European Commission

Common Inspection Criteria on Secondary Containment Systems – Bunds,

A Seveso Inspection Series Publication

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Abstract

This publication on Common Inspection Criteria is intended to share knowledge about technical measures and enforcement practices related to major hazard control and implementation of the Seveso Directive (2012/18/EU). The criteria were developed by Seveso inspectors to aid in dissemination of good enforcement and risk management practices for the control of major industrial hazards in Europe and elsewhere. This particular issue provides criteria for inspecting a site's management and maintenance of open collection systems intended for containing accidental leaks or spills from storage vessels.

Note that this document is not intended as a technical standard nor as a summary or replacement of any existing standards on the matter. This publication is part of the ongoing series of publications on Common Inspection Criteria (CIC) to support inspection by authorities who have responsibility for monitoring and oversight of hazardous sites. The criteria were developed by the EU Technical Working Group for Seveso inspectors, representing the collective knowledge and experience of inspectorates throughout Europe with responsibility for implementing inspection requirements of the EU Seveso Directive (2012/18/EU) for the control of major chemical hazards. The publication is intended to aid the dissemination of good enforcement and risk management practices for the control of major industrial hazards both in Europe and elsewhere.

1 Introduction

Since the establishment of the Seveso Directive in 1982, the Major Accident Hazards Bureau (MAHB) of the European Commission's Joint Research Centre (JRC) has provided scientific support to this European legislation aimed at prevention and mitigation of major accidents involving hazardous substances. The Seveso Directive is based on a performance-based framework, driven by the nature of substances involved, and employs a proportional risk-based approach. In particular, MAHB analyses accidents for lessons learned and emerging trends, facilitates exchange of challenges and practices across Member States, and makes the information that it creates and collects available through various tools and publications.

One of JRC's most important roles has been fostering Member State exchange on challenges and good practice for inspecting major hazard, so-called "Seveso", sites. Notably, the sources of chemical accident risk are highly diversified, far more than any other technological risk, such as aviation or nuclear energy risk, The EU database of Seveso establishments (eSPIRS) specifically identifies 38 different industries. Moreover, many of these industries are collections of several subindustries, e.g., the chemical and petrochemical industries can be divided into 50 or more subindustries. For this reason, there are hundreds of processes and substances, all of them with their own unique hazardous elements, that can be the source of a chemical accident. Through regular exchanges of the EU Technical Working Group on Seveso Inspections ("TWG 2"), the JRC enables the authorities to discuss complex issues surrounding the dynamic and diverse risk management concerns they face in performing their Seveso monitoring and oversight duties.

The TWG 2, guided by the JRC but led by representatives of EU/EEA Seveso inspectorates, prioritises topics for exchange. These topics can be focused on components of good safety management, necessary for all sites (so-called "horizontal topics") such as emergency response or risk assessment approaches. Alternatively, they can be targeted to managing risks associated with specific types of dangerous substances or in specific industries (so-called "vertical topics").. The TWG 2 has created a number of product lines within the Seveso Inspection Series of publications for disseminating good practice based on these exchanges.

The Common Inspection Criteria publications is one of these product lines. First conceived in 2013, it is intended to aid the dissemination of performance criteria that can be used to promote effective enforcement approaches across EU inspectorates, and by extension, risk management practices on chemical hazard sites. As with all products of the TWG 2, the entire complement of Common Inspection Criteria publications can be found on the JRC's Seveso Inspection Series web portal.

Notably, the Common Inspection Criteria do not provide scientific explanations of the hazard phenomena they are addressing. This choice is deliberate since the criteria are intended for process safety experts, not the general public. All such experts in the private and public sector would already have substantial knowledge of the properties of hazardous substances, such as flammability, and the main risks associated with usage and handling in industrial contexts.

The topic for this publication was selected by the EU Technical Working Group on Seveso Inspections as part of a series of Common Inspection Criteria on mitigating the effects of chemical accidents. Secondary containment is a second line of defense for preventing, controlling or mitigating major hazard events. It is intended to stop the spread of a release when control measures associated with the primary containment system have failed. Numerous situations can arise at a hazardous site that necessitate the presence of secondary containment, in particular, poor handling during loading and unloading, overfilling, valve malfunction, and fires and earthquakes that cause primary containment to fail. Even when a proper maintenance programme is followed, various other factors, e.g., wrong procedures, a flawed risk assessment, or an external event, can create unforeseen leaks or fractures in the primary containment. Therefore, it is important that operators can demonstrate to competent authority inspectors that they are designed and managed according to princples of good practice.

