

Above ground horizontal rectangular metallic storage tanks

A guide to their specification, installation, commissioning, inspection, maintenance, repair and disposal

Publication 244

Edition 1

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Engineering Equipment and Materials Users Association

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Contents

Contents	iv
Preface	ix
Acknowledgements.....	x
Abbreviations / Acronyms used in this Guide.....	xi
1 Scope	1
1.1 What is included?	1
1.2 What is not included?	1
1.3 Reference publications for above-ground rectangular metallic tanks.....	2
1.4 Terminology.....	3
2 Tank Procurement	4
2.1 General.....	4
2.2 Selecting a tank provider.....	4
2.3 Requirements for discussion/information to be exchanged between the end user and tank provider	4
3 Electrical Requirements	12
3.1 General.....	12
3.2 Ingress protection.....	12
4 Considerations for Tank and Equipment Location	13
4.1 Environmental consideration.....	13
4.2 Area classification (Hazardous Zoning)	13
4.3 Separation distances.....	13
5 Tank support consideration.....	14
5.1 General.....	14
5.2 Access for inspection and maintenance.....	14
5.3 Design considerations.....	14
6 Delivery, installation and commissioning	15
6.1 Delivery and installation.....	15
6.2 Commissioning	15

7	Operational requirements	16
7.1	General.....	16
7.2	Operating instructions.....	16
7.3	Authorised personnel.....	16
7.4	Operational permits	15
8	Maintenance Requirements	17
8.1	The purpose of maintenance.....	17
8.2	Maintenance programme.....	17
9	Degradation mechanisms and failure modes	18
9.1	General.....	18
9.2	Failure modes.....	18
9.3	Corrosion	18
9.4	Other Weathering.....	19
9.5	Mechanical degradation.....	19
9.6	Buckling.....	19
9.7	Structural degradation.....	19
9.8	Chemical degradation.....	19
9.9	Contamination	19
9.10	Thermal degradation	20
10	Inspection Requirements.....	21
10.1	General.....	21
10.2	The purpose of inspections.....	21
10.3	Safety and preliminary considerations for inspections	21
10.4	Inspector competence.....	22
10.5	Type and frequency of inspection	22
10.5.1	Commissioning inspection	22
10.5.2	Periodic inspections	23
10.5.3	Periodic visual inspection (6 Monthly to Annual).....	24
10.5.4	Periodic in-service inspection (Five Year).....	24
10.5.5	Periodic thorough inspection (Ten Year)	24
10.5.6	Inspection after exceptional circumstances.....	24
10.5.7	Inspection reporting	25
10.5.8	Competence requirement.....	25
10.5.8.1	Commissioning inspection.....	25
10.5.8.2	Periodic visual inspection (6 Monthly to Annual).....	24
10.5.8.3	Periodic in-service inspection (Five Year).....	26
10.5.8.4	Periodic thorough inspection (Ten Year).....	26

11 Life Cycle Considerations	27
11.1 Introduction	27
11.2 Repurposing, relocating or transfer of tanks	27
11.3 Out of service or mothballed tanks	28
11.4 Repairs and modifications	28
11.5 Recommissioning following repair or modification	28
11.6 Deciding end-of-life	29
11.7 Decommissioning and disposal	29
12 Management of Change	30
Appendix A – Typical arrangements	31
Appendix B – Examples	32
Appendix C – Tank capacity and fill levels	38
Appendix D – Nameplates.....	39
D.1 Preferred format	39
D.2 Example nameplates.....	39
Appendix E – Commissioning checklist - Example	41
Appendix F – Example management of change form and assessment checklist	44
F.1 General.....	44
F.2 Management of change form	45
F.3 Assessment checklist	46
Appendix G – Example inspection record forms	50
G.1 Checklist 1 – 6 to 12 Month – Visual inspection.....	51
G.2 Checklist 2 – 60 Month (5-Year) – In-service inspection.....	52
G.3 Checklist 3 – 120 Month (10-Year) – Thorough inspection	57
Appendix H – Ultrasonic thickness measurements.....	59
Bibliography.....	60
EEMUA can offer you a lot more than publications.....	62
EEMUA Publication: feedback form.....	63
EEMUA Online Learning Courses	64
EEMUA Publications Catalogue	66

