BUNCEFIELD TASK GROUP
INITIAL RECOMMENDATIONS – CONSOLIDATED DETAILED GUIDANCE
WORKING DOCUMENT V1.1 03/01/07

Buncefield Standards Task Group
Initial Report – Consolidated Guidance

This document consolidates the detailed guidance from the Task Group that has been developed and posted over the past months on the Group Communications site by the Working Groups involved.

This is a working document and you will be informed of any changes to the document. It does not contain detailed guidance with respect to the recommendation that the overall systems for tank-filling control must be of high integrity. Useful work on this has been carried out on the development of the principles and processes involved; however, further work is required before a suitable worked example can be released. It is anticipated that this will be released shortly.

The time-scales for meeting the Task Group's recommendations as laid out in the Technical Supplement to the initial report still apply and best endeavours should be made to comply with these. As agreed previously, exceptional reasons as to why they cannot be met should be discussed with the COMAH Competent Authority (CA).

If there are any technical queries with respect to this document then they should be addressed with the working group leader involved. Any other queries should be sent to david.pascoe@hse.gsi.gov.uk

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Pipeline Transfers

The Initial Report of the Buncefield Major Incident Investigation Board identified an issue with regard to safety arrangements, including communications, for fuel transfer. To address this the Buncefield Standards Task Group has developed a set of principles for the safe management of fuel transfer and a set of principles for consignment transfer agreements.

Operators involved in the transfer of fuel by pipeline should adopt the principles for the safe management of fuel transfer and should develop consignment transfer agreement procedures consistent with the principles described below.

Parties involved in inter-business transfer of fuel by pipeline should agree on the nomenclature to be used for their product types.

For ship transfers each relevant terminal should carry out a review to ensure compliance with the current edition of the International Shipping Guide for Oil Tankers and Terminals ((ISGOTT - International Shipping Guide for Oil Tankers and Terminals, International Chamber of Shipping, Fifth Edition, 2006).

Principles for the Safe Management of Fuel Transfer

Introduction
These guiding principles shall be developed into specific procedures and protocols by all organisations involved in the transfer of fuel to ensure that at all times the operation is carried out in a safe and responsible manner without loss of containment.

Guiding Principles
All parties involved in the transfer of fuel must ensure that:

- Responsibility for the management of the safe transfer of fuel is clearly delineated.
- There are suitable systems and controls in place to manage the safe transfer of fuel commensurate with the frequency and complexity of the operation.
- There is clear accountability and understanding of all tasks necessary for the transfer operation.
- There are sufficient, adequately rested, competent persons to safely execute all stages of the operation.
- Shift handover procedures comply with latest available industry guidance.
- There is an appropriate degree of integrity in the method of communication, eg telephone, radio, facsimile, e-mail, common server, with positive confirmation of all critical exchanges.
- There is an agreed process to communicate changes to the plan in a timely manner.
- There is clearly understood nomenclature.
- There is clear understanding of what events will initiate an emergency shutdown of the fuel transfer operation.
- Key performance indicators are in place to monitor and review performance.
- Receiving site operators should:
    - Positively confirm that they can safely receive the fuel before transfer commences.
    - Positively confirm that they are able to initiate emergency shutdown of the fuel transfer.

As a minimum, the following information is to be communicated between all relevant parties prior to commencing fuel transfer:

- Grade / type
- Consignment size (including common understanding of units used)
- Flow rate profiles (significant unplanned changes in flow rate during the transfer should be communicated - all parties to agree what constitutes a "significant" change for their operation).
- Start time
- Estimated completion time
- Any critical operations/periods when transfer could adversely affect other operations, eg slow load requirements, roof on legs.

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Consignment Transfer Agreements

Introduction
The following principles apply to pipeline transfers where separate parties control:
- The supply of material to a tank or tanks, and
- The tank or tanks.

This includes, for example, transfers between sites belonging to one business. It does not apply to transfers where a single person or team controls both 'ends' of the transfer, although an equivalent standard of control is necessary.

For the purposes of these agreements the sender is the party primarily responsible for the final transfer of fuel to the receiving terminal.

For transfers from ships into tanks, the current edition of ISGOTT is considered to be the appropriate standard.

General Principles
The agreement involves three stages:
- Stage 1 – a common written description of what is to be transferred.
- Stage 2 – direct verbal confirmation (e.g. by telephone landline) to a specified protocol or procedure, of
  - Key details of the transfer from the written material, and
  - The decision to 'start' by the receiver.

  An analogy is air traffic control, where there is a written flight plan, but permission to 'take off' is always verbally confirmed by the control tower.
- Stage 3 – a procedure for handling significant change during a transfer

Stage 1 – Agreed Description of Transfer
Agreed in writing, between sender and receiver, as close in time as practicable to Stage 2 (for example, during the current or previous shift). The common written description of the transfer should, so far as possible, be kept free of clutter; for example, it should not generally include a significant amount of product quality data. It should include (but not necessarily in this order):
- Nominated batch number (schedules/sequential).
- Product grade/type (in agreed terms).
- Density (if required to enable conversion of volume to weight and vice versa)
- Amount to be transferred, stating units.
- Expected rate of transfer, including initial rate, steady cruise rate, and changes during plan.
- Date and expected time of start (Note: should include the need to agree verbally).
- Estimated completion time.
- Notes regarding abnormal conditions that may affect product transfer and mitigations in place, including risk assessment.
- Name of sender (named individual).
- Name of receiver (named individual).
- Other responsibilities for involvement in the transfer and receipt process, as agreed locally
- Arrangements for receipt terminal to stop the flow in the event of an emergency
- Target tank(s) for receipt.
- Receiving terminal to sign draft consignment (after considering any abnormal conditions) and return to sending terminal to provide confirmation that product can be safely received.

Stage 2 – Verbal Confirmation and Decision To Receive
Following consignment agreement a verbal agreement shall be made, confirming details on the consignment note and the receiver giving permission to start. This shall include confirmation of:
- Batch number(s) being ready.
- The product grade/type and quantity, including a check of units.
- No significant changes to the written agreement that may affect safe receipt.
- Receiving party ready to receive.

Stage 3 – Procedure for Handling Significant Change
Significant changes should be communicated between sender and receiver, and recorded by both parties. The appropriate party should also record actions taken as a result of this communication.

Tank Overfill Prevention

Defining Tank Capacity

Overfill Level (Maximum Capacity)
A vital element of any system to prevent overfilling of a storage tank is a clear definition of the maximum capacity of the vessel. This is the maximum level consistent with avoiding loss of containment (overfilling or overflow) or damage to the tank structure (e.g. due to collision between an internal floating roof and other structures within the tank, or for some fluids overstressing due to hydrostatic loading).

