Environmental Protection Agency

IPC Guidance Note on

Storage and Transfer of Materials for Scheduled Activities

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Environmental Protection Agency

AGENCY STATUS

The Environmental Protection Agency (EPA) is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Heritage and Local Government.

The EPA is managed by a full time Executive Board consisting of a Director General and four Directors. Independence is assured through the selection procedures for the Director General and Directors and the freedom, as provided in the legislation, to act on its own initiative. The assignment, under the legislation, of direct responsibility for a wide range of functions underpins this independence. Under legislation, it is a specific offence to attempt to influence the Agency, or anyone acting on its behalf, in an improper manner.

The Agency is assisted by an Advisory Committee of twelve members, appointed by the Minister for the Environment, Heritage and Local Government.

RESPONSIBILITIES

The EPA has a wide range of statutory duties and powers under the Environmental Protection Act. In addition, the capacity of the EPA in relation to enforcement has been enhanced by powers contained in the Protection of the Environment Act 2003. The main responsibilities of the EPA include the following:

- licensing large/complex industrial and other processes with significant polluting potential;
- monitoring environmental quality, including the establishment of databases to which the public have access;
- publishing periodic reports on the state of the environment;
- promoting environmentally sound practices;
- promoting and co-ordinating environmental research;
- licensing all significant waste disposal and recovery activities, including landfills, and the preparation of a national hazardous waste management plan;
- implementing a system of permitting for the control of VOC emissions resulting from the storage of significant quantities of petrol at terminals;
- implementing and enforcing the GMO Regulations for the contained and deliberate release of GMOs into the environment;
- preparing and implementing a national hydrometric programme;
- drafting a National Allocation Plan for greenhouse gas emissions allowance trading; the establishment of a National Competent Authority for the issuing of trading permits and allowances to those covered by the scheme; the monitoring, overseeing and verification of emissions from participating companies; and the establishment of a National Emissions Trading Registry;

and, under the Office of Environmental Enforcement, established in 2003 and dedicated to the implementation and enforcement of environmental legislation in Ireland:

- improving overall compliance with environmental protection legislation in Ireland;
- raising awareness about the importance of enforcement of environmental protection legislation in Ireland;
- enforcing IPPC licences and Waste licences issued by the EPA;
- auditing and reporting on the performance of local authorities in the discharge of their environmental protection functions, including:
  - enforcement in respect of breaches of waste permits,
  - taking action in relation to illegal dumping,
  - implementation of waste collection permits, and
  - enforcement of producer responsibility initiatives (for example, in the area of packaging waste);
- taking action against local authorities that are not discharging their environmental protection functions in an adequate manner;
- prosecuting, or assisting local authorities to prosecute, significant breaches of environmental protection legislation, in a timely manner; and
- assisting local authorities to improve their environmental protection performance on a case by case basis, through the establishment of an enforcement network to promote information exchange and best practice, and by the provision of appropriate guidance.

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Published by the Environmental Protection Agency, Ireland

ISBN: 1-84095-145-1 12/04/500
Price: €10

CONTENTS

1. INTRODUCTION

The Environmental Protection Agency (EPA) can prepare and publish codes of practice to provide practical guidance for the purposes of environmental protection.

This guidance note provides assistance for industry to comply with Integrated Pollution Prevention Control (IPPC) licence conditions in relation to storage and movement of potentially polluting substances and thereby protect the environment. The document is a general guidance document and sets out the minimum requirements for IPPC facilities.

As described in the Protection of the Environment (POE) Act of 2003, Best Available Techniques (BAT) will be used to prevent, eliminate or, where that is not practicable, limit, abate, or reduce an emission from an activity which is listed in the First Schedule to the Act. The use of BAT is construed in the Act to mean the provision and proper maintenance, operation, use and supervision of facilities which are the most suitable for the purpose.

In determining BAT for an activity, regard shall be had to:

- The use of low waste technology;
- the use of less hazardous substances;
- the furthering of recovery and recycling of substances generated and used in the process and of waste where appropriate;
- comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale;
- technological advances and changes in scientific knowledge and understanding;
- the nature, effects and volume of the emissions concerned;
- the commissioning dates for new or existing activities;
- the length of time needed to introduce the best available techniques;
- the consumption and nature of raw materials (including water) used in the process and their energy efficiency;
- the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- the need to prevent accidents and to minimise the consequences for the environment, and;
- the information published by the Commission of the European Communities pursuant to any exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them, or by international organisations,

and such other matters as may be prescribed.

The techniques identified in this guidance note are considered to be the current best practice, at the time of writing, and are representative of a wide range of currently employed technologies appropriate to particular circumstances. This document does not however replace the need to carry out site-specific assessments / investigations prior to determining the appropriate type of containment / retention facilities. Additionally, the guidance issued in this note in respect of the use of any technology, technique or standard does not preclude the use of any other similar technology, technique or standard which may achieve an equivalent level of environmental protection.

2. SCOPE

The scope of this guidance note covers tanks (including drums and containers), bunds and pipelines which store or transmit potentially polluting substances, be they solid, liquid, gas or combined, including;

- wastes,
- fuels,
- raw materials,
- products or intermediates,
- cleaning and disinfectant agents.

The guidance note addresses design, construction, operation, maintenance and monitoring of such structures. The industrial sectors covered are those listed in the first schedule of the POE Act 2003, which is reproduced in Appendix A for reference. A wide section of industry types, which have varying processing conditions and pollution potentials, are covered by the first schedule of the POE Act. For particular conditions relating to similar industrial sectors, this guidance note highlights the following industrial sectors:

- Intensive Agriculture (Section 6 of the first schedule)
- Food and Drink (Section 7 of the first schedule)
- Other Industries (all other Sections of the first schedule)

The issue of run-off from fire fighting operations is covered under a separate guidance note from the EPA (Fire-Water Retention Facilities; (Draft) Guidance Note to Industry on the Requirements for Fire-Water Retention Facilities).

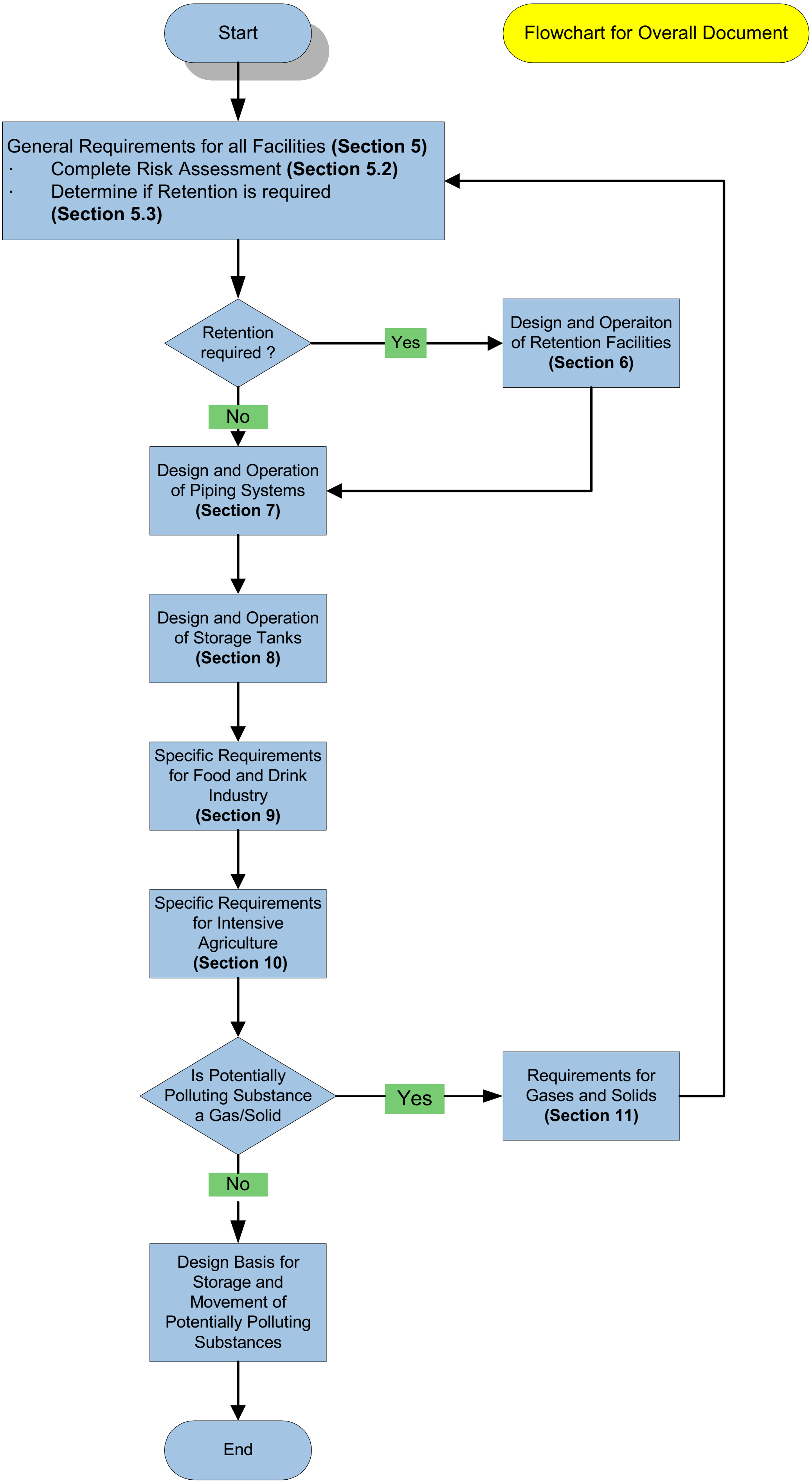
Storage and transfer systems for substances which are not potentially polluting substances, such as uncontaminated surface water drainage or fire water storage are not seen as a pollution risk and therefore do not fall within the scope of this guidance note.

In general, the technologies identified in this guidance note, unless otherwise specifically stated, are regarded as representing BAT for new activities. However, it is also generally envisaged that existing facilities will progress towards attainment of a similar level of environmental protection in which the specific requirements and associated time frames will be identified on a case by case basis. For instance, many of the organisational measures outlined in this guidance document, such as testing of storage tanks and piping systems, can be implemented equally for both new and existing facilities. Technical measures, such as leak detection between a tank base and bund floor, may have to be implemented with due regard to the determination of BAT for existing facilities.

3. HOW TO USE THIS GUIDANCE NOTE

The steps involved in using this guidance note are illustrated in the following flowchart. This enables the user to access the Sections of the guidance note, which are most applicable to the relevant industrial sector.

A worked example of a small pharmaceutical plant is provided in Section 12.


Start
Flowchart for Overall Document
General Requirements for all Facilities (Section 5)
· Complete Risk Assessment (Section 5.2)
· Determine if Retention is required (Section 5.3)
Retention required ?
Yes
Design and Operaiton of Retention Facilities (Section 6)
No
Design and Operation of Piping Systems (Section 7)
Design and Operation of Storage Tanks (Section 8)
Specific Requirements for Food and Drink Industry (Section 9)
Specific Requirements for Intensive Agriculture (Section 10)
Is Potentially Polluting Substance a Gas/Solid
Yes
Requirements for Gases and Solids (Section 11)
No
Design Basis for Storage and Movement of Potentially Polluting Substances
End

4. INTERPRETATION

The following definitions are used in this guidance note, additional piping definitions are provided in Appendix E:

Gases: Gases are materials whose critical temperature lies under 50\C or which have, at 50\C, a vapour pressure of more than 3 bar.

Solids: Solids are materials, the individual particles of which do not exhibit flow characteristics under atmospheric pressure and ambient temperature.

Liquids: Liquids are materials that are neither solid nor gaseous.

Hazard: This means the intrinsic property of a dangerous substance or physical situation, with a potential for creating damage to human health and / or the environment (as defined in Directive 96/82/EC on the control of major-accident hazards involving dangerous substances).

Risk: This means the likelihood of a specific effect occurring within a specified period or in specified circumstances (as defined in Directive 96/82/EC on the control of major-accident hazards involving dangerous substances). In general risk can be considered as the combination of the likelihood of an event occurring and the severity of the outcome or the damage.

Risk = likelihood of an event (probability) x severity of outcome (damage).

Potentially Polluting Substances: This refers to substances, which on the basis of their organic loading and / or toxicity to the receiving environment present a pollution risk in the event of a failure in their containment systems.

Facility: A facility is an independent functional unit licensed under the terms of the EPA Act. Vessels which are used by or connected to the processing or manufacturing activities of the facility are to be considered as part of the facility.

Retention Facility: This is a secondary barrier within the drainage system of a facility, which is designed in the event of a loss of sealing in the plant or any plant component to retain the escaping fluid. Retention facilities can be for example, covered pits or pools, separators (oil / water), drainage systems, balancing tanks or closed vessels, which in the case of a leakage, are filled by gravity or by pumps. Mobile road tankers can also serve as retention facilities.

Bund: A retention facility (including walls and base) built around an area where potentially polluting substances 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.

Underground: Underground plants or plant components are those that are fully or partly embedded in the earth or imbedded in construction components that are immediately in contact with the earth. All other plants or plant components are considered as overground.

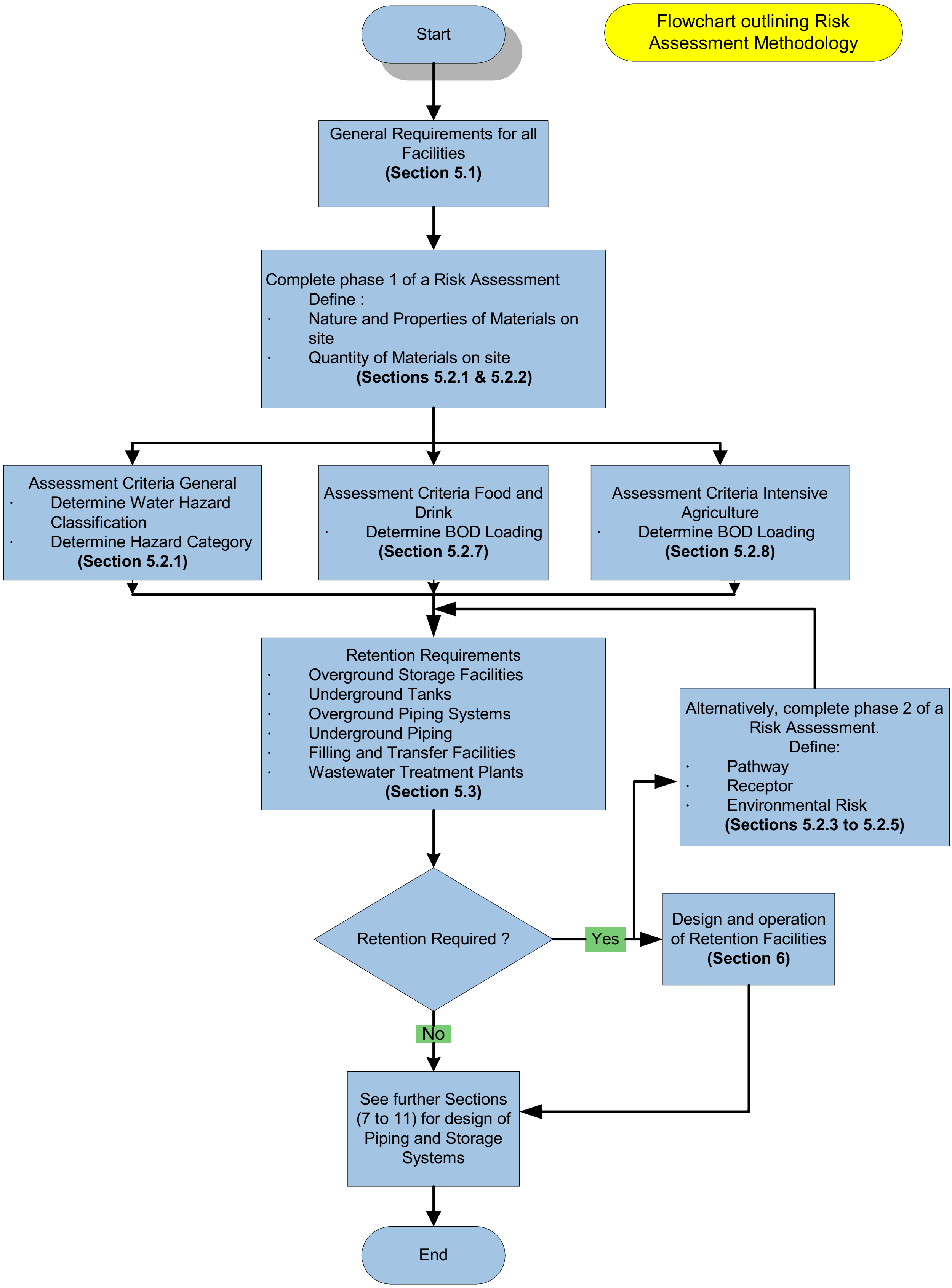
Leak detection: This is defined as a system which will detect the presence of a leak. With automatic leak detection an alarm will be activated without user intervention and monitored by a manned control room. While the preference is for automatic leak detection, it is recognised that this may not be suitable in all cases. For instance detecting leakage from a complex piping system is usually best completed by regular control inspections using a defined procedure and recording the results.

Working area: This is the area of a facility in which leakage is quickly and reliably recognised by trained operating staff, who are present to operate the facility.

Suitably qualified person: This is used throughout the guidance note and refers to a person who has undergone a prescribed course of technical training in the subject matter concerned in addition to a demonstrated period of practical experience. For example, for design and inspection, a chartered engineer in the discipline concerned would fulfil this requirement, while for maintenance a trained technician with relevant experience would fulfil the requirement.

5. GENERAL REQUIREMENTS FOR ALL FACILITIES

The steps involved in this section are outlined in the following flowchart.


Flowchart outlining Risk Assessment Methodology
Start
General Requirements for all Facilities (Section 5.1)
Complete phase 1 of a Risk Assessment
Define :
· Nature and Properties of Materials on site
· Quantity of Materials on site
(Sections 5.2.1 & 5.2.2)
Assessment Criteria General
· Determine Water Hazard Classification
· Determine Hazard Category
(Section 5.2.1)
Assessment Criteria Food and Drink
· Determine BOD Loading
(Section 5.2.7)
Assessment Criteria Intensive Agriculture
· Determine BOD Loading
(Section 5.2.8)
Retention Requirements
· Overground Storage Facilities
· Underground Tanks
· Overground Piping Systems
· Underground Piping
· Filling and Transfer Facilities
· Wastewater Treatment Plants
(Section 5.3)
Alternatively, complete phase 2 of a Risk Assessment.
Define:
· Pathway
· Receptor
· Environmental Risk
(Sections 5.2.3 to 5.2.5)
Retention Required ?
Yes
Design and operation of Retention Facilities (Section 6)
No
See further Sections (7 to 11) for design of Piping and Storage Systems
End

5.1 General

For all facilities it is necessary to complete a **risk assessment** to determine the risk of pollution associated with a facility. In addition the following general requirements apply in so far as they are not altered by other sections of this guidance note:

1. Facilities must be designed, installed, operated and maintained in such a manner that potentially polluting substances do not escape to the surrounding environment. Plant components must be sealed and sufficiently secure from expected mechanical, thermal and chemical effects.

2. A loss of containment of any potentially polluting substances must be quickly and reliably detected.

3. Potentially polluting substances that escape must be quickly and reliably retained and appropriately recycled or managed. As a general rule with polluting substances, the facility should be equipped with a sealed and reliable bund if it is not already equipped with double walled construction and leak detection.

4. In the case of an accident, material that is contaminated with the escaping polluting substances must be retained and appropriately recycled or managed.

5. Operating personnel must be adequately trained in handling potentially polluting substances and the appropriate emergency response procedures. This training should be repeated at regular intervals.

6. With approval of the EPA, in individual cases, equivalent regulations of other EU member states may be considered for the requirements in this guidance note.

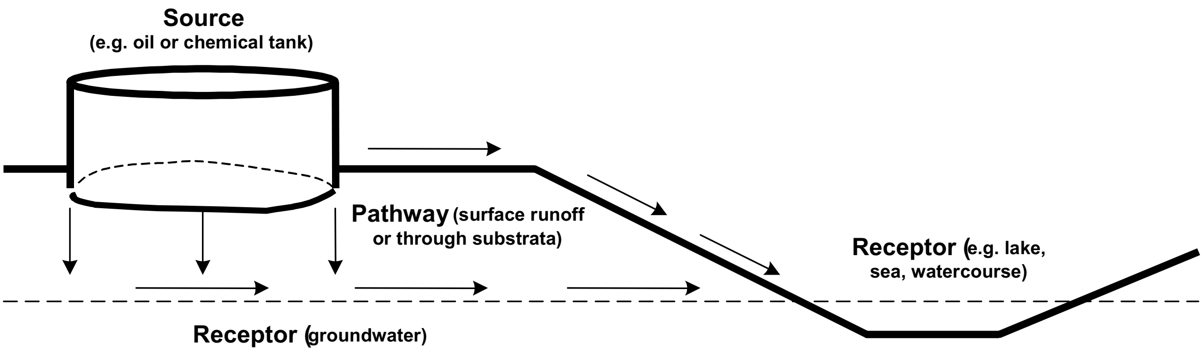
7. Deviations from the threshold values given in this guidance note can be agreed with the EPA in individual cases provided justification of an equivalent level of environmental protection is provided.

8. All facilities should be operated in compliance with the Safety, Health and Welfare at Work Act of 1989 and associated regulations. In the event of a loss of primary containment the secondary containment should provide adequate protection for employees and the general public in the vicinity of the site.

5.2 Risk Assessment

5.2.1 General Principles

Environmental risk is a combination of the likelihood of the event occurring (in this case the probability of potentially polluting substances being discharged to the environment) and the consequence of the event on the environment, i.e. damage to the environment. It is assessed using the source – pathway – receptor method. The diagram below shows schematically how a liquid release from a **source** travels by means of a **pathway** to a **receptor**.



An increasing level of protection is equivalent to reducing the risk of damage to the environment. In order to choose an appropriate level of protection it is first necessary to carry out the following steps of a risk assessment:

a) Identification of the hazard or the **source**.

b) Identification of the **pathway**.

c) Identification of the **receptor** and determination of its sensitivity.

d) Qualitative assessment of consequences and probability of occurrence.

e) Qualitative assessment of risk.

Where Phase 1 of a risk assessment corresponds to step (a) and Phase 2 to steps (b) to (e). Guidelines for each of these steps are presented in Sections 5.2.2 - 5.2.5

Assessment of environmental risk (i.e. phases 1 and 2) therefore attempts to evaluate what could happen. The difficulty is however that the assessment of risk is a more complex exercise than the simpler quantification of hazard (phase 1). If we take two identical chemical processing facilities then the hazard associated with these facilities, i.e. the quantity of chemicals and the polluting potential of these chemicals is the same. However, if the first facility is located on a major groundwater abstraction source and adjacent an important salmon river while the second one has no adjacent watercourse and is sited on impermeable soil over a non-productive aquifer, then it is obvious that the risk of a significant pollution episode with the first facility is higher than that of the second, i.e. the environmental risk is higher.

Unfortunately given the complexity of various release scenarios, varying receptors and the varying weather conditions that can prevail it is not always possible to quantify accurately the risk and establish criteria for an acceptable level of residual risk that remains after taking all reasonable precautions. Therefore, in this guidance note, decision criteria are often based on the simpler concept of hazard quantification, where it is felt that risk quantification would prove difficult to implement. However, the user of this guidance note can complete the more complex risk assessment and provide an equivalent level of safety based on a valid assessment of risk reflecting the individual site conditions.

