

CONTAINMENT OF BULK HAZARDOUS LIQUIDS AT COMAH ESTABLISHMENTS CONTAINMENT POLICY

SUPPORTING GUIDANCE FOR SECONDARY AND TERTIARY CONTAINMENT AND IMPLEMENTATION PRINCIPLES FOR REGULATORS

Introduction

The Containment Policy provides a framework for good practice standards for new and existing plant at COMAH establishments handling petrol (gasoline) and similar petroleum products, or other fuels. Supporting guidance has been prepared by the Petrochemical Process Safety Leadership Group (PSLG), which consolidates many sources of good practice (standards, codes and guidance) which apply to secondary and tertiary containment.

This document includes additional guidance concerning implementation principles for regulators, which is presented within boxes under the following themes:

- Notes for regulators (further information regarding good practice)
- Proposed standards for new and partially new installations
- Actions for improvements of existing installations
- Regulator compliance actions

The aim of this document is to ensure consistency of regulation across the sector as a whole.

The technical issues and the interpretation of these issues are common to operator and regulator and we all aim for a consistent approach. The regulator has duties under COMAH to take enforcement action – where necessary and proportionate. This note for regulators provides guidance on what sort of deficient measures may trigger assessment and decisions around enforcement action.

Implementation principles

1. The first phase of the Containment policy applies to COMAH establishments storing petroleum products and other liquid fuels. These are limited to petroleum products: (a) gasolines and naphthas; (b) kerosenes (including jet fuels); (c) gas oils (including diesel fuels, home heating oils and gas oil blending streams) as named in Schedule 1, Part 2 of the COMAH regulations - See appendix 1 of <http://www.hse.gov.uk/comah/background/summary.pdf> for interpretation. Where establishments are storing both fuels and chemicals, initial attention should focus on fuels, though operators should be aware that chemicals will be included in due course and that improvements to the site in this initial phase may practically include areas storing chemicals.

2. CA intervention plans will be developed and implemented in accordance with the prioritisation principles in **Ops Gateway message OGADJPG190208 - 005**. Copies of inspection reports and improvement programmes and schedules should be sent to Mike Nicholas (x7 25 4353) Technical Advisor in National Process Technical Services.
3. A timetable for operators to review their compliance with the Containment Policy Control Measures and prepare a plan for implementing improvements, is provided in **Ops Gateway message OGADJPG190208 – 005**. We seek the most effective and rapid reductions in risk. All sites will be expected to take every opportunity to upgrade containment measures, especially when tanks are brought out of service.
4. It is the operators responsibility to comply with good practice (standards, codes and guidance) and good practice is the minimum level of compliance in relation to application of all measures necessary (COMAH regulation 4). It is the role of the regulator to identify failure to use good practice.
5. If it is the Competent Authority's opinion that the deficient measure is required for control of a Major Accident To The Environment (MATTE) then it shall be considered that the operator is in contravention of regulation 4 of COMAH. If it has been identified that there is a failure to use good practice, but the deficient measure is not required for control of a MATTE (e.g. the establishment has no potential to cause a MATTE) then the matter shall be discussed with the HSE site inspector to enable consideration of impact to persons.
6. If an operator has failed to use good practice then the operator should be reminded of the need to establish the underlying causes (root causes) within the Safety Management System (COMAH regulations, Schedule 2, 4(f)). In addition the regulator may consider the site intervention plan with particular emphasis given to the common issues in Part C of the Containment Policy, i.e. Facility design, Fire fighting, Maintenance, Change management and Staffing.
7. The Competent Authority will focus it's resource to ensuring proportionate and planned implementation at sites presenting the highest risk. All sites will be expected to take every opportunity to upgrade containment measures, especially when tanks are brought out of service.
8. Enforcement shall follow the Enforcement and Prosecution Policy (including COMAH functional guidance and Public Interest Factors) and should be based on the following principles taking into account the risk presented across all of the COMAH activities carried out by the operation in question : -
 - (a) the protection to people and the environment provided by the totality of measures taken to prevent major accidents and mitigate the consequences of any that may occur, and
 - (b) the human population and the environmental setting surrounding the establishment.
 - (c) the need for a proportionate response, which means implementation of the Containment Policy Control Measures as far as it is reasonably practicable to do so (see item 13 below)
 - (d) consideration of the recommended regulator compliance actions detailed in this document

Please be aware of the implications of instigating enforcement for the same operator at different sites and consistency across the sector as a whole.

9. Enforcement at existing establishments should aim to achieve upgraded control measures to meet the Containment Policy Control Measures, as far as it is reasonably practicable to do so (see item 13 below). **The policy indicates that the improvements required of operators could take between 10 and 20 years to complete, at some sites. In most cases we expect the important works to be carried out within 5 years. A shorter improvement period up to 24 months may be appropriate where there is a sensitive environmental receptor and/or a higher level of risk (relative to other establishments in the sector).**
10. It is expected that improvements will be phased in, with priority given to those improvements where the risk is greatest in terms of protection of both people and the environment. However where it is clear in advance of this that performance falls well below accepted basic good practice standards, and thereby gives the CA cause for serious concern, enforcement of remedial improvements should not be delayed. In these cases consideration must also be given to the requirements of Regulation 18 of COMAH concerning Prohibition of Use.
11. Improvements in primary containment should generally be expected to take the highest priority. Improvements in secondary containment measures may require the longest implementation time in recognition of the scale and costs involved in upgrading existing facilities. Tertiary containment measures may be less costly than secondary, and plans for secondary and tertiary containment should be integrated for optimum reduction of risk.
12. Where it has been identified that an establishment is below good practice, and the operator has prepared and submitted an improvement plan to the CA, the plan shall be reviewed to ensure that it meets the objectives of the Containment Policy and these implementation principles. If the proposals are not acceptable (in terms of measures or timescales) or if an operator fails to implement the improvement plan without reasonable justification, then further enforcement action shall be considered. .
13. The Containment Policy Control Measures apply to the upgrading of existing establishments as far as it is reasonably practicable to do so. In determining whether it is reasonably practicable to upgrade an establishment, the principles of proportionality and reducing risk to a level as low as reasonably practicable (ALARP) need to be considered. The fuel sector has potential for high environmental impact and it is expected that any establishment which has potential to cause a Major Accident To The Environment (MATTE) will be required to implement all Containment Policy Control Measures necessary for preventing and mitigating that MATTE.
14. The regulatory impact assessment for the Containment Policy indicated that the Containment Policy Control Measures are not grossly disproportionate for the sector. Individual site affordability should not be a factor in avoiding upgrade. An element of proportionality has been factored in when establishing the expected timescales for improvement as highlighted in the Containment Policy and this

document. It is expected that only where there is no MATTE potential (i.e. improvements would bring limited environmental benefit) is it possible that some measures may not be required. But, this can only be concluded definitively after discussion with the HSE site inspector to enable consideration of the consequences to people. Further guidance on proportionality can be found in the “COMAH All Measures Necessary Guidance”.

15. Further information on environmental risk assessment can be found in Annex 1 of this document.

16. It is not expected that any one officer will have all competencies necessary to determine whether an operator has used all measures necessary. CA intervention requires a mix of disciplines and resource may be sourced from the EA, HSE or if necessary, external consultants or engineering companies.

Further advice can be sought from Mike Nicholas (x7 25 4353) in National Process Technical Services. It is expected that such advice may be required on matters such as:

- cases where an operator and regulator are in disagreement as to whether a specific measure is good practice.
- appropriate enforcement response
- cases where an operator is proposing not to implement a Containment Policy Control Measure which the CA believes is necessary
- where to source the necessary resource to ensure an adequate system of inspections
- where to source information on Environmental Risk Assessment

This document is based on the guidance produced by the Process Safety Leadership Group with additional text for regulators presented as:

Proposed standards for new and partially new installations

ASTs shall be banded to provide secondary containment.

It should be read in conjunction with Ops Gateway message OGADJPG190208 - 005

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| Bundling of above – ground storage tanks (ASTs) (section 6) | | |
| | ASTs shall be banded to provide secondary containment. | 6 |
| | Bunds shall be impermeable | 8 |
| | Bunds shall have adequate corrosion resistance. | 13 |
| | Bunds shall have adequate strength and durability. | 14 |
| | Bunds shall have the minimum number of tanks within each bund in line with good practice | 17 |
| | Bunds shall have incompatible materials stored in separate bunds | 17 |
| | Bunds shall have sufficient capacity to allow for tank failure and firewater management. This will normally be a minimum capacity of either 110% of the capacity of the largest tank or 25% of the total capacity of all the tanks within the bund whichever is the greater. | 18 |
| | Bunds shall have either no rainwater drain or the drain is into a contained and enclosed system requiring positive action for operation | 22 |
| | Bunds shall have no pipework that penetrates through the bund floor | 23 |
| | Bunds shall have no pipework that penetrates through the bund walls as far as reasonably practicable otherwise it shall be with adequate sealing and support. | 24 |
| | Bunds shall be subject to periodic inspection and certification by a competent person regarding their condition and performance. | 25 |
| Bundling and fire controls (section 7) | | |
| | Bunds shall have adequate capacity and design to allow fire prevention and control measures to be taken. | 27 |
| | Bunds shall have fire resistant structural integrity, joints and pipework penetrations. | 30 |
| | Bunds shall have a means of removing fire water from below the surface of the liquid in the bund (for dangerous substances which are not miscible with water and have a lower density than water). | 32 |
| Tertiary containment (section 10) | | |
| | Tertiary containment plans for establishments storing or using liquid dangerous substances or that may have firewater containing dangerous substances shall be prepared, having regard to the ground and location characteristics of the site | 34 |
| | Tertiary containment measures shall minimise the consequences of a loss of primary containment from equipment that is not provided with secondary containment | 35 |
| | Tertiary containment measures shall minimise the consequences of a major incident that causes the failure of or exceeds the storage capacity of secondary containment | 37 |
| | Tertiary containment measures shall enable additional measures to be deployed in time if an incident escalates | 39 |

This document does not address other sections of the policy.

Policy Statement Reference 6 – Bunding of above – ground storage tanks (ASTs)

Containment Policy Control Measure

ASTs shall be bunded to provide secondary containment.