Tank Rated Capacity
Having established this upper limit, it is then necessary to specify a level below the maximum, to allow time for any action necessary to prevent the maximum level being reached/exceeded. This leads to the definition of the “tank rated capacity”, which will be lower than the actual physical maximum.

The required separation between the maximum capacity and the tank rated capacity is a function of the time needed to detect an unintended increase in level beyond the tank rated capacity and respond to it. The response in this case may require the use of alternative controls e.g. manual valves, which are less accessible or otherwise require longer time to operate than the normal method of isolation.

In some cases, it will be necessary to terminate the transfer in a more gradual fashion, e.g. by limiting the closure rate of the isolation valve, to avoid damaging pressure surges in upstream pipelines. Due allowance should be made for the delay in stopping the transfer when establishing the tank rated capacity. For some fluids, the tank rated capacity may also serve to provide an allowance for thermal expansion of the fluid, which may raise the level after the initial filling operation has completed.

High-High Level Shutdown
To respond to an increase in level beyond the tank rated capacity requires knowledge of the event. The High-High level device provides an **independent** means of determining the level in the tank and is part of the overfilling protection system. It provides a warning that the tank rated capacity has been (or is about to be) reached/exceeded and triggers a response.

- The High-High level should be set at or below the tank rated capacity.
- The function of the High-High level (LAHH) is to initiate a shutdown.
- The outcome of LAHH activation may be limited to a visible/audible alarm to alert a human operator to take the required action. The actions required by the operator to a High-High level warning should be clearly specified and documented.
- The response may be fully automatic, via an instrumented protective system including a trip function that acts to close valves, stop pumps etc. to prevent further material entering the tank. The trip function should include an audible/visual alarm to prompt a check that the trip function has been successful. Different devices can be employed to provide the trip function. These may range from a simple level switch (LSHH) to more sophisticated arrangements including duplicate level instrumentation.

Level Alarm High (LAH)
Providing an additional means of warning that the intended level has been exceeded can reduce the demand on the High-High device. It is anticipated that for the sites within the scope of this guidance, the LAH will be derived from the system used for determining the contents of the tank (ATG: Automatic Tank Gauge).

- The position of the LAH should allow sufficient time for a response following activation that will prevent the level rising to the tank rated capacity (or the High-High Level activation point if this is set lower).
- It is very important that the LAH is NOT used to control routine filling (e.g. filling should not be allowed to continue until the alarm sounds).

Normal Fill Level (normal capacity)

This level may be defined as the level to which the tank will intentionally be filled on a routine basis, using the normal process control system. The normal fill level will be dependent on the preceding levels and should be sufficiently far below the LAH to avoid spurious activation e.g. due to level surges during filling or thermal expansion of the contents.

Other applications
In other applications, the primary means of determining the level may not involve an automatic gauging system. Depending on the detailed circumstances, the LAH may be a separate device e.g. a switch.

Operator Notifications
Some ATG systems include the facility for the user (operator) to set system prompts to notify them when a particular level has been reached or exceeded. As the same level instrument typically drives these prompts and the LAH they do not (arguably) add significantly to the overall integrity of the system.

In a continuously manned control room situation, they may have some value in addressing operator distraction/inattention but should primarily be regarded as an operational convenience rather than a risk reduction measure.

Determining Action Levels

Introduction
Having defined generically the minimum set of action levels in the preceding section, it is necessary to consider the factors that determine the spacing between the action levels in particular cases. In all cases, the spacing should be directly related to the response time required to detect, diagnose and act to stop an unintentional and potentially hazardous increase in level.

Response Times
Particular care is needed when estimating the likely time for operators to respond to an incident. Consideration should be given to the detection, diagnosis, and action stages of response.

- Detection covers how an operator will become aware that a problem exists. Assessment of alarm priorities and frequencies, the characteristics of the operator console displays, as well as operators' past experience of similar problems on sites are all useful aspects to review. Plant problems that appear over a period of time and where the information available to the operators can be uncertain are particularly difficult to detect. When control rooms are not continually staffed, the reliable detection of plant problems needs careful justification.
- Diagnosis refers to how an operator will determine what action, if any, is required to respond to the problem. Relevant factors to think about include training and competence assurance, the availability of clear operating procedures and other job aids, and level of supervision. The existence of more than one problem can make diagnosis more difficult.
- Action covers how a timely response is carried out. Key aspects here include: the availability of a reliable means of communicating with other plant operators, the time needed to locate and operate a control (close a valve, stop a pump), the need to don PPE, the ease of operating the control whilst wearing PPE, and how feedback is given to operators that the control has operated correctly. Occasionally there may be circumstances where operators may hesitate if shutting down an operation might lead to later criticism.
- A 'walk-through' of the physical aspects of the task with operators can provide very useful information on the minimum time needed to detect and respond to an overfilling incident. However due allowance needs to be made for additional delays due to uncertainty, hesitation, communications problems. This will need to be added to the minimum time to produce a realistic estimate of the time to respond.

Response Time 3: LAHH to Overfill/Damage Level (Maximum Capacity)
This is the response time between the LAHH and the overfill level (or maximum capacity - at which loss of containment or damage results) should assume that the action taken to respond to the LAH has not been successful e.g. the valve did not close, the wrong valve closed, and so corrective or alternative contingency action is now urgently required.

The response time to do this is identified as the worst combination[1] of filling-rate and time taken to travel from the control room to the tank and positively[3] close the valve. This may be an alternative valve, may need additional time to identify it, and also to close it if not regularly used.

This could be done per tank, or more conservatively standardised at the longest margin time for a group of, or all tanks. In all cases however, it must be written down so as to be demonstrable.

Response Time 2: LAH to LAHH
The response time between the High Level alarm – LAH, and the independent High-High Level – LAHH, should again be defined based on the worst combination[1] of filling-rate and time taken to activate and close a remotely operated valve if installed, or to get from the Control Room to the Tank manual valve if not[2].

