protection for Storage Tanks in Petroleum Facilities, provides information on overfill protection.
- What method will be used to draw the tank down?
- How frequently will the tank be filled/emptied, and could this frequency change significantly over the lifetime of the tank?
- Considerations for tank emptying/draining; for example, residual concentrated acids and prevention of exothermic reaction occurring with wash water



Figure 4: A tank being filled by discharge from a road tanker

What is the desired maximum emptying rate? (assuming all outlet and drainage nozzles are open free to drain)

- This is to check vent size to ensure there is no danger of producing excessive vacuum in the tank

What is the desired tank base configuration?

- For example, flat base/sloping or conical base
- Skirt to aid drainage
- Raised base on framework/platform

Is tank heating required?

- What types of heating systems can the tank manufacturer offer?
- What would be suitable and safe for the tank type?
- Consider operational heating control parameters required and overheat protection
- Is insulation/cladding required? (Note: this may give rise to limitations for inspection)

Is any mixing/agitation equipment required? What agitation method is to be used?

- The type of mixing/agitating used will depend on the types of products that require blending/diluting
- Agitator/shear mixer top mounted on suitable support bridge/off-centre to avoid baffles

- Recirculation via pump
- Recirculation via pump and in-line mixer
- Recirculation via pump and eductor/jet nozzle

Is a bunded tank required?

- Where possible consider safe accessibility to areas and welds that will need to be inspected
- Ensure the bund is compatible with the intended product
- Ensure the bund is of sufficient strength, dimensions and capacity according to local legislation/regulation
- Note: The presence of a drain in a bund is considered unnecessary as its operation could allow the unauthorised release of product. However, if a drain valve is to be fitted, the end user should be informed that the drain valve should be permanently closed, be suitably controlled and protected from damage
- Note: Bunds should be kept dry and free from the ingress of rainwater and other liquids, preferably with alarms. Is a weather shroud required over the bund to prevent ingress of rainwater? There is a high risk of floatation and damage to the tank if water or liquid from overflow is permitted to enter the bund. In the event of overfilling, where liquid enters the bund, this must be immediately removed to prevent corrosion, floatation, or health and safety or environmental risk
- Note: Where close or integral bunds are fitted, a suitable bund alarm must be fitted to give warning of any leakage or ingress of liquid into the bund area



Figure 5: Bunded tanks

What type of foundation/base/plinth will the tank be on?

- Provide information required to allow the relevant party to cost and plan any required civil works
- In corrosive environments, consider the need for a protective coating to be applied to tank plinths constructed in concrete or steel
- The plinth or platform must give full support to the base, as specified by the supplier
- Any steel work or concrete must be accessible for inspection activities

Is an 'in-tank cleaning system' required?

- Spray ball(s) and other in-place cleaning systems may be required to provide suitable washing of tank internals to facilitate internal inspection and maintenance requirements. Note: particular attention should be paid to the temperature, nature and pressure of the cleaning fluid and process



Figure 6: Tank manway

What size manway is required?

- Manways will need to be suitably sized to provide safe access/egress for tank entry for internal inspection and maintenance work. If the manway cover plate is heavy, a davit or lifting lugs may be required to reduce manual handling risk
Advice on sizing manways can be the UK Health and Safety Executive's (HSE's) guidance on Confined Space Entry, L101



Figure 7: Tank showing access ladders, platforms and circular hand railing

What access systems are required?

Options are covered in EEMUA Publication 105 and may include:

- Access ladder supplied with safety hoops/stairways
- Interspacing and self-closing safety gate at ladder top
- Lockable safety gate at the bottom of the ladder cage
- Circular hand railing
- Posts and suitable kick plates, non-slip roof surface within the handrail area
- All the above must be designed in accordance with relevant standards

Any additional local considerations

- Static electricity/conductivity/earthing
- Vibration during fill/emptying/agitation, or from external plant
- Foaming (dip piping, wall-running)
- Seismic considerations

What manufacturing documentation is required?