Current recognised good practice standards

Note for regulators

See the reference list at the end of this document for the key codes, standards and guidance relevant to secondary and tertiary containment. Specific requirements are highlighted through this document.

In addition PPC guidance notes, such as the Combustion (&Fuel and energy) may be used. These establish many of the Containment Policy Control Measures. These state... All above-ground tanks containing liquids whose spillage could be harmful to the environment should be bunded. For further information on bund sizing and design, see CIRIA 163. Bunds should:

- be impermeable and resistant to the stored materials;
- have no outlet (that is, no drains or taps) and drain to a blind collection point;
- have pipework routed within bunded areas with no penetration of contained surfaces;
- be designed to catch leaks from tanks or fittings;
- have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage;
- be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination;
- where not frequently inspected, be fitted with a high-level probe and an alarm as appropriate;
- have fill points within the bund where possible or otherwise provide adequate containment;
- be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).

Bund general arrangement should take account of primary containment failure modes

- Avoid jetting (CIRIA 164 p.143 & 144)
- Reduce overtopping (CIRIA 164 p. 140 & HSE RR333)
- Slope floor away from tanks (CIRIA 164 p.144 & IP 2, 3.3.19.3 & HSG 176 para 148)
- Promote simple shape & compartmentation (CIRIA 164 p.141)

See risk control measure

Proposed standards for new and partially new installations

ASTs shall be bunded to provide secondary containment. Double-skinned ASTs shall also be bunded due to the risks from the full range of failure modes, including overtopping, fire/explosion, pipework failures and escalation.

Actions for improvements of existing installations

It is a matter of good practice that ASTs shall be banded to provide secondary containment.

Regulator compliance actions

For ASTs without secondary containment regulators need to consider whether the **measures for the establishment as a whole or in part are seriously deficient** and consideration should be given to prohibition. The minimum expected enforcement action in this case is Improvement Notice. .

Further information

A bund is a facility (including walls and a base) built around an area where potentially polluting materials are handled, processed or stored, for the purposes of containing any unintended escape of material from that area until such time as remedial action can be taken.

Reference: CIRIA report 164⁷ Section 10.2

The purpose of a bund also includes providing a delineated zone around a tank or tanks which provides protection against vehicle strikes.

Reference: Process Safety Leadership group

Secondary containment in the form of cavity wall and base construction (i.e. double-skin) is sometimes built into primary containment steel tanks and vessels (e.g. to BS 5500 (BSI,1996)) to control leakage, and for safety reasons. The false bottom of such tanks is fitted with leakproof inspection hatches enabling access for maintenance purposes. Each skin of a double-skin tank should be designed to withstand the same loading as a single-skin tank, with consideration given to additional pressures which may arise from a sudden rupture of the internal skin. Other construction systems include specially designed impermeable foundations which provide for leakage monitoring, interception and collection.

Reference: CIRIA report 164 Section 12.1

Associated risk management measures for double-skin tanks include quick response inventory management techniques to detect loss of containment – given that the leak collection layer will not have the same capacity as a bund. Measures are also required to remove any liquid from the collection layer [which may involve significant risk if flammable or toxic substances are involved], to monitor the condition of the lower floor and to provide ancillary secondary containment.

Reference: Process Safety Leadership group

While priority should be given to preventing a loss of primary containment, adequate secondary and tertiary containment remains necessary for environmental protection in the event of a loss of primary containment of hazardous substances. The failure of secondary and tertiary containment at Buncefield contributed significantly to the failure to prevent a major accident to the environment (MATTE).

Reference: BSTG Final Report paragraph 158

Containment Policy Control Measure

Bunds shall be impermeable

Current recognised good practice standards

Bund wall and floor construction and penetration joints should be leak-tight. Surfaces should be free from any cracks, discontinuities and joint failures that may allow relatively unhindered liquid trans-boundary migration. As a priority, existing bunds should be checked and any damage or disrepair, which may render the structure less than leak-tight, should be remedied.

Reference: BSTG Final Report paragraph 159

A bund should be 'liquid-tight'.

Reference: HSG 176 clause 146

The floor of the bund should be of concrete or other material substantially impervious to the liquid being stored,

Reference: HSG 176 clause 147

Note for regulators

Tank compounds should be made impervious to safeguard groundwater resources against pollution from spillage or leakage. Guidance is given in CIRIA Report No. 164 Design of containment systems for the prevention of water pollution from industrial incidents.

All expansion and construction joints should be similarly impervious and be fire-resistant.

Reference: IP Model Code of Safe Practice, Part 2, 2005

Chapter 10 of CIRIA 164 provides the full range of detailed guidance for bund design and 10.4 for reinforced concrete bunds. 10.4.1 states bunds should be designed and built to comply with the requirements of BS 8007: 1987.

Particular care must be taken by operators to ensure construction methods, as well as design, ensure the bund is liquid tight. A concrete bund (which is seemingly impermeable) may still leak if constructed poorly (e.g. poor mixing between pour of concrete layers resulting in fissuring of the structure, voids left in the concrete, presence of point specific pathways such as tie-bar holes). CIRIA 164, Appendix 9 provides guidance for bund construction, which although focussed on small bunds, does provide an indication of construction techniques required to ensure the structure is liquid-tight. The "Civil Engineering Specification for the Water Industry", published by WRc, provides further guidance on design and construction of structures where liquid-tightness is required.

The current good practice standard for the construction of reinforced concrete bunds is BS 8007:1987 *Code of practice for design of concrete structures for retaining aqueous liquids*. Bund joints are currently required to be rendered leak-tight by the adoption of flexible barriers such as water stops and sealants, bonded into or onto the concrete joint surface.

Reference: BSTG Final Report paragraph 163

The following documents contain important information relating to the design and installation of tanks and containment systems:

- BS EN 14015:2004 Specification for the design and manufacture of steel tanks for the storage of liquids at ambient temperature and above;
- EEMUA publication no. 183 Guide for the Prevention of Bottom Leakage from Vertical, Cylindrical, Steel Storage Tanks;
- API 650 Welded steel tanks for oil storage.

BS 8007 is concerned with structures retaining aqueous liquids and does not specify the use of hydrocarbon-resistant and/or fire-resistant expansion or movement joints. Therefore reference should also be made to the reinforced concrete standard **BS 8110** with the fitting of stainless steel folded water stop sections for expansion joints (as in BSTG 180) or the fitting of stainless steel plates against joints to improve fire resistance and fire-resistant sealants complying with **BS 476**.

Where possible the bund joint sealants should also have resistance to hydrocarbon attack.

Note for regulators

Other metal waterstops, such as copper, are known to have been installed in bunds for storage of flammable liquids. The CA does not currently recognise any one metal type as being preferential to another and the operator should assess and justify specific choice of material of construction.

Retrofit of metal plates has not been proven to give the same degree of liquid-tightness as waterstops, which are integral to the bund structure.

For manufactured or fabricated bunds if the design and construction was in accordance with the relevant Standards and/or Codes of Practice, the bund design can be considered to be leak-tight.

Reference: Process Safety Leadership group

Note for regulators

In addition to design and construction, the bund also needs to be inspected and maintained in accordance with good practice for the bund to be considered leak-tight / liquid-tight. Please refer to the Containment Policy Control Measure "The bunds shall be subject to periodic inspection and certification by a competent person regarding their condition and performance".

For **earth bunds** the floor permeability should not be greater than the equivalent of a 1m depth of soil with a permeability coefficient of $10^{-9} \text{ m}\cdot\text{s}^{-1}$.

References: CIRIA Report 164 s10.3.1; s10.3.9; Box 10.1 page 139
PPG 2
PPC S1.02

Note for regulators

For further guidance on earth bunds see EA Technical Enquiry Directory IR39 and CIRIA 164, section 11 and appendix A13 & A14. BS 5930:1999, "the code of practice for site investigations", is a UK code of practice published in October 1999 by the British Standards Institute. BS5930:1999 is due to be updated on completion of the UK Annex for Eurocode 7 "Geotechnical Design".

In addition to concrete and earth, the use of liners and lining systems can be used to make bunds leak-tight. Some information is provided in CIRIA 164. A key issue is how to incorporate a lining system with existing tanks. Lining a bund floor up to the tank annulus does not provide leak protection under the tank base and under the tank base presents a weak point. Tanks can be lifted and a lining system installed under the tank. Lifting tanks presents additional risks both in terms of safety during the actual operation and introducing stresses to the tank infrastructure.

Reference: CIRIA 164 page 183 section 11.8.1 Types of liner and lining systems

Note for regulators

BS EN 14015 provides detail of typical tank foundation design, including bitumen sand mix, membranes, geotextiles and tell tale drains. Tank foundation design is important for tank integrity and incorporation of secondary containment. CIRIA 164, section 12 provides further guidance. Once installed, membranes are almost impossible to inspect and the likelihood of puncture, allowing a leakage pathway needs to be both minimised by design and construction methods, but also recognised in risk assessments and emergency plans.

Tanks may also be fitted with a false floor, combined with measures for leakage monitoring, interception and collection, however, experience has shown that jacking tanks to replace tank foundations may be preferable. This matter is being referred to the PSLG WG6 (mechanical integrity).

Proposed standards for new and partially new installations

Whilst the expectation is that many, if not most, new build bunds will be of concrete construction, other constructions may be allowed provided they result in an impermeable bund, have adequate strength and durability and can meet all the Containment Policy Control Measures. The CA should require a satisfactory construction quality assurance report on the new bund to be submitted prior to use of the equipment and tanks in the bund.

A new structure exhibiting any cracks, discontinuities and joint failures must not be in operational use.

New concrete bunds will be expected to have complete engineered and reinforced concrete floors and walls designed and built to the appropriate standard (BS 8007 plus

additional measures to ensure performance requirements such as fuel and fire resistance).

For earth bund floors – the permeability should not be greater than the equivalent of 1m depth of soil with a permeability coefficient of 10^{-9} m.s^{-1}

The requirement for bunds to be impermeable shall also apply to bund floors under tanks, (i.e. tank foundations / bases). The permeability of tank foundations should not be greater than the equivalent of 1m depth of soil with a permeability coefficient of 10^{-9} m.s^{-1}

Actions for improvements of existing installations

It is a matter of good practice that:

- a bund should be leak-tight.
- the operator has a programme of inspection and maintenance and that defects are repaired as soon as possible.