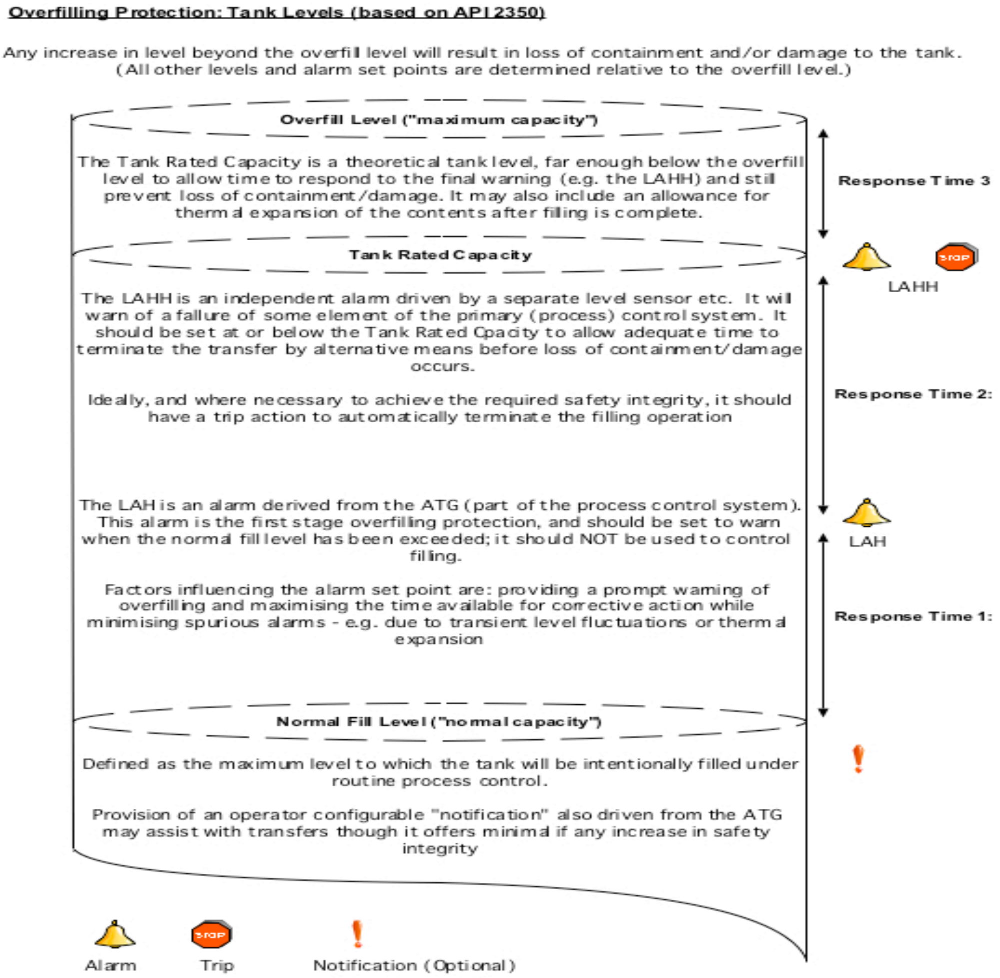
Again, this could be done per tank, or more conservatively standardised at the longest margin time for a group of, or all tanks. In all cases however, it must be written down to be demonstrable.

Response Time 1: Normal Fill Level to LAH
The normal fill level should be close enough to the LAH to enable overfilling to be rapidly detected (and maximise the usable capacity), but should be set an adequate margin below the LAH to prevent spurious operation of the alarm e.g. due to liquid surge or thermal expansion at the end of an otherwise correctly conducted transfer.

Separation between the normal fill level and the LAH may also help to discourage inappropriate use of the LAH to control the filling operation.

Notes for the determination of response times
(1) The highest rate tank might have an ROSOV conveniently in the Control Room, whereas a slower filled (and/or smaller diameter) tank that requires a long journey to get to a local manual valve, could in fact be the worst combination.
(2) This means, taking into account all the organisational and human factors relevant to the Site e.g. failure of remote operation, loss of communications etc
(3) Meaning that remote and automatic systems must now assume to have failed - even if they appear to be working - and positive human action is now required to prevent overfill.

Summary
The figure below summarises the foregoing discussion. The spacing between levels in the diagram is not to scale and it is possible that the greatest response time and hence the largest separation in level will be between the LAHH and the Overfill Level. This is because the response is likely to involve equipment which is more remote and for which the location and method of operation is less familiar. An exception to this would be if the High-High level device included a trip function, when a shorter response time might be anticipated.



Worked Example 1

The following is an example of the application of this guidance to an actual tank.

- **Tank Parameters**
  The tank in this example is a fixed roof type (no internal floating roof) with a shell height of 20m measured from the base, which is flat and level. The tank has a nominal maximum capacity of 10000m^3 if filled to the overfill level.
  It receives a product with an SG of less than 1.0, at rates up to a maximum of 1200m^3/Hr.
- **Maximum Capacity (overfill level)**
  The tank overfill level is defined as the point at which either the tank will suffer mechanical damage or product will be lost from the tank.
  For fixed roof tanks without an internal roof, loss of containment is expected to occur from a fitting in the roof, typically a PV valve or a dip hatch (if open). For the purposes of setting alarms the overfill level for tanks of this type is considered to be the top of the shell. This gives additional safety margins and greatly simplifies the overfill calculation.
  Thus for this example the overfill level is defined as the top of the shell. This is 20m above the base of the tank.
- **LAHH**
  The fundamental aim of the tank alarm and trip system is to ensure that the overfill level is never reached. In reality, there will remain a small, but finite probability of failure of the device.
  On this tank, the LAHH includes a trip function to terminate the transfer. For a well-designed and maintained safety instrumented protective system, a response time of 2 minutes between activation and complete cessation of flow into the tank is claimed. This includes the time needed to take urgent action in case the trip

action is not successful – in this case to immediately close another remotely operated valve, readily accessible in the control room (the system having been designed for this emergency closure).
This equates to a maximum volume of 2 x 1200/60 = 40m^3. Based on the tank dimensions, this is equivalent to a height of 0.08m. Thus, the LAHH is set 0.08m below the overfill level at 19.92m.
There might need to be an additional allowance added to this bare-minimum figure, for "level surges" during filling, and also possible thermal expansion of the contents after the transfer has been stopped.

- **LAH**
  A primary purpose of the LAH is to reduce demand on the LAHH by ensuring that the level of the LAHH is never reached. In reality, there will be a finite probability that the LAH (or other components of the process control system linked with the LAH) will fail.
  In this case, a response time of 5 minutes is claimed between activation of the LAH and complete cessation of flow into the tank.
  This equates to a maximum volume of 5 x 1200/60 = 100m^3. Based on the tank dimensions, this is equivalent to a height of 0.2m. Thus, the LAH is set 0.2m below the LAHH, or 0.28m below the overfill level, at 19.72m.
- **Normal fill level**
  The process control system should ensure that all filling operations are terminated at the pre-determined level and hence should never exceed the specified normal fill level. In reality, there is a finite probability that the process control system will fail and filling will continue.

Worked Example 2

The following is an example of the application of this guidance to an actual tank.