- Tank design calculations, including design life and service conditions
- Manufacturing quality plan
- Material certificates
- As-built drawings
- Test and inspection certificates
- Weld procedures
- Certificate of conformity
- Recommended commissioning information and periodic inspection/testing information
- Correct methods for transporting/lifting and slinging/siting and installation of the tank

3.4 Information to be provided to the end user by the manufacturer

The manufacturer must supply detailed drawings for end-user approval prior to manufacture. On completion, as-built drawings should be provided, including detailed drawings of the tank and any associated ancillary equipment. Design calculations can be provided on tank delivery, but users may wish to request these prior to the tank being manufactured for verification purposes.

3.4.1 Information to be provided for thermoplastic tanks

The structural design of thermoplastic tanks is illustrated in the diagrams below:



Figure 8: Illustration of spiral wound thermoplastic tank



Figure 9: Illustration of sheet constructed thermoplastic tank

For spirally wound or sheet-built thermoplastic tanks, the following information should be provided:

Drawings

- Manufacturer
- Drawing scale
- Manufacturer's address and contact details
- Drawn by/date drawn
- Drawing title, drawing number and revision
- Any notes
- GA and ancillary drawings to include:
 - Stub/full flat face nozzles
 - Type of hold-down lugs
 - Ladder and safety gate
 - Pipe support bracket and clips
 - Seal/lute pot
 - Handrail
 - Ladder support and brackets
 - Lifting lugs
 - Side manway
 - Handrail bracket
 - Ladder security rung and cover board
 - Instrumentation

Design data

- Design code
- Design calculations
- Tank contents
- Specific gravity
- Working temperature
- Design temperature
- Working pressure
- Design pressure
- Chemical reduction factor
- Method of support
- Maximum capacity
- Working capacity
- Approximate weight empty
- Approximate weight full
- Flange standard
- Hold-down lugs
- Lifting lugs/trunnions

Material data

- Material of construction
- Flange gaskets (type of material)
- Backing rings (type and any corrosion protection)
- Type of bolting and any corrosion protection
- Types of valves and other bolt on items including types of seals
- Seals for any unions, instruments and ancillary equipment
- External ultraviolet (sunlight) resistance – material specification and tank colour

Tests and/or inspections

- Scope
- Carried out by?
- Location
 - Works test
 - Site test
- Results

Nozzles, fittings, and instruments

- Nozzle size (mm/NB)
- Nozzle description
- Nozzle identification
- Nozzle orientation
- Instrumentation
- Nozzle flange standard

Fabrication specification

- Base Thickness
- Roof Thickness
- Wall Thickness

3.4.2 Information to be provided for GRP Tanks

The structural design of GRP tanks is illustrated in the cross sections shown in the photographs below:



Figure 10: GRP and lined-GRP flange sections



Figure 11: GRP pipe section



Figure 12: Lined GRP pipe section

For GRP tanks constructed of a glass fibre structural shell, with a thermoplastic lining (TPL) as a corrosion barrier, or a glass fibre structural shell with a resin rich internal corrosion barrier, the following information should be provided:

Drawings

- Manufacturer
- Drawing scale
- Manufacturers address and contact details
- Drawn by/date drawn
- Drawing title, drawing number and revision
- Any notes
- GA and ancillary drawings to include:
 - Stub/flat face nozzles
 - Type of hold-down lugs
 - Manway davit (if required)
 - Ladder and safety gate
 - Pipe support bracket and clips

- Seal/lute pot
- Handrail
- Ladder support and brackets
- Lifting lugs
- Side manway
- Handrail bracket
- Ladder security rung and cover board
- Instrumentation

Design data

- Design code
- Design calculations
- Tank contents
- Specific gravity
- Working temperature
- Design temperature
- Working pressure
- Design pressure
- Method of support
- Maximum capacity
- Working capacity
- Approximate weight empty
- Approximate weight full
- Overall design factor
- Flange standard
- Hold-down lugs
- Lifting lugs/trunnions

Material data

- Materials of construction
- Flange gaskets (type of material)
- Backing rings (type and any corrosion protection)
- Type of bolting and any corrosion protection
- Types of valves and other bolt on items including types of seals
- Seals for any unions, instruments and ancillary equipment
- Metal fittings (type of metal and any corrosion protection)
- Thermoplastic lining – TPL (type of lining/corrosion barrier)
- Type of reinforcement
- Tank colour
- Information on any coating(s) applied to the tank

