Chemical Business Association

SAFed

Non-metallic Storage Tanks manufactured prior to 2007

Guidance for Operators

Chemical Business Association

SAFed

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Users of this Guidance should pay regard to any relevant legislation or authoritative recommendations, which may have evolved subsequently to the date of publication.

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FOREWORD by Peter Baker

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There have been a number of serious incidents in recent years as a result of loss of containment from non-metallic tanks including, in some cases, catastrophic failures. Managing the integrity of non-metallic storage tanks is therefore an important aspect of health, safety and environmental risk management. This publication - prepared by the Chemical Business Association and the Safety Assessment Federation in consultation with the Health and Safety Executive - is a useful addition to the guidance on this subject.

This guidance should not be regarded as an authoritative interpretation of the law, however, if you adhere to the advice set out in it, this should normally be enough to comply with the law in respect of those specific issues on which the guidance gives advice.

CONTENTS

INTRODUCTION

1. This guidance provides information on hazards associated with the storage of liquids in thermoplastic or glass/fibre reinforced plastic atmospheric storage tanks of a capacity greater than $3m^3$ and up to $100m^3$ (Plastic tanks). It sets out practical measures on the operation and maintenance of these tanks. These measures are designed to protect people at work, others who may be affected and the environment by any failure of primary containment.

2. The guidance is aimed at those directly responsible for the safe storage, use and maintenance of plastic storage tanks in all general work activities.

3. Organisations, safety specialists and maintenance personnel may wish to use this guidance as a basis for more specific advice or training for their staff, clients and members.

4. This guidance should not be used in isolation. It makes reference to other documents and they should be consulted wherever appropriate. British Standards and other documents mentioned in this guidance are regularly updated and the reader should ensure that the most recent revision is consulted.

5. The objectives of this guidance are to:

   - Increase the awareness of the hazards associated with the storage of materials in plastic storage tanks
   - Help in the assessment and reduction of the risks associated with the use of plastic storage tanks
   - Advise on safe management procedures and precautions to reduce the risk of catastrophic failure of plastic storage tanks
   - Advise on the need for appropriate precautions, maintenance, training and good housekeeping
   - Provide guidance in areas where the standard of information is inadequate or not yet available.

THE PROBLEM

6. Plastic tanks, manufactured from a variety of materials such as high-density polyethylene (Thermoplastic - HDPE) and glass-reinforced plastic (GRP) have been widely used for the storage of chemicals over many years.

7. Investigations after a series of failures of plastic storage tanks revealed a lack of available and suitable information from the tank manufacturers regarding:

   - Tank design lives
   - Maintenance regimes
   - Inspection frequency

8. The Health & Safety Laboratory (HSL) has carried out research work[1], which planned initially to review inspection methods for thermoplastic hydrofluoric acid storage tanks. The review then expanded to include a range of thermoplastic tank materials and contents, and to include aspects of specification, design and fabrication.

9. The report identified that thermoplastic tanks are an alternative to metal and GRP, for many products but are often installed with the view that they will not deteriorate and do not need to be inspected or assessed. There are generally no established procedures for inspecting these tanks and consequently they are often used without due consideration of their condition and fitness for service.

10. The existing HSE 'best practice guidance for GRP tanks - PM75' is "out dated" and not currently available in print from HSE Books. However, the HSE have already begun to review the document and a new version will be published first quarter 2009.

LEGAL DUTIES

11. Legal duties arise from many sources, and the references contain a number of the most relevant. For the purpose of this guidance those duties may be summarised as requiring safety to be actively managed through a process that starts with risk assessment. Risk assessment in turn starts with a recognition of the hazards presented by any process, identifying who or what (e.g. the environment) may be affected, and to what extent, and putting in controls that are adequate to eliminate or minimise those risks.

12. There are no specific duties or regulation that set out prescriptive rules for storage tank inspections. However, there are duties under:

    - Management of Health and Safety at Work (MHSW) Regulations 1999 [2]
    - Provision and Use of Work Equipment (PUWER) Regulations 1998 [3]
    - Control of Major Accident Hazards (COMAH) Regulations 1999 [4]

    which may apply.

13. The guidance and reference sections list the most relevant legislation

RISK ASSESSMENT

14. Risk assessment is the systematic evaluation of work activities using the following five steps:

Step 1: Identify the hazards.
Step 2: Identify the exposures. Decide who and what could be harmed and how?
Step 3: Evaluate the risks arising. Decide whether existing precautions are adequate or if more should be done.
Step 4: Record the findings and implement them.
Step 5: Review the assessment regularly and revise if necessary.