- **Tank Parameters**
  The tank in this example is an internal floating roof type with a shell height of 20m measured from the base, which is flat and level. The tank has a nominal maximum capacity of 10000m^3 if filled to the overfill level.
  It receives a product with an SG of less than 1.0, at rates up to a maximum of 1200m^3/Hr.
- **Maximum Capacity (overfill level)**
  The tank overfill level is defined as the point at which either the tank will suffer mechanical damage or product will be lost from the tank.
  For internal floating roof tanks a level must be established at the point where the floating roof will be damaged by any internal roof structure. Hence for these tanks this level will always be below the top of shell.
  For this example the overfill level is determined as the point at which the internal floating roof strikes an internal stiffening spar located 0.25m below the top of the shell. The floating roof is 0.25m deep. Thus the overfill level is 0.5m below the top of the shell, or 19.5m above the base of the tank.
- **LAHH**
  The fundamental aim of the tank alarm and trip system is to ensure that the overfill level is never reached. In reality, there will remain a small, but finite probability of failure of the device.
  On this tank, the LAHH includes a trip function to terminate the transfer. For a well-designed and maintained safety instrumented protective system, a response time of 2 minutes between activation and complete cessation of flow into the tank is claimed. This includes the time needed to take urgent action in case the trip action is not successful – in this case to immediately close another remotely operated valve, readily accessible in the control room (the system having been designed for this emergency closure).
  This equates to a maximum volume of 2 x 1200/60 = 40m^3. Based on the tank dimensions, this is equivalent to a height of 0.08m. Thus, the LAHH is set 0.08m below the overfill level at 19.42m.
  There might need to be an additional allowance added to this bare-minimum figure, for "level surges" during filling, and also possible thermal expansion of the contents after the transfer has been stopped.
- **LAH**
  A primary purpose of the LAH is to reduce demand on the LAHH by ensuring that the level of the LAHH is never reached. In reality, there will be a finite probability that the LAH (or other components of the process control system linked with the LAH) will fail.
  In this case, a response time of 5 minutes is claimed between activation of the LAH and complete cessation of flow into the tank.
  This equates to a maximum volume of 5 x 1200/60 = 100m^3. Based on the tank dimensions, this is equivalent to a height of 0.2m. Thus, the LAH is set 0.2m below the LAHH, or 0.28m below the overfill level, at 19.22m.
- **Normal fill level**
  The process control system should ensure that all filling operations are terminated at the pre-determined level and hence should never exceed the specified normal fill level. In reality, there is a finite probability that the process control system will fail and filling will continue.

The normal fill level and the LAH should not coincide. The normal fill level and LAH should be close to maximise the usable capacity of the tank, but sufficiently separated so as to avoid spurious alarms e.g. due to level surge or thermal expansion when the tank is filled to the normal fill level.

Any process alarm/notification used to indicate that the normal fill level has been reached must be clearly distinguishable from the LAH, and reflect the higher priority response applicable to the LAH.

In this example, an allowance of 5 minutes is given for the process control system (including the operator) to terminate the transfer when the level reaches the normal fill level.

This equates to a maximum volume of 5 x 1200/60 = 100m^3. Based on the tank dimensions, this is equivalent to a height of 0.2m. Thus, the normal fill level is set 0.2m below the LAH, or 0.48m below the overfill level, at 19.02m.

Worked Example 3

The following is an example of the application of this guidance to an actual tank.

- **Tank Parameters**

  The tank in this example is an external floating roof type with a shell height of 22m measured from the base (which is flat and level) and a diameter of 24m giving 450m3/m.

  It receives a product with an SG of less than 1.0, at rates up to a maximum of 1100m^3/hr, resulting in a rising level rate of 2.43m3/h.

- **Maximum Capacity (overfill level)**

  The tank overfill level is defined as the point at which either the tank will suffer mechanical damage or product will be lost from the tank.

  The company standard for it's external floating roof tanks, requires:

  800mm for the depth of the floating pontoon
  750mm for the depth of the primary and secondary seal
  50mm additional free clearance between moving parts of the roof and seal, and any parts fixed to the shell

  The total allowance is therefore 1600mm, and so the overfill level is this distance below the top of the shell, or 20.4m above the base of the tank.

- **LAHH**

  The fundamental aim of the tank alarm and trip system is to ensure that the overfill level is never reached. In reality, there will remain a small, but finite probability of failure of the device.

  This tank does not have a trip function to terminate the transfer. The company has determined the actual response time for all it's tanks, based upon actual timed emergency response exercises, has documented that as part of it's tank level documentation, would review it when any relevant change was made, and tank level documentation is included on it's audit schedule. Rather than use specific values per tank, a conservative value of 10 minutes is used for all tanks, in order to achieve standardisation and clarity.

  This 10 mins equates to a height margin of 0.4m (2.43 x 10/60). Thus, the LAHH of the independent device is set 0.4m below the overfill level at 20.0m.

- **LAH**

  A primary purpose of the LAH is to reduce demand on the LAHH by ensuring that the level of the LAHH is never reached. In reality, there will be a finite probability that the LAH (or other components of the process control system linked with the LAH) will fail.

  In this case, the company uses the same 10 mins response time, having confirmed that the same actions would be taken between activation of the LAH and complete cessation of flow into the tank.

  Again, the 10 mins margin results in another 0.4m drop to this LAH setting for the ATG at 19.6m.

- **Normal fill level**

  The process control system should ensure that all filling operations are terminated at the pre-determined level and hence should never exceed the specified normal fill level. In reality, there is a finite probability that the process control system will fail and filling will continue.

  The normal fill level and the LAH should not coincide. The normal fill level and LAH should be close to maximise the usable capacity of the tank, but sufficiently separated so as to avoid spurious alarms e.g. due to level surge or thermal expansion when the tank is filled to the normal fill level. This is the point at which operations *stop* the transfer, and valves are closed. The company has decided that its 10 min gap is again applicable, and so the normal fill level is set at 19.2m.

  Any process alarm/notification used to indicate that the normal fill level has been reached must be clearly distinguishable from the LAH, and reflect the higher priority response applicable to the LAH. This alarm is on the company's Tank Information System computer.

  This particular company also sets an additional "warning" level, again in the TIS, which is intended to alert operations to <u>prepare</u> to stop the transfer. The 10 mins is again used, to give 18.8m.

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Valves

Fire Safe Shut-Off Valves

Fire Safe Shut-Off Valves must be fitted close to the tank on both inlet and outlet pipes. Valves must conform to an appropriate standard - either BS6755-2 or BS EN ISO 10497, equivalent international standards or be of an intrinsically fire-safe design - not be constructed of cast iron, have metal-to-metal seats (secondary metal seats on soft-seated valves are acceptable) and not be wafer bolted.