The information in this report is derived from the experience and knowledge of Seveso inspectors serving on the EU Technical Working Group for Seveso Inspections. On occasion, an open source is cited in the document where the information was used to complement and improve the document.

2 Scope and objectives

The Common Inspection Criteria on secondary containment systems (bunds, dykes and berms) is number 16 in the Seveso Inspection Series of publications. The purpose of the Common Inspection Criteria (CIC) is to provide a baseline criteria to support effective and meaningful inspection of chemical hazard sites. The secondary containment technologies addressed in this CIC are open spill collection systems designed to manage a pooling substance, that is, a hazardous substance that is a liquid, or is likely to liquefy in a fire. There are several technologies that contain liquid spills, and are used either for supplementary or full containment. A subset of these technologies consists of open spill collection systems, particularly bunds, berms, and drip trays. These particular technologies are all commonly used to prevent the spread of liquids spilled or leaked from containers of liquid substances, in particular, storage tanks, barrels, and intermediate bulk (IBC) containers. They are all more or less open basins, of varying shapes and sizes, surrounded by walls, with a few additional features that distinguish one from the other. **Figure 1** shows what a typical tank storage area looks like when surrounded by a square bund.

2.1 Scope

This CIC will focus on inspection of bunds (and similar structures) around large immobile industrial storage tanks, typically found in tank farms, but also sometimes indoors (when conditions permit), and also around indoor reactors and pressure vessels. The CIC is also generally applicable to open collection systems used for mobile indoor and outdoor containers (drums, barrels and IBCs), consisting mainly of drip trays and small scale spill containment berms.

Figure 1 Tank storage n power plant

Source: Photo by M. F. Rehmani (CC0 1.0)

Not included in the scope are drainage and removal systems, including sumps and interceptors, in which spills are directed towards drains and trenches that are then connected to catch basins, carrying the liquid away from the process installation. Secondary containment systems for gaseous releases, such as the fluid curtains of specially designed gas tight buildings, are also out of scope. **See Text Box** 1 for the terminology referring to specific types of collection systems covered by this document.

This publication provides performance criteria that a site an inspector can use to determine whether the operator has fulfilled this obligation and areas that made need improvement. It addresses only the hazardous site operator's preparedness for preventing and mitigating onsite effects of emergencies involving a toxic release dispersion. The criteria outlines the evidence that the inspector can use to determine whether or not the hazardous site operator has implemented an effective programme for a site's management and maintenance of open collection systems intended for containing accidental leaks or spills from storage vessels.. The criteria may equally be useful to operators to self-assess the completeness of their programmes for managing and maintaining secondary containment systems.

Text Box 1 Explanation of terminology

Bunds, dykes and berms are used interchangeably for secondary containment around large, mainly outdoor storage tanks where flammable or toxic liquids are held. In this document, we will use the term "bunds". For materials that are normally gases at ambient conditions, bunds are used where flash fractions are sufficiently low to merit them.

Earth berms and dykes. A berm around a large storage tank is a barrier that keeps liquids from escaping. It is a raised border separating different areas that may provide additional protection from flooding or erosion. Earth berms are constructed from various materials, including gravel, stone, soil, crushed rock, brick, or a combination of these materials.

Both bunds and berms should be designed to contain spillages and leaks of liquids used, stored or processed above ground and to facilitate clean-up operations.

Mobile collection systems prevent the spread of toxic or flammable substances to other plant areas, or to sumps and drains, where secondary effects resulting in a major accident could occur by domino effect. The systems are categorized as 'mobile' because they are not fixed in place, and can be moved around to accommodate plant layout changes, or the addition of containers that require the same kind of secondary protection. **Drip trays** are often used beneath equipment liable to small leaks, such as pumps, in process buildings and are effectively mini-bunds. **Drip pallets and mobile spill containment berms** are typically used for drums, barrels, and IBCs, in indoor or outdoor locations.

Mobile containment systems vary greatly in size and design. They are normally tailored to the individual item of equipment but may serve a number of items. They are often constructed of metals such as stainless steel or strong rigid plastics that can be readily moved. Drainage is not normally provided and liquid collected is normally removed using absorbent material, after neutralisation or dilution (if required).

The United Kingdom's Health and Safety Executive page on Secondary Containment was an additional source for some of the information provided here.
https://www.hse.gov.uk/comah/sragtech/techmeascontain.htm

The response to a toxic dispersion event consists of measures to be taken inside - and to some extent, outside - an establishment to prevent and respond in the event of a toxic release. This document provides guidance to inspectors on assessing the adequacy of the operator's measures for preparing and responding to a toxic dispersion consistent with requirements of the Seveso Directive and containing and controlling incidents so as to minimise the effects and limit damage to human health, the environment and property.