List of Figures

Figure A-1 Current tank type	31
Figure A-2 Inner tank and cabinet.....	31
Figure B-1 Typical newer self-bunded tank with integral dispensing cabinet.....	32
Figure B-2 Typical 'older' tank installation – open steel bund	32
Figure B-3 A further example of an older installation with an open bund.....	33
Figure B-4 An example of a poor installation	33
Figure B-5 Older Tank – Before Inspection and Repainting	34
Figure B-6 Older tank – After Inspection and Repainting	34
Figure B-7 Examples of Tank Corrosion	35
Figure B-8 Examples of Paint deterioration	35
Figure B-9 Water collecting in open bund.....	35
Figure B -10 Paint break down and corrosion on inaccessible surfaces (between open bund and tank wall)	36
Figure B-11 Tank support runner corrosion	36
Figure B-12 Corrosion of lower surface and trapped debris.....	36
Figure B-13 Unplugged drain valve.....	36
Figure B-14 Leaking Piping Joint.....	36
Figure B-15 Inspection Challenges – External, lower surfaces	37
Figure B-16 Inspection challenges, internal, all areas	37
Figure C-1 Tank levels and alarm settings.....	38
Figure D-1 Typical nameplate	39
Figure D-2 Non-typical nameplate (Example 1)	40
Figure D-3 Non-typical nameplate (Example 2)	40

List of Tables

Table 2-1 Product Details.....	5
Table 2-2 Design Considerations.....	6
Table 2-3 Fabrication and Quality Control	9
Table 2-4 Surface Treatment.....	10
Table 2-5 Documentation	10
Table 2-6 Delivery, Installation and Commissioning	11
Table 10-1 Grades of periodic inspection.....	23
Table 10-2 Typical inspection schedule.....	23

Preface

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. In addition, EEMUA 225 - “Above ground plastic tanks: A guide to their specification, installation, commissioning, inspection, maintenance, repair and disposal” provides guidance for the use of plastic tanks. There was, however, no comparable guidance for users of smaller, rectangular metallic tanks.

Rectangular metallic tanks used for fuel storage, across a wide range of industries, have been typically regarded as “low priority” items, with lifetime, inspection and maintenance based purely on manufacturers’ recommendations for nominal operating conditions. This often does not take into account the specific conditions of tank usage and damage mechanisms leading both to tank failure in service, and the unnecessary scrapping of serviceable tanks.

To complement and sit alongside the above referenced publications, EEMUA have produced EEMUA Publication 244, addressing the management of rectangular metallic tanks, through their complete life cycle, including specification, inspection, and maintenance. It provides practical, pragmatic guidance for owners and operators of such tanks which will help reduce the risk of failure in service and enable the extension of service life where appropriate.

Acknowledgements

This Publication was written by a work group made up of representatives and experts from EEMUA member companies, tank system providers and integrity specialists brought together and supported by EEMUA.

This work would not have been possible without the cooperation of the participants and their companies. Their help with, and enthusiasm for, the project is gratefully acknowledged.

Abbreviations / Acronyms used in this Guide

ACOP	Approved Code of Practice
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
ATEX	Atmospheres Explosibles
BS	British Standard
CDOIF	Chemical and Downstream Oil Industries Forum
CIRIA	Construction Industry Research and Information Association
CMMS	Computerised Maintenance Management System
COMAH	Control of Major Accident Hazards
COSHH	Control of Substances Hazardous to Health
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
EA	Environment Agency
EN	Euronorm
GPP	Guidance for Pollution Prevention
HSE	Health and Safety Executive
HSG	Health and Safety Guidance
IPPC	Integrated pollution prevention and control
ISO	International Organization for Standardization
LOLER	The Lifting Operations and Lifting Equipment Regulations
MOD	Ministry of Defence
MPI	Magnetic Particle Inspection
NDE	Non-Destructive Examination
NDT	Non-Destructive Testing
OFTEC	Oil Firing Technical Association
OSR	Oil Storage Regulations
P&ID	Process and Instrumentation Diagram
PCN	Personnel Certification in Non-Destructive Testing
PUWER	Provision and Use of Work Equipment Regulations
QA/QC	Quality Assurance / Quality Control
RAL	Reichs Ausschuß für Lieferbedingungen
SAFed	Safety Assessment Federation
SI	Statutory Instrument
SSOW	Safe System of Work