For existing concrete bunds operators need to determine to what standard the bund was designed and constructed (i.e. was it constructed to a liquid retaining standard). Failure to adhere to the requirements of standards such as BS 8007 can lead to the introduction of potential leakage pathways through concrete slabs and through the joints between them.

Existing non-concrete bunds will not be expected to be replaced with reinforced concrete if permeability and other relevant performance parameters, meet or are improved to meet minimum good practice standards. Permeability in any part of floor (including tank foundations) not greater than the equivalent of 1m depth of soil with a permeability coefficient of 10^{-9} m.s^{-1} . In certain circumstances, following detailed environmental risk assessment, a maximum permeability 10^{-7} m.s^{-1} may be acceptable for earth bund walls and bund floors, but this must be combined with a maximum permeability 10^{-9} m.s^{-1} for tank foundations. These permeability rates may be achieved by the presence of natural clay, however there must be no evidence of fissured or fractured ground, seams of gravels or other natural pathways through the clay under bund and regulators should seek an engineered solution wherever it is reasonably practicable to do so.

Operators need to determine the form of design and construction of tank foundations, Additional measures to provide suitable assurance of primary containment integrity and leak detection may be required. If necessary, tank bases and foundations should be upgraded when a tank is brought out of service – this shall be at the earliest opportunity.

Regulator compliance actions

Any enforcement response is dependant on the scale of dis-repair or design and construction deficiencies and whether it has rendered the bund liable to leak. Serious dis-repair or likelihood of leakage must be a priority for the operator and failure to commit to an immediate improvement should attract an Improvement Notice. In the case where a bund is not proven to be impermeable the CA also needs to consider whether the measures for the establishment as a whole or in part are seriously deficient and consideration should be given to prohibition.

Regulators should seek confirmation from operators of bund design *and* construction i.e. as-built standards. Where standards are in doubt operators should undertake a suitable structural survey to confirm as far as practicable the as-built structure. It is critical that if

surveys have been carried out that the operators act on any recommendations. Failure to do so, within a reasonable time, would provide good reason for the regulator to take enforcement action.

Regulators should confirm design and construction standards used. Where standards are in doubt sites should demonstrate the actual (not literature-based) permeability and liquid-tightness of bund floors and walls.

If the as-built structure cannot be confirmed to adhere to good practice standards then, in addition to giving consideration to improvement action, the increased risk of secondary containment failure needs to be considered in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments)

Further information

When an operator may have to replace a tank or a tank floor, this should be an opportunity to replace or undertake remedial work on the foundations and incorporate an impervious membrane under the whole of the tank.

Permeability criteria are only fully relevant to floors, and walls to the extent that they are in permanent contact with the ground and leaks could potentially continue undetected for extended periods. For walls generally (except for excavated bunds), leak-tightness is the most relevant criterion. A maximum permeability 1×10^{-7} m per second may be acceptable for earth bund walls and bund floors with a maximum permeability 1×10^{-9} m per second required for bund floors underneath tanks.

BS8110 will shortly be replaced by EN1992 Eurocode 2 Part 1-1. For the purpose of enhanced fire resistance of bund joints [see policy statement section 7] Eurocode 2 should be used in conjunction with BSTG Final Report paragraphs 161 - 181.

Eurocode 2 does facilitate a structural design that is fire resistant for a duration of 4 hours maximum and that can eliminate expansion joints. Detail on joint design is weak and no guidance is given on fire resistance.

Reference: Process Safety Leadership group

Note for regulators - use of geo-membranes/geo textile bund lining systems

The use of geotextiles – for example bentonite – is becoming more common in the sector. The suitability of the proposed system should be determined on a case by case basis. No guidance currently exists and this may be subject to further work by the PSLG and may include both the use of lining systems for bunds and provision of secondary containment underneath tanks.

Containment Policy Control Measure

Bunds shall have adequate corrosion resistance.

Current recognised good practice standards

Bunds and bund joints should be resistant to corrosion by water and contained liquids.

Note for regulators

Bunds shall be capable of withstanding the material which escapes from the primary storage: a bund must be able to resist the effects of damaging materials which escape from primary containment, without collapsing or leaking, for the specified retention period (normally eight days)

Reference: CIRIA 164 s.10.3.11 p. 152

Retention period may require to be greater than eight days and will be dependent on foreseeable emergency response / recovery scenarios, including practicable rate of product uplift.

Proposed standards for new and partially new installations

Bund materials of construction will be expected to be resistant to water and proposed contents of tanks

Actions for improvements of existing installations

Where necessary additional measures should be pre-planned to be taken to avoid prolonged contact of incompatible liquids with bund surfaces

Regulator compliance actions

Sites should be able to demonstrate a suitable assessment of material compatibility with bunds in their Safety Management System. If absent the operator should be given the opportunity to address this.

If the as-built structure cannot be confirmed to adhere to good practice standards then, in addition to giving consideration to improvement action, the increased risk of secondary containment failure needs to be considered in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments)

Further information

None

Containment Policy Control Measure

Bunds shall have adequate strength and durability.

Current recognised good practice standards

Design durability life of 50 yrs or more unless otherwise specified.

Reference: CIRIA Report 164 s10.3.1

Bund should be capable of withstanding the static and hydrodynamic loads associated with;

- release of liquid from primary storage tanks
- release of water from hoses during fire fighting operations
- wind (50-year design life)
- potential impact by site vehicles (if not protected by barriers).

Reference: Chemical storage tank systems – checklists (CIRIA publication W003)

Note for regulators

Every main compound wall should be substantially impervious to liquid and of sufficient strength to withstand the pressure to which it would be subjected if the space within the tank compound were filled with water. Consideration may also be given to the forces that may be generated by a sudden release of tank contents.

Reference: IP Model Code of Safe Practice, Part 2, 2005

CIRIA report 164, sections 10.3.10 “Strength” and 10.3.11 “Durability” provide further guidance, a summary of which is provided in Box 10.1, p.139.

HSE report RR333 “An experimental investigation of bund wall overtopping and dynamic pressures on the bund wall following catastrophic failure of a storage vessel” gives a correlation by which operators can estimate dynamic pressures at the bund in the event of catastrophic tank failure and hence whether design forces could be exceeded, risking bund collapse (plus overtopping considerations).

Construction of reinforced concrete bunds should be to an appropriate standard e.g. **BS8007 or BS 8110**. (See references to Eurocode 2 and 6)

References: BS476
CIRIA 164 s10.3 p 139, p154

Proposed standards for new and partially new installations - concrete

Bunded areas will be expected to have complete engineered and reinforced concrete floors and walls to the appropriate standard and to have a satisfactory construction quality assurance report.

Actions for improvements of existing installations - concrete

Where appropriate design and construction standards cannot be demonstrated for existing bunds, a documented inspection report and if necessary testing by a competent person will be required.

Regulator compliance actions - concrete

Regulators should confirm design and construction standards. Where these are in doubt survey/ testing to establish basic fitness for purpose should be enforced.

If the as-built structure cannot be confirmed to adhere to good practice standards then, in addition to giving consideration to improvement action, the increased risk of secondary containment failure needs to be considered in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments)

Further information

Note: BS 8007 is not directly intended for design of bunds to contain substances other than water. Enhanced fire resistance to be specified for bunds containing flammable liquids.

BS 8007 is concerned with structures retaining aqueous liquids and does not specify the use of hydrocarbon-resistant and/or fire-resistant expansion or movement joints. Therefore reference should also be made to the reinforced concrete standard **BS 8110** with the fitting of stainless steel folded water stop sections for expansion joints (as in BSTG 180) or the fitting of stainless steel plates against joints to improve fire resistance and fire-resistant sealants complying with **BS 476**.

Reference: Process Safety Leadership group

Note for regulators

Other metal waterstops, such as copper, are known to have been installed in bunds for storage of flammable liquids. The CA does not currently recognise any one metal type as being preferential to another and the operator should assess and justify specific choice of material of construction.

Retrofit of metal plates has not been proven to give the same degree of liquid-tightness as waterstops, which are integral to the bund structure.

Earth/clay bunds are often standard practice for older and/or larger installations, and range in construction from walls simply profiled (constructed made from soil removed for tank foundation works) and floors of existing subsoil, to engineered clay-lined earth structures to an appropriate standard.

References: BS5628
CIRIA Report 164 s4.3.3, s11.2, s11.2.4

Proposed standards for new and partially new installations – earth/clay

Walls should be capable of withstanding erosion by fire-fighting water and hydrodynamic forces resulting from catastrophic tank failure or weathering (wind/rain action). Durability life of 20 years should be designed for.

Actions for improvements of existing installations - earth/clay

Existing bunds will be expected to be able to demonstrate adequate strength and durability, by reference to appropriate constructional standards used. Where these are not available inspection and testing should be used e.g. analysis of core samples.

Regulator compliance actions - earth/clay

Regulators should confirm design and construction standards. Failure to provide evidence of constructional standards and/or evidence from inspection or an incident indicating that the integrity of the bunds is in doubt, survey/ testing to establish basic fitness for purpose should be enforced.

If the as-built structure cannot be confirmed to adhere to good practice standards then, in addition to giving consideration to improvement action, the increased risk of secondary containment failure needs to be considered in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments)

Masonry:

The use of masonry bunds on older installations may have un-reinforced or reinforced masonry bund walls.

Reference: CIRIA Report R164 s10.5

Proposed standards for new and partially new installations - masonry

Unreinforced masonry construction is not considered to meet current good practice standard for other than small bunds or where containing tanks storing non-hazardous liquids. Reinforced construction is acceptable.

Actions for improvements of existing installations - masonry

Existing bunds will be expected to be able to demonstrate adequate strength and durability, by reference to appropriate constructional standards used and/or by testing. Unreinforced masonry bunds will be expected to be replaced or augmented to provide adequate strength and durability

Regulator compliance actions - masonry

Regulators should confirm design and construction standards (in terms of both permeability and structural integrity). Where these are in doubt survey/ testing to establish basic fitness for purpose should be enforced. Anything below good practice standards – for example unreinforced construction can be seen as seriously deficient.