2.2 Objective of the inspection

In general, bunds are provided for atmospheric storage tanks and for fully refrigerated storage tanks of liquefied gas or, with some exceptions, semi-refrigerated storage of liquefied gas or for acid or alkali storage. Therefore, the inspection is intended to verify that the operator can demonstrate that the design, use and maintenance of the bund is sufficient that the containment can fulfil its functions and cause no harm.

In particular, a bund serves a number of purposes, including the following:

- prevent the flammable liquid or vapour from reaching ignition sources
- prevent the liquid entering the drainage or water systems where it may spread to

uncontrolled ignition sources

- allow the controlled recovery or treatment of the spilled material
- minimise the surface area of the liquid and so reduce the size of any fire that may occur
- prevent the spread of burning liquids which could present a hazard to other plant or personnel both on and off site
- contain water used in firefighting or tank cooling
- prevent contamination of land and water courses

Therefore, the operator must convince the inspector with evidence that the design and maintenance of the bund system will support all these functions and that it will also function properly in an emergency.

3 Elements of an inspection

The inspection of a bund, or any other open collection system, will generally focus on the following elements:

- Design
- Construction
- Maintenance and mechanical integrity
- Emergency response

3.1 Design

Secondary containment should be designed in relation to the size and nature of the substance stored in the primary container. It should be big enough to contain the spilled substance, and the material of the secondary containment must be compatible with the substance.

Generally speaking, design of bunds around primary containment is fairly standardized, although which standards apply depends on what is being stored. The standards provide decision criteria that address a number of factors, in particular,

- the classification of the materials stored
- hazardous area classification
- maximum capacity of the primary containment
- separation distances, if the bund surrounds a group of storage tanks,
- Hydrostatic and hydrodynamic loads on bund walls, and
- fire protection measures.

These factors will determine the size, capacity, dimensions, and composition of the bund. Decision criteria are given in various codes and other publications, such as NFPA 30[1], API RP 752[2], HSG 176[3], and sometimes also national legislation.

The operator should be able to present documentation that indicates the design standards that were applied in construction of the bund.

If there has been a material change in the content of the primary containment, the operator should have documented a management of change (MOC) assessment of the adequacy of the bund to accommodate this change, and that changes to the bund design were subsequently implemented based on this assessment.

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[1] NFPA 30, Flammable and Combustible Liquids Code

[2] API RP 752, Management of Hazards Associated with Location of Process Plant Permanent Buildings, Third Edition

[3] HSG 176 The storage of flammable liquids in tanks

The bund wall should be designed to withstand a catastrophic tank failure and subsequent wave surge and overtopping event. The operator should be able to demonstrate that the tank is adequately resilient to such scenarios based on accident scenarios of the site.

Criteria influencing design of drip trays, drip pallets and spill containment bunds is described in **Text Box 2**.

3.2 Construction

Construction of the bund should also take into consideration appropriate requirements for materials of construction and for permeability based on design standards and local conditions.

3.2.1 Construction materials

The materials used in the bunding system should be able to withstand exposure to the hazardous material being stored and resist any corrosion or degradation that may occur over time. Compatibility should also be considered when selecting any sealants or coatings used in the construction of the bunding system.

Incompatible materials should not be stored in a common bund especially if the product material formed in the accidental mixing of the materials (e.g., due to error in tank filling) is incompatible with bund materials of construction.

In case of inflammable substance, the construction materials should be fire resistant. Particular attention should be paid to seams in the walls and seals around piping perforating the walls. Either a fire resistant material should be used, either the seams and seals should be protected against fire (e.g. by a non-combustible plate).

3.2.2 Permeability

It should be demonstrated that the bund beneath the tank floor is impermeable. Unlined earth bunds rely entirely on the impermeability of the soils forming the base and walls to provide containment.

Where pipework penetrates the bund wall and/or bund floor the operator must be able to demonstrate that the impermeability is not compromised.

On older sites, some bunds may have been built around existing tanks and may not have an impermeable layer beneath the tank floor. In such situations, the operator is required to have taken remedial actions, such as:

- retrospectively installing an impermeable bund floor
- installing a second floor within the tank with a drain out to the bund between the two tank floors. This system should be coupled with leak detection between the tank floors, in addition to leak detection under the original tank floor.