UKAS	United Kingdom Accreditation Service
UL	Underwriters Laboratories Inc.
UT	Ultrasonic Testing
WAH	Working at Height
WEEE	Waste from Electrical and Electronic Equipment
WPS	Welding Procedure Specification
WPQR	Welding Procedure Qualification Record

1 Scope

1.1 What is included?

This Publication is aimed at owners and operators of above-ground rectangular metallic tanks and 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.

It covers tanks generally used for storage of 'flammable'¹ liquids with a flashpoint of 23°C or higher e.g. diesel, kerosene etc. but may be applicable to other uses if considered suitable by the reader.

The scope of this document is generally for tanks that are sited on 'high hazard' sites (e.g. COMAH) or other business / industrial sites where tank failure may lead to significant health, safety or environmental consequences.

1.2 What is not included?

This is a general guide, and not a design standard and the reader is assumed to be an owner and operator rather than a tank provider or manufacturer. For this reason, other than by reference to design standards, and to the general requirements given in Section 2.3, fabrication and manufacturing techniques are not covered.

Although reference to mainly UK guidance is given in Section 1.3, relevant local and international references, including design standards, should be followed.

Excluded, are:

- Underground / buried tanks of any sort
- Lined tanks
- Tanks for transport containment
- Intermediate bulk containers (IBCs) and similar containers
- Cylindrical tanks
- Spherical tanks
- Irregular shaped tanks
- Insulated tanks
- Domestic installations

The document's content is aimed 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 (Safety) Regulations.

¹ Clarification on categories of flammable liquids is given in the Classification, Labelling and Packaging Regulation (CLP Regulation) where three categories of flammable liquids are defined:

- Extremely flammable flashpoint less than 23°C and a boiling point of 35°C or lower
- Highly flammable flashpoint less than 23°C and a boiling point greater than 35°C
- Flammable flashpoint of 23°C or higher and a boiling point of 60°C or lower

Tanks containing highly or extremely flammable substances with a flash point less than 23°C (e.g. petrol, methanol etc.) are also excluded.

The effect of radioactivity is a specialist area which is not addressed in this document.

1.3 Reference publications for above-ground rectangular metallic tanks

Regulations, standards and guidance commonly used for this type of tank include the following:

Regulations

UK SI No. 2954	The Control of Pollution (Oil Storage) (England) Regulations 2001 (the 'Oil Storage Regulations' or OSR)
SSI No. 209	The Water Environment (Controlled Activities) Scotland Regulations 2011
SSI No. 389	The Water Environment (Miscellaneous) (Scotland) Regulations 2017
WSI No. 359	The Water Resources (Control of Pollution) (Oil Storage) (Wales) Regulations 2016
SRNI No. 412	Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010
UK SI No. 2306	The Provision and Use of Work Equipment (PUWER) Regulations 1998

Standards

BS 799-5	Oil burning equipment Part 5 Carbon steel oil storage tanks
BS EN 1011-1	Welding — Recommendations for welding of metallic materials Part 1: General guidance for arc welding
BS EN 590	Automotive fuels. Diesel. Requirements and test methods
BS 2869	Fuel oils for agricultural, domestic and industrial engines and boilers. Specification
BS 5410-3	Liquid fuel firing Part 3: Installations for liquid fuelled standby generators, furnaces, kilns, ovens and other industrial purposes — Code of practice