15. Advice on carrying out risk assessments is contained in an HSE Guidance leaflet INDG163 [5].

TANK DESIGN LIFE

16. All new plastic tanks/vessels purchased by CBA members **must** have a prescribed manufacturers "design life". A copy of the design life documentation should be included in the tank maintenance records for future reference.

17. The design life will be calculated to take into account all of the aspects of the tank/vessel usage, which should be communicated to the tank manufacturer during the initial contract stages, prior to placement of the order.

    Therefore, it is vital that the following information is determined prior to commencement of purchase negotiations:

    - Substance to be stored
    - Number of inlets and outlets required, allow for future expansion
    - Fill and discharge cycles (GRP only)
    - Local weather conditions
    - Tank duty
        - Storage only, or
        - Storage and dilution
        - Presence of exothermic or endothermic reactions
        - Particulates
        - pH , very alkaline or acidic
        - Temperature of operation
            - Product discharge filled above ambient temperature

18. The list above is not exhaustive but is designed to indicate the level of detail that may be necessary when agreeing a tank/vessel specification.

INSPECTION REGIME

19. For plastic tanks manufactured **post 2007** users should rely on the guidance issued by the original tank manufacturer for the design life period and requirements for inspection and maintenance during that period.

20. The actual recommended regime and frequency of tank inspections will vary from manufacturer to manufacturer but as an industry standard should suggest a combination of External inspections and Internal inspections.

21. External inspections should be designed to highlight developing failure modes, such as bulging walls, stress cracking, and leaks or weeps from plastic tanks and associated pipework at an early stage and the type and complexity of inspections will vary from operator to operator but ultimately there should be two type of external inspection performed:

    - Competent person
        - Performed by external agency such as insurance assessor; or
        - Performed by trained employee such as maintenance engineer

    - Operator/site management
        - Performed by senior management; or
        - Performed by tank operator

22. Internal inspections generally require the decommissioning of the tank, which involves the removal of contents, decontamination of the tank and in some cases the erection of scaffolding to allow entry to the top of the tank.

23. There are various options regarding Internal inspection methods but at present the merits of these are being debated between industry, regulators and tank inspection bodies. The most frequently described methods are:

    - Physical inspection by tank entry
    - Remote video surveillance (RVS)

24. The actual method of tank inspection should be subjected to a thorough risk assessment. The physical entry of personnel into storage tanks is discouraged due to the increased risk posed to employees and contractors. Where, on balance, physical inspection by tank entry is assessed as essential, e.g. for tanks storing hazardous materials where alternative methods such as RVS may not provide the necessary level of confidence that possible defects will be found, the requirements of the Confined Spaces Regulations 1997 [6] and of Permit To Work systems [7] (PTW) need to be complied with.

25. The manufacturers regime will guide the operators inspection regime up to the prescribed ‘design life’ each manufacturer has given each of their tank designs against each duty and stored substance

26. For non-metallic tanks storing hazardous substances the inspection regime , when the design life is exceeded, must not exceed **twelve months** for internal inspections but would also be dependant on the nature of the tank duty, along with the findings and any recommendations of the last regular inspection.

27. The inspection frequency can be shortened but **must never** be extended beyond annually.

28. For non-metallic tanks storing "low hazard" substances the inspection regime, when the design life is exceeded, will be dependant on the nature of the tank duty, a risk assessment to determine the effects of failure in conjunction with the findings and any recommendations of the last regular inspection.

EXPERIENCE DERIVED DESIGN LIFE

29. With regard to any tanks/vessels commissioned **pre 2007,** where the tank manufacturers did not provide suitable guidance regarding the design life and maintenance and inspection regimes, CBA has been determined an "experience derived design life" (EDDL) for specific substances against specific material of construction, from industry records and operational experience.

30. The EDDL is measured from the date of tank installation and is a conservative estimation derived from operational data.

Substance	Construction material	Experienced life
Hydrochloric Acid	Thermoplastic	15 years
Hydrochloric Acid	GRP	10 years
Sulphuric Acid	Thermoplastic	15 years
Sulphuric Acid	GRP	15 years
Acetic Acid	GRP	20 years
Phosphoric Acid	Thermoplastic	20 years
Phosphoric Acid	GRP	20 years
Sodium Hypochlorite	Thermoplastic	12 years
Sodium Hypochlorite	GRP	12 years
Other products *	Thermoplastic & GRP	15 years

Table 1: CBA experience derived design lives

* The other products identified within the context of this guidance are:

Ferric Sulphate solution	Ferric Chloride solution	Formic acid
Potassium Hydroxide solution	Sodium Hydroxide solution	Ether sulphate
Sodium chlorite solution		

31. The EDDL should be used to guide the operator to prescribe a suitable inspection and maintenance regime to allow tanks/vessels to operate beyond these derived values.