5.2.2 Source

A source is defined as a substance which has the potential to cause harm to human health, water resources or the wider environment. It includes raw materials, intermediates, products, waste materials and fuels.

- Sources of release would include loss of sealing on valves or pumps, leaking drums, overfilled tanks, etc.

The factors influencing the consequences of potentially polluting substances discharged to the environment are:

- The nature and properties of the materials on site.
- The quantity of materials on site.

These are outlined in further detail below.

a) Nature and Properties of Materials

The nature and properties of the material on site will to a large extent determine the consequences of a release of the material to the environment. If the material does not possess any hazardous properties, the significance of adverse impacts from a release to the environment are reduced.

The following ecotoxicological and associated legislative classifications of a material can be used to assess the potential consequences of a release of the material to the environment. This list is not exhaustive and self-classification with respect to environmental hazards should be based on reputable scientific data:

- The new Water Framework Directive 2000/60/EC took over the framework for control of pollution by dangerous substances previously established under Directive 76/464/EC for List I and List II compounds. Priority substances, which present a significant risk to or via the aquatic environment, are listed in Annex X of Directive 2000/60/EC.
- Material has one or more of the following ecotoxicological properties, where the Risk Phrases (R-phrases) are from EU Classification, Packaging and Labelling legislation (Directive 67/548/EEC as amended):
  - Very Toxic to aquatic organisms (R50).

  - Toxic to aquatic organisms (R51).
  - Harmful to aquatic organisms (R52).
  - May cause long-term adverse effects in the aquatic environment (R53).
  - Toxic to flora (R54).
  - Toxic to fauna (R55).
  - Toxic to soil organisms (R56).
  - May cause long-term adverse effects in the environment (R58).

- Material has one or more of the following toxicological properties:
  - Carcinogenic: May cause cancer (R45).
  - Mutagenic: May cause heritable genetic damage (R46).
  - Teratogenic: May cause harm to the unborn child (R61) or possible risk of harm to the unborn child (R63).
- Material is classified under the German WGK (Water Hazard Classification) system, which is discussed in more detail in Section 5.2.7:
  - Non-hazardous to waters.
  - WGK 1 Low hazard to waters.
  - WGK 2 Hazard to waters.
  - WGK 3 Severe hazard to waters.

However, substances may exhibit low toxicity or be non-hazardous to waters, i.e. not classified under the above legislative classifications, yet elicit a pollution response due to their Biological Oxygen Demand (BOD), examples would be food materials or agricultural wastes. As such, the parameters above, based primarily on toxicity factors, are not suitable to categorise the aquatic hazard with these compounds, which demonstrate low toxicity and bioaccumulation but a high pollution risk due to their organic loading. Guidelines for classification of such materials are provided in Sections 5.2.7 and 5.2.8.

For emissions to air it is necessary to differentiate between a level of exposure in the workplace which is considered acceptable for regular exposure and that which occurs in an emergency situation such as a major fire or toxic release. This is a realistic approach as Occupational Exposure Limits (OELs) apply to regular and sustained exposure in the workplace, in general amounting to a 40-hour week, though in some cases 15-minute peak values are also given. Therefore, the approach in setting these levels is based on a ‘no adverse observed effect level’. This approach is not however considered appropriate for the emergency release scenario, which is for a short and very infrequent occurrence.

For emergency planning purposes other indices have been developed to cover short-term emergency exposures, primarily:

- Acute Exposure Guideline Levels (AEGLs); these have been developed by US EPA in association with the German federal environment agency specifically for emergency planning purposes. They represent toxicologically sustained ceiling levels for different relevant exposure periods (10 minutes, 30 minutes, 1 hour, 4 hours, 8 hours). Three different degrees of severity of toxic effects are defined:

  - AEGL-1: Threshold for notable discomfort.
  - AEGL-2: Threshold for serious long-lasting effects or an impaired ability to escape.
  - AEGL-3: Threshold for lethal effects.

- Emergency Response Planning Guidelines (ERPGs) are published by the Emergency Response Planning Guideline Committee of the American Industrial Hygiene Association (www.aiha.org):

  - ERPG-1: The maximum airborne chemical concentration or hazardous energy level below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly objectionable odour.
  - ERPG-2: The maximum airborne chemical concentration or hazardous energy level below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
  - ERPG-3: The maximum airborne chemical concentration or hazardous energy level below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Additionally, for airborne pollutants with an unpleasant odour it is necessary to consider the odour threshold, which is the concentration at which 50% of an odour panel can detect an odour.

A number of physical, chemical and biochemical properties of the material influence the likely environmental fate of the material once it is released to the environment including:

- Water Solubility – Water soluble chemicals will more rapidly disperse in the environment and tend to be more biodegradable.

- Octanol / Water Partition coefficient 4 This indicates the relative solubility of the material in fatty materials. Fat soluble materials are more likely to bioaccumulate in fatty tissues of fauna and are generally less biodegradable.

- Bioaccumulation Factor – This also indicates the bioaccumulation potential of the material.

- Biodegradibility –The more biodegradable the material the more rapidly it will be degraded in the environment and the less likely it is to have a long term impact.

- Biological Oxygen Demand (BOD) – Materials with high oxygen demand are likely to deplete the dissolved oxygen levels in an aquatic environment and thus have an adverse impact.

- The potential visual impact of a material, e.g. dyes, detergents, oil, on a receiving water body will be influenced by a number of physical and chemical properties such as colour, solubility and dispersal characteristics.

- Volatility – Indicated by Vapour Pressure and Latent Heat of Vaporisation. Volatile materials tend to evaporate and disperse more rapidly.

- Relatively density – Emissions which are lighter then air will tend to rise and rapidly disperse, conversely those that are heavier than air will tend to sink and accumulate in recessed areas such as sumps. Similarly emissions heavier than water will tend to sink in a watercourse while those lighter than water will tend to float on the surface.

All of the above should be considered when assessing the polluting potential of a material. Some of this information will be available on the Safety Data Sheets for the material.

b) Quantity of Materials on Site

The larger the quantity of material released the greater the consequences on the environment will be. Additionally, there may be threshold quantities below which the escape to a watercourse or to air may not have a significant environmental impact.

c) Potential Protection Measures

A number of measures can reduce the potential for a release on site including:

- Double containment or bunding of tanks, storage areas, offloading areas, etc

- Proper maintenance of all tanks, bunds and other material containing structures.

- Proper use and maintenance of control technology, e.g. tank high level protection.

- Proper procedures for the loading and unloading of potentially polluting substances from tanks and drums.

- A properly trained workforce.

- Auditing and inspection of material storage areas.

5.2.3 Pathway

The pathway is defined as the physical route by which released materials may travel from the source to an environmental receptor such as a receiving waterway. It is necessary to take into account all of the pathways by which the material may reach the environmental receptor. Potential pathways for released materials include:

- All water drainage systems on site including sewers, drains and culverts, with the exception of sealed systems that are routed to waste water treatment plants.

- Any damage to the site drainage systems which provide other potential pathways, e.g. cracked pipework which allows material to drain to underlying soil and groundwater.

- Cracks or leaks in storage systems while allows material to drain to underlying soil and groundwater.

- The surface area of the site if the volume of material that could be released exceeds the capacity of the site drains.

- Permeable areas of the facility, i.e. those that do not have a hard surface or relatively impermeable cover (e.g. concrete) which would allow material to drain to the underlying soil and groundwater.

- The subsurface conditions, such as soil permeability. These are assessed in the Geological Survey of Ireland's (GSI) aquifer vulnerability classification system.

- For gaseous releases or releases of volatile compounds the surrounding atmosphere is a pathway for dispersion. For emissions of particulate matter in gas streams these will show a tendency to deposit downwind of the release point.

Potential Protective Measures

Factors which limit the potential pathways for released material include:

- Methods of construction, i.e. double containment of drainage systems, bunds to contain spillages.

- Control mechanisms incorporated into the site drainage system, e.g. shut-off valves, which can stop or divert the flow of material.

- Impermeable surfaces on site to prevent released material draining to the underlying ground and groundwater.

- Procedural controls, e.g. emergency response procedures to contain and mitigate accidental releases of a material.

- Maintaining appropriate equipment, e.g. adsorbent materials, booms, on site to contain any accidental releases of a material.

- For emergency releases of pollutants to the air, water sprays can be utilised in certain circumstances to reduce the dispersion.

5.2.4 Environmental Receptors

A receptor can be defined as something which could come to harm, including human health, water resources, surface water courses or the wider environment by the escape of the pollutants to the receiving environment.

It is necessary to identify the potential receptors and assess the sensitivity of these receptors. For aqueous emissions, the Water Framework Directive 2000/60/EC provides guidance. This directive is not only risk based, but is receptor oriented, with the degree of risk depending not just on the pressures and physical characteristics of the pathway, but also on the 'sensitivity' of the receptors, such as ecosystems and their particular requirements. 'Sensitivity' is a property of the receptor.

The presence and nature of the environmental receptor can be thought of as the fixed point in any hazard or risk assessment. Although the site operator is able to modify sources and, to some extent perhaps, on-site pathways, altering the receptor is more difficult. In such situations the sensitivity of the receptor should be assessed and the level of protection appropriately upgraded.

The following criteria can be used to assess the sensitivity of environmental receptors in the surrounding environment:

- Characteristics of aquifers in the area:
    - The vulnerability of the aquifer – Extreme (E), High (H), Moderate (M), Low (L) - based on the Geological Survey of Ireland (GSI) classification system.
    - The importance of the aquifer – Regionally Important (R), Locally Important (L), Poor (P).
    - Aquifers located within Source Protection Zones.
- Rivers or other watercourses with a high fisheries potential including rivers designated as salmonid waters under the European Communities (Quality of Salmonid Waters) Regulations, 1988 and waters designated as shellfish waters under the Quality of Shellfish Waters Regulations, 1994.
- Rivers or other watercourses from which water is abstracted for drinking purposes.
- Waters designated as bathing waters under the Quality of Bathing Waters Regulations, 1992 (as amended).
- Areas designated as special protection areas for the conservation of wild birds under the European Communities (Conservation of Wild Birds) (Amendment) Regulations which implement EU Council Directive 79/409/EEC on the conservation of wild birds.
- Areas covered by a scientific or conservation designation, such as a Special Area of Conservation (SAC), a Natural Heritage Area (NHA), a Special Protection Area (SPA) or a wetland of international importance under the Ramsar convention or other conservation designation.
- Areas covered by special amenity orders or other environmental or recreational designations in the local authority development plan.
- For airborne releases, the proximity of the neighbouring population and in particular sensitive locations such as hospitals, schools or creches should additionally be considered.

5.2.5 Assessment of Environmental Risk

The objective of this phase is to determine which hazards may cause a major pollution episode. Hazards taken forward to this phase of the assessment have been identified as having the potential to cause a major pollution episode with a non-insignificant probability of occurrence.

Assessing the environment risk is a highly complex exercise, although past experience of accidents in similar industries can aid in this regard. A good database on past accidents can be found at the European Commission's Community Documentation Centre on Industrial Risk (http://mahbsrv2.jrc.it/cdcir/index.html). While every release situation will involve its own unique set of circumstances, some guidance on how the environmental risk assessment can be completed is provided in the UK Department of Environment, Transport and Regions' guidance documentation:

- A Guide to Risk Assessment and Risk Management for Environmental Protection.
- Guidelines for Environmental Risk Assessment and Management (Revised Departmental Guidance).
- Comparative Environment Index.
- Management of Harm to the Environment: Criteria for the Management of Unplanned Releases.

In most cases a large degree of qualitative judgement is necessary as the degree of quantification possible is often limited. Regardless of the manner in which the assessment is made it is important to document the basis on which the assessment was made.

Environmental risk is a combination of the likelihood of the event occurring (in this case the probability of potentially polluting substances being discharged to the environment) and the consequence of the event on the environment, i.e. damage to the environment.

Probability of an Event Occurring

The probability of the event occurring should be categorised in the following terms where the examples provided are for indicative purposes only:

- **High:** Greater than once per year.
- **Medium:** Between once per year and once per 100 years.
- **Low:** Between once per 100 years and once per 10,000 years.
- **Negligible:** Between once per 10,000 years and once per 1,000,000 years.

Consequences on the Environment

Consequences should be categorised in the following terms where the examples provided are indicative for a living environment other than human beings:

- **Severe:** A significant change in the numbers of one or more species, including beneficial or endangered species, over a short or long term. This might be a reduction or complete eradication of a species, which for some organisms could lead to a negative effect on the functioning of the particular ecosystem and / or other connected ecosystems.

- **Moderate:** A significant change in population densities, but not a change which resulted in total eradication of a species or had any effect on endangered or beneficial species.

- **Mild:** Some change in population densities, but without total eradication of other organisms and no negative effects on ecosystem function.

- **Negligible:** No significant changes in any of the populations in the environment or in any ecosystem functions.

Each of the above components will represent a judgement on the basis of knowledge and experience.

The estimation of risk is derived for each separate hazard by combining the probability of the consequences and the magnitude of the consequences to yield an estimation of the risk. Again given the likelihood that the assessment of probability and consequence is semi-quantitative or qualitative the simple matrix below, from the above UK guidance documentation, can serve as a focus for estimating the risk.

Table 5.1: Estimation of risk from categorisation of magnitude of consequences and probabilities.

Probability	**Consequences**			
	Severe	**Moderate**	**Mild**	**Negligible**
High	High	High	Medium / Low	Near Zero
Medium	High	Medium	Low	Near Zero
Low	High / Medium	Medium / Low	Low	Near Zero
Negligible	High / Medium / Low	Medium / Low	Low	Near Zero

Such a matrix is a gross simplification which cannot represent the true complexity of the risk assessment process but used with care it can be helpful, however, used uncritically the answers it appears to give could be misleading. In its application, such a matrix is unavoidably judgemental because the hazards must be evaluated on a case-by-case basis. For example, a particular case of “mild” consequences but “high” probability might be judged to be of “medium” or “low” risk. The decision should be on the basis of previous experience or relevant published information.

5.2.6 Assessment Criteria General

A suitable ranking is required based on the hazardous properties of the materials transported or stored to quantify the level of hazard.

For aqueous releases this would normally include the following basic data:

- Acute oral or dermal toxicity to mammals (e.g. LD_{50} in rats).
- Data on aquatic toxicity – fishes (acute), daphina (acute) or algae.
- Biodegradability.
- Potential for bioaccumulation.

A water hazard classification, based on these data, is proposed which defines three water hazard classes (WHC), where:

- WHC 1 = low hazard to waters
- WHC 2 = hazard to waters
- WHC 3 = severe hazard to waters

Otherwise materials are considered non-hazardous to waters.

For over twenty years German industry and authorities have been classifying substances according to this form of rating, which they call a WGK rating. This catalogue of information is available in English on the website of the German Environment Agency at www.umweltbundesamt.de/wgs-e . A search can be made using the CAS number or the English substance name.

From the downloads section, the 'Guidelines for self-classification' show how substances and mixtures can be classified based on the Risk Phrases (R-phrases) from EU Classification, Packaging and Labelling legislation (Directives 67/548/EEC and 1999/45/EC). In particular, the procedure for classification of mixtures of substances with different WGK numbers is provided. If an appropriate water hazard classification cannot be determined, then WGK 3 should be assumed for the mixture.

A substance is classified as "non-hazardous to waters" (denoted in German as 'nwg') if it fulfils <u>all</u> of the following prerequisites:

- Low solubility in water (less than 100 mg/l in the cases of gases and solids, less than 10 mg/l in the case of liquids),
- No toxicity at saturated levels (tested with at least two organisms – fish, daphina or algae),
- Ready biodegradability in the case of organic liquids.

While the WGK rating provides the most developed system for water hazard classification other methods could be used which provide an equivalent ranking.

However, substances may exhibit low toxicity or be non-hazardous to waters, yet elicit a pollution response due to their biological oxygen demand. Food materials and agricultural waste in particular may fall under this category. As such, the ranking method above is therefore not suitable for these compounds and further guidance is provided in Sections 5.2.7 and 5.2.8.

The hazard associated with the site can be categorised according to the following table based on volume and water hazard classification:

Table 5.2: Hazard Category Table

Volume in m^3 or mass in t	**Hazard Categorisation**		
	WHC 1	**WHC 2**	**WHC 3**
Ω0.1	Category A	Category A	Category A
> 0.1 Ω1	Category A	Category A	Category B
> 1 Ω10	Category A	Category B	Category C
> 10 Ω100	Category A	Category C	Category D
> 100 Ω1,000	Category B	Category D	Category D
> 1,000	Category C	Category D	Category D

In general, the following criteria apply to the categories defined above:

- Category A – Low hazard facility.
- Category B – Moderate hazard facility
- Category C and D – High hazard facility

Particular consideration needs to be given in relation to sensitive environmental receptors in the cases of overground facilities of category D and underground facilities of categories C and D. This can be addressed by completing a full risk assessment as outlined previously.

5.2.7 Assessment Criteria Food and Drink

The method of assessment of hazardous materials outlined above, i.e. the WHC method, does not readily lend itself to the Food and Drink Industry as food materials are by nature non-toxic and readily biodegradable although they do present a high organic loading and therefore a potential pollution risk. However, some common food ingredients, such as ethanol and glucose, are classified according to the German WGK method and for these compounds and for standard chemical compounds found in food processing plants, such as hydrochloric acid, the classifications provided should be used. **Additionally, while not formally defined by the German WGK system, tallow from animal rendering, blood and milk should be treated as WHC 1 for the purpose of piping design and storage systems, see Sections 7 and 8. This decision of the EPA is based on the fact that these compounds, while not exhibiting an acute toxicity, do present a high pollution load.**

Food materials in the large quantities commonly found in processing plants present a threat to the aquatic environment due to the large organic loading of an inadvertent release. It is important to note here that the human consumption of small quantities of a compound as a food, which is judged to be completely safe, does not infer safety with regard to environmental organisms exposed in the very different circumstances of a significant release.

It is recognised that every release of food material is different as factors such as pH (acidity), temperature, oxygen concentration, etc, will all influence the degradation of the material. However, it is necessary to make an initial hazard assessment based on the properties of the material and the quantity that could be released. The most relevant parameter for food stuffs is the Biological Oxygen Demand (BOD). This parameter measures the amount of oxygen consumed by biological degradation activity over a defined period, usually 5 days (BOD_5). Higher strength organic materials will have a higher BOD. For the food industry some typical BOD values would be:

Table 5.3: Typical BOD values for the Food Industry

Product	**BOD_5 (mg/l or g/m^3)**
Cream, 40% fat	400,000
Whole milk, 4% fat	120,000
Skimmilk, 0.05% fat	70,000
Whey, 0.05% fat	40,000
Blood	150,000 to 200,000
Tallow	1.7 g BOD_5 / g Oil

Therefore if we take a typical 100 m^3 whole milk tank in a dairy, the BOD loading would be:

$$\text{BOD load in kg} = 100 \times 120{,}000 \times 10^{-3} = 12{,}000 \text{ kg}$$

To put this BOD loading into perspective, a standard ‘Population Equivalent’ is 0.06 kg BOD/day. Thus the 100 m^3 milk tank has the equivalent pollution loading of a small city of some 200,000 inhabitants. It would of course be unacceptable in the event of a tank failure to discharge this quantity of milk to an unprotected water course.

It is therefore necessary to make an assessment of the BOD loading of the food storage system and the impact on the receiving environment. For salmonid waters the BOD Environmental Quality Standard set in National Legislation is Ω5 mg/l. Therefore for all but the largest of rivers the assimilative capacity would be small. Conversely, a large municipal wastewater treatment plant, e.g. the 1.7 million population equivalent Dublin plant, could assimilate a reasonable shock load, although the company discharging would be in breach of the effluent discharge section of its IPC licence.

5.2.8 Assessment Criteria Intensive Agriculture

Intensive agriculture does not in general have the chemical storage systems associated with other industrial sectors. This sector does however have considerable volumes of liquid manure, which poses a pollution threat due to the manure's ability to enrich surrounding groundwater and surface waters and the toxic impact of the slurry to aquatic organisms found in surface waters. Furthermore, slurries have high bacteriological levels such that uncontrolled releases present a threat to the integrity of drinking water supplies.

Slurry from livestock has a BOD concentration of typically 30,000 mg/l. Thus, if we use the same criteria as above of a 100 m^3 tank, in this case containing slurry, we arrive with a BOD load of 3,000 kg, or the equivalent of a large town of 50,000 inhabitants. Again it would be unacceptable in the event of a tank failure to discharge this quantity of slurry to an unprotected watercourse. The risk assessment for such facilities needs to focus in particular on the proximity of groundwater and surface water abstractions for the purpose of drinking water, i.e. the pathways and receptors. This is also addressed in the Department of Agriculture, Food and Forestry's Specifications S108 and S123, which specify minimum distances from manure pits to wells or springs.

For the purpose of piping design, Section 7, slurry should be treated as WHC 1.

5.2.9 Site Risk

For the engineering design of retention systems, discussed later in Section 6, it is necessary to determine if a site is a low, medium or high risk. As mentioned in the previous sections the estimation of risk is highly complex and therefore thresholds have been set based on hazard assessment. However, the user of this guidance note can complete the more complex risk assessment and provide an equivalent level of safety based on a valid assessment of risk reflecting the individual site conditions. The following relationship based on hazard categories defined previously in Table 5.2 or the risk as calculated in the individual case is considered appropriate :

Low site hazard (Category A) or *low* site risk. For the Food and Drink Industry a BOD load value of less than 5,000 kg qualifies as a *low* site hazard.

Moderate site hazard (Category B) or *moderate* site risk. For the Food and Drink Industry a BOD load value of greater than 5,000 kg and less than 20,000 kg qualifies as a *moderate* site hazard.

High site hazard (Category C&D) or *high* site risk. For the Food and Drink Industry a BOD load value of greater than 20,000 kg qualifies as a *high* site hazard.

5.3 Retention Requirements

Retention is the provision of secondary containment, which is designed in the event of a loss in sealing in the plant or any plant component to retain the escaping fluid. It is a general requirement of facilities licensed by the EPA that tank and drum storage areas be bunded. The following section outlines where retention is required and the methods for calculating the volume required. Given the complexity of completing a risk assessment in each individual case thresholds are set above which retention is required based on the simpler hazard assessment, i.e. Phase 1 of Section 5.2.1. For plants, where the criteria below are not fulfilled it is then necessary to go to Phase 2, i.e. the calculation of pathways, receptors, consequences, probability of occurrence and hence risk, to determine if existing containment systems are adequate.

The retention requirements relating to volume and water hazard class are considered fulfilled if those of a higher water hazard class are met.

5.3.1 Overground Storage Facilities

For overground facilities the requirements for retention outlined in Table 5.4 apply. Volume is defined as that of the largest operating unit that can be isolated. For drum and container stores the total volume of all drums and containers applies.

Table 5.4: Retention Requirements for Overground Facilities

Volume in m^3	**Water Hazard Class (WHC)**			
	Non-hazardous to waters	**1**	**2**	**3**
Ω0.1	Retention not required	Retention not required	Retention not required	Retention not required
> 0.1 Ω1	Retention not required	Retention not required	Retention required	Retention required
> 1	Retention not required (Note 1)	Retention required	Retention required	Retention required

Note 1: For materials classified as non-hazardous to waters retention will not be required if the volume of the storage unit is below 100 m^3. For larger tanks a risk assessment must be carried out, e.g. It would not be considered necessary to bund large water storage tanks.

For the Food and Drink Industry the general criteria is that new storage systems with a BOD loading of greater than 1,000 kg should be equipped with retention systems. Specific details for the food and drink industry are given in Section 9.