Guidance

CIRIA C535	Above-ground proprietary prefabricated oil storage tank systems
GPP2	Above ground oil storage tanks
HSG 176	Storage of Flammable Liquids in Tanks
MOD TS-P-04	Design, Inspection, Maintenance and Testing of Equipment Installed at MOD Mechanical Transport Filling Installations (MTFIs)
OFTEC Standard	OFS T200 - Steel oil storage tanks with and without secondary containments for use with distillate fuels, bio-fuels, lubrication oils and waste oils
SAFed IMG02a	Guidelines for Users and Competent Persons – The Integrity Management of Metallic Storage Tanks
UL 142	Steel Aboveground Tanks for Flammable and Combustible Liquids

Other regulations, standards and guidance that end users and tank providers may wish to refer to include:

UK SI No. 1713	The Confined Spaces Regulations 1997
L101	Safe Work in Confined Spaces (Approved Code of Practice)

UK SI No. 2307	The Lifting Operations and Lifting Equipment Regulations (LOLER) 1998
L113	Safe Use of Lifting Equipment (Approved Code of Practice)
UK SI No. 735	The Working at Height (WAH) Regulations 2005
UK SI No. 483	The Control of Major Accident Hazards (COMAH) Regulations 2015
UK SI No. 2776	The Dangerous Substances and Explosive Atmospheres (DSEAR) Regulations 2002
BS 4800	Schedule of paint colours for building purposes
EEMUA 101	Lifting Points Design Guide
EEMUA 105	Factory stairways, ladders and handrails
CDOIF	Guideline Environmental Risk Tolerability for COMAH Establishments

Note: A full list of all EEMUA publications is given at the end of this document.

1.4 Terminology

The term 'tank provider' is used throughout.

For tanks of the type covered by this document, the 'tank provider' may be either the tank fabricator / manufacturer or a separate organisation providing, for example, a 'turnkey' fuel tank system.

The 'end user' is the owner and / or operator of a tank or tank system.

Sketches of typical tank arrangements (with terminology for common components) are given in Appendix A.

2 Tank Procurement

2.1 General

Items for consideration in a tank procurement process are detailed further in Section 2.3 below.

As well as initial design criteria, the full life cycle of the tank system should be considered. In particular, requirements relating to maintenance and future inspection should be considered at an early stage.

These may include:

- Application of suitably specified surface treatment such that the need for maintenance re-painting is reduced or eliminated during the life of the tank. In particular, enhanced surface treatment should be considered on external surfaces that may be inaccessible.
- In some duties (e.g. aviation fuel) enhanced internal coating (e.g. epoxy coatings or similar) may be required.
- Provision of sufficient access to upper surface of tanks (e.g. by means of fixed ladders and platforms)
- Provision of means to carry out internal inspection (e.g. by means of suitably sized access hatches, manways, inspection ports etc.)
- Provision of means to carry out inspection on lower surface of tanks (e.g. by installing the tank on raised plinths etc.)

2.2 Selecting a tank provider

Points for consideration in selecting a tank provider include:

- Relevant experience in the provision of similar tanks
- Understanding of relevant design and fabrication standards
- Operating in accordance with a recognised quality assurance system (e.g. by assessment and certification against standard BS EN ISO 9001).
- Membership of a relevant trade association

2.3 Requirements for discussion/information to be exchanged between the end user and tank provider

Requirements for information to be exchanged between the end user and tank provider are given in the tables below.

The lists of items shown are not necessarily exhaustive or even necessary in every case but are given to enable appropriate dialogue to take place.

The aim is to ensure that design, fabrication, testing or any other specific requirements (e.g. commissioning inspections, see Section 10.5.8.1) are communicated to the tank provider, and understood by them, at an early stage during the procurement and supply process.

In particular, standards for welding and fabrication quality should be defined and agreed at an early stage. Experience has shown that contractual disputes can arise during commissioning or subsequent inspections if this isn't done.

Reference should also be made to sections in relevant standards (e.g. Clause 4 of BS799-5) to ensure that the correct information is specified and exchanged.

In the UK, different pollution / environmental regulations apply to each country (see Section 1.3). The specific requirements of these regulations need to be considered at the specification stage.