If the as-built structure cannot be confirmed to adhere to good practice standards then, in addition to giving consideration to improvement action, the increased risk of secondary containment failure needs to be considered in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments)

Containment Policy Control Measure

Bunds shall have the minimum number of tanks within each bund in line with good practice

Current recognised good practice standards

The number of tanks within a bund should comply with relevant HSE and industry guides with respect to separation distances.

References: HSG 176 The storage of flammable liquids in tanks
IP Fire precautions at petroleum refineries and bulk storage installations: model code of safe practice part 19

Proposed standards for new and partially new installations

In accordance with HSG 176 [re spacing] – refer to <http://www.hse.gov.uk/comah/sragtech/techmeassegregat.htm>

Actions for improvements of existing installations

Spacing between tanks is the key criteria rather than the number of tanks. It may be better to have more, smaller tanks on a risk and operability basis

Regulator compliance actions

This measure would not be a priority for action unless in connection with another deficient measure

Further information

None

Containment Policy Control Measure

Bunds shall have incompatible materials stored in separate bunds

Current recognised good practice standards

It is important that multiple tank storage systems containing different chemical types or adjacent separate systems that store chemicals that may react with each other, are not located within the same bund [It is also good practice not to store toxic and flammable chemicals in the same bund]. The extent of the separation required should be determined by risk assessment.

Reference: CIRIA C598 Section 3.4.1

Proposed standards for new and partially new installations

Risk basis should be applied for likelihood of mixing through accident. HSG 71 Chemical warehousing: the storage of packaged dangerous substances 2nd edition ISBN0 717614840 addresses the key issues – but is aimed at the chemical warehousing sector. Table 1 [pages 24 – 25] provides recommendations for the segregation of dangerous

substances according to their hazard classification.

Actions for improvements of existing installations

See “Proposed standards for new and partially new installations”

Regulator compliance actions

Sites should be able to demonstrate a suitable assessment of material compatibilities in their SMS. Should only be considered following discussion with HSE colleagues.

Further information

None

Containment Policy Control Measure

Bunds shall have sufficient capacity to allow for tank failure and firewater management. This will normally be a minimum capacity of either 110% of the capacity of the largest tank or 25% of the total capacity of all the tanks within the bund whichever is the greater.

Current recognised good practice standards

Note for regulators

When calculating bund capacity, tank capacity is defined as the maximum volume of the tank at which point the tank would overflow (also referred to as brimful capacity).

When estimating the bund capacity, the space occupied by other tanks should be taken into account. i.e. the space occupied by tanks other than the largest one cannot be considered as available for secondary containment and their volume (up to height of bund wall) must be deducted from the overall geometric bund size.

Reference: HSG 176, item 140

Where significant, tank supports and other intrusions also need to be allowed for CIRIA 164, 9.4 (p.120).

The core principles are that secondary containment should be capable of containing:

- the total volume of substance that could be released during an incident;
- the maximum rainfall that would be likely to accumulate in the secondary containment either before or after an incident;
- fire fighting agents (water and/or foam), including cooling water;

where bunds are used they should have sufficient freeboard to minimise the risk of substance escaping as a result of dynamic factors such as surge and wave action.

Reference: CIRIA 164

The minimum capacity for bunds containing tanks in scope at existing installations is 110% of the largest tank.

Reference: BSTG Final Report paragraph 182

Where a single bulk liquid tank is banded, the recommended minimum bund capacity is 110% of the capacity of the tank.

Reference: CIRIA 164

110% does not always provide provision for fire scenarios which may affect several tanks and involving the application of firewater and other agents.

Reference: CIRIA 164

The factors to be taken into account when sizing bunds to deal with multi-tank failure scenarios and fire water management, plus the capacity for remote [tertiary] containment systems, are:

- a) Primary capacity - 100% of primary capacity. Consider the possible failure modes and where appropriate, include the capacity of all primary tanks in multi-tank installations, incidence of multiple tanks in one bund and where tanks are hydraulically linked in which case they should be treated as if they were a single tank.
- b) Rainfall - subject to operational procedures, in order to calculate the volume to be contained, allow for a 10 year return, 8 days rainfall prior to the incident, and a 10 year return, 24 hour rainfall, plus an allowance for rain falling directly on to remote containment and areas of the site draining into it, immediately after the incident. The post-incident component and the allowance for dynamic effects (see e) are not additive.
- c) Fire fighting and cooling water - Allow for the volume of extinguishing and cooling water delivered through fixed and non-fixed installations based on BS5306, VCI, CEA, ICI and Institute of Petroleum methodologies, with appropriate adjustments in the light of the particular circumstances. Consultation with the regulators and the fire service essential.
- d) Foam - Allow a freeboard of not less than 100 mm.
- e) Dynamic effects - this is to allow for the initial surge of liquid and for wind-blown waves.
- f) In the absence of detailed analysis, allow 250mm (750 mm for earth walled bunds).

Reference: PPG 18

Note for regulators

With respect to

f) In the absence of detailed analysis, allow 250mm (750 mm for earth walled bunds).

reference to 250 or 750 mm is in relation to required freeboard (CIRIA 164, Chapter 9.7). Further detail on bund capacity calculations can be found in CIRIA 164, Chapter 9, and summarised in 9.8, p.133.

Other references: PPG2 [Appendix B]
Control of Pollution (Oil Storage) (England and Wales) Regulations 2001
Energy Institute IP Model Code of Safe Practice Part 19
HSG 176
PPC 1.02

Proposed standards for new and partially new installations

Bund capacity must meet 110% or 25% rules, whichever is the greater. Capacity over and above this must provide adequate additional capacity for fire-fighting/cooling water and foam accumulation, the additional volume to be determined to reflect credible worst case scenarios.

Consideration should be given to dynamic effects resulting from catastrophic or major primary containment failure. These additional allowances are not additive, but design capacity (including tertiary containment) should be adequate to contain worst-case foreseeable liquid volumes.

Secondary and tertiary containment combined should have adequate capacity to contain firewater and/or contained polluting substances released or generated in a major accident

In some cases it may be disproportionate to size bunds to be able to fully contain the dynamic consequences of a catastrophic tank failure. Tertiary containment provisions should be taken into account.

Actions for improvements of existing installations

Bunds which do not meet the 110% capacity minimum must be upgraded. 110% of the maximum capacity of the largest shall be considered as the minimum standard. In addition, operators should aim to provide for 25% of the total capacity of all tanks within the bund if this is greater and the cost of doing so is not grossly disproportionate.

Alternatively, primary containment volume could be reduced appropriately to comply, but this reduction in volume should be by physical means to reduce the brimful capacity (e.g. installation of false tank floor or decommissioning of one or more tanks within a bund) as opposed to alteration of tank gauging/alarm levels.

The requirement for additional capacity for credible failure and fire scenarios should be established by risk assessment.

The risk assessment for secondary containment capacity should take into account available tertiary capacity.

Regulator compliance actions

Regulators should confirm that bund capacities have been calculated. For earth bunds, operators should periodically review (re-calculate) capacity to take into account potential for erosion of the bund with subsequent reduction in bund capacity (see bund inspection and certification control measure).

110% minimum capacity should be enforced as minimum good practice (but is not

necessarily sufficient to meet All Measures Necessary where flammable substances are stored). Regulators should confirm that the worst-case credible scenario has been used to calculate firewater and polluting liquid volumes likely to require containment management

The 25% rule is an indicative value based on the assumption that although the probability that more than one tank will fail at any one time is relatively low, there should be provision to mitigate the consequences of a major fire, which could affect all of the tanks within a bunded area.

Operators should be assessing where they are against the 25% rule and if it is not being met, providing justification as to why they cannot meet it. In some cases they may be close to it and should be providing an assessment of how the shortfall may be balanced through tertiary measures. Significant deficiency against the 25% measure should be addressed in the same way and a judgement will be required as to whether the shortfall in both the 25% measure and mitigating tertiary measures is acceptable. The presumption is that it is unlikely that the risk will be acceptable in serious cases. Then improvement or prohibition notices should be considered.

See Annex 1 for further guidance on ERA, including credible scenarios.

Further information

Improved measures in terms of overfill protection and tank integrity will reduce the risk from loss of containment. Provision of secondary containment is a good practice measure. However, demonstration of a lower risk associated with primary containment cannot remove the requirement for secondary containment. The starting point for sizing secondary containment provision are the core principles referred to above. The minimum requirement is for secondary containment to provide 110% of the primary containment.

The 25% rule is an indicative value based on the assumption that, although the probability of more than one tank will fail at any one time is relatively low, there should be provision to mitigate the consequences of a major fire that could affect all of the tanks within a bunded area. It addresses the issue of a bund having sufficient capacity to allow for tank failure and firewater management. This provides a buffer to deal with the incident and informs risk assessment as to the degree of tertiary containment that may be required to deal with subsequent failure of secondary containment in a severe and prolonged event. The actual sizing for multi-tank bunds will be determined by the hazard and the risk.

It is recognised that for some multi-tank bunds applying the 25% capacity criterion results in a much larger bund size, which may not be required. For example a bund containing 60000 m³ of tankage in 12 tanks would require 15 000 m³ of bund capacity under the 25% rule and 5 500 m³ under the 110% rule.

Where modification to the bund either by enlargement or partition is not practical, greater emphasis is placed on provision for tertiary containment.

The risk of increasing the potential pool area for a spillage should be considered in bund capacity calculations. For flammable substances this may increase potential radiative effects resulting from a pool fire and for toxic substances the distances downwind to safe concentrations.

Reference: Process Safety Leadership group

Containment Policy Control Measure

Bunds shall have either no rainwater drain or the drain is into a contained and enclosed system requiring positive action for operation

Current recognised good practice standards

Note for regulators

Provision must be made to empty rainwater and other liquids from bunds using mobile or fixed pumps. It is recommended that these are switched manually. It is recommended that bunds should not be equipped with means for gravity discharge, even if lockable valves are provided, unless the bund is part of a properly designed combined system.