Specific details for Intensive Agriculture are given in Section 10 and in general for this sector retention is not required provided the requirements of Section 10 are met.

Where retention is required the following capacity is to be provided, either locally or remotely, to a volume not less than the greater of the following:

1. 110% of the capacity of the largest tank or drum within the bunded area,

2. 25% of the total volume of the substance which could be stored within the bunded area.

The exception to this being double walled tanks equipped with leak detection, which do not require additional retention.

5.3.2 Underground Tanks

While the preference is for overground tanks for environmental considerations, new underground tanks should be of double skinned construction with leak detection, where a leakage in the primary containment will be retained and detected in the intersitial space. These tanks therefore do not require additional retention. For Intensive Agriculture sector refer to Section 10.

5.3.3 Overground Piping Systems

In general the requirement for retention from overground piping can be summarised by the table below.

Table 5.5: Retention Requirements for Overground Piping

Water Hazard Class (WHC)	Measures
Non-hazardous to waters	Retention not required
1	Retention not required
2	Retention required (Note 1)
3	Retention required (Note 1)

Note 1: Refer to Section 7 on design of piping systems for specific retention requirements.

In general for piping systems containing food stuffs and animal slurries retention is not required.

For calculation of retention volumes for a piping system see Appendix B.

5.3.4 Underground Piping Systems

While the preference is for overground piping for environmental reasons, the design of underground piping is discussed in more detail in Section 7. Essentially new underground piping should be of double walled construction and therefore does not require additional retention.

5.3.5 Filling and Transfer Facilities

Filling and transfer facilities represent a high spillage risk in which a volume in excess of the container being filled could be discharged to the environment. Retention is not required for filling and transfer facilities for materials classified as non-hazardous to waters or for food stuffs. However, the following retention requirements apply to other materials:

Table 5.6: Retention Requirements for Filling and Transfer Facilities

Vessel/Packaging	Water Hazard Class (WHC)		
	1	2	3
Filling and emptying of mobile vessels	Retention required	Retention required	Retention required
Transfer of liquids into packaging, which does not meet the Dangerous Goods Regulations or their equivalent	Retention required	Retention required	Retention required
Transfer of liquids into packaging, which meets the Dangerous Goods Regulations or their equivalent	Retention not required	Retention required	Retention required

For calculation of retention volumes for filling and transfer see Appendix B.

5.3.6 Wastewater Treatment Plants

Wastewater Treatment Plants generally comprise a balancing section and a biological treatment section. In the balancing section of industrial waste water treatment plants, strong effluent streams may be equalised and the pH adjusted to neutral values. As high strength effluent with varying pH and temperature may be present, the balancing tanks should be assessed as for a standard overground or underground storage tanks.

For the biological section of the plant, the effluent concentration is maintained such that detrimental impacts do not occur to the microbiological activity. It can therefore be assumed that the contents of the biological section are non-hazardous to waters and this should be treated according to Section 5.3.1 above, i.e. for volumes greater than 100 m^3 a risk assessment is necessary to determine if retention is required. In general it is thought that retention will not be required for standard activated sludge systems. However, large scale high strength anaerobic facilities do present a higher pollution risk and should be compared to the BOD criteria given in Section 5.3.1.

6. Design and Operation of Retention Facilities (Bunds) for Potentially Polluting Substances

6.1 General

The most common type of retention facility is the open topped bund, though closed vessels or tanks can also be used. These secondary containment facilities provide retention in the event of a loss of containment in the primary system and should be designed to a recognised engineering code, operated according to defined procedures and maintained to a high standard such that the risk of pollution is minimised.

The steps involved in this Section are outlined in the flowchart overleaf.

6.2 Risk Assessment

The retention requirements relating to overground storage facilities and filling facilities are outlined in Section 5.3. Where retention is required, this can be provided by constructing a bund local to the storage or filling location or by conveying the escaped material to a remote retention facility. The operator of a facility requiring retention as determined by Section 5.3 can follow the guidance in this section or complete a risk assessment following the criteria given in Section 5.2 and provide an equivalent level of safety, i.e. demonstrate that existing containment measures are adequate.

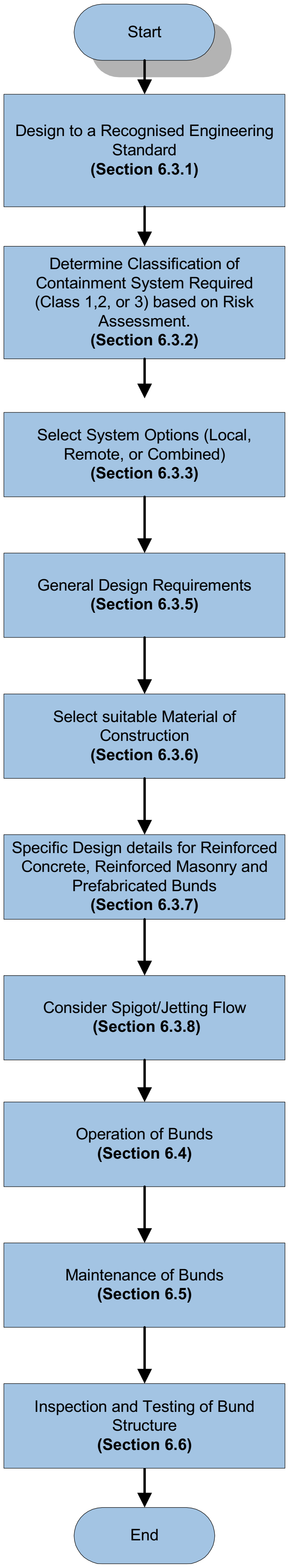
6.3 Design

6.3.1 Design Standards

The following is a sample of recognised engineering standards used in the design of bunds:

- BS 8007: Code of practice for the design of concrete structures for retaining aqueous liquid.
- BS 8110: Structural use of concrete – code of practice for design and construction.
- CIRIA Report 163: Construction of bunds for oil storage tanks.
- CIRIA Report 164: Design of containment systems for the prevention of water pollution from industrial accidents.
- CIRIA Report C535: Above-ground proprietary prefabricated oil storage tank systems.
- DIN 28052: Surface treatment of concrete components in process plants using non-metallic materials (available in English).

Flowchart for Retention Facilities



6.3.2 Classification of Containment Systems

Containment systems can be considered in three categories, each representing a different level of integrity to match the different requirements of *high*, *moderate* and *low* site risk situations.

A Class 1 containment system would be purpose-designed to comply with normal engineering standards and codes of practice to meet the requirements of the lowest site category. At the other end of the scale, a Class 3 containment system would include specially designed civil and / or structural works, incorporating amongst other things fail-safe systems and higher than usual safety factors necessary to meet the more stringent needs of the highest site risk category.

Although there is no direct quantifiable link between the significance of the hazard or site risk and the design of the containment system, it is suggested that the following simple relationship is appropriate in most circumstances which uses the categories defined previously in Section 5.2.9:

- *Low* site hazard (Category A) or *low* site risk – containment type Class 1, i.e. normal degree of integrity. For the Food and Drink Industry a BOD load value of less than 5,000 kg qualifies as a *low* site hazard.
- *Moderate* site hazard (Category B) or *moderate* site risk – containment type Class 2, i.e. intermediate degree of integrity. For the Food and Drink Industry a BOD load value of greater than 5,000 kg and less than 20,000 kg qualifies as a *moderate* site hazard.
- *High* site hazard (Category C&D) or *high* site risk - containment type Class 3, i.e. highest degree of integrity. For the Food and Drink Industry a BOD load value of greater than 20,000 kg qualifies as a *high* site hazard.

The proposed three classes of containment are defined below.

Class 1 Containment System – low site hazard or risk

The quality of design and construction will be based on:

- Normal standards and codes of practice or equivalent (e.g. Irish, EN, British or DIN codes).
- Normal British Standard Materials Specifications or equivalent.
- Irish Building Regulations (where applicable).
- Drainage to a recognised standard such as BS 8301: Code of practice for building drainage.
- Design life consistent with life of primary installation.
- Safety factors as per normal standards or equivalent.

Class 2 Containment System – moderate site hazard or risk

The quality of design and construction will be as Class 1 but with the addition of:

- Additional redundancies built into the concept design, e.g. for a remote system a gravity operated system or a pumped overground system, designed so that there is no possibility of the local catchment overflowing.
- Full soil report with test results.
- Full site survey, above and below ground, with all hazards identified.
- Full drain survey and test results.
- Any enhanced standards, e.g. water retaining structures (BS 8007) and quality standards (I.S. EN ISO 9000).
- Higher safety factors.
- Construction; rigorous control, full supervision and certification of operatives.
- Subsidence control.
- Materials testing, including certification where appropriate.
- Tender and contract control.
- Where there is insufficient clearance between the base of the primary liquid storage tank and the bund floor a means of detecting leakage should be installed.

Class 3 Containment System – high site hazard or risk

The quality of design and construction will be as Class 2 but with the addition of:

- Additional redundancies built into the concept design. For example the ability of the system to provide some measure of protection in the event that the release of material exceeds (either in volume terms or rate) that assumed in the design, e.g. fire water run-off. Alternatively, a local bund where there is no possibility of a prolonged fire leading to volumes of fire water exceeding the volume of the bund.
- Duplication of systems and key components where necessary to provide a fail-safe overall system, e.g. duty / standby transfer pumps for remote systems.
- Alarms and monitoring equipment, e.g. where an area is not permanently manned, bunds should be equipped with alarms at low level to indicate the need for emptying before containment capacity is reduced and at high level to warn of overtopping.

6.3.3 Containment System Options

6.3.3.1 General

Depending on the way in which they provide protection, all secondary containment systems may be categorised broadly as either:

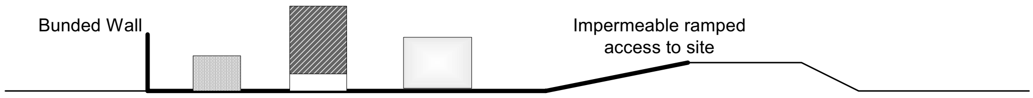
1. Local (i.e. bunds)
2. Remote, or
3. Combined (combined local and remote)

It is important for the designer to understand the differences between the three methods of providing secondary containment, the situations in which they may be suitable and the protection that they can afford, before moving on to detailed system and component design. The preference of the EPA is that local bunds be provided where possible.

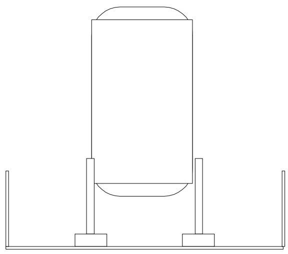
6.3.3.2 Local Containment (Bunds)

Bunds provide a second container around the primary container (which may be, for example, a tank or an area in which bulk chemicals are stored), designed to prevent the spread of any material that may escape from the primary containment. They contain the material at source, hence the term *local* containment.

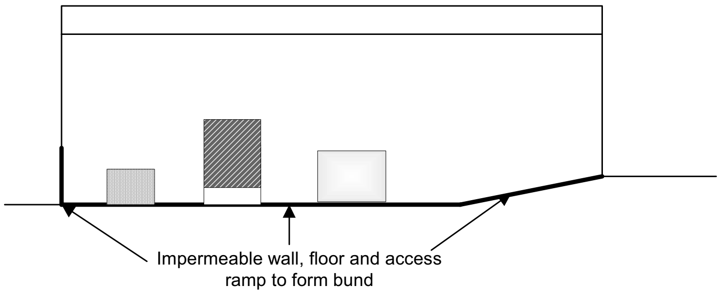
Storage tanks or other areas used for storing or handling hazardous materials may be bunded individually or in groups. Although the layout of facilities usually dictates that bunds are built outside, they may also be built inside buildings. Some buildings, for example warehouses used for storing chemicals, may be specially built or modified so that the structure itself provides an effective bund. See Figure 6.1 below.



(a) Bund Surrounding Whole Site



(b) Bund around single tank



(c) Bunded Warehouse

Figure 6.1 Typical bund arrangements

6.3.3.3 Remote Containment Systems

With a remote containment system any material that escapes from the primary container is intercepted and transferred to secondary containment facility which may be sited close to the primary, or more usually, some considerable distance away. This is illustrated in Figure 6.2.

In contrast to a bunded facility, the arrangements for intercepting any escaped material close to the source provide only limited containment capacity, generally less than the primary storage capacity, and the effectiveness of remote systems relies therefore on the rapid transfer of the material to the secondary container. Transfer may be through a drainage system (above or below ground) or over the surface of appropriately graded paved areas of formations. Drainage systems, paving and formations must of course be impermeable and designed to cope with the rates of flow that would be associated with a sudden loss of primary containment.

It is always necessary with remote systems to ensure that sufficient volume is present at the remote location for the necessary secondary containment function. This will need to be demonstrated to the EPA inspector on request by means of a suitable management system. If a wastewater treatment facility is used for the purpose of containment it is necessary to ensure that neither the parameters in the effluent discharge licence are exceeded or a transfer of the pollutants to another medium occurs.

With regard to the use of oil separators as remote containment systems, it must be recognised that these are typically designed for the separation of relatively small spills of oil from surface water drainage systems. As a rule, their oil storage capacity would not be sufficient to provide retention for a major release from a primary storage system.

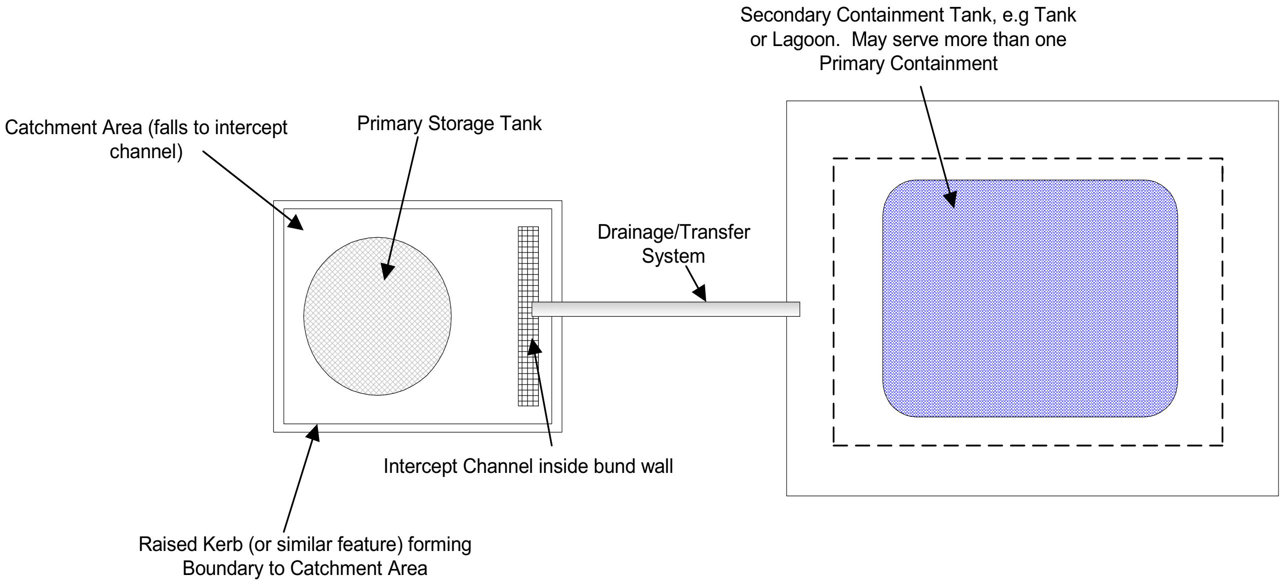


Figure 6.2 Schematic plan of remote containment system

6.3.3.4 Combined Containment Systems

Environmental protection at some large facilities combines features of both the local and remote systems described above. Such systems are often defined as combined systems. A typical schematic arrangement is shown at Figure 6.3. Combined containment systems are designed with the ability to contain some of the escaped material close to the source, as in local containment, but with the facility also for transferring liquid (including escaped product, rainwater and fire fighting water) by gravity or by pumping to a secondary containment facility at a remote location.

A combined containment system may provide only limited local containment, in which case it becomes, in effect, a remote system as just described. At the other end of the scale, a combined system may include full secondary containment at source in which case the additional facility to transfer contained material to remote secondary containment can provide an extra degree of environmental protection. The remote secondary containment may be regarded in this situation as tertiary containment.

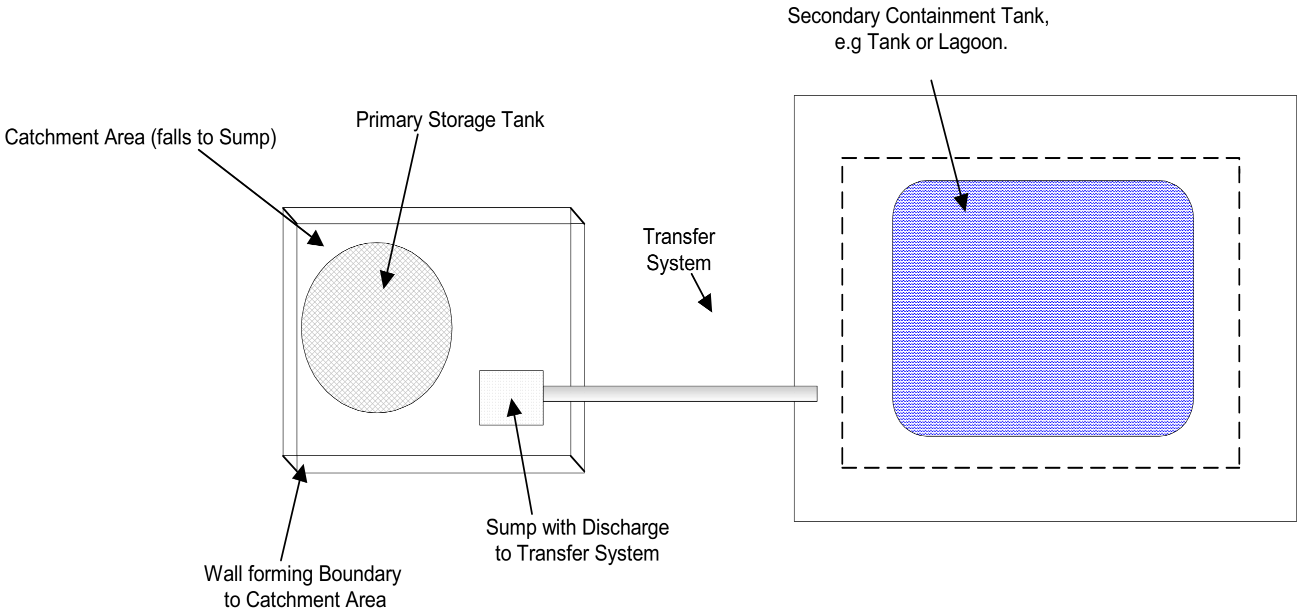


Figure 6.3 Schematic plan of combined contained system

6.3.4 System Selection

System options have been outlined in Section 6.3.3. The assessment of which type of system, or combination of systems, would be most effective and provide best value for money in a particular situation involves consideration of a wide range of factors including:

- The nature of the primary system, for example whether single tank, tank farm, process plant, warehouse, pipeline, loading point or drum store.
- The potential for sharing containment facilities across different process areas of a site where a range of different materials may be present, bearing in mind potential incompatabilities.
- The potential for using or adapting existing containment facilities, for example interceptors, lagoons and bunds and on-site or external treatment plant facilities which may have spare storage or treatment capacity.
- The type of drainage system including the method of disposal of trade effluents, sewage and storm water, and how the drains interconnect.
- Site topography.
- Physical constraints, particularly the space available for containment works.
- Future development plans for the site, either physical changes in layout, plant or buildings, or in the processes to be carried out.
- Quantity of material to be contained, in particular whether fire fighting water is included.

- Nature of the material present on the site and any “cocktails” that may result from an incident.
- Cost constraints.
- The site hazard or risk rating.

System design is an iterative process, beginning with a consideration of which systems would be capable of satisfying the main functional requirements and then choosing from amongst those systems, or adapting them, to provide the best practical solution given the other constraints including cost. For secondary containment, the primary functional requirements is for it to contain potentially polluting substances safely and reliably.

6.3.5 General Design Requirements

The sealed surface providing the retention must be impermeable to the liquid being retained. This applies also to any connecting elements, such as pipes, penetrating the structure, the sealing of which must provide the same level of retention as the bund itself. The EPA inspector may require that piping systems penetrating bunds are relocated to eliminate the potential for loss of sealing at piping / bund interfaces.

There must be no adverse chemical reaction that could occur between different liquids in a bund that would impact on the integrity of the bund or the safety of personnel in its vicinity. This should be addressed during the Hazard and Operability (HAZOP) review of the design. Information on material compatibility can be obtained from Safety Data Sheets, which should comply with Directive 2001/58/EC. The German Federation of Chemical Industry’s (VCI) concept for mixed storage of chemicals provides guidance in this area for chemical storage in mobile containers, this can be downloaded from www.vci.de. A similar approach is taken by the UK Health and Safety Executive in their guidance book HS(G)71 ‘Chemical warehousing: the storage of packaged dangerous substances’.

For flammable liquids, bunds serve to limit the surface area of the spillage and also the potential for spread of the fire. For these liquids, fire fighting issues should be considered when sizing bunds i.e. the choice of one large bund or a number of sub-sectioned bunds. The upper guidance value for a bund storing flammable liquids, which includes the tank surface areas, is 7,000 m^2, unless the fire protection is guaranteed for a larger area. This is based upon TRbF 20 the German regulations for storage of flammable liquids.

Additionally, for flammable liquids the containment facility should be suitably zoned for flammable vapours (ATEX directives 94/9/EC and 1999/92/EC) with the correct Ex signage according to 1999/92/EC. The bund overflow should be designed to prevent burning liquid spilling over and thereby spreading the fire to other parts of the site (see CIRIA Report 164 Section 10.3.5). Further information of the design of fire protection for flammable and combustible liquids is provided by the US National Fire Protection Association (www.nfpa.org), in particular NFPA 30.

Safety or health signs (or both) should be provided in circumstances where hazards cannot be avoided or adequately reduced by collective protection measures or by methods or procedures used in the organisation of work processes. Any signs provided should be in strict accordance with the Safety, Health & Welfare at Work (Signs) Regulations 1995.

In general bund walls should not exceed 1.5 m in height so that:

- Fire-fighting operations are not hindered.
- Egress from a bunded area in event of an emergency is relatively easy.
- Natural ventilation of the bunded area is encouraged.

It is important that, where practicable, pumps, valves, couplings, delivery nozzles and other items associated with the operation of a tank are located inside the bund, although health and safety implications must be taken into account where pumps and other electrical equipment operate in bunds where flammable vapours may collect. Items not connected with the operation of the tanks should not be located within the bunded area.

The vent from a storage tank being overfilled should be contained within the bund.

It is strongly recommended that all pipework leading to or from tanks within a bund are routed over the top of the bund in order to avoid the need to breach the walls.

Bunds may be filled with liquid in the event of a spillage or may be deliberately filled with liquid during testing (see Section 6.6), electrical equipment should therefore ideally be placed above the maximum liquid height or designed for submersion.

The designer of a bund should assess and take into account in the bund design:

- All possible modes of escape of pollutant from the primary containment.
- All possible modes of failure of the bund.
- All possible incident scenarios.

It is recommended that all bunds (irrespective of classification) be designed and constructed to comply with the performance criteria which are summarised in the following table.