Remotely Operated Shut-Off Valves (ROSOVs)

Introduction
Current guidance on the failure modes of ROSOVs is contained in HSG 176 (paragraph 101) and HSG 244 (paragraph 113). HSG244 provides guidance on how to assess the need to provide ROSOVs for emergency isolation. It has been written for a wide range of circumstances and as a result the section dealing with ROSOV failure modes requires additional interpretation.

It was anticipated that examples of HSG244 assessments would have been available from industry or HSE for inclusion in this guidance, however only one very recent example was forthcoming. So as the Task Group originally recommended, an HSG244 assessment should be completed for tanks in scope. Trade Associations should share and discuss them, to ensure consistency of approach. The following paragraphs offer additional guidance.

Configuration
Bulk storage tanks can have their import and export lines arranged in a variety of configurations. These have a bearing on the necessary arrangements for isolating the tank inlets/outlets. Some tanks will have separate, dedicated import and export lines. Within this group, some will fill from the top and export from the base; some will both fill and export from either the top or the base. Others will have a single common import/export line, commonly connected at the base of the tank.

Dedicated Import Line
Tanks with dedicated import lines, whether these enter at the top or the base can be protected against backflow from the tank by the provision of non-return valves. Lines that enter at the top of the tank and deliver via a dip leg may in some cases be adequately protected by the provision of a siphon break to prevent the tank contents flowing back out via the feed line.
The provision of either or both of these features may affect the conclusion of any assessment of the need to provide a ROSOV for the purpose of emergency isolation of the tank against loss of the contents.
ROSOVs may be required on filling lines (in addition to non-return valves?) as part of other systems to prevent overfilling of the tank.
These factors need to be considered when determining the appropriate failure mode for the valve (or whether motorised “fail in place” type valves are acceptable).

Dedicated Export Line
Dedicated export lines on bulk tanks containing petrol should ideally be fitted with fire-safe, fail-closed ROSOVs and this would be the minimum expectation for a new tank installation.
For existing installations, the need to provide ROSOVs retrospectively should be subject to an assessment according to the principles in HSG244. Included in this assessment will need to be consideration of an individual having to enter a hazardous location to manually operate a valve for emergency isolation.
In some cases ROSOVs may be currently provided for the purpose of emergency isolation, but these do not fail to the closed position. These should be upgraded to fail-safe.

Common Import/Export Lines
These lines cannot be provided with a non-return valve and it appears most appropriate to assess the ROSOV requirement, including the failure mode of the valve, based on the export function.

Containment Measures

Fire-resistant Joints

Introduction
This guidance document addresses the required improvement of fire-resistance of relevant bund joints in:

- Concrete Bunds.
- Masonry (Brickwork and Block-work) bund walls.
- Earth/clay bund walls and floors

Relevant bund joints are wall or floor joints in bunds containing tanks that are within the scope of the Task Group work.

Limitations of this guidance
This guidance does not address the fire-resistance of the main material of construction for existing bunds, because:

- This was not believed to be a significant factor in the Buncefield incident, except insofar as (i) the contraction on cooling of concrete walls may have caused the opening-up of wall-joints and consequent integrity failure; and (ii) the reason for concrete floor heave and associated loss of integrity and the comparative performance of earth/clay, is not known to the Task Group and any recommendation relating to this would be a matter of speculation.
- Further information from the Buncefield investigation and additional civil engineering resource, will be needed to properly consider the comparative impact of fire on earth/clay bund walls and floors against that of reinforced concrete.

Concrete Bunds
The current good practice standard for the construction of reinforced concrete bunds is BS 8007:1987 "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 waterstops and sealants, bonded into or onto the concrete joint surface. BS 8007 does not address the retention of non-aqueous liquids or of liquids above 35°C. BS 8007 does not address bund joints at pipework and other penetrating structures. Note that CIRIA/Environment Agencies Joint Guidance referring to CIRIA report 163 is also relevant to the design and construction of smaller reinforced concrete bunds.

In order to achieve bund joints capable of resisting fire improvements may be required to the fire-resistance of: -

- The main material(s) of construction (not addressed in this guidance).
- The waterstops and flexible sealant(s) used to make joints leak-tight.
- Joints to wall and floor penetrations such as pipework.

It may also be necessary to provide additional fire-protection to joints by the fitting of a "fire-proof" barrier such as steel plate.

Masonry (Brickwork and Block-work) bund walls
On older sites masonry bund walls are still in use. Vertical expansion and contraction joints and penetration joints rely on sealants to keep bund watertight. These will require improvement to fire-resistance. In addition, where significant cracks in masonry joints have been repaired with flexible sealant, these also will require improvement.

Earth/clay bunds
Earth/clay bunds are in very common use, often as floors of bunds with concrete or masonry walls. In such floors there are normally no construction joints, but penetrating drains or other pipework result in points of weakness and potential failure.

Modifications to bund joints for improved fire resistance

The following modification options for improvement of fire resistance should be assessed for practicability and likely effectiveness:

Flexible sealants
Sealants are now available for which enhanced resistance to fire is claimed. A list of products so far identified is provided at Appendix A. The only fire-resistance standards that are quoted on these products are BS 472-20:1987 and BS 472-22:1987. The maximum fire resistance quoted to BS 472 is 4 hours. The relationship of performance to this standard, to actual performance in a bund-joint application, is yet to be determined. In considering the use of fire resistant sealants, due regard should also be given to the suitability and compatibility (eg hydrocarbon and water resistance) of candidate products in the specific application.
While fire resistant sealants represent a significant improvement over non fire-resistant sealants, nevertheless a very severe pool fire, such as seen at Buncefield, is likely to result in failure of joints. The prolonged pool fire scenarios at Buncefield are thought to have resulted in considerable longitudinal expansion of wall sections, and consequent compression of wall-joints, resulting in extrusion of sealant from joints and the burning out of the extruded sealant. When walls cooled and contracted after the fire was extinguished, it is thought that joints opened up and, with sealant burnt out, loss of integrity and containment resulted.

Steel protection plates
Steel plates, observed in some locations at the Buncefield incident site, are thought to have provided significant additional protection to bund joints. It is believed that these plates were not designed for fire protection purposes, however. Nevertheless, the relevant joints appeared to withstand a severe pool fire without losing integrity. **It is therefore likely that, where fitting of these is practicable, suitably designed protective steel plates will provide more effective fire resistance than fire-resistant sealants.**

Detailed information is not currently available for the design of steel plate fire protection, and operators should design for specific applications. However, the Task Group has postulated for consideration the following general guidance:

- Material of construction: stainless steel
- Width: minimum 20cm
- Thickness: minimum 6mm
- Fixings to bund walls: stainless steel bolts through oversized slotted holes, minimum 30 cm intervals
- Additional protective features to be considered: fireproof backing material such as cement board and/or fire-resistant coating such as intumescent material to the front face.