Table 2-1 Product Details

Information	Details Required
Product characteristics	- Fuel type (e.g. diesel, biodiesel, kerosene etc.) - Relevant product standard (e.g. diesel fuel to BS EN 590) - Relevant 'Material Safety Data Sheet'
Operating Temperatures	- Generally ambient temperature (with due account taken of increasing ambient temperatures arising due to climate change etc.) Note: In certain circumstances (e.g. if an unusual or 'non-standard' product is being stored), it may be necessary to specify: - Design temperature - Incoming liquid temperature - Maximum operating temperature - Minimum operating temperature
Pressures (Design and Test)	- Design pressure is generally equivalent 'head' of water acting on bottom, sides and top of a tank when full. - Test pressure (pneumatic or hydraulic) in accordance with design standard. Note: Reference to be made to relevant design standard to ensure correct values for design and test pressures are used.
Capacity (volume)	- Nominal or safe working capacity (litres) - Maximum capacity Note: Terminology relating to capacity varies between different design standards or other guidance. A typical interpretation (using BS 799-5 as reference) is given in Appendix C.

Table 2-2 Design Considerations

Information	Details Required
Regulations	Any applicable regulations (including those that are country specific).
Proposed design standard	Examples include: • BS 799-5 type J or K • UL 142 Note: Although Sound Engineering Practice (SEP) may be referenced or proposed by a tank provider, this is not considered sufficient as a design standard.
Specific additional requirements to the specified design standard	Examples include: • Access hatches and covers • Thicknesses or type/nature of stays • Detail (e.g. nozzle location)
Permitted deviations from the specified design standard	Any deviations from the design standards to be specified on drawing documentations. Note: Tank providers may wish to provide a tank that is <u>generally</u> in accordance with a particular design standard. This isn't a recommended approach and end users should endeavour to ensure that tanks are <u>fully compliant</u> with the relevant standard.
Tank Material	Steel to be structural grade carbon steel sheet or plate in accordance with a relevant material standard (e.g. BS EN 10025).
Connections Material	Nozzles, fittings, pipe etc. to be carbon steel in accordance with a recognised standard and to be compatible with tank material.
Corrosion allowance	• Corrosion allowance is not specified in relevant design standards. If required, a minimum of 0.75mm should be considered. • Additional corrosion allowance or material thicknesses should be considered for inaccessible surfaces. Note: Inaccessible surfaces are those that cannot be easily viewed or otherwise accessed for inspection or maintenance purposes e.g. tank bottom surface.
Tank Dimensions	• Overall dimension (length, width, height) • Tank weight • Any limitations or restrictions with regard to dimensions (e.g. maximum permitted length or height etc.)
Fill and venting requirements	• Generally, sizing of venting and fill requirements is determined by the provider in accordance with design standard used. Note: The following additional information may occasionally be required as part of the vent and / or fill system design. • Anticipated fill /empty cycles • Intended method of delivery/filling • Anticipated fill rate • Anticipated draw rate • Anticipated working volume with ullage.

Information	Details Required
Nozzle, piping and equipment schedule	- Generally, identify any specific nozzles needed, diameter and configuration (e.g. coupling, flange etc.). Tanks are typically provided with: - Fill pipe with a lockable valve (in accordance with the OSR) - Vent and vent pipe - Outlet / draw pipe - Contents gauge - Bund Drainage connection Other considerations include: - Nozzle / connection locations e.g. tank end or side. - Pipe support requirements
Safety Devices	- Overfill alarm (Low and High levels) - Bund alarm - Dispenser hose breakaway coupling - Overfill prevention device / valve (OPV) Note: Cut off level of OPV to be specified / agreed.
Anchorage and Foundation Details	- No or Yes. If Yes, type of anchorage / foundation detail. - Transverse support requirements (ref. BS799-5, Clause 4).
Lifting points	Any specific lifting/tailing lugs needed if the tank is to be lifted into a specific area (refer to LOLER and ACOP L113)
Nameplate / Marking (see Appendix D)	Identify specific details to be marked on the tank or nameplate, to include: - Manufacturer's name - Manufacturer's reference number (e.g. serial number etc). - Design standard (inc. date) (e.g. BS 799-5:2010) - Type of tank (e.g. Type II) - Capacity (in litres) - Date of manufacture - Design pressure - Test pressure and date of testing Note: Depending on the design standard used, other information may also be required e.g., venting capacity, identification of vents etc.)
Secondary containment	- Capacity (e.g. minimum of 110% of primary containment) - Bund Drainage arrangement - Drip trays
Electrical requirements (see Chapter 3)	- Hazardous area / zone rating - Location and type of any earthing points - Power requirements
Personal Access	Personal Access With reference to the WAH Regs, consideration to be given to: - Provision of safe access to upper areas / top surface of tank (e.g. by means of fixed access ladder, platform and handrails in accordance with EEMUA 105). - Harness attachment points.