Tests and/or inspections

- Scope
- Carried out by?
- Location
 - Works test
 - Site test
- Results

Nozzles, fittings, and instruments

- Nozzle size (mm)
- Nozzle description
- Nozzle identification
- Instrumentation
- Nozzle flange standard
 - raised face (requires special consideration)
 - stub with backing rings
 - full face
- Total compensation laminate on shell (kg/m²)
- Diameter of compensation laminate (mm)

3.5 Tanks with secondary containment

Where no concrete bund is present, thermoplastic and GRP composite tanks are often supplied with a plastic bund. Such secondary containment is seen in a variety of types and tanks supplied with it are often referred to as “double skinned” or “double walled” tanks. Bund size varies with tank capacity, but plastic bunds are limited to a maximum diameter of about 4-5m. Beyond this size, they become difficult to transport.

The most vulnerable parts of a plastic tank are the flanged nozzles and outlet valves below liquid level. It is considered good practice to incorporate the initial low-level shut off valves within the bund.

Bunds should be kept dry. Control of the ingress of rainwater into the bund area can be achieved by fitting a cover around the top of the bund. These are often referred to as “rain shrouds”. Where the bund wall is high and difficult to access for inspection, a leakage alarm should be fitted.

The most common types of integral containment are described below:

3.5.1 Bunded tanks

These tanks have separate bunds, whose diameter is considerably larger than the tank itself. The bund wall is much lower than the tank wall and the bund area can, therefore, be accessed by personnel. This type of configuration substantially increases the overall footprint but allows access to welds for inspection and the incorporation of a shut-off valve within the bund area. Depending on the capacity and design, the complete system is generally delivered to site in two pieces which increases installation time and costs.

The bund requires a rain cover and should be fitted with a low level leak detection alarm.

3.5.2 Close bunded tanks

These tanks have separate bunds, whose diameter is slightly larger than the tank itself. The bund wall is close to the tank wall and the bund therefore cannot be accessed by personnel. This type of configuration substantially reduces the overall footprint. Depending on capacity and design the complete system may be assembled at the manufacturer’s site and delivered to site in one piece which reduces installation time and costs.

3.5.3 Tanks with low-level nozzles

When a close bunded tank is fitted with nozzles at low level, it is not possible to incorporate shutoff valves within the bund area. This can be partially overcome by using a double containment pipework arrangement, where the pipe passes through the bund wall to a double-valved outlet point.

The bund area should be fitted with a low-level leak detection alarm.

3.5.4 Tanks with “over the top” discharge systems

This configuration has no nozzles below the maximum liquid level in the tank and is designed to reduce the risk of loss of liquids from low-level nozzles.

3.5.5 Integrally bunded tank

Thermoplastic integrally bunded tanks are similar to close bunded. The difference is that the bund is physically attached to the tank with a suitable gap between the tank and bund wall. Integrally bunded tanks are produced by using a process in which thermoplastic spiral profile sections, or spacers, are extruded onto the outside of the tank shell, creating a suitable gap for the bund.

A leak detection alarm is normally part of the installation.

For GRP composite tanks, an additional bund shell can be applied, using structured glass fibre fabric material to provide a gap between the tank and bund shell. This space, including the additional base, is monitored by a continuous vacuum alarm system to detect any leakage.



Figure 13: A thermoplastic tank insulated to 150mm above base level

Overflow arrangements:

Integrally bundled tanks do not have an overflow. The overflow prevention devices normally supplied with these types of tanks are based on a fail-safe design within the filling system, which may include additional capacity above the normal maximum operating level. More detailed information about overflows can be found in relevant standards, for example EN 13616.

3.5.6 Thermal insulation

Close bundled or integrally bundled tanks seldom require additional thermal insulation as the sealed air space between tank and bund wall acts as an insulation barrier unless the thermal insulation requirements are critical.