Reference CIRIA 164 p.145

See risk control measure

Proposed standards for new and partially new installations

See Containment Policy Control Measure

Actions for improvements of existing installations

Where drains are in place and not routed to secure remote secondary (i.e. another bund) or tertiary containment, they must be removed and replaced with pumped blind sumps or rerouted. Where removal or rerouting is not reasonably practicable, additional integrity assurance measures should be taken to ensure that drains do not provide a pathway for pollutant releases to the environment.

Regulator compliance actions

Regulators should require sites to assess the practicability of removal of drains which do not meet good practice requirements and replacement with pumped blind sumps.

If a site is proposing to rely on a bund drain to an enclosed system requiring positive action regulators should carefully assess the entire system to ensure it is truly enclosed and capable of containing the foreseeable volumes of liquids for a worst case scenario. Any un-enclosed equipment (e.g. typically interceptors) may overflow given sufficient volumes of liquid.

Alternatives include timed valve actuation (i.e. manual open, timed close) or valve interlocked with bund hydrocarbon detection (i.e. liquid leakage detection). Emergency response issues should be included in the assessment

Further information

Many older bunds have rainwater drains, usually to oil interceptors with manually operated valves. Modern installations have blind sumps.

Reference: CIRIA 164 s10.3.5 p145 et seq

Containment Policy Control Measure

Bunds shall have no pipework that penetrates through the bund floor

Current recognised good practice standards

Existing [see stated CIRIA 164 reference] guidance recommends avoiding pipework penetrations. Most installations limit floor penetrations to drainage pipework but some have process and services penetrations.

Reference: CIRIA 164 p145

Bund floor penetration joints are points of inherent weakness where any failure of integrity is very difficult to detect and may continue unnoticed for some time. Consequently, existing bund floor penetrations should be eliminated wherever practicable. Where flexible sealants are used in floor penetration joints, these should be removed and replaced with fire-resistant sealants.

Reference: BSTG Final Report paragraph 177

Proposed standards for new and partially new installations

No pipework penetrations of bund floors should be incorporated into new build or modified installations (except as part of a contained bund drainage system for rainwater or firewater control purposes, though this arrangement should be avoided if possible – see Containment Policy Control Measures regarding bund drainage and firewater management).

Actions for improvements of existing installations

For existing bunds floor-penetrating pipework must be assessed for practicability of removal. Where removal is not reasonably practicable additional integrity assurance measures must be implemented based on the likely risk to environmental receptors.

Regulator compliance actions

Inspectors should require sites to assess the practicability of removal. Demonstration must be made where appropriate of the adequacy of additional integrity measures.

Containment Policy Control Measure

Bunds shall have no pipework that penetrates through the bund walls as far as reasonably practicable otherwise it shall be with adequate sealing and support.

Current recognised good practice standards

Note for regulators

Piercing the walls or floor of a bund, particularly for pipework, introduces a source of potential leakage, and should therefore be avoided (with the exception of overflow pipes for firewater management) unless there is no practicable alternative. Routing pipework over the top of the bund wall, rather than through it, is regarded as essential for high hazard/risk situations and is highly recommended for moderate hazard/risk situations.

Reference CIRIA 164 p.145

The integrity of the bund wall may be put at risk if pipework and other equipment are allowed to penetrate it. If it is necessary to pass pipes through the bund wall, for example to the pump, then the effect on the structural strength should be assessed. Additional measures may be needed to ensure that the bund wall remains liquid tight.

Reference HSG 176

Wall penetrations should not be incorporated into new bunds unless alternative over-wall routings are impracticable. Where wall penetrations are unavoidable, joints should be designed to be fire resistant. Consideration should be given to incorporating puddle flanges cast into the concrete structure.

Reference BSTG Final report para 179

For earth bunds, the following is relevant:-

Unless it is unavoidable, embankments should not be penetrated below the design liquid surface level. Where it is necessary for a pipe to penetrate an embankment, anti-seepage collars should be provided at a spacing of not more than 10 times the pipe diameter. The collar increases the length of the potential seepage pathway and thereby minimises any leakage.

Unavoidable pipe entries through liners should be properly made and positioned so that they can be readily maintained (see Figure 11.7).

CIRIA 164, 11.9 Pipe entries through embankments (p.186)

For penetrations of concrete and masonry, the first option should be to consider re-routing the pipework or other penetrating structures to eliminate the need for the joint. Where this is not practicable, or planned removal is significantly delayed for operational reasons, the fire-resistance of the joint must be improved. The fitting of steel collars, bellows or similar to improve fire resistance at pipework penetrations may introduce local corrosion initiation sites in the pipework, and is therefore not recommended where this may be likely. In such cases joints should be improved by replacing existing sealants with fire-resistant sealants. For penetration of earth bund walls, these joints may be inherently less vulnerable because of the greater joint thickness. However, insufficient information has been considered to allow reliable guidance to be produced for this case. Joints should be assessed on a site-specific basis.

Reference: BSTG Final Report paragraph 175

Existing guidance recommends avoiding pipework penetrations but most installations have many examples of it.

Reference: CIRIA 164 s10.3.5 p145

There can be a trade-off as lower routing allows for possible protection by water layer.

Reference: Process Safety Leadership group

Proposed standards for new and partially new installations

See Containment Policy Control Measure

Risk assessment to determine practicability of avoiding pipework penetration should take into account environmental sensitivity of installation surroundings

Actions for improvements of existing installations

For existing bunds wall-penetrating pipework must be assessed for practicability of removal. Where removal is not reasonably practicable additional integrity assurance measures must be considered based on risk to environmental receptors.

Regulator compliance actions

Inspectors should require sites to assess the practicability of removal or upgrade. Enforcement of removal or alternative measures should be based on the outcome of the agreed risk assessment methodology.

If the CA accepts that it is not practicable to remove all pipework and re-instate the wall to an acceptable standard then the (likely) risk of the bund wall failing at the location of pipe penetration needs to be reflected in the tertiary containment plan and emergency plans (i.e. through introduction of additional source/pathway considerations into their Risk Assessments). Retrofit of puddle flanges or anti-seepage collars would lower, but not eliminate, the risk of bund failure at pipe penetrations.

Further information

None

Containment Policy Control Measure

The bunds shall be subject to periodic inspection and certification by a competent person regarding their condition and performance.

Current recognised good practice standards

Note for regulators

BS 8007, section 9 refers to wet testing of the structure whilst CIRIA 164 notes this may not be feasible for some installations due to presence of process equipment in the bund. Wet tests should be discussed with operators on a site specific basis. Even a partial wet test (filling the bund to a limited level or combining inspection with testing of firewater

systems) can be beneficial with regard identification of low level leakage pathways.

Repaired cracks in existing concrete and masonry bund surfaces must be assessed for significance with regard to the potential to fail in a fire scenario, resulting in loss of secondary containment. Where cracks are superficial, improvement may not be required, but where cracks are significant, the flexible sealant used must be replaced by fire-resistant sealants.

Reference: BSTG Final Report paragraph 178

Proposed standards for new and partially new installations

Thorough visual inspection should be made annually by a competent person, the outcome documented and certification and maintenance recommendations made. Intermediate routine inspection by operational personnel should be documented and to a suitable methodology. These should make use where appropriate of observed rainwater accumulation.

Operators can also usefully combine inspection with times of addition of water into the bund (e.g. from testing of firefighting systems) which can indicate location of leakage pathways more effectively than at times of rain, (during rain both inside and outside of the bund will be wet making it harder to locate leakage than when the outside of the bund is dry)

Operators should define minimum competency and training required for bund inspection and certification, but inspectors should ensure that roles have been identified for the following activities:

- Routine inspection (e.g. daily / monthly)
- More detailed inspection / testing of integrity (annually or additionally if required as a result of routine inspection findings)
- Detailed engineering review of suitability of the bund and compliance of whole bund structure with good practice (i.e. benchmarking with standards, codes and practice both in place at time of construction and newer ones). This may take place at time of review of safety reports or every 5 years or as a result of deficiencies identified by other inspection and testing or lessons learnt from incidents.

The competency required for a detailed engineering review or inspection / testing of integrity (e.g. requiring a chartered civil or structural engineer) can be seen to be different from the competency required for routine inspection.

Planned maintenance shall include planned sealant replacement frequency, based on sealant manufacturer recommendations and overall bund design lifetime.

Actions for improvements of existing installations

See proposed standards for new and partially new installations

Regulator compliance actions

Agency inspectors should confirm and review sites' various bund inspection, assessment and planned maintenance regimes and methodologies used, and assess their adequacy. Absent or inadequate regimes and methodologies should be challenged.

An inspection and maintenance programme should be an element in the operator's safety management system. If absent the operator should be required to address this.

Further information

Regular "housekeeping walk-around" inspections are common, although the results are usually not recorded. This should be against specific criteria and a system which will require significant defects to be recorded, assessed further and if necessary improved.

Routine inspection should be supported by more detailed and documented inspection to an adequate methodology by a competent person who has been adequately trained. For more complex and/or critical assessments, this may increase the need for inspection by suitably trained personnel and certification by a chartered civil engineer.

Hydrostatic testing is referred to in CIRIA 164 [s10.3.9]. There are risks with hydrostatic testing that should be considered. Immersion of the tank floor may result in instability and could force water under the tank floor leading to corrosion.

Reference: Process Safety Leadership group

Policy Statement Reference 7 Bunding and fire controls

ASTs containing substances that are flammable, highly flammable or extremely flammable shall be bunded to provide secondary containment of the dangerous substance as stated in policy statement references 6 and 7 above and in addition shall have the following the risk control measures.

Containment Policy Control Measure

Bunds shall have adequate capacity and design to allow fire prevention and control measures to be taken.

Current recognised good practice standards

Note for regulators

Consideration should be given to providing secondary containment systems for handling firefighting water. In the United Kingdom reference should be made to Environment Agency Publication PPG18 Control of spillages and fire fighting run-off, and to Guidance Note, EH70: The control off firewater run-off from CIMAH sites to prevent environmental damage, published by the Health and Safety Executive.

Reference: IP Model Code of Safe Practice, Part 2, 2005

Well-planned and organised emergency response measures are likely to significantly reduce the potential duration and extent of fire scenarios, and so reduce firewater volumes

requiring containment and management. Site-specific planning of firewater management and control measures should be undertaken with active participation of the local Fire and Rescue Service, and should include consideration of:

- bund design factors such as firewater removal pipework, aqueous layer controlled overflow to remote secondary or tertiary containment (for immiscible flammable hydrocarbons);
- recommended firewater/foam additive application rates and firewater flows and volumes at worst-case credible scenarios; and
- controlled-burn options appraisal, and pre-planning/media implications.