Table 6.1: Performance criteria for bunds

Aspect of Performance	**Recommended criteria**
General arrangement	Size and layout should take account of all possible modes of failure of primary containment. There should be no provision for gravity discharge of the bund unless part of a combined system.
Capacity	Refer to Section 5.3.
Retention period	Three categories are defined for the length of retention: Low: Short term retention time of less than 8 hours. This requires monitoring through automatic incident alarm systems in connection with a permanently manned control room providing recognition of deviation from normal operating parameters. Medium: Limited retention time of between 8 and 72 hours. Monitoring as in the clause above or by means of control inspections every workday with recognition of deviation from normal operating parameters. High: Long term retention time of between 72 hours and 3 months. Monitoring by means of monthly control inspections with recognition of deviation from normal operating parameters.
Impermeability	Impermeability means, that in the period of use the liquid does not penetrate or in the case of non-metallic materials penetrates less than $^{2}/_{3}$ of the material thickness. (For earth structures not less than the equivalent of 1 m depth of soil with a permeability coefficient of 10^{-9} m/sec). The retention system must therefore be constructed such that its resistance exceeds the demands placed on it.
Strength	Capable of withstanding the static and dynamic loads associated with: - Release of liquid from primary storage tanks. - Release of water from hoses during fire fighting operations. - Wind loading. Bund floor to be capable of withstanding loads from activities within bunded area and the effects of differential settlement.
Durability	Capable of resisting the effects of weather, aggressive ground conditions and abrasion (in each case assuming a durability life of 50 years unless otherwise specified or shown to be adequate), fire and, depending on the primary storage inventory, corrosive materials for the duration of the specified retention period. Bunds to be protected from mechanical impact of vehicles in the area.
Structural Independence	Bund walls to be structurally independent from the primary containment. Wherever possible, raised bunds to be supported independently from primary containment.
Accessibility	Walls and where practicable, floors, to be sufficiently accessible to permit inspection and for maintenance to be carried out. Adequate access into and out of bunds must be provided to satisfy fire-fighting and health and safety requirements. In addition, adequate access and clearance between the primary tank (or tanks) and the bund should be provided to permit routine inspection and maintenance (typically a minimum of 0.75 m). Where access to parts of the floor is not practicable (e.g. large tanks sited directly on the bund floor) provision should be made to detect any leakage through the base of the primary containment.

Figure 6.4 illustrates the recommended general arrangement for a bund for a typical small tank situation.

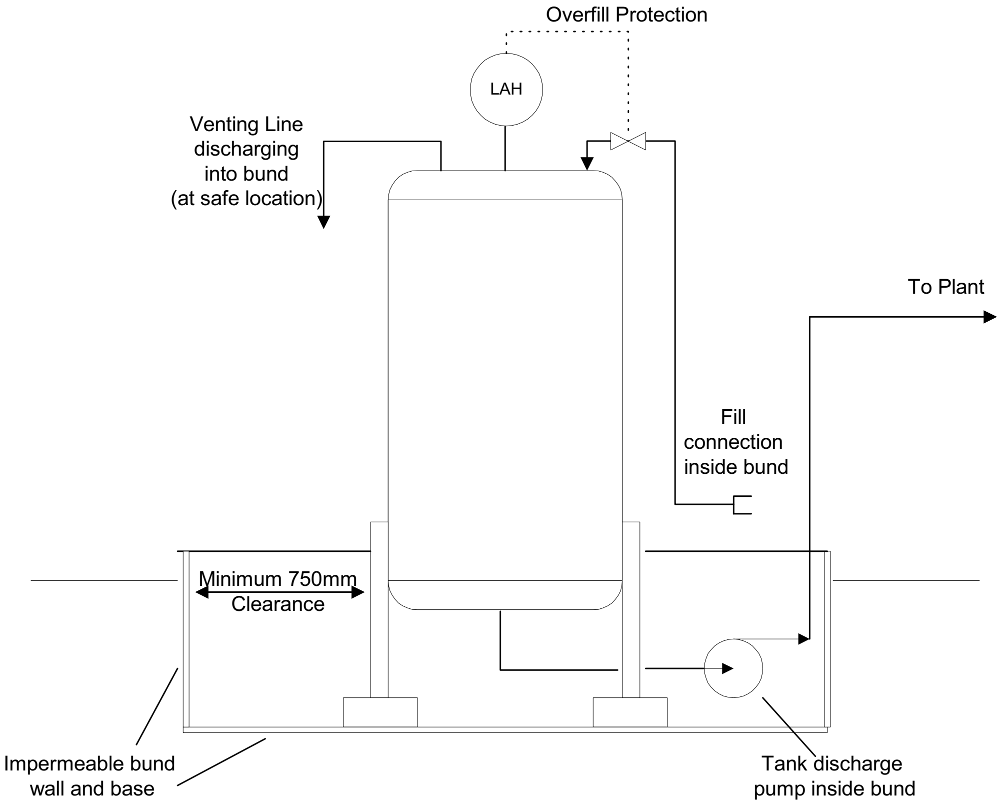


Figure 6.4 Typical bund arrangement for a small tank

6.3.6 Materials of Construction

All possible chemical, mechanical and thermal demands, as well as UV resistance, are to be considered in the choice of material for the retention system.

The material must be impermeable for the period of retention. For steel, this can be determined by the use of recognised corrosion resistance charts. Typically a wear rate of < 0.1 mm per annum defines corrosion resistance but for retention systems, a wear rate of < 0.1 mm is acceptable for the period of retention that applies to the system. However, local corrosion effects are to be avoided.

For concrete - for the period of retention the material should not penetrate more that two thirds of the concrete thickness. For determination of the penetration depth of potentially polluting liquids in concrete see the table in Appendix C.

For plastics - recognised corrosion resistance charts can be used for the selection of materials. DIN 28052 provides information in this regard, though the manufacturers of plastic linings can usually advise on the suitability of their products to a range of chemicals.

Chemical resistant tiles should be manufactured and installed to a recognised standard for chemical resistance. An example is the AGI standard S 10 (AGI: Arbeitsgemeinschaft Industriebau e.v., the German construction industry association)

Material selection can also be performed on the basis of laboratory investigations and practical plant experience.

Appendix D contains an extract from the German technical regulations TRwS 132 on the selection of containment surfaces. This provides guidance on the selection of suitable materials of construction for containment systems.

6.3.7 Specific Design Details

In general, the most common type of bund is that of reinforced concrete. Appendix D also provides engineering details for reinforced concrete bunds, reinforced masonry bunds and prefabricated bunds. Reinforced concrete bunds to BS 8007 meet the requirements for Class 2 or 3 containment, while BS 8110 can only be used for Class 1 containment. It is recommended that reinforced blockwork is restricted to bunds for Class 1 containment only.

Prefabricated bunds are suitable for small tanks and drum stores, up to a total volume of circa 1,200 l. They should be protected from damage during transportation and erection and once installed protected by crash barriers from possible impact from passing vehicles.

For small tanks, such as 1 m^3 bulk containers, temporary bunds can be provided using collapsible plastic structures. It is essential that these are protected from impact by passing traffic and are replaced with a permanent structure if the storage requirement becomes permanent.

6.3.8 Design Conditions for Spigot / Jetting Flow

A failure at the side of a tank, e.g. through a rupture or corrosion of the side wall, could result in the escape of a jet of liquid with sufficient force that it projects over the bund wall, even though the capacity of the bund is within the requirements of this section. In practice this phenomena, called spigot or jetting flow, is rare and when it does occur the amount lost is likely to be relatively small. In addition, it is likely to be highly visible and it would be relatively easy to take emergency action (for example, using temporary baffles) to deflect the jet into the bunded area.

For a Class 2 or 3 containment system, where the level of risk is considered high, it is recommended that an impermeable surface be provided which would enable collection and treatment of any liquid sprayed beyond the bund. The perimeter around the tank must therefore have a width of at least half the height (h) by which the tank protrudes above the bund wall (see following sketch). If the tanks have thermal insulation or are equipped with protective cladding then this measure is not necessary.

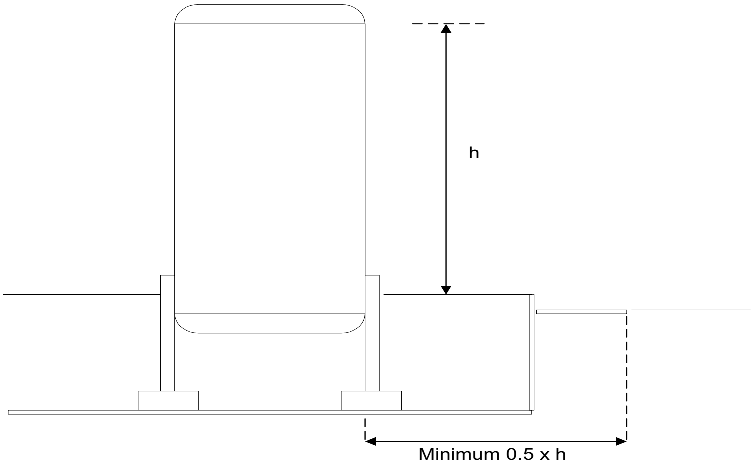


Figure 6.5 Key dimensions for spigot / jetting flow

6.4 Operation

As outdoor open topped structures bunds will fill up with rainwater. This rainwater will displace the volume available for retention and it needs to be drained at suitable intervals. The use of valves to gravity drain bunds has led in the past to pollution incidences due to the fact that these valves have been unintentionally left open. Underground drains for emptying of bunds should be limited to existing installations although the EPA inspector may request these to be upgraded to a pumped discharge. These should be lockable or designed with another suitable control system and used only under supervised conditions for the bund drainage.

Contaminated rainwater or spillages of potentially polluting substances should not be directed to a surface water discharge. It is therefore recommended that rainwater in the bund be routinely sampled and analysed before disposal in an appropriate manner. New bunding installations 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. Therefore, provision must be made to empty rainwater and other liquids from bunds using mobile or fixed electrical or air driven pumps. See Appendix D for design details for emptying of bunds. Records of bund inspection, sampling and release of contents should be maintained. Contents should only be released to surface water drainage systems when it has been determined that contamination levels are sufficiently low for surface water discharge, otherwise, the contents should be treated before discharge.

6.5 Maintenance of Bunds

Bunds need to be maintained to a high standard such that they are able to fulfil their design duty in the event of a loss in primary containment.

Cracks in a bund can allow corrosive agents to penetrate the concrete. Cracks may be caused by thermal or shrinkage stresses or by overloading. In bund floors, cracking may be the result of uneven or inadequate ground support. These cracks need to be repaired using recognised repair methods (see CIRIA Report 164, Section 10.4.7).

Damage to liners, usually in the form of puncturing, bursting or tearing, can be minimised by ensuring that the site is properly prepared and the liner is placed carefully. Depending on the nature and extent of any site damage and the type of liner, it may be possible to make site repairs by patching. Instructions on repairs should be provided by the liner manufacturer or supplier. On sites with a high hazard or risk rating i.e. Class 2 or 3 containment systems, it is recommended that the entire damaged section is replaced with undamaged material. Where a liner has deteriorated generally through age, it should be replaced entirely.

6.6 Inspection and Testing of Bund Structures

6.6.1 General

Most Integrated Pollution Control Licences issued by the EPA address the issue of bund integrity in a condition under the heading of 'facilities for the protection of groundwater and surface water', as follows;

'The integrity and water tightness of all the bunding structures and their resistance to penetration by water or other materials stored therein shall be tested and demonstrated by the licensee to the satisfaction of the Agency within three months from the date of grant of this licence'.

Further reference to the testing of bund structures is often specified as follows;

'All bunds shall be tested at least once every three years. A report on such tests shall be included in the AER.'

This Section sets out guidelines on the approach which should be taken by IPC licensed operators in conducting tests on the integrity and water tightness of site bunds. A sample record sheet to be used in bund testing reports is provided in Appendix D.

6.6.2 Procedure

The flow chart on the next page shows the basic process which should be adopted in determining the most appropriate course of action to establish and confirm the integrity of each individual bund structure at a facility.

The first distinction that needs to be made regarding each bund is whether the structure is a newly constructed bund or a bund that has been in service for some time.

All newly constructed bunds must be tested in accordance with the testing requirements specified in the codes and standards to which the bund has been designed. The required testing procedure should be carried out prior to any equipment, as well as the primary storage vessel(s), being installed within the bund.

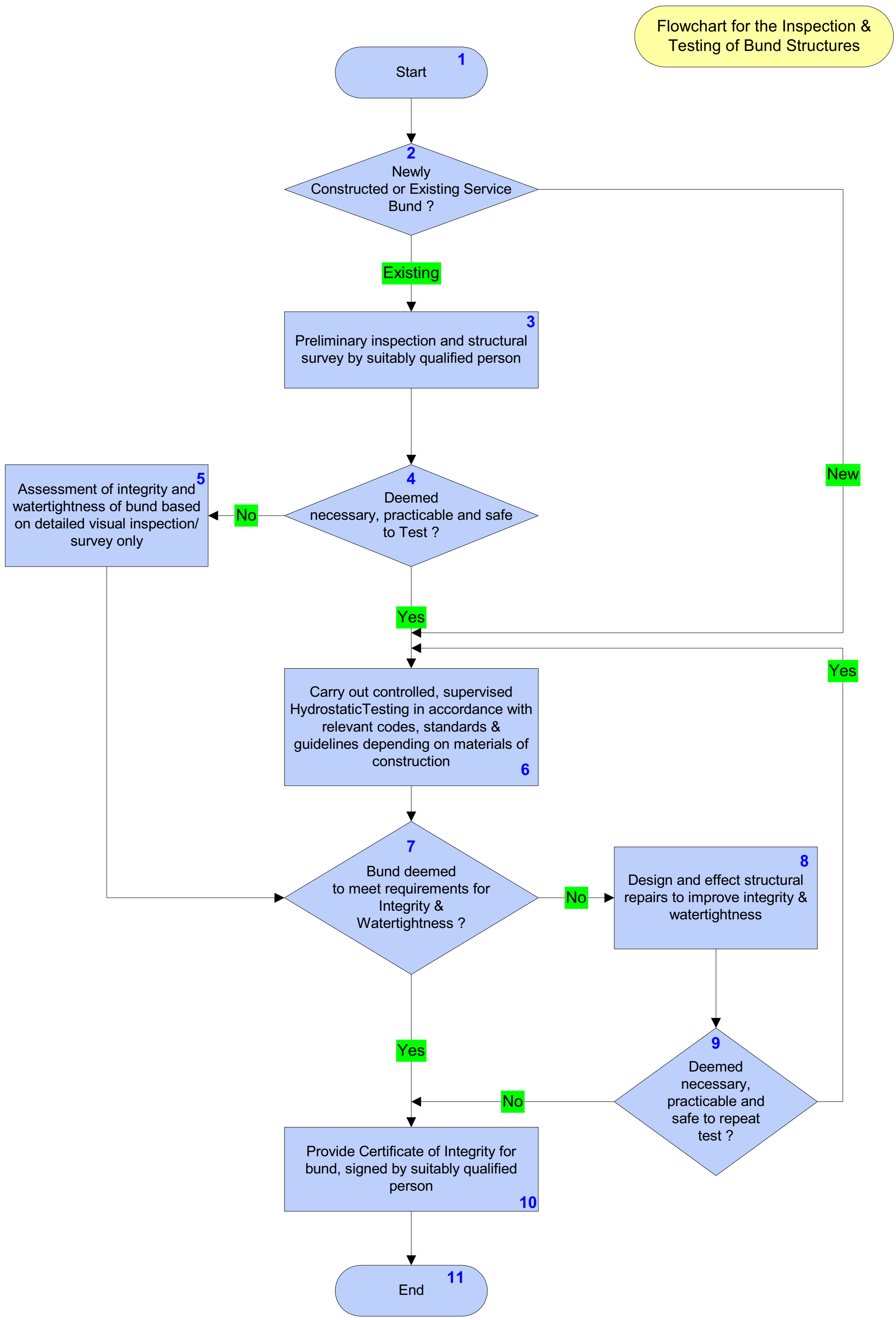
In the case of bunds that have been in service for some time, a number of factors must be considered before deciding the most appropriate course of action in assessing the integrity and water tightness of each individual structure. Consideration of the following factors should determine whether or not a physical test, such as a hydrostatic test, should be conducted on the structure;

1. Is it necessary to test the bund?

2. Is it safe to test the bund?

3. Is it practicable to test the bund?

In all cases where it is deemed unnecessary, unsafe or impracticable to conduct a physical test, the integrity and water tightness of the bund must be determined on the basis of a detailed inspection and structural survey which will be carried out by a suitably qualified person.


Flowchart for the Inspection & Testing of Bund Structures
1
Start
2
Newly Constructed or Existing Service Bund ?
Existing
New
3
Preliminary inspection and structural survey by suitably qualified person
4
Deemed necessary, practicable and safe to Test ?
No
5
Assessment of integrity and watertightness of bund based on detailed visual inspection/ survey only
Yes
Yes
Carry out controlled, supervised HydrostaticTesting in accordance with relevant codes, standards & guidelines depending on materials of construction
6
7
Bund deemed to meet requirements for Integrity & Watertightness ?
No
8
Design and effect structural repairs to improve integrity & watertightness
9
Deemed necessary, practicable and safe to repeat test ?
Yes
No
Provide Certificate of Integrity for bund, signed by suitably qualified person
10
11
End

6.6.2.1 The Necessity to Test

The necessity to carry out a hydrostatic or similar physical test on a bund should be a factor of the hazard/risk classification of the bund and contained vessel(s). It is generally considered unnecessary to conduct a physical test on a Class 1 (low risk) containment system. If the classification of the containment system is unknown or cannot be established with certainty, then it must be assumed that a classification greater than 1 applies. As such, assuming it is safe and practicable, a hydrostatic test should be conducted on the structure. If it is deemed unnecessary by the licensee to test a particular bund, the reasons for not testing shall be clearly stated in the bund report.

6.6.2.2 Safe Testing

Prior to conducting any test procedure that will involve the filling of a bund with clean water, an assessment of the issues of health and safety must be carried out by the licensee. No hydrostatic test should be carried out unless it has been deemed safe to do so. Issues of health and safety that should be considered prior to testing include, but are not limited to;

- The presence of electrical equipment or components within the bund that might create a hazard when submerged or in contact with the test water.
- A flammable atmosphere where the risk might be exacerbated by the presence of a filled bund.
- Tank contents which could react with water where the bund is covered to prevent ingress of rainwater.
- Where the filling of a bund will impede or prevent access to an emergency control point such as a valve or emergency stop button.
- Where the filling of a bund could cause the floatation of the primary vessel(s).

It will be the responsibility of the licensee to determine whether it is deemed safe or unsafe to conduct a hydrostatic test on each bund structure. If it is determined by the licensee that it is unsafe to test a bund to the design retention capacity then a lower test level may be used. The reasons for not testing or using a lower test level shall be clearly stated in the bund report.

6.6.2.3 Practicable Testing

In some cases it may be impracticable to carry out a prescribed test procedure on a bund. There are a number of reasons why this might arise, including:

- Large capacity bunds may require an inordinate amount of water to be drawn from site supply, as well as creating problems of disposal following completion of the test. This issue should be considered on a site by site basis.

  For these large capacity bunds, consideration may be given to testing with a reduced level of water that would be sufficient to test the integrity of the base, sumps, drainage valves and the wall / floor joint.
- Filling of a site bund and allowing it to stand for a period of time may in certain circumstances cause a significant interference in the ongoing

day to day operations of a production plant. Examples would be where filling the containment bund would effectively mean the primary vessel(s) would need to be taken out of use for the duration of the test period. The onus is with the licensee to ensure in such cases that the test can be carried during a shut-down period or a period when the primary vessel(s) may not be required in the operations.

It will be the responsibility of the licensee to determine whether it is deemed practicable to conduct a hydrostatic test on each bund structure. If it is determined by the licensee that it is impracticable to test a bund, the reasons shall be clearly stated in the bund report.

Summary Note: The design and construction of new bunds should be carried out in a manner that will facilitate the future periodic hydrostatic testing of the structure in a safe and practicable manner.

6.6.3 Test Methods

Where a bund has been deemed safe and practicable to test, a prescribed test method shall be used which shall be appropriate to the nature of the containment situation and the materials of construction of the bund. In all cases, the test procedure should be specified, supervised and reported on by a suitably qualified person.

6.6.3.1 Reinforced Concrete

Existing bund structures constructed of reinforced concrete should be tested in general accordance with the principles set out in Section 9 of BS 8007(1987). The general requirements of BS 8007 specify that after filling, a test period of 7 days should follow a period of up to 7 days for liquid stabilisation. (Note: The stabilisation period may be reduced where the bunds are lined with an impervious material). The liquid level should be recorded at 24 hour intervals. During the test period, the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed 1/500th of the average water depth of the full tank, 10mm or another specified amount.

It should be understood that BS 8007 is a code of practice for the design of aqueous retaining concrete structures and as such the procedure described strictly only applies to newly constructed tanks/bunds. In the case of existing / established bunds, the supervising engineer shall determine the most appropriate methodology and tolerances for deciding on whether a bund is deemed to be of adequate integrity and water tightness following the test. Based on the principles of BS 8007, the licensee’s appointed engineer should specify the following test parameters:

- The required fill rate (usually not greater than 1.5 m in 24 hours).
- The required stabilisation period.
- The duration of the test.
- The total permissible drop in water level for the given bund situation.

6.6.3.2 General Purpose Concrete or Masonry Bunds

General purpose bunds with a design duty for Class 1 or Class 2 applications will typically be constructed of reinforced concrete (to BS 8110) or reinforced masonry. A test procedure such as that defined in BS 8007 will generally not be appropriate or necessary for these installations. Examples of such bunds are those surrounding small capacity (< 5 m^3) fuel oil tanks. In such cases, the licensee's engineer should specify and conduct a hydrostatic test procedure appropriate to the application. The following basic criteria should be adhered to;

- The bund should be fully cleaned out prior to the test.
- The bund should be filled to as close to maximum capacity as possible, without creating a risk of overtopping in conditions of unusually high winds or rain. A freeboard of 150 mm from the top of the bund should be adequate.
- A reference vessel, e.g., a suitably sized barrel of sound integrity, should be provided adjacent to the bund and filled to within 150 mm of the brim. The reference vessel will be used to take account of variations due to evaporation and rainfall during the test period.
- The bund should be allowed to stand for a period of time, to be determined by the engineer, prior to commencing measurement.
- The water level in the bund and the reference vessel should be measured at even intervals, over a suitable period, to be specified by the engineer.
- The engineer will also determine the permissible drop in level in the bund, beyond which the integrity and water tightness cannot be certified. This will be based on:
    - The required duty and risk classification of the bund.
    - The capacity of the bund.
    - The surface area of the bund.
    - The depth of the bund.

6.6.3.3 Prefabricated

Where prefabricated bunds are constructed under factory-controlled conditions in accordance with an appropriate Standard or Code of Practice (e.g. BS 799: Part 5) for tank manufacture, testing for integrity and water tightness should be in accordance with those Standards or Codes. The test procedure should be confirmed and witnessed by the Licensee's appointed engineer.

7. DESIGN AND OPERATION OF PIPING SYSTEMS FOR POTENTIALLY POLLUTING SUBSTANCES

7.1 General

Piping systems should be designed to a recognised engineering code and maintained to a high standard such that the risk of pollution is minimised. Other requirements for piping systems, such as the Pressure Equipment Directive (97/23/EC), remain unaltered by this guidance note.

The steps involved in this section are outlined in the flowchart overleaf.