Note: in designing plate protection plates, consideration should be given to avoiding weakening the wall structure in relation to resistance to fire, hydrostatic and hydrodynamic forces.

Recommended improvement actions

Existing bunds:

- **Bund wall construction joints**
  For concrete and masonry bunds, relevant joints should be protected where practicable with steel plates. Existing sealant should also be replaced where practicable, with a suitable fire resistant sealant. Where fire resistant sealants with adequate chemical resistance are not available, options which could be considered include (a) fire resistant sealant protected by a facing layer of suitably chemically resistant sealant, or (b) reliance solely on metal plate protection to existing non fire resistant sealants. Where the fitting of steel plates is impracticable, existing joint sealants should be removed and replaced with a fire resistant sealant, protected if necessary by an appropriate chemically resistant sealant.
- **Bund wall penetration joints**
  For penetrations of concrete and masonry, the first option should be to consider re-routing 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 the replacement of existing sealants with fire resistant sealants.
  For penetrations 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.
- **Bund floor construction joints**
  For concrete bund floors vulnerability to fire should be capable of being reduced by managed emergency response measures such as the maintenance of 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.

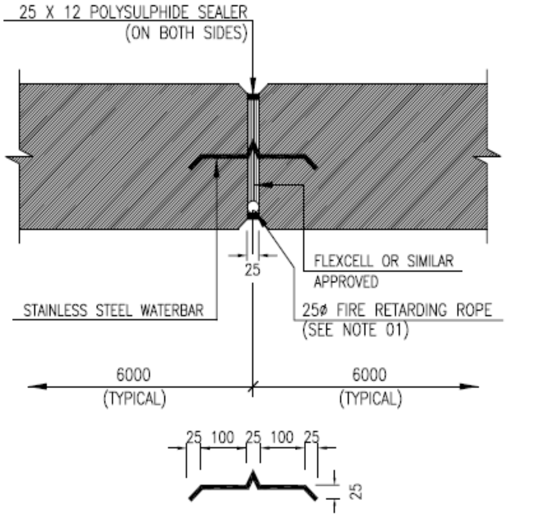
- **Bund floor penetration joints**
  Bund floor penetration joints are points of inherent weakness where any failure of integrity is very difficult to detect and may continue unnoticed for some time. Consequently existing bund floor penetrations should be eliminated wherever practicable. Where flexible sealants are used in floor penetration joints, these should be removed and replaced with fire-resistant sealants.
- **Cracks in concrete and masonry bund walls and floors**
  Repaired cracks in existing bund surfaces must be assessed for significance with regard to the potential to fail in a fire scenario resulting in loss of containment integrity. 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.

New bunds:

- **Comment**
  The standard for new bund material of construction has not been addressed during the Buncefield Standards Task Group Initial Actions (quick wins) stage, and there is currently no agreed position. This aspect will be considered in the next phase of work. Where new bund construction is proposed using materials other than reinforced concrete to BS 8007, operators are recommended to discuss specific cases with the Competent Authority.
- **New Concrete bunds**
  New bunds should be fully engineered reinforced concrete bunds constructed generally to meet BS 8007. However, in order to achieve the maximum practicable fire resistance for bund joints the following additional measures should be incorporated.
- **Bund wall and floor construction joints**
  Joints should be designed to be fire resistant. Consideration should be given to the incorporation of stainless steel waterstops and expansion joints bonded into the structure, 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 the incorporation of puddle flanges cast into the concrete structure.
- **Bund floor penetration joints**
  Floor penetrations should not be incorporated into new bunds.

Stainless Steel waterstop designs

New designs are available incorporating stainless steel waterstops. A drawing of an example system is below:



BUND WALL EXPANSION JOINT DETAIL (1/10)

NOTES:

01. FIRE RETARDING ROPE (BY BESTOBELL OR SIMILAR APPROVED) TO BE PLACED ON BOTH SIDES OF AN INTERNAL BUND WALL AND ON INTERNAL SIDE ONLY OF AN EXTERNAL BUND WALL.

02. WATERBAR, ROPE AND POLYSULPHIDE SEALANT TO BE OMITTED IN BUNDWALLS FOOTINGS.

03. STAINLESS STEEL FOR WATERBAR TO BE GRADE 316 AND 1.0 mm THICK.

NEW TANKAGE ON PORTION LOT 114B	DRAWN MAF	ENG. MAF	DATE 16/06/94
P D TERMINALS (PTY) LTD.	JOB. No. D12175	STANDARD DWG. No. SK05	

ACAD FILE: 1368S01.DWG (1=10)

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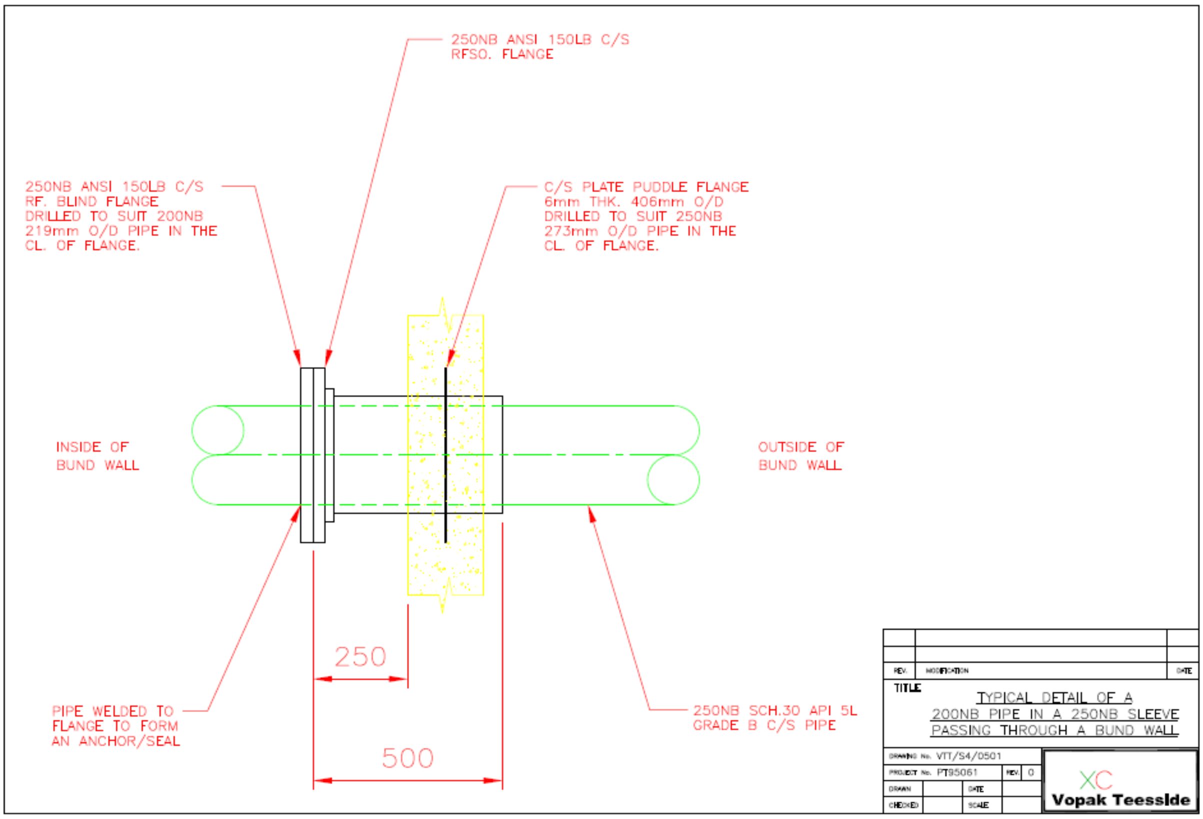
Fire resistant wall penetration joints