Text Box 2 Design features of drip trays, drip pallets and spill containment bunds

Drip trays, drip pallets and spill containment bunds are simple trays or basins underneath storage containers to collect leaks and spills. They are intended for use with a single drum or a few small containers, in storage or at point of use. They are normally tailored to the individual item of equipment but may serve a number of items.

The size and capacity are determined on a similar basis as larger fixed open collection systems. For example, if you store oil on a drip tray in drums, the tray must be able to contain at least 25% of the total drum volume, or 110% of the largest one, whichever is the greatest.

Design should also take account of:

- the nature of the product that could be released, e.g. toxicity, persistence
- impermeability and resistance to attack from materials stored
- fixed fire-fighting systems and fire water containment
- fire resistance, including the effects of fire on the containment system
- effect of extremes in weather, freezing or high temperatures
- availability of ventilation at high and low levels (above secondary containment)
- the need to segregate products, especially if they are incompatible and would react if mixed
- separation from ignition sources, process areas, occupied buildings and site boundaries
- distance between other storage zones to stop fire spreading
- signage, to indicate the presence of secondary containment and any handling recommendations, for example, when equipment are being loaded or unloaded

Materials of construction are often metals such as stainless steel or strong rigid plastics that can be readily moved. Drainage is not normally provided and liquid collected is normally removed using absorbent material, after neutralisation or dilution (if required).

Drip trays can be used inside or outside buildings, but if used outside, regular procedures should include inspection following rainfall similar to bunds.

In general, the inspection and maintenance programmes for mobile and semi-mobile open spill collection systems should be modelled after those for bunds, with minor exceptions associated with their much smaller size.

The emergency response, fire prevention, and mitigation measures of the area in which they are located should also take into consideration the presence of localized secondary containment measures.

Services such as electricity supply should be carried over the secondary containment system rather than penetrating it. Mains water supply (except water-based fixed fire-fighting systems and safety shower/eye wash stations) shouldn't enter the containment area of the store.

In clad buildings where racking extends above any containment system, provision should be made to prevent a high level leak running down between the cladding and the containment wall. Containers shouldn't be stored at such a height or so close to the walls that they might fall outside the containment system or that liquid 'jetting' from a leak would reach over the wall.

Source: Guidance for Pollution Prevention Safe Storage of Drums and Intermediate Bulk Containers (IBCs): GPP 26) (Natural Resources Wales (NRW), the Northern Ireland, Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA)).

3.2.3 Drainage

The removal of rainwater is normally achieved by incorporating a drain at a low point of a sloping floor with a manual valve, normally kept closed. The capacity of the closed system should be based on documented estimates of maximum rain fall from historic data.

If the bund contains a rainwater drain, and requires manual draining, there must be a clear demonstration that the action can be done a safe manner in a bund fire event. Manually operated drain valves cannot be located inside bunds.

Where the design allows firewater to be drained off manually, there may be a risk of flame carryover through the drain system. This risk needs to be assessed and appropriate control measures should be put in place to prevent flame carryover.

There should be a means for removal of firewater from below the surface of the liquid, in particular, to evacuate a substance that is not miscible with water and has a lower density.

3.2.4 Leak detection equipment

Hydrocarbon detectors (flammable and/or toxic), positioned within the containment basins of the tanks, in order to promptly detect any product leaks.

3.2.5 Environmental impacts

The operator should have evaluated the site of the bund from a geological and a hydrogeological point of view. The analysis should consider environmental consequences of any accidental spills. It should also include an assessment of the time required for the pollutant to travel vertically and horizontally and to reach potentially sensitive targets. Depending on the impacts foreseen, the operator should have in place appropriate prevention and mitigation control measures.

3.2.6 Natural hazard events

The site should have conducted an assessment of risks from natural hazards, e.g., earthquakes and floods, and incorporated these into design criteria.

Many sites may not have conducted such evaluations before having constructed their bunds.

In this case, the operator must demonstrate that the bund has been retrofitted as necessary to address any risks from natural hazards not adequately mitigated by the original design.

In addition, bunds can protect the tank area from flooding, which may be taken into consideration in determining the dimensions (e.g., height, thickness).

3.2.7 Tertiary Containment

The operator should also calculate the possibility that the bund could overflow (‘bund overtop’) to determine whether a tertiary containment is required.

Some national authorities may require tertiary containment for certain specified dangerous substances.

The tertiary containment can be located in areas that are normally occupied by workers, such as yards. The location of the tertiary containment should be sited as to avoid risk to site personnel, responders or for escalation. In these situations, the emergency procedures must evaluate the additional risk of ignition of flammable vapours and health and safety risk to personnel), and establish control measures as necessary to mitigate the risk.