7.2 Risk Assessment

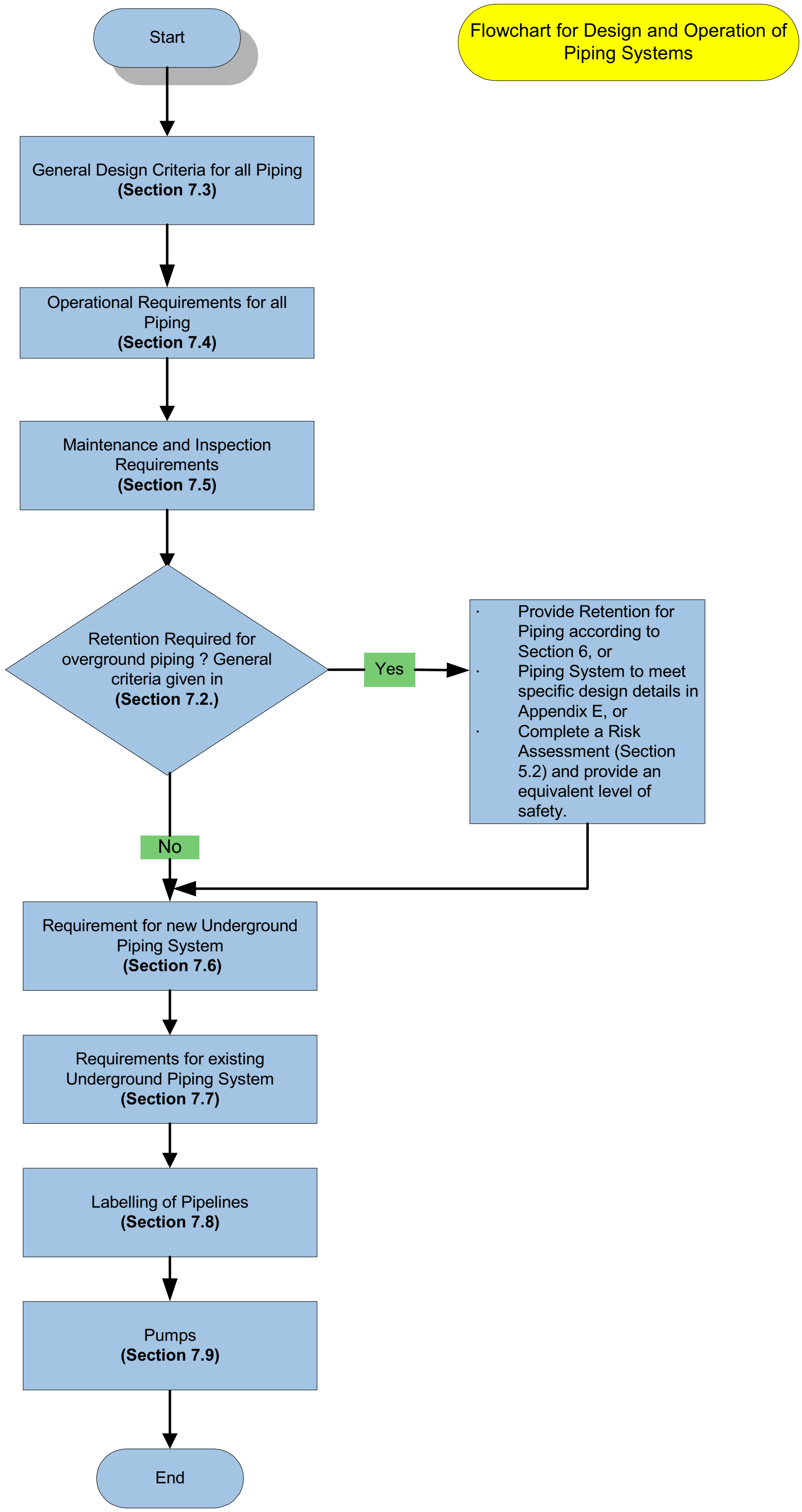
The use of risk assessment techniques determines if retention systems are required in addition to the primary containment offered by the piping system itself. The retention requirements for possible leakage from overground and underground piping systems were outlined in Section 5.3. Essentially new underground piping conveying potentially polluting substances should be of double walled construction and therefore does not require additional retention. Underground piping is addressed further in Sections 7.6 and 7.7.

For overground piping systems the requirement for retention is based on the water hazard class of the material being conveyed in the piping system. Retention is not required for materials non-hazardous to waters or materials of water hazard class WHC 1. For materials of water hazard class WHC 2 and 3 retention is required. However, the operator of a facility with material of water hazard class WHC 2 and 3 can:

a) Provide retention for the overground piping system as per Section 6. This should be provided by a suitable impermeable surface as specified in Section 6.3.6 of this guidance note, or

b) Utilise the organisational and technical measures outlined in Appendix E which reduce and in some cases eliminate the retention requirement. By following these measures it is not necessary to complete a further risk assessment as the relevant measures, such as the necessary retention volume and hydrogeology of the environment, have already been considered, or

c) Complete a risk assessment following the criteria given in Section 5.2 and provide an equivalent level of safety.


Flowchart for Design and Operation of Piping Systems
Start
General Design Criteria for all Piping (Section 7.3)
Operational Requirements for all Piping (Section 7.4)
Maintenance and Inspection Requirements (Section 7.5)
Retention Required for overground piping ? General criteria given in (Section 7.2.)
Yes
· Provide Retention for Piping according to Section 6, or
· Piping System to meet specific design details in Appendix E, or
· Complete a Risk Assessment (Section 5.2) and provide an equivalent level of safety.
No
Requirement for new Underground Piping System (Section 7.6)
Requirements for existing Underground Piping System (Section 7.7)
Labelling of Pipelines (Section 7.8)
Pumps (Section 7.9)
End

7.3 Design

The following is a sample of recognised engineering standards for the design of piping systems:

- I.S. EN 13480: Metallic industrial piping; Parts 1 to 7 (Covers design, materials, fabrication and installation, inspection and testing, conformity assessment procedures).

- ASME B31.3: Process piping.

- BS 806: Specification for design and construction of ferrous piping installations for and in connection with land boilers (now superseded).

- TRR 100: German technical regulations for metallic piping systems (available in German only).

For all piping systems a design file is required for the piping system which outlines the material of construction, the dimensions, the connections, the fittings, the equipment, the fluid properties and the maintenance procedures.

The piping system must be resistant to internal corrosion or protected by means of a suitable coating or internal layer. Resistance to internal corrosion is to be documented and is differentiated by:

- Wear rate of Ω0.1 mm/a

- Wear rate of > 0.1 mm/a. However, it is not permissible to have a wear rate of greater than 0.5 mm/a and negative effects are not permissible on the integrity of the system, e.g. local pitting.

Corrosion resistance can be determined by industry publications and standards, such as DIN 6601 or Perry's Chemical Engineers' Handbook, by experience with existing operating systems or by means of laboratory investigation. Where inner linings are used, the corrosion resistance must also be determined for these.

Pipework must also be protected from external corrosion and mechanical impact, e.g. collision with fork trucks.

Pipework should be installed over impervious structures and this should be considered in the design of a facility, particularly in relation to large pipe racks and flexible piping.

Shut-off valves should be accessible and easy to operate.

7.4 Operation

An appropriate alarm and emergency response plan for the facility is required that includes measures to minimise potential water pollution from a loss of containment in the piping systems.

The piping system should be operated at all times within the parameters documented in the design file.

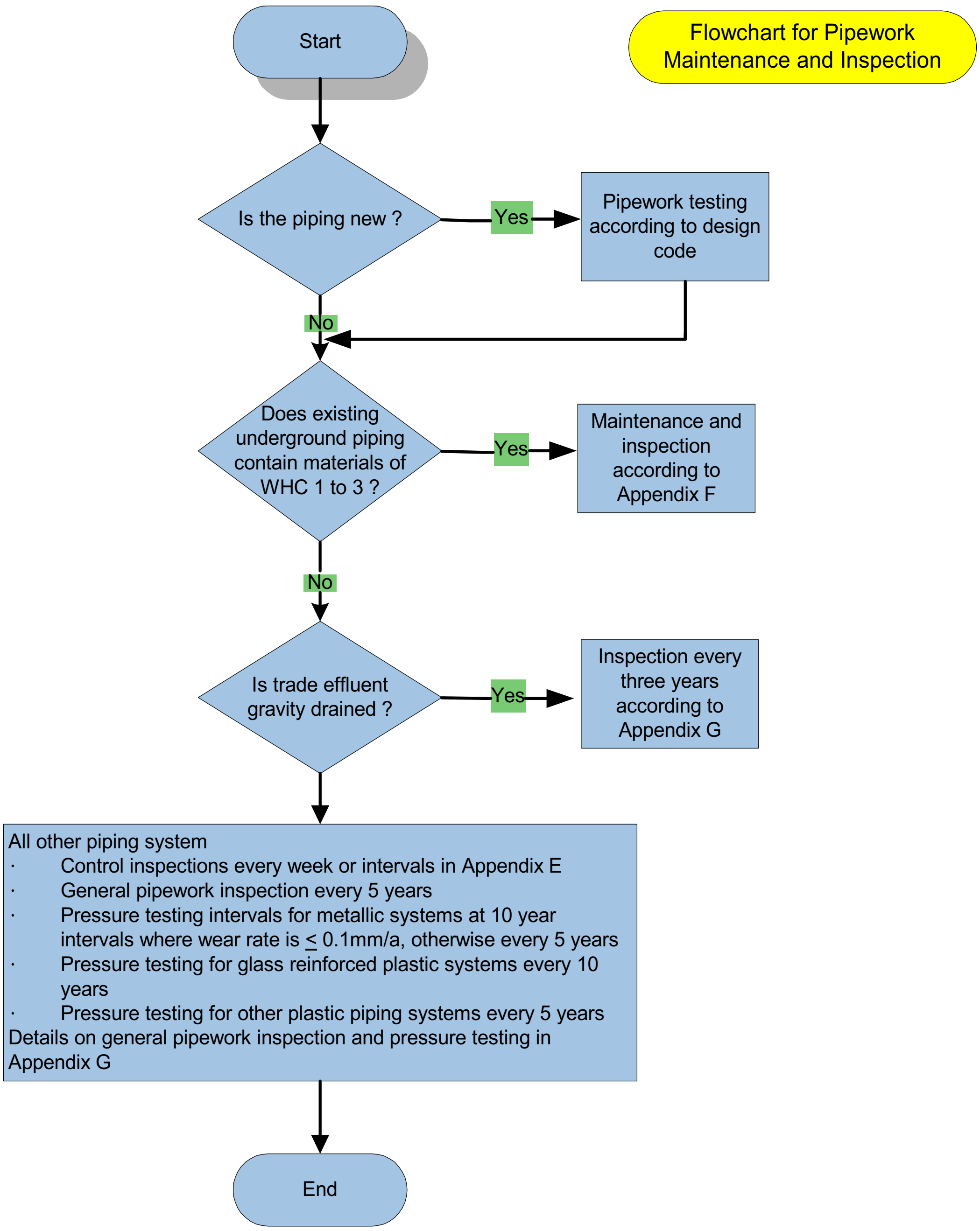
7.5 Maintenance and Inspection

The piping system should be monitored by means of automatic alarm equipment and manned control rooms or by means of regular control inspections. Any deviation from operational values are to be followed by the necessary protective measures. Control inspections should be completed at least weekly by trained personnel using visual or other means to detect for leaks. However, shorter inspection intervals are required in certain circumstances as outlined in Appendix E.

The key requirements relating to pipework maintenance and inspection are:

- New pipework should be tested according to the design code before it is brought into service.
- Maintenance and inspection requirements for existing underground piping systems containing materials hazardous to waters, WHC 1 to 3 or equivalent, are documented in Appendix F.
- Trade effluent gravity drainage systems, where the effluent is not strong enough to be classified as WHC 1, yet contains potentially polluting substances, should be inspected every three years according to the requirements of Appendix G.
- For all other piping systems, a general pipework inspection is required ever five years. This should include an inspection for outer corrosion, pipe support integrity, function of safety devices, etc.
- For metallic piping systems pressure testing is required at a ten year interval where the wear rate is Ω0.1 mm/a. Where the wear rate is > 0.1 mm/a the test interval is reduced to every five years.
- For Glassfibre Reinforced Plastic systems the pressure testing interval can be extended to 10 years, for other plastic piping systems 5 years applies.
- Wall thickness measurements and Non-Destructive Testing (NDT) at critical points can replace pressure testing. Where the wear rate is > 0.1 mm/a spot wall thickness measurements are to be completed in addition to the pressure test.

All inspections and preventative maintenance shall be recorded in a log which shall be available for inspection by the Agency. Appendix G provides further details on the testing of piping systems, while the above points are summarised in flowsheet form overleaf.



7.6 New Underground Piping Systems

Underground piping systems conveying potentially polluting substances are only permissible if an overground construction is not possible due to safety or other considerations.

Disconnectable connections and fittings on underground piping systems must be installed in monitored and sealed control shafts. The underground piping systems must correspond on a basis of their technical construction to:

- Double walled construction: A loss in sealing of the pipe wall must be indicated by a suitable self-acting leak detector.
- The piping system must be operated under suction pressure, in which the liquid column is broken in the event of a loss of sealing.
- The piping system must be protected by a protection pipe or laid in a protective channel; escaping material must be visible in a control device.

Exceptions to the above can be made for trade effluent **gravity drainage** systems, where the effluent is not strong enough to be classified as WHC 1, yet contains potentially polluting substances.

7.7 Existing Underground Piping Systems

Existing underground piping systems must be suitable for all expected physical and chemical demands. The operator must ensure that existing pipework installations and modifications met the regulations and state of technology prevailing at that time for the design, construction and maintenance, e.g. BS-Standards, DIN-Standards, ASME-Code. If documentation is no longer available relating to initial design and inspection then the system should be inspected by a suitably qualified person and a report on state of compliance generated.

The pipework must be protected from both internal and external corrosion. This corrosion resistance must be guaranteed through reference samples, by laboratory investigations or by appropriate published corrosion literature.

Disconnectable connections and fittings on underground piping systems must be installed in sealed control shafts and be of Type A design, Appendix E provides engineering details on Type A connections and fittings.

For material hazardous to waters, WHC 1 to 3 or equivalent, the requirements presented in Appendix F apply, which are as set out in the German technical regulations TRwS 130.

7.8 Labelling of Pipelines

Pipelines should be colour coded to a recognised standard to aid in identification. Recognised standards include British Standards Institute ‘Specification for identification of pipelines and services’ BS 1710:1984 or DIN 2403; Identification of pipelines according to fluid conveyed (available in English). The Safety, Health and Welfare at Work (Signs) Regulations, 1995 (S.I. No. 132 of 1995) specifies in Schedule 3 the minimum requirements for signs on containers and pipes.

7.9 Pumps

In general pumps are to be found in the bunded areas of process plants. The retention volume is to be calculated according to Appendix B. Pumps are to be designed such that they are suitable for all chemical, mechanical and thermal demands that may arise.

Pumps which are classified as long term technically sealed do not require retention. Split ring motor pumps, seal-less magnetic drive pumps, pumps with double seals, in which the barrier fluid is monitored, e.g. by regular controls (as a rule, once per day) or by means of process monitoring technology, can be considered as long term technically sealed. For the connecting flanges the requirements of Appendix E applies for flange connections of Type A.

Other designs can be considered as long term technically sealed if they provide an equivalent level of protection as above and have documentation to demonstrate this level of sealing from an approved organisation.

8. DESIGN AND OPERATION OF STORAGE TANKS AND SYSTEMS FOR POTENTIALLY POLLUTING SUBSTANCES

8.1 General

The EU Integrated Pollution Prevention and Control (IPPC) Bureau in Seville (http://eippcb.jrc.es) publishes Guidance Notes for sectors licensed under IPPC. A Draft Reference Document on Best Available Techniques on Emissions from Storage was issued in September 2001 and is due for finalisation in 2004. Storage tanks and systems are discussed in considerable detail in this reference document.

For chemical storage tanks systems a specific good practice guidance document (C598) has been prepared by CIRIA in collaboration between the UK Environment Agency and the UK Health and Safety Executive. The comments and recommendations in this document are also relevant to the storage of other substances such as foodstuffs. Sections of the guidance document can be accessed via CIRIA's website at www.ciria.org.

For underground storage tanks containing liquid hydrocarbons, the Scottish Executive Environment and Rural Affairs Department has published a code of practice, which is available at www.scotland.gov.uk/about/ERAD/WEU/00015561/Guidance.aspx.

All storage tanks and systems should be designed to a recognised engineering code and be suitable for the mechanical, chemical, thermal and UV effects that can arise during their operating life. A storage system is one in which potentially polluting substances are present continuously or for long periods. Processing equipment, such as reactors or distillation columns are to be treated as storage systems for the purpose of this guidance note, while strong effluent collection sumps, in which a liquid level is present for long periods would also fall under this definition.

Tank installations should be designed such that subsidence or displacement does not occur. This is particularly important in areas that are prone to flooding.

Tanks should be fitted with access ports which allow inspection of the tank internals. The safe entry of a person to inspect a tank should be considered during its design, i.e. refer to the Safety, Health and Welfare at Work (Confined Spaces) Regulations, 2001 (S.I. No. 218 of 2001).

Single walled tanks must be located a sufficient distance from walls and other plant components such that visual leakage recognition and inspection of the bunds is possible. The base of the tank should be located sufficient distance above the bund to allow for leakage detection or alternatively a leak detection system should be installed. This is mandatory for Class 2 and 3 containment systems (refer to Section 6.3.2).

The Safety, Health and Welfare at Work (Signs) Regulations, 1995 (S.I. No. 132 of 1995) applies with regard to the minimum requirements for signs in the vicinity of storage systems containing hazardous compounds.

8.2 Underground Tanks

8.2.1 New Underground Tanks

New underground tanks should be of double skinned construction with leak detection and therefore do not require additional retention. The exception to this rule being new single skinned underground storage for solid materials where a risk assessment shows there is a minimal risk of pollution. Underground tanks should be correctly installed to best engineering standards, e.g. the UK Environment Agency Pollution Prevention Handbook Entry P2-234/HE.

8.2.2 Existing Underground Tanks

It is recognised that a large number of existing installations do not meet the above requirement. These can be categorised as:

T 1: Single walled tanks, including those where an impermeable drainage surface and sump(s) are located underneath the tank.

T 2: Single walled tanks in non-accessible bunds. This also includes double walled tanks without automatic leak detection, whereby the walls are so designed, that with a loss of sealing in the primary wall the other wall remains impermeable until the safe recognition of the incident. Additionally, the space between the outer and inner wall is suitable as a monitoring space.

The operator must ensure that existing underground tanks and any modifications to them meet the regulations and state of technology prevailing at that time for design, construction and maintenance, e.g. ASME-Code, DIN-Standards, API-Standards. If documentation is no longer available relating to initial design and inspection, then the tank should be inspected by a suitably qualified person and a report on the state of compliance generated. The tanks must be protected from both internal and external corrosion. This corrosion resistance must be guaranteed through reference samples, by laboratory investigations or by appropriate published corrosion literature.

For materials hazardous to waters, WHC 1 to 3, the following additional requirements apply:

- **Tanks of Category T 1:** When storing material hazardous to waters, WHC 1 to 3, the wear rate on the tank must be Ω0.01 mm/a. An estimation of the life of the system is required to be completed by a qualified person as for underground piping (M 3 in Appendix F). Suitable pollution limitation measures and rehabilitation measures must be documented for the facility. Rehabilitation measures must in addition to the water hazard classification address the result of the system life estimation and the hydrogeological features of the location.

- **Tanks of Category T 2:** For these tanks the requirements for safe operation are met when:
  - A leak recognition installation is installed in the bund or monitoring space, and
  - a liquid impermeable or medium resistant bund is installed in compliance with Section 6 and the wear rate of the tank is Ω0.1 mm/a, or

4# the system life estimation has a tank wear rate of Ω0.01 mm/a.

In the event of a pollution incident the bund integrity is to be verified by a qualified person before the system is returned to service. Suitable pollution limitation measures must be documented for the system.

8.2.3 Decommissioning Underground Storage Tanks

Potential environmental concerns arise when underground tanks have been temporarily taken out of use or left in-situ for a substantial period of time without being properly decommissioned. In these instances, underground tanks should be cleaned, and:

- If being temporarily decommissioned, the tank should be completely filled with water or hydrophobic foam.
- If being permanently decommissioned, the tank should be infilled and left in the ground. This may be the only option where the tank cannot be removed.
- If being removed, the tank and associated pipework should be removed. This is the most environmentally sustainable solution once a tank has been fully decommissioned.

The UK Environment Agency Pollution Prevention Handbook Entry P2-234/HE provides further guidance in this area.

8.3 Overfill Protection

The overfilling of tanks is recognised as one of the most frequent causes of spillages of potentially polluting substances. Tanks and vessels storing potentially polluting substances should only be filled with fixed piping connections and an overfill protection should be provided that independently shuts off the filling process prior to reaching the permissible fill level and activates an alarm. This does not apply to single overground tanks with a volume of not greater than 1,000 litres if they are filled with a self-closing dispensing valve or for the filling of mobile vessels in a filling facility.

Tanks and vessels for the storage of heating oil, diesel oil and petrol should only be filled from transportation tankers under the use of automatic shut off overfill protection.

The requirements for fixed piping connection and overfill protection may be replaced by an equivalent design offering similar protection, although this would have to be agreed in the individual case with the relevant EPA inspector.

Droplets of liquids that are released during the filling process are to be caught and retained.

8.4 Testing and Inspection

8.4.1 General

The operator of a facility shall ensure the integrity of the primary containment (tanks) and the functionality of the associated safety equipment, such as overfill protection. The operator of the plant shall complete inspections of this equipment, either by his own qualified staff or qualified staff of a third party, according to the following requirements:

∉# Prior to bringing into service or after significant alterations.

∉# Prior to bringing into service equipment that has been out of operation for more than a year.

∉# When equipment is being permanently taken out of service.

∉# For existing equipment an assessment test is required, which is used in the determination of the time interval for repeat inspections.

∉# Repeat inspections are required based on the time intervals specified in the next section.

Appendix G provides more detailed engineering information on the inspection of tanks and vessels. This is applicable to both overground and underground systems.

8.4.2 Time Interval for Repeat Inspections

The time interval for repeat inspections should be based on risk assessment which considers primarily the design of the tank, the water hazard class and quantity of the material stored, the results of previous inspections and the process related corrosion effects. Storage and processing equipment can be generally designated as:

a) Pressure vessels.

b) Underground tanks.

c) Tanks in which leakage from the surroundings of the tank base can be rapidly and reliably detected. This would include among others double floored tanks with leak detection in the interstitial spacing or tanks raised on legs or strip foundations.

d) Tanks in which it is not possible to detect leakage from the base of the tank into the foundations, examples would include foundations of compacted sand covered with a layer of asphaltic concrete or a ring foundation in which the core is composed of sand.

The most catastrophic place for a tank to fail is at or near the base, as this can lead to the full contents escaping. It is also the point of highest structural stress in the tank, particularly if the tank is prone to settling and also the location most susceptible to corrosion. The tank base is therefore one of the most critical areas with regard to inspection and testing.

The wear rate of the walls of a tank is related to the surface corrosion at the operating conditions. This wear rate can be determined by actual measurements, such as data from previous inspections, from corrosion tables in the literature or by laboratory investigations. If the operating conditions of a tank system are changed, it is necessary to re-evaluate the wear rate estimation. The tank wall thickness minus the wear rate over the period until the next inspection should be compared with the design thickness of the vessel. In general for small diameter (< 10 m) atmospheric metal storage tanks the minimum wall thickness should never be less than 3 mm and wear rate for all vessels never greater than 0.5 mm/a. Larger tanks and pressure vessels will have accordingly greater minimum thickness requirements.