A drawing of an example puddle flange cast into a bund wall is attached below - a 200NB pipe in a 250NB sleeve passing through a bund wall.



Flexible Sealant products with claimed fire resistance

- **Hilti (http:/www.hilti.com) -** CP 601S Elastomeric firestop sealant. Rated up to 4 hours
- **Sika (http:/www.sika.com) -** Firesil N silicone sealant tested to B476-20.
  - Firestop silicate based intumescent-fire proof sealant BS476-4 rated up to 1000°C
- **Environmental Seals Ltd (http:/www.envirograf.com) -** Product 58 Intumescent Acrylic Mastic
  - Product 39 Intumescent Expansion Joints
- **Astroflame (Fire Seals) Ltd (http:/www.astroflame.com) -** Astro Intu Mastic tested to BS476 –20 Rated up to 4 hours
- **Dow Corning (http:/www. dowcorning.com) - F**ire Stop 400 (no details)
- **Corkjoint (Aust) Pty Ltd (http:/www.corkjointaust.com) -** Promaseal IBS Fire rated rod - AS1530-4rated up to 4 hours
  - Promaseal Fyrestrip – tested to BS476, AS1530-4 and AS4072-1 rated to 4 hours

Tertiary containment measures

Introduction
This guidance is applicable only to the loss of secondary containment from bunds containing tanks that are within the scope of the Task Group work.

The term “tertiary containment” is used to describe containment systems and measures that are implemented 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.

COMAH installations where bunds contain tanks within the scope of the Task Group work are required to assess the requirement for tertiary containment, on the basis of environmental risk, and to make site action plans for improvement by January 2007.

Risk assessment
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 firefighting.
    - The potential impact of fire on bund integrity including joints in walls and floors.
    - Worst-case foreseeable delivered firewater volumes including fire-fighting agents.
    - Passive and active firewater management measures.
- Environmental setting, including
    - Surrounding environment including all relevant categories of receptors as specified in the DETR “Guidance on the Interpretation of Major Accidents to the Environment”, underlying aquifers.
    - Site and surrounding topography.
    - Geological factors affecting the permeability of surrounding land and environmental pollution pathways.
    - Hydro-geological 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.

Design Standards
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 the foreseeably entrained or dissolved pollutants.
- Utilise 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 firefighting and other emergency action requirements.
- Allow the controlled movement of contained liquids within the site under normal and emergency conditions.
- Facilitate the utilisation 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.
- Facilitate clean up and restoration activities.

Onsite 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.

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Design Options

Selection of tertiary containment options will be highly dependent on site-specific factors such as layout, topography and available space. The term "Transfer Systems" (Ref 2 Ch13) is used to describe the means for collecting and conveying spillage/firewater to remote and combined secondary and tertiary containment.

Design options for tertiary containment include:

- Local cellular tertiary containment surrounding secondary containment – gravity fed.
- Local gravity collection systems at identified failure points, connected with:
- Gravity transferred to remote containment.
- Pumped transfer to remote containment.
- Tankage dedicated to tertiary containment.
- Sacrificial land.
- Local dedicated gravity drainage and collection sump(s), capable of handling total emergency liquid flows into secondary containment, and connected with pumped transfer to remote containment.

Remote tertiary containment may serve more than one secondary containment system, as long as it is designed to be capable of accommodating total foreseeable flows and quantities.

Existing secondary containment systems may be used to provide tertiary containment for other secondary containment, as long as foreseeable secondary containment failure scenarios are mutually exclusive and equipment eg pumps are independent and reliability of emergency operation is assured.

Available Guidance

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 those listed below.

Catchment areas used for tertiary containment often serve a dual purpose eg roadways, hardstanding, car parks. Such areas are normally routinely drained to surface water drainage systems. Therefore, in order to be considered for emergency tertiary containment, such areas must be capable of reliable emergency sealing of drains and interception of pollutants. Further, arrangements must not compromise emergency access or compromise unduly day-to-day operations.

Major Acccident Case studies provide valuable approaches to tertiary containment design, for example:
Allied Colloids, Bradford (July 1992)
Monsanto, Wrexham (1985/5)
Sandoz, Switzerland (1986)
The first two of these are described in Ref 2 below.

Risk assessment Guidance

Numerous guidance documents are available on environmental risk assessment. A selection only of those available is listed below.

For the purpose of this initial Buncefield Task Group guidance document on tertiary containment, no opinion is expressed on the suitability of any of the specific guidance listed below.