Information	Details Required
Separation Distances (See Chapter 4.3)	• From tank to buildings, process areas etc. • From tank to sources of ignition • From tank to site boundaries • Between tanks (in a multi tank installation) • From tank to other hazardous substance storages • From tank to environmental receptors
Periodic Inspection	Consideration to be given to future inspection requirements and 'inspectability' of system • Tank top access • Access hatches (including size / diameter) • Inspection ports (e.g. to enable the use of borescopes or similar inspection aids) • Raised foundation steelwork or concrete piers to enable access for base inspection.
Equipment cabinet	• Location • Pumps (quantity, type etc.) • Door (e.g. roller shutter etc). • Lighting (inc. hazardous zone rating) • Fuel management system

Table 2-3 Fabrication and Quality Control

Information	Details Required
Proposed fabrication standard	Examples include: • BS 799-5 type J or K • UL 142 Note: Although Sound Engineering Practice (SEP) may be referenced, this is not considered sufficient as a fabrication standard.
Materials	Note: Tanks are generally constructed from 'commercial' or 'structural grade' carbon steel sheets or plates that meet the requirements of a recognised national standard (e.g. BS EN 10025-2, ASTM A36M etc.). The relevant material standard to be used (which can vary depending on the tank duty) is normally specified in the design standard. In some standards, the use of stainless steel is permitted although this is relatively rarely used for the type of fuel storage tanks under consideration. Connections and attachments (e.g. nozzles, access hatches, lifting points etc.) should be of a compatible material, particularly where welded to the tank.
Welding requirements	For example: • Welding standard (e.g. BS EN 1011) • Weld Procedure Specification (e.g. in accordance with BS EN 288) • Additional requirements not given in the welding standard (e.g. agreement on standards of welding to be achieved)
Fabrication quality control	• Requirements for inspection (e.g. use of manufacturer's inspection checklists, specifying of any fabrication 'hold points' etc.) • Requirements for any end user or 3rd party witnessing of fabrication activity
NDE / NDT	• NDE / NDT requirements in addition to those specified in fabrication standard or welding standards e.g. on welded seams, on nozzle connections, on lifting lugs, on safety rails etc. • Type of NDT required (e.g. MPI, radiography etc.) • Extent of NDT (e.g. 10% of weld seams etc.) • Advise if NDT with external certification are required on lifting lugs and safety rail

Table 2-4 Surface Treatment

Information	Details Required
Painting	- Paint standard (including initial surface preparation) to be specified and agreed. Examples include: - Manufacturer's standard paint system OR 1 x coat zinc phosphate primer, 1 x topcoat gloss 'enamel' OR - shot blasting to ISO 8501-1 SA 2½ followed by two pack epoxy etc. - Consideration as to whether an 'enhanced' surface treatment on the lower / inaccessible tank surfaces is required (e.g. 'marine' or other specialist grades etc.)
Colour	- Colour details and reference (e.g. BS4800, RAL number etc.) - Gloss or matt finish.
Materials	Requirements for spare / touch up paint