The table below provides guidance on the recommended time intervals for repeat inspections in so far as inspections for compliance with other legislation is not required within a shorter timeframe.

Table 8.1 Recommended time intervals for repeat inspections.

Vessel type	**Inspection requirements**
(a) Pressure vessels	Minimum of an internal inspection every five years accompanied by a pressure test every ten years.
(b) Underground tanks	Inspection required every three years.
(c) Tanks in which leakage from the tank base can be rapidly and reliably detected.	For installations in which automatic leak detection is installed in conjunction with a permanently manned control room or monitoring by means of daily inspection, then the time interval for inspection is to be based on the wear rate and minimum wall thickness. Otherwise (d) applies.
(d) Tanks in which leakage from the tank base cannot be rapidly and reliably detected.	The following wear rates and inspection periods have been developed for flat bottomed metal tanks for which a wall thickness measurement of the complete tank floor is required as part of the assessment test. (i) Contents non-hazardous to waters: ∉# Wear rate < 0.01 mm/a; every 15 years including a wall thickness measurement of the complete tank floor. ∉# Wear rate Ω0.1 mm/a; every 10 years including a wall thickness measurement of the complete tank floor. ∉# Wear rate > 0.1 mm/a: every 5 years including a wall thickness measurement of the complete tank floor every 15 years.

	(ii) Contents of water hazard class WHC 1 to 3: - Wear rate < 0.01 mm/a; every 10 years including a wall thickness measurement of the complete tank floor. - Wear rate ∅0.01 mm/a; every 5 years including a wall thickness measurement of the complete tank floor every 10 years.

Exceptions to the above inspection intervals can be made for:

- Facilities of hazard category A, as defined in Section 5.2.7, or in which processes are completed in laboratory or pilot scale.
- Facilities containing solid materials with the exception of those of hazard category D.

In individual cases, EPA inspectors can, on the basis of the pollution hazard, request additional testing or shorter test intervals. Alternatively, where the pollution risk is sufficiently minimised the EPA inspector can in the individual case reduce the extent of testing required.

9. SPECIFIC REQUIREMENTS FOR FOOD AND DRINK INDUSTRY

In Section 5.3.1 for overground storage facilities it was stated that the general criteria for new storage systems with a BOD loading of greater than 1,000 kg should be equipped with retention systems. However, it is recognised within the Food and Drink Industry that the general approach has not been to provide retention facilities for storage systems for food stuffs, despite the fact that in the event of spillage such compounds can present a significant organic load. For existing facilities, a risk assessment should be completed according to the criteria in Section 5.2. The following considerations are however valid to the Food and Drink Industry:

- Food materials and chemicals used at their cleaning concentrations are not generally aggressive.
- Corrosion resistant stainless steel is the material of choice for vessels and piping systems.
- The frequency of vessel failure within the industry is low.
- Process control technology can reduce greatly the possibility of overfilling.
- A programme of vessel inspection and estimation of vessel life (as per Appendix F; M 3) can be implemented.

Based on the outcome of the risk assessment and agreement with the site inspector a bunding philosophy for the facility can be agreed.

10. SPECIFIC REQUIREMENTS FOR INTENSIVE AGRICULTURE

10.1 Design Requirements

The EU Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs, available at http://eippcb.jrc.es, provides guidance on the design of facilities for this sector. In the past, farmers often prepared their own designs for construction by farm labour or local builders worked to their own designs, developing specifications that were often based on many years' practical experience. There is therefore considerable more variation in construction standards in this sector than that prevailing in general industry. All new installations however should conform to a recognised design standard for slurry storage. Examples being:

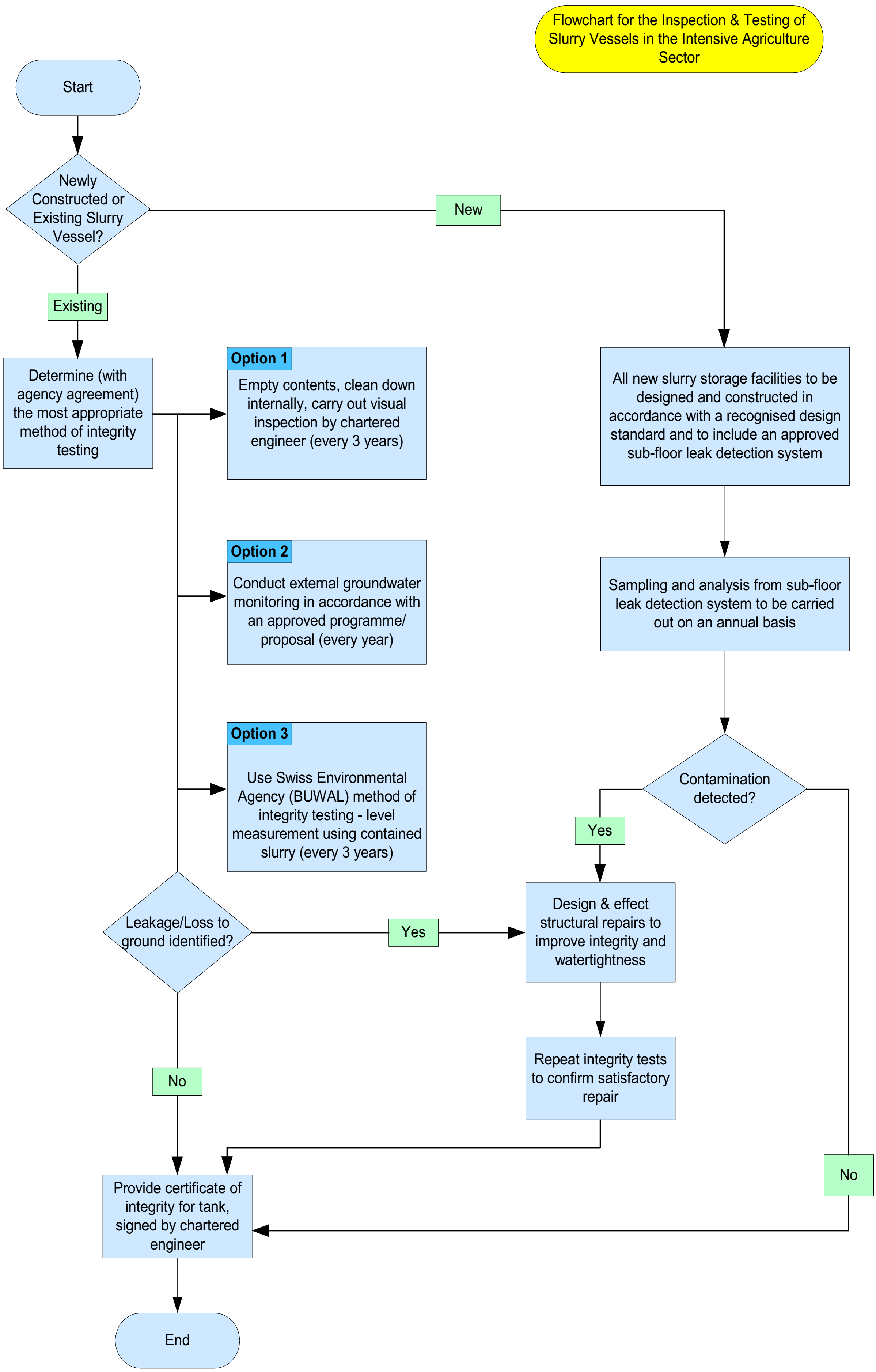
- The Irish Department of Agriculture and Food specifications S108 (manure pits), S123 (bovine livestock units and reinforced tanks) and S126 (geomembrane-lined external slurry / effluent stores).
- The UK CIRIA Report 126 on Farm Waste Storage.
- BS 5502: Part 50, 1993: Code of Practice on Buildings and Structures for Agriculture.
- IPPC Reference document on Best Available Techniques for Intensive Rearing of Poultry and Pigs
- DIN 11622: Silage and liquid manure containers (available in German only).

These standards should also be used for the design of facilities for the transfer of slurry within a site, i.e. slurry channels and piping systems.

In Section 5.3 – Retention Facilities, it was stated that for the Intensive Agriculture sector in general, retention (secondary containment) is not required for storage facilities or piping / channel systems. This is based on the understanding and assumption that adequate equipment, frequent monitoring and proper operation is utilised to prevent leakage and spillage from slurry storage facilities. It is therefore necessary for facilities in this sector to develop an effective system of maintenance and inspection, including procedures and response measures, which should be followed so as to prevent and protect against the escape of liquid effluent.

10.2 Requirements for Integrity Testing

Periodic integrity testing of slurry vessels and transfer systems must be carried out at all licensed facilities. In all cases, this testing should be supervised by a suitably qualified person and documented accordingly. Depending on the nature, scale and date of construction of an individual facility, there are a number of methods by which integrity testing might be conducted. A description of the methodology that should be followed for integrity testing is included in the flowchart overleaf. The various methods for integrity testing are discussed below. In general, slurry channels should be considered as vessels and should be included in the scope of the integrity assessments. Slurry pipelines, external to the vessels, should be tested in accordance with the general guidelines outlined in Appendix G.


Flowchart for the Inspection & Testing of Slurry Vessels in the Intensive Agriculture Sector
Start
Newly Constructed or Existing Slurry Vessel?
New
Existing
Determine (with agency agreement) the most appropriate method of integrity testing
Option 1
Empty contents, clean down internally, carry out visual inspection by chartered engineer (every 3 years)
Option 2
Conduct external groundwater monitoring in accordance with an approved programme/ proposal (every year)
Option 3
Use Swiss Environmental Agency (BUWAL) method of integrity testing - level measurement using contained slurry (every 3 years)
All new slurry storage facilities to be designed and constructed in accordance with a recognised design standard and to include an approved sub-floor leak detection system
Sampling and analysis from sub-floor leak detection system to be carried out on an annual basis
Contamination detected?
Yes
No
Leakage/Loss to ground identified?
Yes
No
Design & effect structural repairs to improve integrity and watertightness
Repeat integrity tests to confirm satisfactory repair
Provide certificate of integrity for tank, signed by chartered engineer
End

Some of the main difficulties associated with conducting an effective and conclusive assessment of the structural integrity and water tightness of a slurry tank or vessel in the intensive agriculture sector are recognised as being:

- More often than not, slurry tanks in intensive agriculture are partially or substantially underground.
- Slatted units and related tanks are generally in use all year round, and are difficult to isolate for testing purposes.
- Slurry tanks, particularly in the pig rearing activities, can be extremely large in terms of footprint area and consequently emptying, cleaning and inspection can be impracticable.
- Tanks are quite often shallow and/or substantially covered, thus preventing access for inspection.
- Tanks or slatted units are often interconnected by channels or pipes by means of valves, sluices or weirs. Such arrangements can make it difficult or impossible to sub-divide the farm into manageable zones for testing.

Because of these factors, each site should be considered individually when determining the means by which the slurry tanks and systems should be tested. The first distinction that needs to be drawn is between newly constructed and existing slurry vessels.

For all new tanks a sub-floor leak detection system should be installed. Some details of the basic requirements for such a system are shown in Figures 10.1 and 10.2. This will greatly simplify the process of integrity assessment whereby periodic, minimum once per year, sampling and analysis of liquid contained in specifically constructed monitoring chambers can be used as the basis for assessing the integrity of the slurry tanks. It is recommended that a sufficient number of separate leak detection systems, each with a separate monitoring point, are provided such that in the event of contamination being detected, the source of the contamination can be narrowed down by location. As a guide, an individual monitoring system should cover a tank footprint area of not more than 1,000 m^2.

In the case of existing or established facilities, where a sub-floor leak detection system is not in place, the most appropriate method of testing must be determined for each site, as well as each individual slurry storage situation. It will be the responsibility of each licensee to determine the means of integrity testing to be used at their site. The methodology to be used must have prior approval from the Agency. It is recommended that the licensee employ the services of suitably qualified personnel to determine the most appropriate method of testing, as well as supervising the test procedures.

Depending on the particular site arrangements and conditions, three options for integrity assessment are recommended;

- Emptying of the slurry tank followed by cleaning and visual inspection by a suitably qualified person. This is the least desired method given the high labour and time requirements. A minimum repeat frequency of three years is recommended for this test method.

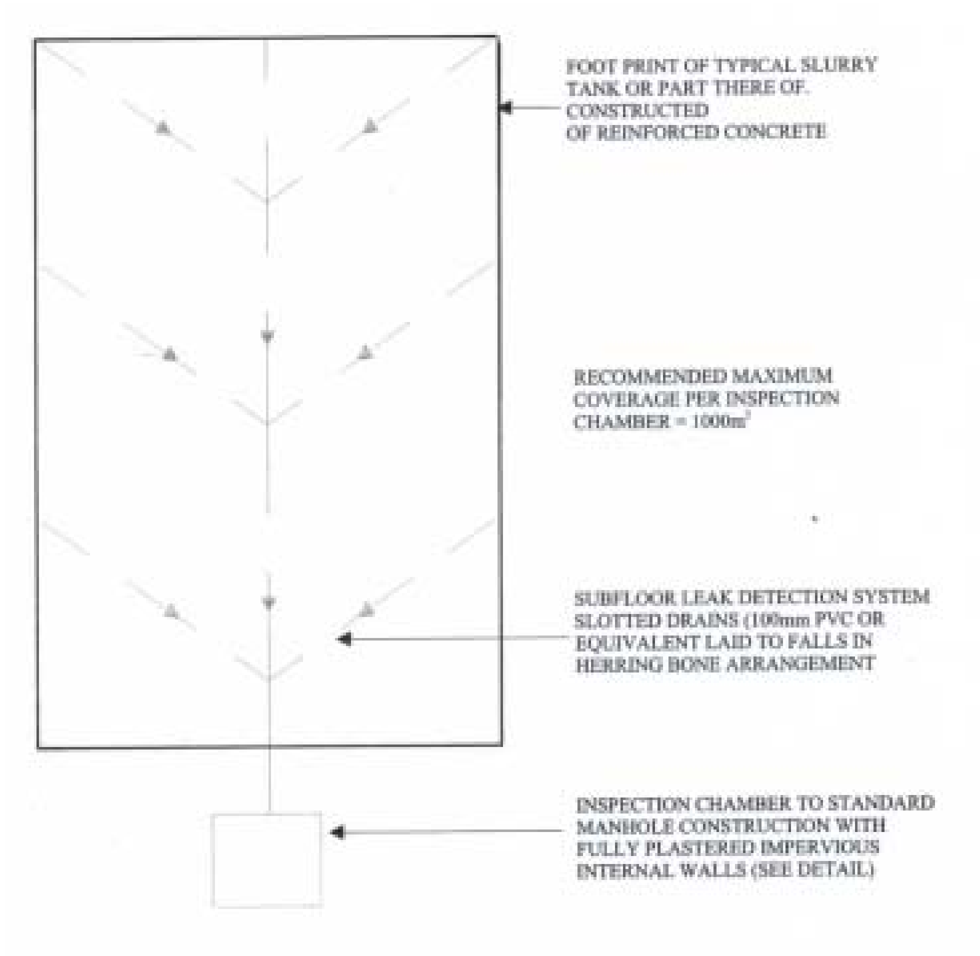


Figure 10.1 Plan view of typical leak detection system for a partially below-ground slurry tank

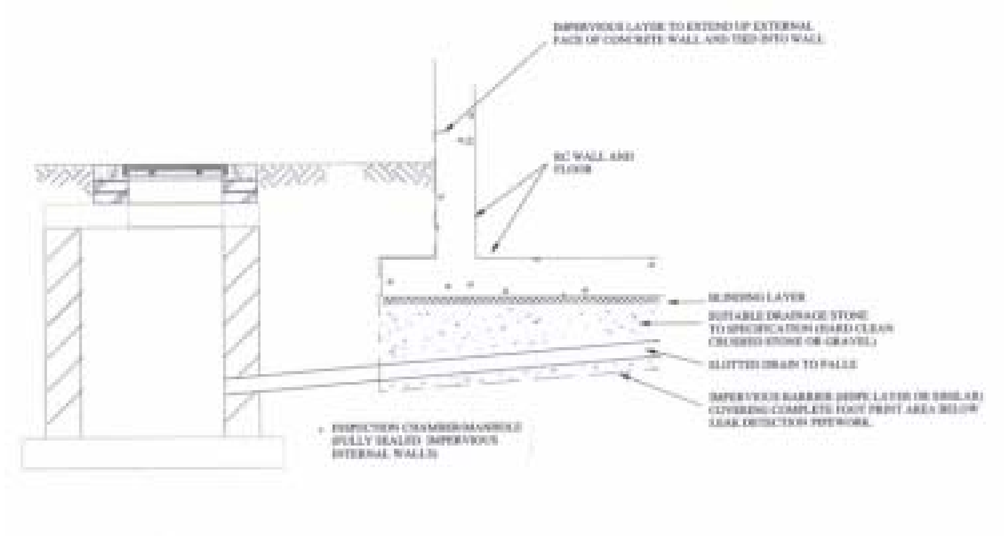


Figure 10.2 Section through sub-floor leak detection system at monitoring chamber

- Conduct external groundwater monitoring in accordance with an approved programme. If this option is deemed to be preferred, the licensee should provide an outline proposal to the Agency detailing the proposed monitoring programme, in particular, the number, location and depth of monitoring wells to be installed in the context of the hydrogeological status of the site. A minimum monitoring frequency (sampling and analysis for an agreed list of pollutants) of once per year is recommended for this test method.

- The Swiss Environment Agency (BUWAL) has developed a method for testing of slurry vessels without the necessity for emptying and cleaning. This method is based on the use of high accuracy level measurement over a period of 24 hours. More information on this testing method can be obtained from the translation of their summary guidance note in Appendix H. However, this method cannot be considered suitable for locations where the ground water levels are high in relation to the slurry storage levels. A minimum repeat frequency of three years is recommended for this test method.

If leakage is discovered due to cracks or other structural defects, then remedial action should be taken. Tests as necessary should be repeated so as to confirm the repairs have been successful. Where satisfactory repairs are not possible, the storage facility should be abandoned and new facilities provided.

A system of regular control inspections, e.g. weekly, of slurry tanks and pipelines is required which addresses fill levels and any signs of corrosion or leakage, while measures also need to be implemented to ensure that tanks and sumps are not overfilled.

10.3 Storage Systems for Fuels and Farm Chemicals

Storage systems for diesel and other fuels, pesticides, and other chemicals as may be used in the intensive agriculture sector, should comply with the requirements of the previous Sections of this guidance note. Solid chemical fertiliser storage and animal feed storage should be protected from rainwater as addressed in the next Section for solid storage.

11. REQUIREMENTS FOR GASES AND SOLIDS

The guidance in this note relates primarily to liquid substances. A release of a gaseous compound from a vessel or piping system may not present as high a pollution risk to the surrounding environment as that of a liquid. This is based on the property of a gas to rapidly disperse. Similarly, solids do not present as great a pollution threat as liquids due to their limited flow characteristics. Hence the requirements developed in the previous sections may prove to be conservative for the gases and solids. A risk assessment should therefore be completed according to the requirements in Section 5.2, which would include the considerations for gases and solids addressed in the next sections.

11.1 Risk Assessment for Gases

Gases differ from liquids in their ability to rapidly disperse into the surrounding atmosphere, particularly in an open environment when climatic conditions are favourable for dispersion. This tendency to disperse makes it difficult to contain a release at source, indeed the options can be limited to the few measures below:

- Double contained tanks with leak detection.
- Bunding of volatile liquid releases and covering them with a foam layer to reduce the evaporation rate.
- For readily soluble gases the use of water sprays to reduce dispersion rates. However, with refrigerated gas spills, such as liquid ammonia, it is necessary to ensure that the water does not enter the pool of refrigerated gas and thereby increase the thermal input and the vapourisation rate.

For materials that are normally gases at ambient conditions, bunding may be required where the vapourised fractions are sufficiently low to merit them i.e. for refrigerated gases but not for the same gas stored under pressure. However, for gases that rapidly disperse, guidance in this document for retention derived primarily for liquid releases may prove to be too conservative.

In completing a risk assessment to determine whether retention is required for gaseous systems and to assess the volume of retention where required, the following should be considered:

- The potential volume of release in an accident situation (see Appendix B).
- Whether the installation is overground or underground.
- For overground installations, the fraction of the compound that would be vapourised and dispersed under the release scenario. This can be calculated by process simulation software packages.
- For underground installations, the solubility of the gas in water and the hazard of the solubility byproducts to the aquatic environment.

In addition to environmental considerations, the requirement for bunding can be driven by safety considerations. For example with toxic gases the requirement for containment of a toxic release will often dictate that retention systems are required, an example being double skinned refrigerated ammonia storage tanks.

Fire protection considerations also impact greatly on design of gaseous storage systems. Pressurised gaseous storage tanks, when engulfed for an extended period by fire, can explode violently. There is therefore a tendency to install these tanks underground, where they are protected by an earth barrier. Additionally, bunding of overground gas storage systems serves to prevent the spread of a pool of a flammable liquified gas, thereby reducing the fire risk. For example, retention is required by the following codes where there is no pollution risk associated with the gaseous release:

- The Institute of Gas Engineers: Liquified Natural Gas (LNG) Storage Safety Guidance (IGE/SR/11).
- The British Compressed Gases Association: Bulk Liquid Oxygen Storage at Production Sites (CP20).

11.2 Solids

Solids in a fine granular form can give rise to dust emissions. Pollution of the aquatic environment can also occur from spillages of solids, particularly those which are soluble in water and produce pollution by-products.

Dust emissions can be minimised by use of the following technologies in decreasing order of effectiveness:

- Enclosed storage, e.g. inside buildings or silos.
- Temporary enclosure, e.g. tarpaulins.
- Water sprays to reduce wind blown dust.
- Placing storage mounds in line with rather than at 90° to the prevailing wind.

With uncovered solid storage there is the additional pollution risk from the drainage run-off. Covered storage systems are thus the preferred option.

Minimisation of dust emissions is discussed in more detail in the Draft Reference Document on Best Available Techniques on Emissions from Storage available from the EU Integrated Pollution Prevention and Control (IPPC) Bureau in Seville (http://eippcb.jrc.es).

With regard to the pollution risk to the aquatic environment, solids, like gases, do not present as great a pollution threat as liquids. Therefore, the requirements in this guideline developed for liquids, such as prohibiting the use of new single walled underground vessels, may not be applicable for the storage of solids.

The environmental considerations with a spillage of solids are not so much the loss of material but the ability of the solid to react with the moisture present, such as rainwater and form solubility by-products that are potentially hazardous to the aquatic environment. In general, an impermeable surface is recommended under storage systems and transport conveyors. This is to allow for recognition of small spillages and aid in their clean-up. Additional measures would depend on individual risk assessments, which would consider:

- The degree of release of the material. Such as routine and accidental spillages.
- Whether the installation is overground or underground.
- The potential for contact with water, e.g. uncovered storage areas. In particular the clean-up procedures for spillages or contact with groundwater or rainwater.
- The solubility of the solid in water and the hazard of the solubility by-products to the aquatic environment.

A common example of a pollution risk from the storage of solids is that of creosote impregnated wood, such as railway sleepers or telephone poles. Creosote contains residues of Polyaromatic Hyrdocarbons (PAHs), including traces of the carcinogen benzo(a)pyrene. PAHs are on the priority list of compounds under the Water Framework Directive 2000/60/EC, discharges from these compounds are to be phased out over the next 20 years. Therefore, it is necessary to eliminate any run-off containing creosote from the storage of wood products.