Tertiary Containment Guidance documents

1. Managing Fire Water and Major Spillages: PPG 18 - Pollution Prevention Guidelines Series - Joint publication of the Environment Agency, Scottish Environmental protection Agency and the Environment and Heritage Service for Northern Ireland. Ref HO-6/00-12K-C-BBUD. Available from http://www.environment-agency.gov.uk
2. Design of Containment Systems for the Prevention of Water Pollution from Industrial Accidents - CIRIA Report 164: Construction Industry Research and Information Association 1997 ISBN 0 86017 476 X http://www.ciria.org.uk
3. Chemical Storage Tank Systems – Good Practice – CIRIA C598: Construction Industry research and Information Association 2003 ISBN 0 86017 598 7. http://www.ciria.org.uk
4. Energy Institute: (Formerly Institute of Petroleum) (Draft) Model Code of Safe Practice Part 19: Fire Precautions at Petroleum Refineries and Bulk Storage Installations 2nd ed. 2006 Available from http://www.energyinst.org.uk

5. Energy Institute: Environmental Guidelines For Petroleum Distribution Installations *Draft*6 (2006) http://www.energyinst.org.uk

General and Risk Assessment Guidance documents

6. DEFRA: Guidelines for Environmental Risk Assessment and Management.http://www.defra.gov.uk
7. Environment Agency: Sector Guidance Note IPPC S 1.02 - Guidance for the Gasification, Liquefaction and refining Sector. http://www.environment-agency.gov.uk

8. IC IPPC Reference Document on Best Available Techniques (BREF) on Emissions from Storage: July 2006, http://www.ippc.jrc.es
9. Design of Containment Systems for the Prevention of Water Pollution from Industrial Accidents - CIRIA Report 164: Construction Industry Research and Information Association 1997 ISBN 0 86017 476 X http://www.ciria.org.uk
10. Energy Institute: Guidance document on risk assessment for the water environment at operational fuel storage and dispensing facilities. http://www.energyinst.org.uk
11. Energy Institute: Guidelines on the environmental risk assessment for major installations handling hazardous substances. http://www.energyinst.org.uk
12. Energy Institute (Formerly Institute of Petroleum) Environmental risk assessment of liquid bulk storage facilities. Trial screening tool under development. http://www.energyinst.org.uk
13. Environment Agency: IPPC H7 Guidance on the Protection of Land under the PPC Regime – see p24 Box 6. http://www.environment-agency.gov.uk
14. DEFRA (DETR): Guidance on the Interpretation of Major Accident to the Environment for the purposes of the COMAH Regulations 1999. http://defra.gov.uk

Suitable and precautionary methodologies should be used for the above risk assessment. In view of the high uncertainties in modelling the transport of entrained or dissolved pollutants in liquids escaping secondary containment, it is recommended that assessments concentrate on quantifiable physical parameters such as those indicated in the following table.

Action/parameter	**Guidance**
For the worst case foreseeable severe pool fire scenario	
Identify firewater volumes	Ref 2 & Ref 4 below
Assess firewater management effects	
Identify bund potential failure points.	
For each failure point, assess: Likely liquid/firewater flow and volume Direction of escaped liquid flows	
For the worst case catastrophic tank failure	
Identify expected liquid volumes, flow directions and receiving locations outside bund walls	
For the surrounding environment, construct a conceptual site model	
Construct Conceptual Site Model	Ref 13 below
Identify surrounding environmental receptors e.g SSSIs, rivers, agricultural land	Environment Agency, Natural England, Tables 1-12, Ref 14 below
Identify geological characteristics	British Geological Survey
Identify hydrogeology	
Identify flow gradients and likely flow outcomes	
Identify direct pathways e,g, drains, boreholes	
Identify indirect pathways to sensitive receptors e.g. permeable ground	
Assess permeability of ground and thus permeation flow-rates and quantities of pollutant into ground	Ref 2 below
Consider appropriate defensive tertiary containment measures	
Kerbing to roadways, car parks etc, toe walls, area grading	
Eliminate direct pathways e,g cap boreholes	
Emergency drain seals (e.g. auto actuated bellows)	
Overflows to remote containment lagoons	
Channel spillages to remote containment	
Additional hardstanding	
Dedicated tankage	
Transfer to other secondary containment (care)	

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SHIFT HANDOVER

Introduction
Transfer of volatile fuels into storage frequently continues across shift changes, and there is little doubt that unreliable communications about plant or transfer status at shift change could potentially contribute to a tank overfill. It has been a contributory factor in several previous major accidents, including Piper Alpha, Esso Longford, and BP Texas City.

The HSE publication HSG48 (1) discusses how unreliable communications can result from a variety of problems. It identifies some high-risk communication situations, and some simple steps that can be used to improve communications in the workplace.

HSE's Safety Alert review of oil / fuel storage sites in early 2006 indicated that many sites had structured shift handover formats in place, but some relied on event-type logs or unstructured logs that did not clearly specify the type of information that needed to be communicated.

The minimum requirement is for a handover procedure, or standard, that specifies simple and unambiguous steps for effective communications at shift and crew change. These include carefully specifying what information needs to be communicated, using structured easy-to-read logs or computer displays, ensuring key information is transmitted both verbally and in writing, and encouraging two-way communication.

Action
Each site should set and implement a standard for effective and safe communication at shift and crew change handover.

For Top Tier COMAH sites a summary of the standard should be included in the next revision of the Safety Report.

The standard should be based on the principles described in HSG48. It should:

- Carefully specify what key information needs to be communicated at shift and crew change, at key positions in the organisation. The requirements may well be different for different positions, but should consider issues such as:
  - Product movements, both ongoing and planned
  - Control systems bypassed
  - Equipment not working or out of commission
  - Maintenance and permitry
  - Isolations in force
  - Trips defeated
  - Critical or high priority alarms activated & actions taken,
  - Health, safety or environment incidents or events
  - Modifications
  - Personnel on site
- Use suitable aids, such as logs, computer displays etc. to provide a structured handover of key information, whilst aiming to cut out unnecessary information
- Capture key information that needs to be carried forward across successive shifts (e.g. equipment out of service)
- Allow sufficient time for handover, including preparation time
- Ensure that key information is transmitted both verbally and in writing
- Encourage face-to-face, and two-way communication, with the recipient asking for confirmation, repetition, clarification etc. as appropriate
- Specify ways to develop the communication skills of employees

The standard should take account of situations that are known to be especially liable to problems, including:

- During maintenance, if the work continues over a shift change
- During deviations from normal working
- Following a lengthy absence from work (either as a result of a regular long shift break, or individual absence)
- Handovers between experienced and inexperienced staff

Techniques that have been reported from the industry, and that companies may wish to consider in development of their standards, include:

- Use of electronic logs, with password systems for acceptance
- Systems to project electronic logs onto a screen (for team briefing)
- Use of team briefings e.g. with staggered shift changes between supervisors and operators
- Use of pre-printed paper logs in a structured format
- Use of white boards for recording systems that may be out of service for several shifts

Companies must have the facilities and management arrangements necessary to ensure that the standard set are indeed complied with. These include:

- Arrangements to minimise distractions during handover
- Instruction and training of employees in handover procedures
- Supervision, audit and review to ensure that the procedure is complied with and the necessary information is communicated and understood

Reference:

(1) HSG48 Reducing Error and Influencing Behaviour, HSE Books, 2nd edition, 1999, reprinted 2003, ISBN 0 7176 2452 8