RECOMMENDATIONS

32. Following publication of this guidance an operator should perform an internal inspection to determine the condition of all tanks manufactured and commission pre 2007. If no internal inspections have been performed on the tank since date of installation these inspections should be performed as soon as possible, prioritised by risk assessment, and a schedule of inspections should be written and adhered too.

33. If no failure precursors are detected during the inspection there should then be no further internal inspections undertaken up to the experienced derived design life in table 1, unless internal company procedures dictate otherwise. However, an external monitoring programme should be implemented and reviewed.

34. Once the experienced derived design life has been reached the operator must internally inspect the tanks “at least” annually or more frequently if the inspection / risk assessment suggests this in order to continue extending the tanks life span.

35. Inspection will:

- Be Risk assessment driven
- Include operational conditions such as:
  - Product Duty
    - Product to be stored
  - Cyclic fill frequency
  - Speed of fill/discharge
  - Presence of any Endothermic or exothermic reactions

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An agency of the Health and Safety Executive (HSE), which carries out research and other work in the field of health and safety.

GLOSSARY OF TERMS

Glass Reinforced Plastic (GRP)
A laminate consisting of a synthetic resin system – usually polyester, epoxy, furane, vinyl ester – reinforced with glass or other fibres. GRP is therefore used interchangeably with the more generic FRP (Fibre Reinforced Plastic) term. GRP can either be manufactured by:

- The wet lay up process i.e. by the process of applying laminates in position on a former prior to cure
- Machine controlled filament winding for cylindrical forms
- Spray application of chopped glass and resin

Thermoplastic
Plastic that is capable of being softened repeatedly by heating and hardened by cooling through a temperature range characteristic of the plastic and, in the softened state, of being shaped by flow repeatedly into articles by moulding, extrusion or forming.

Vessel
A closed container subject to applied pressure or vacuum, with or without hydrostatic head

Plastic Tank
A container of greater than $3m^3$ and up to $100m^3$ manufactured from thermoplastic or glass/fibre reinforced plastic for the storage of liquids subject only to its own hydrostatic head and freely vented to atmosphere

Vessel or Tank Liner
A non-structural material, which is in contact with the substance being stored. The liner is designed from chemically resistant material and allows the main body of the tank or vessel to be manufactured from other, less resistant materials. Some typical examples of liners are:

- Steel with rubber or glass lining
- GRP with Polypropylene lining

Maximum allowable pressure
The maximum pressure for which the equipment is designed, as specified by the manufacturer

REFERENCES

1. **HSL/2006/21** - Specification and Inspection of Thermoplastic Storage Tanks http://www.hse.gov.uk/research/hsl_pdf/2006/hsl0621.pdf

2. **L21** - Management of Health and Safety at Work Regulations 1999 Approved Code of Practice and Guidance - **ISBN 0-7176-2488-9**.

3. **L22** - Safe Use Of Work Equipment - Provision And Use Of Work Equipment Regulations 1998 Approved Code Of Practice And Guidance **- ISBN 0-7176-1626-6**

4. **L111 -** A guide to the control of Major Accident Hazards Regulations 1999 (as amended) **– ISBN 0-7176-6175-X**

5. **INDG163** - Guidance 5 Steps To Risk Assessment – **ISBN-0-7176-6189-X**
6. **L101** – Confined spaces regulations 1997 Approved Code of Practice and Guidance – **ISBN-0-7176-1405-0**

7. **HSG250** – Guidance on permit-to-work systems – **ISBN –0-7176-2943-5**

GUIDANCE

- HSE

	Publication Title	ISBN Number
HSG176	The storage of Flammable Liquids in tanks	**0-7176-1470-0**
HSG250	Guidance on permit-to-work systems	**0-7176-2943-0**
L134	Design of plant, equipment and workplaces (DSEAR 2002 ACOP)	**0-7176-2199-5**
L135	Storage of dangerous substances (DSEAR 2002 ACOP)	**0-7176-2200-2**
L136	Control and mitigation measures (DSEAR 2002 ACOP)	**0-7176-2001-0**
L137	Safe maintenance, repair and cleaning procedures (DSEAR 2002 ACOP)	**0-7176-2202-9**
CRR 363	Best practice for risk based inspection as a part of plant integrity management http://www.hse.gov.uk/research/crr_htm/2001/crr01363.htm	**0-7176-2090-5**
INDG258	HSE Safe work in confined space Leaflet	**0-7176-1442-4**

- Others

Publication Title	Reference
Users' guide to the inspection, maintenance and repair of aboveground vertical and cylindrical steel storage tanks (3rd edition) EEMUA (Engineering Equipment and Materials Users' Association)	EEMUA 159 : 2003