With regard to repeat inspections of storage systems for solids it is recognised that the potential for pollution is far less than for those storing liquids. Therefore the repeat inspection requirement has been limited to high hazard facilities of Category D (Section 5.2.3).

12. WORKED EXAMPLE

A worked example of a small pharmaceutical plant (activity Class 5.6 under the first schedule of the EPA Act) is provided to demonstrate the use of the guidance note.

12.1 Description of Plant

The small pharmaceutical plant comprises of the following main elements:

Table 12.1: Main Elements of Small Pharmaceutical Plant Example.

Area	Equipment	Duty
Solvent storage	8 x 30m^3 storage tanks Tanker loading and unloading station	2 x acetone storage 2 x toluene storage 2 x methanol storage 2 x waste solvent storage Unloading virgin solvents and loading of waste solvent.
Production area	2 x production bays. Each bay comprises: 4 m^3 head tank. 5 m^3 reactor. 5 m^3 crystallisation vessel. 5 m^3 pressure filter/dryer. 10 m^3 mother liquor tank.	Reaction of primary raw materials, formation and isolation of intermediates and final products.
Waste water treatment.	2 x 100 m^3 balancing tanks. Activated sludge system.	Biological treatment of low strength aqueous effluent.
Warehousing	400 m^2 warehouse, containing up to 50 m^3 in drums.	Storage of raw materials, intermediates and final products in liquid form (200 litre drums) and solids packaging (fibre drums).
Hydrogen storage	16 cylinders (100 litre) of pressurised hydrogen.	For hydrogenation reactions.

12.2 Hazard Assessment

The principal solvents at the site are acetone, toluene and methanol. Using the Assessment Criteria described in Section 5.2.7 from the German Environment Agency website the WGK classification of acetone and methanol is WGK 1, while that of toluene is WGK 2. These are equivalent to WHC 1 and WHC 2 in this guide.

For the purpose of this exercise it is assumed that the products and intermediates are non-hazardous to waters such that the solvent blends in the production equipment are not rendered more hazardous by the product fraction. However, by reviewing the 'Guidelines for self-classification', which can be downloaded from the website, www.umweltbundesamt.de/wgs-e, it is clear that small quantities of hazardous components, particularly those that are rated R45 'May cause cancer', can impact significantly on the WGK number of the mixture. Additionally, it is necessary to consider heat transfer fluids and other miscellaneous compounds in the assessment if they are present.

It is assumed that the solvent blend in the plant is in the ratio of the storage quantities, i.e. 1:1:1. In reality due to the usage of water this might be lower in actual plant conditions. Table 5 in the 'Guidelines for self-classification' (printed below) allows a WGK classification for a mixture to be derived from the WGK classification of the individual components. In this case, if the concentration of WGK 2 , i.e. toluene, is ∅5% then the mixture is classified as WGK 2.

Table 5: Computation rule for the derivation of the WGK of a mixture from the WGK of its components.

Ingredients (Components)	***Result*** **WGK 3**	***Result*** **WGK 2**	***Result*** **WGK 1**	***Result*** **Non-Hazardous**
WGK 3	≥ 3%	0.2 to 3%	< 0.2% in case of additives	< 0.2% (no additives permitted)
WGK 2		≥ 5%	0.2 to 5%	< 0.2%
WGK 1			≥ 3%	< 3%
Non-Hazardous				
R45 (carcinogenic)	≥ 0.1%	≥0.1%, but WGK 2	< 0.1% in case of additives	< 0.1% (no additives permitted)

With regard to the hydrogen storage, hydrogen is a non-toxic gas which is essentially insoluble in water. It therefore presents no water pollution risk.

The hazard associated with the facility is the product of the volume stored and site water hazard classification, in this case WGK 2. If we assume all the storage and production vessels are full of the solvent mixture then we obtain a volume of 298 m^3. To this should be added the volume related to the solvent fraction in the waste water treatment and drum storage. This has been nominally assumed at 62 m^3, hence a total of 360 m^3. From Table 5.2, the Hazard Category Table, a volume of 360 m^3 and a WHC 2 classification gives a Category D classification. The plant is therefore a **high hazard facility** and particular consideration needs to be given to its location with regard to sensitive environmental receptors such as groundwater and surface water resources.

12.3 Retention Requirements

Using Table 5.4, Retention Requirements for Overground Facilities, it is clear that the tank farm is well over the thresholds required for retention. The retention capacity should be the greater of 110% of the largest tanks, 33 m^3 in this case, or 25% of the total volume, 60 m^3 in this case. Therefore, the required retention volume for the tank farm is 60 m^3.

Solvent for the site and waste solvent for off-site incineration/recovery are loaded and unloaded into 20 m^3 ISO-tankers. As these are single compartment vessels it is necessary to provide retention for 110% of this volume at the transfer point. However, if controls were in place to reduce the volume of potential spillage, e.g. self closing break away couplings, then this volume could be reduced. See Appendix B, Section 3 for calculation of retention volume.

The production area is well over the volumes specified in Table 5.4 for retention, while the warehouse will also require retention as the drum storage will exceed the specified thresholds. Using the same 25% rule for the production area the required retention volume is 14.5 m^3. For the warehouse using the same 25% rule a volume of 12.5 m^3 applies.

With regard to the balancing tank the solvent mixture used in the plant has been classified as WGK 2. From Table 5 of the 'Guidelines for self-classification' the aqueous solution in the balancing tanks will have a WGK 1 classification if the fraction of solvent mixture exceeds 0.2% but is below 5%. As this is considered likely then the balancing tanks, which are overground, should be treated as WGK 1 and therefore require retention according to Section 5.3.1, i.e. 110% of the largest tank, in this case 110 m^3.

The aeration section in the activated sludge system will have very low levels of residual solvent and therefore can be considered as non-hazardous with no requirement for retention.

The overground piping for acetone and methanol will not require retention according to Section 5.3.3, Table 5.5 as these solvents can be considered WHC 1. The toluene pipework and those containing mixtures classified as WHC 2 will require retention unless the specific requirements of Section 7 on piping design are met.

A summary of the retention requirements is provided in Table 12.2.

Table 12.2: Summary of Retention Requirements

Area	Remarks	Retention Volume
Tank farm	25% of total volume stored	60 m^3
Tanker unloading	110% of single compartment tanker	22 m^3
Production area	25% of total production volume	14.5 m^3
Warehouse	25% of total liquid volume	12.5 m^3
Balance tanks	110% of tank volume	110 m^3
Acetone and methanol piping	No retention required	
Pipework containing toluene and mixtures of WHC 2	Retention required or compliance with specific requirements in Section 7	

12.4 Design and Operation of Retention Facilities (Bunds)

As the site hazard is Category D the containment type required is Class 3, the highest degree of integrity. After a review of the containment system options available, the design team selected the following:

- A single local bund for the tank farm of volume 60 m^3.
- Containment for tanker loading/unloading could be provided by a stand alone bund of 22 m^3. Alternatively if site drainage conditions allow this could be incorporated into the local bund for the tank farm, which would now require a volume of 25% of 260 m^3, i.e. 65 m^3.
- Remote bunding of production area and warehouse to a volume of 27 m^3 (14.5 + 12.5 m^3). This will be provided by routing the floor drains in the area to the waste water treatment balance tanks. These will be operated such that one tank feeds forward to the activated sludge system while the other collects process effluent and floor washings from the production area and warehouse. Controls will be implemented to ensure there is always 27 m^3 of free space in the collection tank.
- A single local bund for the balancing tanks to a volume of 110 m^3. It was considered during the design phase that the retention volume for the production and warehouse areas could be provided by increasing the volume of this bund, but it was judged to be a more environmentally contained solution to use the free volume in the balancing tank.

A review of the solvents during the design safety review showed that there are no adverse chemical reactions that could occur in the bunds. With regard to warehouse design there are restrictions with regard to the combined storage of flammables and non-flammable toxics, see reference to VCI guide in Section 6.3.5. This has been accommodated within the design of the warehousing.

As the containment type required is Class 3 the following features have been built into the design:

- A full fire water risk assessment has been provided for the site and additional fire water retention volume provided.
- Duty/standby pumps for transfer of floor drains in production area to the balancing tanks. The detailed design of the plant was to consider the option of a power supply for the pumps linked to the site emergency generator or installing one of the pumps as a diesel unit. (Note: Diesel pump option may not be suitable given the flammability of the solvents).
- The tank farm bund and the balancing tank bund are in permanently manned areas where any collection of rainwater or spillages into the bund would be quickly recognised. It was therefore not considered necessary to install bund low and high level monitoring and alarms.

As the plant is lightly manned during night hours it would not be possible to remove a spillage within the same shift. Therefore a medium retention period of between 8 and 72 hours has been selected for the design of the bunding. From Appendix D water impermeable concrete according to DIN 1045 edition 07.88 with the specified crack limitation is suitable for WGK 2 for a medium retention period. The minimum concrete thickness can be assessed from Appendix C, where for keytones, aliphatic hydrocarbons and aromatic hydrocarbons the penetration depths in concrete after 72 hours are 80, 85 and 80 mm respectively. By applying the two thirds rule the minimum concrete thickness is 128 mm. A reinforced concrete bund design was chosen according to BS 8007 as this is suitable for Class 3 containment. Testing of the structure is according to BS 8007 with the crack limitations as per Section 1 of Appendix D.

For emptying of the bunds a procedure for sampling and pump-out was developed using a portable air driven pump for discharge of the rainwater. Crack monitoring, as per Section 1 of Appendix D was scheduled on a half-yearly basis with bund testing every three years according to Section 6.6.

12.5 Design and Operation of Piping Systems

The piping system at the plant was designed to I.S. EN 13480. For toluene and other WHC 2 piping, retention was required unless the requirements of Appendix E were met. This was incorporated into the plant design by using connections and fittings of Type A for this duty where bunding had not already been provided, e.g. external pipework to the production building. In fact piperacks were designed to be delivered in welded pre-fabricated sections with a minimum of connecting flanges. No underground process piping was installed as the floor drains in the production area were pumped by overground pipework to the waste water treatment plant balance tanks. Instead underground piping was limited to the outfall of the waste water treatment plant to the municipal sewer.

A system of weekly pipework control inspections was established, while a general pipework inspection was scheduled for every five years. It is anticipated that the wear rate of metallic piping will be Ω0.1 mm/a, this will be confirmed by spot checks at positions where pipe wear is to be expected. Therefore, it is anticipated that the pressure testing for metallic piping systems can be extended to 10 years. For the sewer connection a three yearly inspection programme was developed according to the requirements of Appendix G.

12.6 Design and Operation of Storage Tanks and Systems

The balance tanks and solvent storage tanks in the tank farm were designed according to BS 2654. Clearance between the base of the tanks and the bund floor was incorporated to allow for leak detection, while level control with an independent high level switch with shut-off was provided on the tanks. The pressure vessels in the production areas were designed and certified according to the EU Pressure Equipment Directive (97/23/EC). Additionally, the aeration basin was installed with monitoring pipes for the purpose of leak detection as shown in Figures 10.1 and 10.2.

Prior to being brought into service, all vessels were inspected and documented as fit for use according to the methodology in Appendix G. For the atmospheric tanks an initial repeat inspection was scheduled for five years at which the wear rate of the system was to be determined. Based on the outcome of this testing a scheduled was to be derived for further testing intervals. For the pressure vessels the period for repeat inspections was to be left at five years.

13. ABBREVIATIONS

AEGL: Acute Exposure Guideline Levels.

AER: Annual Environmental Report, as required by the EPA for IPC sites.

API: Active Pharmaceutical Ingredient.

ATEX: Short for 'Explosive Atmospheres' in French and refers to Directives 94/9/EC and 1999/92/EC.

BAT: Best Available Techniques (as defined by the IPPC directive, see below).

BOD: Biological Oxygen Demand; a standard analysis of the oxygen requirements of sample of waste water i.e. the strength of the effluent.

BS: British Standard

BUWAL: Swiss Agency for the Environment, Forests and Landscape.

CCTV: Close Circuit Television.

DIBt: German Institute for Construction Technology.

DIN: Deutsches Institut für Normung (German Standard)

EPA: Environmental Protection Agency.

ERPG: Emergency Response Planning Guidelines.

EU: European Union.

Ex: Denotes explosion protection.

HAZOP: Hazard and operability study.

HPDE: High Density Polyethylene.

IPC: Integrated Pollution Control; as established by the EPA Act of 1992.

IPPC: Integrated Pollution Prevention and Control; as established by Directive 96/61/EC.

ISO: International Standards Organisation.

LL: Leak Limiting.

LR. Leak Recognition.

LNG: Liquified Natural Gas.

NDT: Non-Destructive Testing.

NFPA: National Fire Protection Association (US).

NPT: National Pipe Thread.

OEL: Occupational Exposure Limit.

PAHs: Polyaromatic Hydrocarbons.

pH: Power of hydrogen, a measure of acidity.

POE: Protection of the Environment Act 2003

TRwS: German technical regulations for materials hazardous to waters.

UK: United Kingdom.

US: United States.

UV: Ultra-violet light.

VCI: German Federation of Chemical Industry.

WGK: German Environment Agency Water Hazard Classification.

WHC: Water Hazard Classification (see Section 5.2.7)

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APPENDIX A

FIRST SCHEDULE OF POE ACT

FIRST SCHEDULE

ACTIVITIES TO WHICH PART IV APPLIES

Interpretation

If 2 or more activities falling within the same paragraph under a particular heading of this Schedule are carried on in the same installation by the same person, then, for the purpose of any threshold specified in that paragraph, the capacities of those activities shall be aggregated.

1. Minerals and Other Minerals

1.1.1 The production of asbestos

1.1.2 The extraction, production and processing of raw asbestos, not included in paragraph 1.1.1.

1.2 The extraction of aluminium oxide from an ore, not included in paragraph 5.13.

1.3. The extraction and processing (including size reduction, grading and heating) of materials within the meaning of the Minerals Development Acts 1940 to 1999, where an activity involves –

(a) a metalliferous operation, or

(b) any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes.

and storage of related mineral waste

1.4 The extraction of peat in the course of business which involves an area exceeding 20 hectares.

2. Energy

2.1 The operation of combustion installations with a rated thermal input equal to or greater than 50MW.

3. Metals

3.1.1 The production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour.

3.1.2 The initial melting or production of iron or steel, not included in paragraph 3.1.1.

3.2.1 The processing of ferrous metals:

(a) Hot-rolling mills with a capacity exceeding 20 tonnes of crude steel per hour,

(b) Smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW,

(c) Application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour.

3.2.2 The processing of iron and steel in forges, drawings plants and rolling mills where the production area exceeds 500 square metres, not included in paragraph 3.2.1.

3.3.1 The operation of ferrous metal foundries with a production capacity exceeding 5 tonnes per day.

3.3.2 The production, recovery, processing or use of ferrous metals in foundries having melting installations with a total capacity exceeding 5 tonnes, not included in paragraph 3.3.1.

3.4.1 The –

(a) production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes,

(b) smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals

3.4.2 The production, recovery or processing of non-ferrrous metals, their compounds and other alloys including antimony, arsenic, beryllium, chromium, lead, magnesium, manganese, phosphouus, selenium, cadmium or mercury, by thermal, chemical or electrolytic means in installations with a batch capacity exceeding 0.5 tonnes, not included in paragraph 3.4.1.

3.5 The reaction of aluminium or its alloys with chlorine or its compounds, not included in paragraph 5.13.

3.6.1 The roasting or sinterling of metal ore (including sulphide ore).

3.6.2 The calcining of metallic ores in plants with a capacity exceeding 1,000 tonnes per year.

3.7 Swaging by explosives where the production area exceeds 100 square metres.

3.8 The pressing, drawing and stamping of large castings where the production area exceeds 500 square metres.

3.9 Boilmaking and the manufacture of reservoirs, tanks and other sheet metal containers where the production area exceeds 500 square metres.

4. Mineral Fibres and Glass

4.1 The processing of asbestos, and the manufacture and processing of asbestos-based products.

4.2.1 The melting of mineral substances including the production of mineral fibres with a milting capacity exceeding 20 tonnes per day.

4.2.2 The manufacture of glass fibre or mineral fibre, not included in paragraph 4.2.1 or 4.3.

4.3 The manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day or 5,000 tonnes per year.

4.4 The production of industrial diamonds.

5. Chemicals

Production, for the purposes of the activities mentioned in paragraph 5.12 to 5.17, means the production on an industrial scale by chemical processing of substances or groups of substances mentioned in any of those paragraphs.

5.1 The manufacture of chemicals in an integrated chemical installation, not included in paragraphs 5.12 to 5.17.

5.2 The manufacture of olefins and their derivatives or of monomers and polymers including styrene and vinyl chloride, not included in paragraphs 5.12 to 5.17.

5.3 The manufacture, by way of chemical reaction processes, of organic or organo-metallic chemical products other than those specified in paragraph 5.2 and not included in paragraphs 5.12 to 5.17.

5.4 The manufacture of inorganic chemicals, not included in paragraphs 5.12 to 5.17.

5.5 The manufacture of artificial fertilisers, not included in paragraphs 5.12 to 5.17.

5.6 The manufacture of pesticides, pharmaceutical or veterinary products and their intermediates, not included in paragraphs 5.12 to 5.17.

5.7 The manufacture of paints, varnishes, resins, inks, dyes, pigments or elastomers where the production capacity exceeds 1,000 litres per week, not included in paragraphs 5.12 to 5.17.

5.8 The formulation of pesticides, not included in paragraphs 5.12 to 5.17.

5.9 The chemical manufacture of glues, bonding agents and adhesives, not included in paragraphs 5.12 to 5.17.

5.10 The manufacture of vitamins involving the use of heavy metals, not included in paragraphs 5.12 to 5.17.

5.11 The storage, in quantities exceeding the values shown, of any one or more of the following chemicals (other than as part of any other activity) and not included in paragraphs 5.12 to 5.17—

methyl acrylate (20 tonnes); acrylonitrile (20 tonnes); toluene di-isocyanate (20 tonnes); anhydrous ammonia (100 tonnes); anhydrous hydrogen flouride (1 tonne).

5.12 The production of basic organic chemicals, such as:

(*a*) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic),

(*b*) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins,

(*c*) sulphurous hydrocarbons,

(*d*) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates,

(*e*) phosphorus-containing hydrocarbons,

(*f*) halogenic hydrocarbons,

(*g*) organometallic compounds,

(*h*) basic plastic materials (polymers, synthetic fibres and cellulose-based fibres),

(*i*) synthetic rubbers,

(*j*) dyes and pigments,

(*k*) surface-active agents and surfactants.

5.13 The production of basic inorganic chemicals, such as:

(*a*) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride,

(*b*) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids,

(*c*) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide,

(*d*) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate,

(*e*) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide.

5.14 The production of phosphorous-based, nitrogen-based or potassium-based fertilisers (simple or compound fertilisers).

5.15 The production of basic plant health products and of biocides.

5.16 The use of a chemical or biological process for the production of basic pharmaceutical products.

5.17 The production of explosives.

6. Intensive Agriculture

6.1 The rearing of poultry in installations, whether within the same complex or within 100 metres of the same complex, where the capacity exceeds 40,000 places.

6.2 The rearing of pigs in an installation, whether within the same complex or within 100 metres of the same complex, where the capacity exceeds—

750 places for sows in a breeding unit, or

285 places for sows in an integrated unit, or

2,000 places for production pigs. In this paragraph—

'breeding unit' means a piggery in which pigs are bred and reared up to 30kg in weight;

'integrated unit' means a piggery in which pigs are bred and reared to slaughter;

'production pig' means any pig over 30kg in weight which is being fattened for slaughter;

'sow' means a female pig after its first farrowing.

7. Food and Drink

7.1 The manufacture of vegetable and animal oils and fats where the capacity for processing raw materials exceeds 40 tonnes per day, not included in paragraph 7.8.

7.2.1 The treatment and processing of milk, the quantity of milk received being greater than 200 tonnes per day (average value on a yearly basis).

7.2.2 The manufacture of dairy products where the processing capacity exceeds 50 million gallons of milk equivalent per year, not included in paragraph 7.2.1.

7.3.1 Brewing (including cider and perry production) in installations where the production capacity exceeds 25 million litres per year, not included in paragraph 7.8.

7.3.2 Distilling in installations where the production capacity exceeds the equivalent of 1,500 tonnes per year measured as pure alcohol, not included in paragraph 7.8.

7.3.3 Malting in installations where the production capacity exceeds 100,000 tonnes per year, not included in paragraph 7.8.

7.4.1 The operation of slaughterhouses with a carcass production capacity greater than 50 tonnes per day.

7.4.2 The slaughter of animals in installations where the daily capacity exceeds 1,500 units and where units have the following equivalents—

1 sheep = 1 unit,

1 pig = 2 units,

1 head of cattle = 5 units, and not included in paragraph 7.4.1.

7.5 The manufacture of fish-meal and fish-oil, not included in paragraph 7.8.

7.6 The manufacture of sugar, not included in paragraph 7.8.

7.7.1 The disposal or recycling of animal carcasses and animal waste with a treatment capacity exceeding 10 tonnes per day.

7.7.2 The processing (including rendering) of animal carcasses and by-products, not included in paragraph 7.7.1.

7.8 Treatments or processes for the purposes of the production of food products from—

(*a*) animal raw materials (other than milk) with a finished product production capacity greater than 75 tonnes per day,

(*b*) vegetable raw materials with a finished product production capacity greater than 300 tonnes per day (average value on a quarterly basis).

8. Wood, Paper, Textiles and Leather

8.1 The production of paper pulp, paper or board (including fibre-board, particle-board and plywood) with a production capacity exceeding 20 tonnes per day.

8.2 The production of pulp from timber or other fibrous materials.

8.3 The treatment or protection of wood, involving the use of preservatives, with a capacity exceeding 10 tonnes of wood per day.

8.4 The manufacture of synthetic fibres, not included in paragraph 5.12.

8.5.1 The pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day.

8.5.2 The dyeing, treatment or finishing (including moth-proofing and fireproofing) of fibres or textiles (including carpet) where the capacity exceeds 1 tonne per day of fibre, yarn or textile material, not included in paragraph 8.5.1.

8.6.1 The tanning of hides and skins where the treatment capacity exceeds 12 tonnes of finished products per day.

8.6.2 The fell-mongering of hides and tanning of leather in installations where the capacity exceeds 100 skins per day, not included in paragraph 8.6.1.

9. Fossil Fuels

9.1 The extraction, other than offshore extraction, of petroleum, natural gas, coal or bituminous shale.

9.2 The handling or storage of crude petroleum, not included in paragraph 9.3.1 or 9.3.2.

9.3.1 The operation of mineral oil and gas refineries.

9.3.2 The refining of petroleum or gas, not included in paragraph 9.3.1.

9.4.1 The operation of coke ovens.

9.4.2 The operation of coal gasification and liquefaction plants.

9.4.3 The production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitization.

9.4.4 The pyrolysis, carbonisation, gasification, liquefaction, dry distillation, partial oxidation or heat treatment of coal, lignite, oil or bituminous shale, other carbonaceous materials or mixtures of any of these in installations with a processing capacity exceeding 500 tonnes per day, not included in paragraph 9.4.1, 9.4.2 or 9.4.3.