Reference: BSTG Final Report paragraph 183
CIRIA R164 page 121 section 9.6.1
PPG 28

Detailed guidance on methodologies to determine required overall capacity including firewater from typical application rates of water, foam and other agents can be found in the **Energy Institute IP Model Code of Safe Practice Part 19: Fire Precautions at Petroleum Refineries and Bulk Storage Installations Annex D**

Risk assessment should consider the worst-case scenario for the fire event. For fuel depots this is considered to be either the largest tank in a single bund or the largest group of tanks in a single bund.

Reference: BSTG Final report paragraph 305 page 60

Note for regulators

IP19 (and HSG 176) establish the requirements for application rates and typical duration of application of firewater to control or extinguish a fire. These are minimums required by good practice. During an incident total firewater volumes may exceed that suggested by IP19 or HSG 176 due to factors including:

- The scale of incident scenario exceeding that anticipated in IP19
- A failure to extinguish the fire in the timescale anticipated
- Fire Brigade importing additional water to the existing firewater supply
- The ongoing need to maintain foam blankets after a fire is extinguished and prior to product uplift

It has been recognised that IP 19 (2007) may require further review and possibly revision due to release of additional findings of the Buncefield investigation (see forward note).

Work on understanding the Buncefield explosion mechanism is ongoing. Until this is complete it cannot be concluded what the credible worst-case scenario may be in terms of petroleum Vapour Cloud Explosion. However, other credible scenarios as identified by review of historic incident data (including tank explosions and escalating fires) indicates that an incident could readily escalate beyond the tanks in a single bund.

Understanding potential volumes of firewater requires dialogue between operators and the Fire Brigade. Total volumes may be reduced by reuse of water (e.g. uncontaminated cooling water), if this is acceptable to the Fire Brigade.

Risk assessments should include the typical magnitude of fire-fighting media application rates.

Reference: Model code of safe practice Part 19
HSG176

Reference can also be made to Verband der Chemischen [VCI Germany] European Insurance Commission guidelines for calculating capacity of fire fighting water retention.

Reference: CIRIA Report No. 164

Proposed standards for new and partially new installations

See Risk Control Measure

Emergency planning must take account of worst-case credible scenarios. Note: Total containment of fuel and firewater by secondary containment alone may not be ALARP. The aim should be total containment of firewater quantities (by secondary and tertiary containment combined).

Actions for improvements of existing installations

Existing installations should be subject to risk assessment to determine secondary containment capacity requirement and beyond this the requirement for additional measures such as transfer of fuel and/or firewater to remote secondary (other bunds) or to tertiary containment. Risk of transferring fuel elsewhere needs to be considered

The start-point should be that secondary containment capacity will be exceeded and only where consequent environmental impact, considering installed tertiary containment capacity and design is not potentially serious should capacity be judged adequate.

Where there is insufficient installed secondary containment capacity additional measures should be taken including consideration of remote secondary containment, tertiary containment and firewater minimisation e.g. by recycling equipment provision, controlled burn pre-planning.

Regulator compliance actions

Regulators should confirm sites' assessment of capacity and design requirements, and their installed fire(water) control measures, based on worst case credible scenarios.

Regulators should review or partake in the discussions that should take place between operators and the fire brigade to determine potential firewater volumes and planned firewater management strategy.

Further information

HSG 176 quotes the requirement of an application rate of 10 l/min/m² for a pool fire at the tank base, fire engulfment. The application rate of 2 l/min/m² is the minimum application rate for a tank exposed to radiation from a non-impinging fire.

Reference: HSG176
Process Safety Leadership group

Like Eurocode 2, Eurocode 6 does not cover fire resistance in bunds and requires supplementary reference to BSTG report.

Containment Policy Control Measure

Bunds shall have fire resistant structural integrity, joints and pipework penetrations.

Current recognised good practice standards

Note for regulators

Compound walls should be fire-resistant and substantially impervious.

All expansion and construction joints should be similarly impervious and be fire-resistant.

Reference: IP Model Code of Safe Practice, Part 2, 2005

Improvements should be made to the fire-resistance of bund joints by suitable protection (e.g. metal plate covering) and/or by the use of fire-resistant sealants.

Reference: BSTG Final Report paragraph 175

Bund floor construction joints: For concrete bund floors, vulnerability to fire should be capable of being reduced by managed emergency response measures such as maintaining an insulating water layer on the bund floor. Removal of existing flexible sealant for replacement with fire-resistant alternatives may result in reduced performance with regard to water tightness. Floor joints nevertheless remain potential weaknesses for loss of integrity in a severe pool fire. A case-by-case assessment of floor joint fire-resistance improvement options should be made.

Reference: BSTG Final Report paragraph 176

For new bunds, to achieve the maximum practicable fire resistance for bund joints the following additional measures should be taken:

- **Bund wall and floor construction joints:** Joints should be designed to be fire resistant. Consideration should be given to incorporating stainless steel waterstops and expansion joints bonded into the structure, or stainless steel plates against bund joints in combination with fire-resistant sealant.
- **Bund wall penetration joints:** Wall penetrations should not be incorporated into new bunds unless alternative over-wall routings are impracticable. Where wall penetrations are unavoidable, joints should be designed to be fire resistant.

Consideration should be given to incorporating puddle flanges cast into the concrete structure.

- **Bund floor penetration joints:** Floor penetrations should not be incorporated into new bunds.

Reference: BSTG Final Report paragraph 179

Reference: BSTG Final report paragraphs 161 - 181

Sealant should be both chemically resistant and fire-resistant. Consideration should be given to the chemical resistance of sealants to gasolines in floor joints, otherwise the joint may be compromised by drips/spillages.

Reference: Process Safety Leadership group

New designs are available incorporating stainless steel water stops into bund walls.

Reference: BSTG Final Report paragraph 180

Note for regulators

Other metal waterstops, such as copper, are known to have been installed in bunds for storage of flammable liquids. The CA does not currently recognise any one metal type as being preferential to another and the operator should assess and justify specific choice of material of construction.

Proposed standards for new and partially new installations

Concrete bunds should be designed and constructed to BS 8007, with suitably enhanced specification for fire-resistant floor and wall joints, incorporating metal waterstops, metal fire shielding and/or fire resistant sealants to bund joints. Number of joints should be reduced to the minimum acceptable for control of cracking.

Where pipework penetrations are unavoidable, pipework and joint design should be fire resistant. Penetrations through concrete or earth bunds should incorporate puddle flanges.

Adequately constructed earth bunds may provide better fire resistance than concrete bunds. With adequate performance for other criteria earth bunds may represent good or best practice in site-specific cases.

Actions for improvements of existing installations

Existing relevant installations should implement improved fire resistance to bund joints (BSTG recommendation), by: application of protective steel plates and fire-resistant sealants.

Where necessary relevant bund joints should be improved with regard to fire resistance by means of protective shielding and/or fire resistant sealants.

Regulator compliance actions

Inspectors should confirm the status of sites' implementation of improved fire-resistance.

Buncefield Task group recommendations should be regarded generally as minimum good practice and should be enforced as necessary measures.

Further information

A preventative measure would be to reduce the number of joints within a bund.

Reference: Process Safety Leadership group

The BSTG Final Report makes reference to the following standards:

- BS 8110 Structural use of concrete
- BS 476 Fire tests on building materials and structures

Containment Policy Control Measure

Bunds shall have a means of removing fire water from below the surface of the liquid in the bund (for dangerous substances which are not miscible with water and have a lower density than water).

Current recognised good practice standards

Where bunds may be required to retain flammable liquids which are less dense than water, they should incorporate overflow arrangements which, in the event of the bund capacity being exceeded (e.g. by fire fighting water) will prevent burning liquid spilling over and thereby spreading the fire to other parts of the site. In this situation it is recommended that the overflow pipework does pierce the bund but only in the freeboard zone which would normally be above the level of liquid.

Reference: CIRIA 164 section 10.3.5 page 145

Proposed standards for new and partially new installations

New bunds should have integrated design features enabling removal of firewater and controlled overflow to remote or tertiary containment, and in addition temporary provision as defined by supplementary and contingency plans developed with the input of the Fire Service and PSLG.

There is currently no common technical solution for firewater removal. The hazard posed by bund overtopping (hence fuel overtopping) is clear. However, there are risks associated with various methods proposed for firewater removal. Gravity systems may fail and allow uncontrolled emptying of the bund contents. In addition outflow pipe(s) may need to be substantial in order to allow removal of firewater at the anticipated application rate and the associated wall or floor penetration may cause further bund failure. Pumped

systems rely on site power or the ability of emergency responders to establish sufficient pumping arrangements. Until such time as a common solution is agreed then site specific solutions should be implemented and their risks of failure recognised in risk assessments and emergency plans.

Actions for improvements of existing installations

Existing bunds should be assessed for optimal methodology to implement firewater removal, and appropriate measures should be installed. Site-specific plans should be prepared in liaison with the fire and rescue service.

Regulator compliance actions

Regulators should confirm sites' arrangements as part of emergency response compliance assessment

Further information

Bunds could have either: -

- (a) installed provision of pipework systems that enable liquid removal by suction or pumping of accumulated firewater, and/or
- (b) pre-planned arrangements with the Fire Service to provide suitable facilities to empty the bund.
- (c) Gravity drainage system with lockable valves that is connected to properly designed combined drainage system.

Provision must be made to empty rainwater and other liquids from bunds using mobile or fixed pumps. It is recommended that these are switched manually. It is recommended that bunds should not be equipped with means for gravity discharge, even if lockable valves are provided, unless the bund is part of a properly designed combined system.

Reference: CIRIA 164 section 10.3.4 page 145

Gravity drainage has the advantage in that it is relatively simple, requires no pumping - therefore reducing complexity in an emergency, can be easily monitored and should be drained to a safe area for collection. It also requires bund penetration and for any existing systems the risks associated with any penetration must be weighed against the potential environmental impact.