Table 2-5 Documentation

Information	Details Required
Document schedule to be supplied by the tank provider prior to starting work	For example: - General Arrangement Drawing - Weld detail drawings - Manufacturer's data sheet - Calculation pack - Paint specification - Proposed weld procedures and welding standards to be met. - Inspection test plan (weld procedures etc...)
Document schedule to be supplied by the tank provider upon completion of work	For example: - Certificate of conformity (to a recognised standard) - Guarantee or warranty statements - Manufacturer's data sheet - Inspection reports (providers and third party) - NDT reports - Test pressure certificate - Paint inspection reports - Fabrication quality pack including WPS, WPQR and certificates (e.g. welder, materials, consumables etc.) - Lifting lug certification (e.g. confirmation of safe working load) - Inspection and maintenance requirements (also with reference to the requirements of PUWER) - Dimensional check certificate - Integrity check procedure (to identify any transport related damages) - As-built drawing (record of modifications)

Table 2-6 Delivery, Installation and Commissioning

Information	Details Required
Delivery	• Destination of tank and site access • Responsibility for off-loading • Transport and off-loading requirements • Any site access restrictions
Installation (See Section 6.1)	• Installation plan (inc. SSOW, risk assessments etc.) • Manufacturer's recommendations • Tank location (within site) • Tank foundation • Any holding down arrangements • Position and orientation of tank • Proximity to other items / high hazard fluids • Craneage details • Any specific lifting information if needed (e.g. use of lifting/spreader beams, tank centre of gravity and reference to LOLER, etc)
Commissioning (See Section 6.2)	• Manufacturer's recommendations • Commissioning process • Personnel to be involved • Required documentation

3 Electrical Requirements

3.1 General

The 'end user' should ensure that an electrical supply, sufficient to provide all tank system power requirements, is available.

The electrical system should be specified, designed and maintained in accordance with relevant regulatory requirements (e.g. BS 7671, 'The Wiring Regulations'), appropriate national standards and industry 'best practice' guidance.

Tank systems should be correctly earthed, again, in accordance with relevant requirements.

3.2 Ingress protection

Due to the exposed nature of electrical systems, it is recommended that control panels, switchgear, sockets etc. be specified with an 'ingress protection' rating of IP65.

4 Considerations for Tank and Equipment Location

4.1 Environmental consideration

Risks to the environment should be considered and assessed when determining locations for tank systems. For example, they may need to be located away from surface waters, located on a surface where spills can't contaminate the land or groundwater or equipped with suitable spillage containment systems etc.

Location in relation to public and environmental receptors should also be considered.

Local regulations relating to environmental impact, pollution control etc. should be referenced.

4.2 Area classification (Hazardous Zoning)

Generally, storage of high flashpoint products such as diesel will not require electrical systems to be suitable for 'hazardous areas' (e.g. by being 'ATEX' compliant or in accordance with BS EN 60079 etc.). Similarly, mechanical systems will also not require to be 'ATEX' compliant or in accordance with BS EN 80079 etc.

For diesel, however, it is recommended that fuel filler nozzles (when stored in the nozzle holster) be located a minimum of 1m away from electrical panels.

The use of 'hazardous area' rated equipment may be required for other products, where there is a risk of a flammable mist occurring or due to the proximity of other flammable / hazardous substances.

An end user's own site or company rules may require the use of 'hazardous area' rated electrical or mechanical equipment, irrespective of the substance being stored.

In all cases, appropriate advice shall be taken (e.g. from the tank provider or an 'area classification' / 'hazardous zoning' specialist). A suitable DSEAR risk assessment may need to be carried out and where required, area classification should be carried out in accordance with relevant standards or guidance (e.g. BS EN 60079-10-1 or EI15 etc.).

4.3 Separation distances

Tanks should be positioned at recognised 'separation distances' away from site boundaries, buildings, process areas, other hazards and fixed sources of ignition. Further advice and recommendations for separation distances are given in other standards (e.g. BS 5410 Part 3) or in readily available industry guidance e.g. HSE publication HSG176. (The chapter 'Separation distances for 'small' tanks' is relevant in this regard).