3.6 Vents

Careful consideration should be given to the size of the vent fitted. It is important that the manufacturer knows how a tank is to be filled and emptied, and any additional information that could affect vent design, such as the use of a fume scrubber.

Vents must be designed to relieve any pressure that develops as a result of the fill process; this is especially important where the tank is to be filled by means of compressed air (air pad delivery). Similarly, vents should be adequately sized to relieve any vacuum that develops as result of drawing the contents from the tank, or a sudden discharge of contents from a low-level nozzle.

For example, in the chemical industry, where delivery is often by air pad, typical dimensions, when associated with a standard connection intake of 50mm/2" and a 100mm/4" overflow, vent diameter is typically a minimum of 150mm/6".

More detailed information about venting requirements can be found in relevant standards, for example, EN-ISO 28300 and API 2000. Details on regulatory requirements for venting and ensuring that tanks do not become over-pressurised can be found in Regulation 15 of the UK Pressure Systems Safety Regulations (PSSR), 2000.

4 Nameplates, data book, and management of change

Historically, plastic tanks have often been considered as “fit and forget” items. The lack of knowledge and records that results introduce risks at all stages of the tank lifecycle, both in terms of their operation and maintenance and at the decommissioning and disposal stages. It is, therefore, essential that users put in place and maintain comprehensive records throughout all stages of a tank’s life, from initial design to final decommissioning and disposal.

Good practice in record keeping is facilitated by putting in place practical means to record and maintain information about the tank and its history, including duty, inspection, maintenance, modifications, and repairs. Users should pay particular attention to ensuring that the tank is fitted with a suitable nameplate, has its service history recorded in the data book and that any management of change information is maintained over the tank’s life.

4.1 Tank nameplates

A suitably designed nameplate is an important first stage in good practice in record keeping. Nameplates should remain legible for the duration of the tank’s service life. Relevant standards define minimum requirements for nameplate content, but users may wish to specify additional information.

Nameplates should record essential information about the design of the tank, its design parameters, and its intended duty.

Examples of well-designed tank nameplates are in Appendix 1.

4.2 Tank data book

While nameplates are specified at the design stage and provided by the manufacturer, records of tank service history can be easily neglected. All aspects of a tank’s history should be recorded in the data book.

This is a single dedicated repository of information which must remain with the tank throughout its life, including if the tank is re-sited.

Whatever the system and storage medium selected for information relating to service history, a key point is deciding what information to capture.

An example list of the essential information to be recorded in terms of tank service history is shown below:

- Manufacturer’s design information
 - Specification
 - Design calculations
 - Materials and methods of construction
 - Approvals and certifications, if applicable

- As-built drawings
- Installation handling and lifting techniques
- Inspection schedule and reports
 - Manufacturer's inspection reports
 - Delivery and commissioning inspection reports
 - Inspection schedule
 - Inspection reports
- Modifications
- Operational history
 - Excursions beyond design parameters
 - Incidents (for example, overfills, mechanical damage)
 - Change of duty (for example, change of contents – chemical, concentration, or temperature; or a change in service conditions)
 - Re-siting
 - Mothballing
 - Decommissioning
 - Disposal
- Maintenance
- Repairs

Data books may incorporate photographs taken before use, for both the internal and external shell alongside the manufacturer's inspection reports. This is to give a "baseline" reference point which can assist in assessing the condition of the tank on future inspections during the lifetime of the tank.

4.3 Management of change

An important part of maintaining a full record of a tank's service history is good practice in the management of change. While the tank data book covers all relevant information over the life of a tank, a well-designed change management system allows the assessment of specific changes and their consequences.

When designing and assessing a proposed modification, there are a number of factors to consider which will help ensure that the modification does not introduce further hazards to the plant or process, appropriate consideration has been given to each of the potential factors, and that potential effects of the change, both positive and negative, are clearly set out.

Proposed changes should be recorded on a suitable document. The record should show details of the change, the reasons for making it, and also information about parties, both internal and external, who should be informed. To ensure that all relevant factors are given proper consideration, a checklist can be used. Examples of a change record and checklist are shown in Appendix 2.