3.3 Inspection

A suitable bund inspection program is required to be in place set at appropriate intervals. Bunds should be immediately inspected after a tank loss of containment event. Bund impermeability should be confirmed by suitable tests such as a hydraulic water test in accordance with industry standards.

A typical inspection programme should consist of daily, weekly and monthly inspection protocols, as well as special protocols for checking the bund conditions following rainfall. In addition, bunds should be immediately inspected after a tank loss of containment event. **Text Box 3** provides a list of some common signs of poor bund maintenance.

Text Box 3 Signs of badly maintained bund system

For a dike, berm, or other engineered secondary containment system:

- Capacity of the system to contain oil as determined in accordance with good engineering practice and the requirements of the rule
- Cracks in containment system materials (e.g., concrete, liners, coatings, earthen materials)
- Discoloration
- Presence of spilled or leaked material (standing liquid)
- Corrosion of the system
- Erosion of the system
- Operational status of drain valves or other drainage controls
- Dike or berm permeability
- Presence of debris;
- Level of precipitation in diked area and available capacity versus design capacity
- Location/status of pipes, inlets, and drainage around and beneath containers;
- Excessive vegetation that may inhibit visual inspection and assessment of berm integrity;
- Large-rooted plants (e.g., shrubs, cacti, trees) that could affect the berm integrity;
- Holes or penetrations to the containment system created by burrowing animals; and
- Drainage records for rainwater discharges from containment areas

Source: US EPA. SPCC Guidance for Regional Inspectors

3.4 Maintenance

The maintenance of bunds should include a program of periodic integrity checks, through the use of non-destructive methods (NDT). Depending on the expected result, the test can be carried out visually or via instrumentation. Other elements may include:

- Where there are continuous monitoring systems, it is important that there are also periodic checks of the reliability of the instrumentation, based on the manufacturer's indications or on the operating experience.
- All bund repair work should be recorded in sufficient detail and the records kept for the duration of use of the bund.
- Operating schedules should include daily opening of the valve to remove accumulated water, this will also assist in identifying minor leaks.

3.5 Emergency response

Credible scenarios should be developed in consultation with the Fire and Rescue Services to inform the design of the containment system.

It is noted, however, that commonly available intumescent construction sealants are fire-rated for up to four hours. In the absence of any other information on the likely incident scenario, a minimum fire duration of four hours should be adopted.

The bund firewater retention capacity should be designed for the expected fire-fighting requirements based on the worst-case fire event. For example, a tank fire in a bund with multiple tanks would require fire water/foam application rates for the tank on fire and additional firewater application rates for adjacent tanks subject to flame impingement.

The use of adjacent bund retention capacity may be acceptable subject to a detailed risk assessment and appropriate design.

Where flammable materials are stored, the operator should

- have estimated the volume, of firefighting and cooling water that may have to be applied during an incident
- make sure that the components of the containment systems including the walls, and perhaps more importantly, the materials used to seal any joints, are fire resistant
- demonstrate that the firefighting water and foam demand requirements have been correctly specified for that bund.

For high-walled bunds, the site operator should demonstrate by means of a written risk assessment that there is not a risk of tanks floating in the event of the bund filling with firewater or due to extreme rainfall events.

The local emergency services, in particular the fire service, should be advised of the bund and firefighting equipment design & water usage in the event of a fire. Operators should have established the actions to be taken in case a bund risks flowing over, that should include:

- criteria for when to stop firefighting attempts

- a strategy for emptying the bund, e.g., removal of content of bund to an additional containment (e.g., large trench), to relieve the danger and allow the firefighting to continue

4 Conclusions

Secondary containment systems, such as bunds, dykes, and berms, that surround large storage tanks and other similar containment are technological systems for containing releases of hazardous substances so that they do not enter the environment. When designed, operated, and maintained properly, they are an important barrier in the sequence of events that could lead to a catastrophic chemical accident. The criteria provided in this document can be used as concrete measures for Seveso and other hazardous site inspectors to verify that the operator has implemented this risk management measure according to good practice.

This document summarises good practices recommended by the EU Technical Working Group for Seveso inspections that all inspectors of hazardous sites can use to assess whether a site has sufficiently reduced risk of death or injury to onsite populations to toxic dispersion events through careful planning within the internal emergency response plan. The criteria can be used by any inspector of chemical hazard sites handling hazardous substances anywhere in the world. Moreover, by following these recommendations, any hazard site operator can demonstrate that they are taking all necessary measures to prevent this kind of chemical accident risk.

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