With controlled bund overflows there are practical considerations that require consideration:

- what flow rate will the overflow be designed for?
- if a pipe is used what head is required to achieve the flow?
- where will the overflow be routed?

For larger bunds this may require 8" or even 10" diameter for larger bunds. This may present difficulties in arranging a line of this size towards the top of a bund wall (almost the height of the free board). One option is to install a valved emergency emptying line which would enable drainage by gravity (or pump if available) from the bund without endangering

personnel. For practical pump priming/drainage reasons there is no reason why this line cannot be correctly designed to run through the bund wall at a lower level. The risks of any additional penetration of the bund wall must be taken into account.

Large volume transfer of liquids is typically more practical for general tank storage sites that tend to have common pipework systems – compared with fuel storage sites that are more reliant on high volume pumps provided by fire service in the event of an incident. These arrangements should be included in on-site emergency plans.

Reference: Process Safety Leadership group

Policy Statement Reference 10 – Tertiary Containment

Tertiary containment plans for establishments storing or using liquid dangerous substances or that may have firewater containing dangerous substances shall be prepared, having regard to the ground and location characteristics of the site.

The term ‘tertiary containment’ is used to describe containment systems and measures to contain potentially polluting liquids which may escape as a result of loss of secondary containment, and would otherwise be released into the environment causing pollution.

Reference: BSTG Final Report paragraph 185

Containment Policy Control Measure

Tertiary containment plans for establishments storing or using liquid dangerous substances or that may have firewater containing dangerous substances shall be prepared, having regard to the ground and location characteristics of the site

Current recognised good practice standards

- a risk assessment should be undertaken to determine the extent of the requirement for tertiary containment, taking into account:
 - foreseeable bund failure modes
 - firewater volumes including firefighting agents;
 - environmental setting
 - known pathways and potential pathways to environmental receptors in the event of failure of secondary containment;
 - likely environmental impact consequences, in terms of extent and severity, of the pollutant and/or firewater quantities and flows resulting from foreseeable bund failure scenarios.

Note for regulators

Further guidance on Environmental Risk Assessment can be found in Annex 1 of this document.

- The size, type and location of tertiary containment should be based on the scope and capacity determined by the site-specific risk assessment,

Reference: BSTG Final report paragraphs 184 – 200

Proposed standards for new and partially new installations

New and partially new installations should implement suitable tertiary containment plans taking into account potential bund failure modes, environmental pathway and receptors.

Actions for improvements of existing installations

See proposed standards for new and partially new installations.

If it is identified that the establishment does not meet the Containment Policy Control Measures, then tertiary containment plans shall reflect this through consideration of potential failure modes and the probability of failure, based on the site specific circumstances for foreseeable scenarios.

Regulator compliance actions

Agency inspectors should review sites' tertiary containment plans for adequacy.

Further information

Tertiary containment is informed by risk assessment taking into account the configuration of primary and secondary containment and the environmental setting of the site. Further information on environmental risk assessment can be found in the COMAH Competent Authority "**Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports**" December 1999 <http://www.environment-agency.gov.uk/business/1745440/444663/comah/1769899/?version=1&lang=e>

Reference: Process Safety Leadership group

Containment Policy Control Measure

Tertiary containment measures shall minimise the consequences of a loss of primary containment from equipment that is not provided with secondary containment

Current recognised good practice standards

Assessment of tertiary containment requirements, i.e. type and capacity should start with an initial worst-case assumption that available secondary containment will fail or capacity will be exceeded, and the consequent firewater flows and directions should be identified and estimated.

Reference: BSTG Final Report paragraph 194

Based on the scope and capacity determined by the site-specific risk assessment, tertiary containment should be designed to:

- be independent of secondary containment and any associated risks of catastrophic failure in a worst-case major accident scenario;
- be capable of fully containing foreseeable firewater and liquid pollutant volumes resulting from the failure of secondary containment;
- be impermeable to water and foreseeably entrained or dissolved pollutants;
- use cellular configuration, to allow segregation of 'sub-areas' so as to limit the extent of the spread of fire and/or polluted liquids;
- operate robustly under emergency conditions, for example in the event of loss of the normal electrical power supply;
- avoid adverse impacts on fire fighting and other emergency action requirements;
- allow the controlled movement of contained liquids within the site under normal and emergency conditions;
- facilitate the use of measures for the physical separation of water from entrained pollutants;
- incorporate practical measures for the management of rainwater and surface waters as required by the configuration;

and

- facilitate clean up and restoration activities.

Reference: BSTG Final Report paragraph 187

Proposed standards for new and partially new installations

Equipment, such as filters, pumps and pipework should be locally banded to provide secondary containment so far as is reasonably practicable.

Adequate remote secondary and/or tertiary containment measures must be installed where equipment containing polluting dangerous substances cannot be fully locally banded.

Actions for improvements of existing installations

Adequate remote secondary and/or tertiary containment measures must be installed where equipment containing polluting dangerous substances is not fully locally banded

Regulator compliance actions

Regulators should confirm sites' provision. Enforcement should be based on the compliance with overall capacity as per design parameters for banding in the CA containment policy.

Further information

None

Containment Policy Control Measure

Tertiary containment measures shall minimise the consequences of a major incident that causes the failure of or exceeds the storage capacity of secondary containment

Current recognised good practice standards

Note for regulators

See section 2.9 of IP2 for discussion of drainage, including 2.9.5 fire water...

Allowances should be made in the design of drainage and separator systems to accommodate increased flows during fire-fighting operations. Most fire-fighting foams inhibit gravity separation of oil. Consideration should be given to providing holding capability to permit subsequent disposal other than to surface waters.

Reference: IP Model Code of Safe Practice, Part 2, 2005

General guidance on the design of remote containment systems (including lagoons, tanks and temporary systems such as sewerage storm tanks and sacrificial areas such as car parks, sports field and other landscape areas) is available in numerous documents including CIRIA report 164, 23 and PPG18.30

Reference: BSTG Final Report paragraph 196

A wide variety of products are available to deal with spillages or to contain spills in emergency containment areas, for example drain seals.

Reference: PPG 18

A risk assessment should be undertaken to determine the extent of the requirement for tertiary containment, taking into account:

- foreseeable bund failure modes, including:
 - the amount of spilled substances, including hydrodynamic effects of catastrophic tank failure and emergency response actions such as fire fighting;
 - the potential impact of fire on bund integrity including joints in walls and floors;
 - worst-case foreseeable delivered firewater volumes including fire fighting agents;
 and
 - passive and active firewater management measures.
- environmental setting, including:
 - all relevant categories of receptors as specified in *Guidance on the interpretation of Major Accident to the Environment*;
 - proximity of receptor, e.g. groundwaters under the site;
 - site and surrounding topography;

- geological factors affecting the permeability of surrounding land and environmental pollution pathways;
- and
- hydrogeological factors affecting liquid pollutant flows and receptor vulnerabilities;
- known pathways and potential pathways to environmental receptors in the event of failure of secondary containment;
- likely environmental impact consequences, in terms of extent and severity, of the pollutant and/or firewater quantities and flows resulting from foreseeable bund failure scenarios.

Reference: BSTG Final Report paragraph 186

Site-specific planning of firewater management and control measures should be undertaken with active participation of the local Fire and Rescue Service, and should include consideration of bund design factors, such as firewater removal pipework, aqueous layer controlled overflow to remote secondary or tertiary containment (for immiscible flammable hydrocarbons);

Reference: BSTG Final Report paragraph 46

Plan with the Fire and Rescue Service suitable fire fighting strategies, such as:

- reducing the amount of firewater generated: using sprays rather than jets
- recycling firewater where this is not hazardous
- a controlled burn where it is safe to do so. In cases where action is required to prevent the fire spreading, for example the application of cooling water to the areas around the storage tanks, care should be taken to ensure 1) this water does not become a pollutant or 2) the cooling process does not cause significant increases in air pollution

Reference: PPG 28

Proposed standards for new and partially new installations

New establishments storing liquid dangerous substances that are flammable, highly flammable or extremely flammable, in more than one tank, should have appropriate tertiary containment. Suitable risk assessments should be made taking into account credible scenarios and environmental factors. Adequate tertiary containment measures should be implemented to prevent and minimise the consequences of a failure of or inadequate secondary containment

Actions for improvements of existing installations

Suitable risk assessments should be made taking into account primary and secondary measures, credible scenarios and environmental factors. Adequate tertiary containment measures should be implemented so far as is reasonably practicable to prevent and minimise the consequences of a failure of or inadequate secondary containment.

Regulator compliance actions

Regulators should confirm sites' risk assessment of bund failure modes and consequent provision. Enforcement should be based on failure to conduct adequate risk assessments and implementation of measures proportionate to the risk. This is a site specific

assessment.

Further information

Many installations do not have tertiary containment designed to mitigate the effects of a loss of secondary containment.

Reference: BSTG Final Report

Tertiary containment is as much about assessment as it is containment. It is using environmental risk assessment techniques to assess what would happen to product and fire water in the event of an incident. Once this has been established relatively simple measures such as curbing to divert flows away from sensitive areas can be implemented.

Containment Policy Control Measure

Tertiary containment measures shall enable additional measures to be deployed in time if an incident escalates

Current recognised good practice standards

Note for regulators

HSG191 "Emergency Planning for major accidents" and in particular page 27 onwards gives guidance for planning for the environmental aspects of major accidents.

On-site effluent treatment facilities, sized to allow collection and treatment of polluted firewater, are a desirable design feature, but may only be justifiable at larger establishments.

Reference: BSTG Final Report paragraph 185

To limit fire spread, low walls or kerbs should be provided and each should be connected to a drainage system (but not any storm water system).

Reference: Section 4.8.4 Model code of safe practice Part 19

Proposed standards for new and partially new installations

Tertiary containment measures may involve both installed onsite measures and temporary emergency (onsite and offsite) measures. Logistics planning should ensure that timely and effective deployment of measures can be made.

Emergency plans should include development of generic risk assessments/method statements for activities such as uplifting of product, deployment of emergency containment equipment or temporary repair of containment facilities such that the risk to both persons and the environment of mitigatory actions are explored prior to an incident and their implementation is not unnecessarily delayed during an incident.

Actions for improvements of existing installations

The tertiary containment at existing establishments storing liquid dangerous substances that are flammable, highly flammable or extremely flammable, in more than one tank, should be improved to meet the new plant standard. So far as is reasonably practicable

If it is identified that the establishment does not meet the Containment Policy Control Measures, then additional (mitigatory) measures shall be planned to be in place until such time as the establishment is upgraded.

Regulator compliance actions

Regulators should confirm sites' provision vs requirements as determined by risk assessment. Regulators should inspect emergency plans to ensure that they give sufficient attention to deployment of additional measures to prevent and mitigate environmental impact when the installed secondary and tertiary containment provision is considered.

Regulators should ensure that operators are aware that under regulation 4 they are expected to take both on and off-site mitigatory action to minimise the consequences of a major accident so far as is reasonably practicable to do so. This shall include both short term mitigation to minimise impact and longer term environmental clean-up and restoration. Off-site mitigation is not the sole responsibility of emergency responders.

Further information

Provision could be made for site-dedicated or mutual aid provision to accommodate product and firewater.

REFERENCES

- Safety and environmental standards for fuel storage sites Buncefield Standards Task Group (BSTG) Final report – July 2007
<http://www.hse.gov.uk/comah/buncefield/bstgfinalreport.pdf>
- HSG 176 The storage of flammable liquids in tanks [HSE Books 1998. ISBN 0 7176 1470 0. 14
- IP Model code of safe practice in the Petroleum Industry Part 19: Fire precautions at petroleum refineries and bulk storage installations 2nd edition January 2007. Published by The Energy Institute London ISBN 978 0 85293 437
- CIRIA Report 164, 1997, P A Mason, H J Amies, P R Edwards, G Rose, G Sangarapillai, Design of containment systems for the prevention of water pollution from industrial incidents ISBN 0 86017 476 X
- CIRIA 598 Chemical Storage systems – Good Practice Construction Industry Research and Information Association; Cassie S, Seale L. 2003 ISBN 0 86017 598 7
- EN 1992 Eurocode 2: Design of concrete structures ISBN 0 580 48267 7
- EN 1992 Eurocode 6: Design of masonry structures ISBN 0 580 46902 6
- PPC S1.02 Guidance for the Gasification, Liquefaction and Refining Sector IPPC Sector Guidance Note S1.02 http://www.environment-agency.gov.uk/commondata/acrobat/1_1151773.pdf
- PPG 28 pollution prevention guidelines Controlled Burn: PPG28 July 2007
http://www.netregs.gov.uk/commondata/acrobat/ppg_28_1840138.pdf
- PPG 2 Pollution Prevention Guidelines Above Ground Oil Storage Tanks: PPG2
http://www.environment-agency.gov.uk/commondata/acrobat/ppg02feb04_126893.pdf
- PPG18 pollution prevention guidelines Managing Fire Water and Major Spillages
<http://publications.environment-agency.gov.uk/pdf/PMHO600BBUD-e-e.pdf>
- C I R I A / Environment Agencies Joint Guidelines Concrete Bunds for Oil Storage Tanks <http://www.environment-agency.gov.uk/commondata/acrobat/concretebunds.pdf>

Note for regulators

See also

IP Model Code of Safe Practice in the Petroleum Industry Part 2: Design, Construction and Operation of Petroleum Distribution Installations 3rd Edition 2005 Published by The Energy Institute London ISBN 0 85293 383 5

Annex 1 – Key principles and further guidance relating to Environmental Risk Assessment (ERA) for liquid releases at fuel storage terminals.

In accordance with the requirement to use “all measures necessary” operators are required to use good practice as a minimum and then, on a site specific basis, adopt a risk based approach to assessment of what further measures could be adopted. This means that for establishments where there is potential of a MATTE (which is expected to be the majority of establishments storing petroleum products) then it is expected that operators will have to make a case specific ALARP demonstration, and further steps (above and beyond good practice) must be taken unless their cost is grossly disproportionate. This is because it is anticipated that for most establishments, the cumulative (all event) frequency of a MATTE occurring will lie in the region 10^{-4} to 10^{-6} – the Tolerable if ALARP zone – and it is unlikely that operators will be able to demonstrate that the cumulative risk is Broadly Acceptable (see 76_03_v1 COMAH all measures necessary guidance for further details).

Both Top Tier and Lower Tier establishments are required to carry out ERA. ERA is an integral part of ensuring compliance with regulation 4. ERA is also required to be included in the SMS (regulation 5, Schedule 2 4(b)).

Guidance on ERA

The COMAH Competent Authority “Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports” December 1999 provides an outline of various risk assessment approaches. The guidance should ensure that operators address the key principles of ERA and the check tables towards the end are useful for regulators to assess whether the operator has included all relevant information.

Further guidance gives specific advice on how operators and regulators decide all measures necessary have been used, and for Top Tier establishment, how this is to be demonstrated in Safety Reports.

- [COMAH All Measures Necessary Guidance](#)
- [Identifying COMAH Major Accidents to the Environment](#)
- Safety Report Assessment Manual (SRAM) and Safety Report Assessment Guides (SRAG)
- HSG190 – preparing safety reports

In addition, the Energy Institute [EI] is developing an “Environmental Risk Assessment of Bulk Liquid Storage Facilities – Screening tool” which will be a further risk assessment tool. Further consideration will be given to this tool once it is complete with regard to it’s role in ensuring the upgrade of existing establishments.

Source

The source term for ERA can be thought of as the combination of hazardous substance released from primary containment, and any additional firewater and other substances released or created during the incident. There are various foreseeable scenarios which may lead to an incident involving multiple storage tanks and associated equipment failure. Operators and regulators should in the first instant consult the “ SAFETY REPORT

ASSESSMENT GUIDE: HFLs”, HID, 09 July 2001 to ensure that all scenarios, their probabilities and credible modes of escalation have been considered.

Failure modes to be considered should include both rapid (such as explosions or catastrophic tank failure with 50% bund overtopping) and gradual (such as longer term leakage through a tank floor or pipework leakage).

The total quantity of hazardous substances and firewater to consider will be dependent on escalation. Foreseeable escalation mechanisms, resulting in potentially large quantities of material released from primary containment (with or without associated fires) include

- Tanks moving/floating due to liquid in a bund and subsequent equipment damage
- Damage due to explosion overpressures
- Release from primary containment due to thermal impact (e.g. process equipment damaged by jet fire or by surrounding pool fire).
- Physical impact due to failure of neighbouring equipment (including equipment explosion or collapse and dynamic forces of released liquid)
- Failure of pipework/equipment common to multiple tanks, which may allow the contents of those tanks to be released.
- Failure of installed firefighting systems, allowing fire escalation

Where more than one COMAH establishment have been designated as a Domino group then, in accordance with regulation 16, operators should exchange information to allow them to take account of the nature and extent of the overall hazard of a major accident in their MAPP, safety report and emergency plans.

Work on understanding the Buncefield explosion mechanism is ongoing. Until this is complete it cannot be concluded what the credible worst-case scenario may be in terms of petroleum Vapour Cloud Explosion. However, other credible scenarios as identified by review of historic incident data (including tank explosions and escalating fires) indicates that an incident could readily escalate beyond the tanks in a single bund.

Please contact Mike Nicholas (x7 25 4353) in National Process Technical Services if further information is required on where to find guidance on failure modes, frequencies or historical incident information.

Pathway

Onsite pathways to be considered include release from bunds and flow through drainage systems or across the ground due to local topography. In addition to on-site pathways, operators need to assess pathways under the site and off-site. The operator should have considered potential for historic drainage that may be in place within, under or near the establishment.

Foreseeable bund failure modes include,

- catastrophic bund failure at pipework penetrations or due to the dynamic effects of catastrophic tank failure
- flow out from bund via process/other pipework if damaged on both sides of the bund wall
- wall/floor joint failure causing leakage
- catastrophic failure of earth bunds due to saturation of wall weakening the structure
- flow out from bund due to open drainage valves or overflowing of interceptors (e.g. if incident occurs during routine bund draining or valves fail)

- release from bund due to poor quality of construction
- release from poorly maintained bund or due to previously unidentified loss of integrity (not identified by inspection / maintenance regime)
- overtopping (dynamic and with firewater)
- impact damage from exploding / collapse of process equipment
- thermal damage due to fire in bund
- chemical corrosion
- gradual leakage over time due to a bund not being liquid-tight at time of incident

Environmental Risk Assessment should similarly consider potential failure modes of tertiary containment, including

- Loss of integrity (either due to poor maintenance or incident damage)
- Capacity being exceeded
- Loss of power rendering pumped transfer inoperable
- Firefighting foams inhibiting gravity separation
- Presence of historical drainage within the establishment

Pathways outside of the immediate infrastructure of the establishment include

- Natural geology / hydrogeology underlying and surrounding the establishment
- Surrounding topography
- Surrounding drainage (foul and surface waters, including highways or that of other properties)

Basis for ALARP decisions

EA guidance, 76_03_v1 COMAH all measures necessary provides a discussion of tolerability of risk thresholds as applied to ERA.

| Table 1 : Risk Targets for MATTES | |
|--|---|
| Risk level | Target frequency pa |
| Intolerable | 10^{-4} for accident of EC reportable severity |
| Tolerable if ALARP | |
| Broadly Acceptable | 10^{-6} EC for accident of EC reportable severity |

It is important to recognise that these thresholds refer to the risk posed by the establishment as a whole.

It is common for operators to compare the frequency of individual scenarios with the tolerability criteria when aiming to demonstrate risks have been reduced to ALARP. This does not truly reflect the risk from the establishment as a whole. For example, it may be cited that the only risk of a MATTE occurring due to failure of a storage tank is less than 10^{-6} and thus broadly acceptable. This would not be a correct conclusion if the operator failed to consider all tanks within the establishment (i.e. single tank failure rate multiplied

by number of tanks). Even then this would be a significant underestimate of the risk if other failure modes could lead to a MATTE.

It is expected that the cumulative risk to the environment from most establishments will lie in the Tolerable If ALARP zone, This will require operators to make a case specific ALARP demonstration and further measures (above and beyond good practice) must be taken unless their cost is grossly disproportionate.