10. Cement

10.1 The production of cement.

11. Waste

11.1 The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

12. Surface Coatings

12.1 Operations involving coating with organo-tin compounds, not included in paragraph 12.2.1 or 12.2.2.

12.2.1 The surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year.

12.2.2 The manufacture or use of coating materials in processes with a capacity to make or use at least 10 tonnes per year of organic solvents, and powder coating manufacture with a capacity to produce at least 50 tonnes per year, not included in paragraph 12.2.1.

12.3 The surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m^3.

13. Other Activities

13.1 The testing of engines, turbines or reactors where the floor area exceeds 500 square metres.

13.2 The manufacture of integrated circuits and printed circuit boards.

13.3 The production of lime in a kiln.

13.4.1 The manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, or with a kiln capacity exceeding 4 m^3 and a setting density per kiln exceeding 300 kg/m^3.

13.4.2 The manufacture of coarse ceramics including refractory bricks, stoneware pipes, facing and floor bricks and roof tiles, not included in paragraph 13.4.1.''.

APPENDIX B

CALCULATION OF RETENTION VOLUMES

1. GENERAL

The calculation methods outlined in this section are as set out in the German technical regulations for materials hazardous to waters TRwS 131 of 1996. These technical regulations are issued by the German Association for Water, Wastewater and Waste (ATV-DVWK).

Due to copyright reasons it is not possible to access these regulations free of charge over the internet. The relevant sections as an unofficial translation are available on purchase of this guide direct from the EPA or alternatively the original German language text can be sourced directly from ATV-DVWK.

APPENDIX C

PENETRATION DEPTHS IN CONCRETE

1. EXISTING CONCRETE SURFACES

Penetration depth of materials hazardous to waters in existing concrete surfaces (by kind permission of the German Concrete Association DAfStb). This is an unofficial translation of the authentic German language version.

Designation	Material Group	Test Medium	Penetration depth after 72 hours (mm)	Depth of attack after 72 hours (mm)
A	Aliphatic hydrocarbons	n-Octane n-Heptane	85	0
B	Aromatic hydrocarbons	Benzene Toluene	80	0
C	Alcohols (single group)	n-Butanol	65	0
D	Ester	Currently no data		
E	Other organic acidic compounds (e.g. Ether, outside of groups C/D/F/G/H/L)	3-Methoxy-butanol	80	0
F	Multi-group alcohols (e.g. Glycol)	Ethylene glycol	30	0
G	Aldehyde	n-Butr-aldehyde	45	0
H	Ketone	Methylethyl-ketone	80	0
I	Aliphatic nitrogenous compounds (e.g. Amine, Nitrile, Cyanide, Amide)	n-Butylamine	60	0
J	Aromatic nitrogenous compounds (e.g. Amine, Nitrile, Cyanide, Amide)	Aniline	45	0
K	Halogenated aliphatic hydrocarbons without additional function group	Currently no data		
L	Organic acids (e.g aliphatic carbonic acids)	Acetic acid (10%)	30	2

Designation	Material Group	Test Medium	Penetration depth after 72 hours (mm)	Depth of attack after 72 hours (mm)
M	Aqueous Solutions (outside of surfacant solutions)	10% Sodium chloride solution	40	0
N	Inorganic Acids (e.g. mineral acids)	Currently no data		
O	Inorganic alkalis (e.g. caustic)	20% Sodium hydroxide	15	1
P	Nitrated aromatics	Nitro-benzene	75	0
Q	Aqueous surfacant solutions	10% Sodium chloride solution + 0.1% Hostapur	40	0
R	Halogenated aromatic hydrocarbons	Chloro-benzene	85	0
T	Halogenated aliphatic hydrocarbons with additional functional groups	Epichloro-hydrin	45	0
U	Inorganic compounds (outside of acids and esters)	Thionyl-chlorid	25	1
V	Organic sulphur compounds (outside of acids and esters)	Dimethyl-sulfoxide	25	0
W	Organic phosphorous compounds (outside of acids and esters)	Currently no data		
Y	Metallic organic compounds	Trimethyl-chlorosilane	45	3
Depth of attack = 0 is equivalent with 'no significant attack'				

APPENDIX D

DESIGN DETAILS FOR BUNDS

1. EXTRACT FROM TRWS 132 (UNOFFICIAL TRANSLATION OF THE AUTHENTIC GERMAN LANGUAGE VERSION)

TRwS 132 is one of a series of German technical regulations addressing the handling of materials hazardous to waters. For new facilities the following table from TRwS 132 provides guidance for suitable choice of construction, though other equivalent materials may be used if it can be documented that an equivalent level of protection is provided.

Due to copyright reasons it is not possible to access these regulations free of charge over the internet. The relevant sections as an unofficial translation are available on purchase of this guide direct from the EPA or alternatively the original German language text can be sourced directly from ATV-DVWK.

2. REINFORCED CONCRETE BUNDS

Reinforced concrete bunds should be designed and built to comply with the requirements of BS 8007 for Class 2 or 3 containment, but BS 8110 which is slightly less onerous may be used for Class 1 containment. Conformance with these standards will ensure an adequately impermeable bund through:

- Specification of concrete mixes that can be well compacted, resulting in low permeability.
- Specification of details to control structural cracking.

BS 8007 is concerned specifically with water containment. Where aggressive substances may be present, as in many bund situations, additional corrosion protection may need to be considered. Although adequate for Class 1 containment, concrete bunds built to BS 8110 cannot be expected to achieve the same degree of impermeability as BS 8007 structures, the concrete itself may be more permeable and more significantly, BS 8110 does not provide details to control structural cracking to prevent liquid leakage.

3. REINFORCED MASONRY BUNDS

It is recommended that the use of reinforced blockwork is restricted to bunds for Class 1 containment only. Reinforced brickwork (other than grouted cavity construction) is not recommended for bunds.

Unreinforced masonry is not recommended for bund construction because of its susceptibility to thermal and shrinkage cracking and vulnerability to impact damage.

Important specific points regarding the design of reinforced masonry bunds are:

For blockwork bunds:

- Hollow concrete blocks should have a minimum compressive strength of 10 N/mm^2.
- Mortar mix should be class (i) to BS 5628 (BSI, 1992, 1985).

- Cores of blocks should be thoroughly filled with high workability concrete.
- Reinforcement should be provided both in the blockwork cores and the bed joint (the latter is to reduce thermal and shrinkage cracking and susceptibility to impact damage).
- The need for movement and construction joints should be avoided wherever possible, even if that means restricting the size of individual bunds.
- The inside face of the bund should be rendered with a dense sand/cement render.

4. PREFABRICATED BUNDS

A prefabricated bund is a prefabricated tank, usually constructed from steel or plastics, inside which the primary container is placed. One-piece prefabricated bunds are available in capacities up to 100m^3 , though the EPA preference is that such systems should be limited to 1,200 l due to the ease in which they can be damaged.

Prefabricated tanks are manufactured items and their detailed design is outside the scope of this guidance note. The following comments are limited to general guidance.

Prefabricated bunds should comply with the capacity recommendations and the requirements for access for inspection, or alternatively provision for leakage detection, as described earlier in Section 6 of the main document.

Prefabricated tanks used as bunds should be designed in accordance with the relevant material structural codes, where they exist, to comply with the actions defined in Table 6.1. Where there are no relevant structural codes it is recommended that a prospective purchaser should require the supplier to provide evidence, either in the form of independently certified test results or analyses, that the product is capable of meeting the required service duty with an expected service life of 50 years.

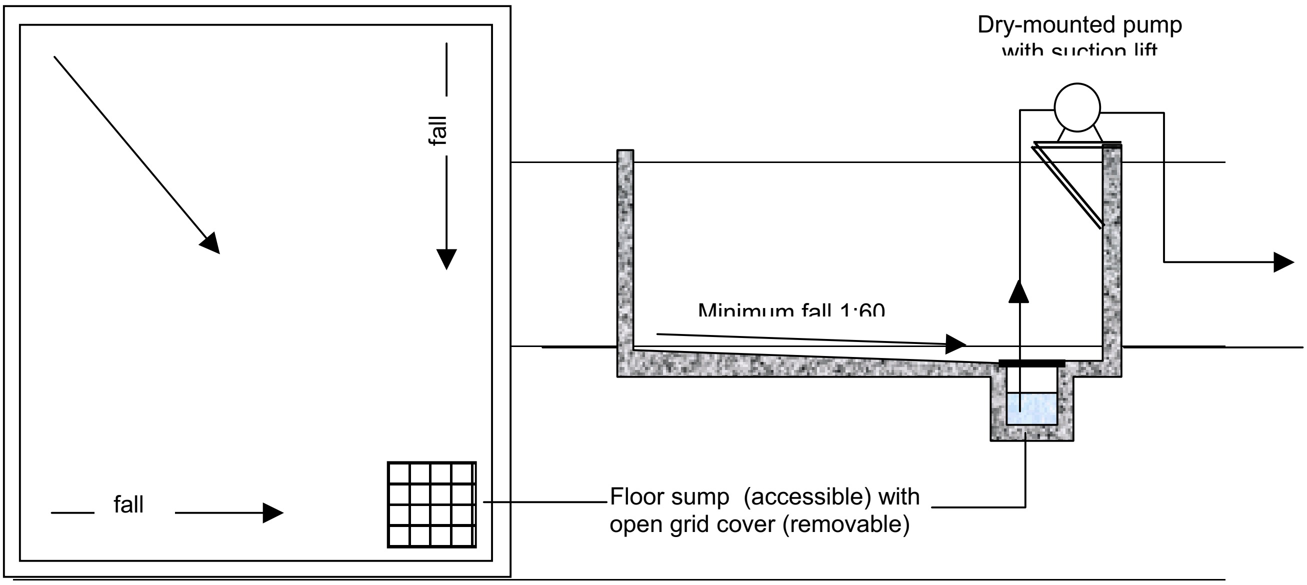
A prefabricated bund must not rely on structural linkage with the primary tank for its stability.

5. DESIGN DETAILS FOR EMPTYING OF BUNDS

It is recommended that, where possible, bunds should be emptied via pumped sumps. There are a number of considerations to be taken into account at design stage to facilitate emptying of bunds by means of pumping.

- Bund floors should be constructed in such a way that they fall to one location for ease of pumping out the contents. Where a sump is installed the fall should be towards the sump.
- The sump should be located in an area easily accessible from outside the bund for pumping, maintenance, cleaning and inspection.

- Sumps may create a trip or fall hazard, therefore covers such as grills should be fitted (strong enough to withstand traffic that is likely to pass over it (human or vehicular).
- Sumps should be within the impermeable seal on internal surfaces of bunds.
- Pumps can either be permanently fitted in sumps / bunds (submersible) or dry mounted at bund wall height with suction lift (self-priming). Mobile pumps may also used as and when required.
- Fixed pumps may utilise automatic on / off switches, provided that the discharge is to tertiary containment. The exact design should reflect the sites requirements and the results of a risk assessment.
- Pumps should be specified for a rating capable of removing the volume of liquid required within the time required to avoid the bund over spilling.
- Pumps should be specified so that they can withstand attack from the chemicals that may be pumped.



BASE OF BUND - PLAN **SECTION**

6. SAMPLE RECORD SHEET FOR BUND TESTING

Company:	**IPC Reference No.:**	
Site:	**IPC Category:**	
Bund Ref. No.:	**Bund Type – Local, Remote, Combined:**	
Bund Location:	**Bund Risk Classification 1, 2 or 3:**	
Bund Dimensions:	**Primary Vessel(s) – Materials of Construction:**	
Bund Materials of Construction:	**Primary Vessel(s) – Total Storage Volume:**	
Bund Lining Material:	**Primary Vessel(s) – 110% of Volume of Largest Vessel:**	
Bund Retention Volume (local/Remote):	**Primary Vessel(s) – 25% of Total Storage Volume:**	
Deemed practicable/safe to conduct hydrostatic test? Yes / No		
If no, give reasons:		
Description and Results of Hydrostatic Test:	**Date of Hydrostatic test:**	
Description and Results of Visual Inspection:	**Date of Visual Inspection:**	
Recommendations:		
Signed:	**Title/Position:**	**Date:**

APPENDIX E

PIPING DETAILS FOR SYSTEMS CONVEYING MATERIALS OF WATER HAZARD CLASS WHC 2 AND 3

1. GENERAL REQUIREMENTS FOR METALLIC AND PLASTIC PIPING SYSTEMS

1.1 Piping Definitions

Piping systems: Piping systems are flexible or fixed lines for the conveying of potentially polluting materials. This includes not only the piping itself but also the fittings, flanges and gaskets. Additionally, components that are built into the piping system and are necessary for the operation of the piping system e.g. filters, strainers, compensators, are to be considered as part of the piping system.

Disconnectable connections: These are connections that can be disconnected with a loss in sealing of the system but without damage to the piping system.

Non-disconnectable connections: These are connections, which can only be disconnected by destruction of the connection.

Secured fittings: These are fittings in which drop leakage / leakage is eliminated by design features and maintenance, or in which drop leakage / leakage is retained locally without any pollution. Secured fittings in which drop leakage / leakage is eliminated by means of design features and maintenance are considered as ‘Fittings of Construction Type A’, while secured fittings in which drop leakage / leakage is retained locally without any pollution are considered as ‘Fittings of Construction Type B’.

Secured disconnectable connections: These are disconnectable connections, in which drop leakage / leakage is eliminated by means of design features and maintenance (Type A), or in which drop leakage / leakage is retained locally without any pollution (Type B).

Corrosion resistance: This defines that the wear rate within the inspection interval of the piping system does not lead to any unpermissable weakness in the piping system. In particular, point corrosion is ruled out using the current state of technology.

1.2 General Requirements

This Appendix provides specific engineering data for the design, construction and maintenance of piping systems for conveying of materials of water hazard class WHC 2 and 3. Essentially piping systems can be divided into those for which retention is required and higher specification designs for which the retention requirements can be reduced or even eliminated.

Piping systems comprise of pipe lengths, connections and fittings, as defined above. In general for a well maintained piping system the leakage potential is restricted to the connections and fittings. Type A piping connections and fittings are those in which drop leakage / leakage is eliminated by means of design features and maintenance, while Type B connections and fittings are those in which drop leakage / leakage is retained locally, or routed to a remote bund, without any pollution. Therefore for Type B connections and fittings it is necessary to estimate the leakage quantity and provide sufficient retention. These aspects are addressed in the Section 2 of this Appendix.

Alternatively a higher standard piping systems comprising predominately Type A connections and fittings can be used in which retention requirements are reduced or even eliminated. These piping details are addressed in Sections 3 and 4 of this Appendix.

2. PIPING SYSTEMS FOR WHICH RETENTION IS REQUIRED

2.1 Retention for Connections of Construction Type B

Flange connections of construction Type B should be equipped with a suitable flange guard. These serve to prevent spraying of the escaping liquid and to duct the leakage to the collection surface.

The volume of retention required can be assessed from Eqns (1) and (2) in Appendix B. Where applicable an additional retention volume of 50 l/m^2 is to be applied to allow for rainwater from uncovered collection areas. For piping systems that are protected from impermissible pressure impacts, e.g. water hammer, then the leak area A can be calculated from equation (5), otherwise equation (6) should be used.

(5) $A = 0.00035 \times (DN)^{2.2}$

(6) A = Distance between two neighbouring flange bolts by the thickness of the gasket.

Where:

A = Leak surface area (Note: mm^2)

DN = Nominal diameter of the pipe in mm (e.g. DIN or BS designation).

2.2 Retention for Fittings of Construction Type B

If drop leakage / leakage cannot be ruled out at the connection flanges of the fittings, then the calculation method above applies. For fittings with connection flanges of Type A the following applies:

- An estimate of the leak surface area A should be made and the volume of retention calculated according to Appendix B. With fittings of Type B using bellows construction only drop leakage is possible. On construction grounds the seal cannot be forced out of the housing.

- The system for collection of leaks / spillages has to surround the projection of the fitting i.e. be designed to collect any possible spillages.

2.3 Design of Collection Surface

A raised edge of 2 cm is generally seen as sufficient for the collection surface, though this is not required if the collection surface drains directly to a remote bund or suitable waste water treatment plant. Where applicable an additional retention volume of 50 l/m^2 is to be applied to allow for rainwater from uncovered collection areas. For a local retention system where no external drained surface areas flow into the retention system this can be simply implemented by an additional freeboard of 5 cm in height.

2.4 Monitoring

Monitoring is to be completed each working day or by automatic monitoring. The condition of the sealing is to be checked during the control inspections. Fittings, which are in the working area of operating staff and are clearly visible, are considered as permanently monitored. Automatic alarm systems are not required for these areas.

3. SPECIAL MATERIAL AND CONSTRUCTION REQUIREMENTS FOR METALLIC PIPING SYSTEMS THAT ALLOW FOR A REDUCTION IN RETENTION REQUIREMENTS

3.1 General

This section is based on the concept that the escape of potentially polluting substances in hazardous quantities into the surrounding area can be avoided through the use of high integrity sealed equipment. Equipment is considered long term technically sealed if:

- It is implemented such that on the basis of its construction it remains technically sealed or
- its technical sealing is permanently guaranteed through maintenance and monitoring.

For a piping system of metallic components the retention requirements are summarised in Table E.1 overleaf.

3.2 Design and Construction

For compliance with the concept of long term technically sealed the design of the piping system should follow recognised design standards for the appropriate operating pressures and temperatures. Section 7.3 of this guidance note provides an example of some recognised engineering standards. (Note: The engineering standard for piping components and installation referred to in this Appendix are only a sample of those most commonly used). Equivalent standards, which provide an equivalent degree of protection, may be used.

Table E.1: Requirements for metallic piping systems conveying liquids of WHC 2 and 3

	Piping System Type 1	Piping System Type 2	Piping System Type 3	Piping System Type 4	Piping System Type 5	Piping System Type 6	Piping System Type 7	Piping System Type 8
Connections	Non-disconnectable Connections or Connections of Type A				Connections of Type B			
Fittings	Fittings of Type A		Fittings of Type B		Fittings of Type A		Fittings of Type B	
Wear Rate (w) (mm/a)	w Ω0.1	0.1 < w Ω5	w Ω0.1	0.1 < w Ω5	w Ω0.1	0.1 < w Ω5	w Ω0.1	0.1 < w Ω5
Retention for connections	Not Required	Not Required	Not Required	Not Required	Required	Required	Required	Required
Retention for fittings	Not Required	Not Required	Required	Required	Not Required	Not Required	Required	Required
Pressure Testing	Every 10 Years	Every 5 Years	Every 10 Years	Every 5 Years	Every 10 Years	Every 5 Years	Every 10 Years	Every 5 Years

The stresses to be expected in the pipework under maximum operating conditions (internal pressure, temperature, fill weight) are to be calculated according to a recognised engineering standard with regard to support spans and elasticity control e.g. I.S. EN 13480, TRR 100 or ASME B31.3.

Pipes, pipe sections, flanges, gaskets, as well as fittings and other equipment components are to be manufactured from materials, which demonstrate sufficient mechanical properties for the lowest and highest expected temperatures and pressures, e.g. sightglasses to TRB 404 or DIN 7079.

Testing of the piping system and documentation of the testing is to be completed by a suitably qualified person.

The fabrication, erection and testing of the piping system are to be completed by suitably qualified personnel. Welding is to be completed to the welding quality control standard I.S. EN 729 part 3. Testing of the welding and the process testing can be completed according to I.S. EN 287, I.S. EN 1418 or I.S. EN 288.

Non-Destructive Testing, x-ray, ultrasound, etc, should be completed according to the design code used, e.g. I.S. EN 13480-5, before the system is first brought into operation.

For lined and coated pipe, pipe design is to follow as per standard piping system. For inner lining of organic materials DIN 28055 Parts 1 and 2 serve. For inner coatings of organic materials DIN 28054 Parts 1 to 5 serve as well as DIN 55670 for testing of pores and tears.

For innercoatings of inorganic materials (e.g. glass) DIN 2876 applies. These piping systems are to be protected from mechanical damage.

3.2.1 Non-Disconnectable Connections and Connections of Type A

These connections must be designed, installed and maintained such that for all foreseen process conditions they remain technically sealed. In general connections should be reduced to the minimum number necessary and are to be opened as seldom as possible. A new gasket should be used and the sealing tested before return to service.

- **Non-disconnectable connections:** Welded and soldered connections can be considered as long term technically sealed non-disconnectable connections.
- **Flange Connections of Type A:** Long term technically sealed flange connections of Type A are those in which the connection is made in such a manner that the gasket cannot be pushed out of its seat. This is fulfilled by the use of the following designs:

1. Flange with nut and bolt:	Type C/D	I.S. EN 1092-1
	Form N/F	DIN 2526
Gasket to:	I.S. EN 1514 Parts 1 to 4	
or to	DIN 2691	

2. Flange with front and back seat:	Type E/F I.S. EN 1092-1
	Form V/R DIN 2526
Gasket to	I.S. EN 1514 Parts 1 to 4
or to	DIN 2692
3. Smooth flange connection:	Type A I.S. EN 1092-1
	Type B I.S. EN 1092-1
	Form A/B DIN 2526
	Form C/D DIN 2526

Permissible gaskets are:

- armoured gaskets to I.S. EN 1514-1.
- metal jacketed/metal inner ring gaskets to I.S. EN 1541-1.
- Grooved O-ring seals to I.S. EN 1514-4 or DIN 2697.
- Spiral wound gaskets to I.S. EN 1514-2 Form C/I.
- Rubber gaskets with metal clamp to I.S. EN 1514-1.

4. Ring joint connection to I.S. EN 1591, parts 1 and 2 as well as connections to ANSI-B 16.5 and API-Standard 6A with regard to constructive form.

- **Connections with monitored sealing system.**
- **Break and clamp ring screws of Type A:** These comply as long term technically sealed if they are of a recognised engineering standard, e.g. DIN 2353, up to a maximum size of DIN 32 and restricted to the connection of precision steel piping (see TRR 100 No. 5.6 and 7.4).
- **Screwed connections for fittings of Type A:** NPT (National Pipe Thread) or other conical pipe threads up to a maximum of DIN 50 comply as long term technically sealed in so far as they are not subjected to fluctuating thermal loads of ÷t > 100\C (see TRB 600 No. 5.4.2, 2).

Other engineering designs can be considered as long term technically sealed when they provide an equivalent level of sealing and are supported by sufficient documentation to demonstrate this.

3.2.2 Fittings of Type A

Fittings of Type A must be designed such that for all foreseen operating conditions they remain technically sealed.

Fittings of Type A are considered technically sealed when they have connecting flanges according to section above and are equipped with particular sealing requirements on the spindle or bellows sealing, such as:

- Fittings with stuffing box according to DIN 3356 Part 1, which are maintained to a maintenance plan and inspected for sealing integrity (control inspections).
- Fittings with folding bellows according to DIN 3356, Part 3.
- Fittings with protective caps according to DIN 3162.
- Monitored double walled fittings or
- fittings with other sealing systems, e.g. cambered stuffing box, blow out prevention, with documentation to demonstrate sealing by an approved organisation.

Other fittings are to be classified as Type B.

3.3 Maintenance and Monitoring

As well as the pure constructive measures given in the sections above, technical measures combined with organisational measures can lead to long term technically sealed equipment. For instance NPT fittings > DIN 50 and break and clamp ring screw fittings > DIN 32 can provide a long term technically sealed system where the sealing is guaranteed through monitoring and maintenance. The extent and frequency of the monitoring and maintenance is to be addressed in the individual case with regard to the type of construction, operating conditions and process demands such that long term technical sealing is guaranteed. Particular attention needs to be paid to ensure that the extent and frequency of this monitoring and maintenance is laid down in the operating instructions.

For monitoring one of the following measures can be seen as sufficient:

- Inspection of the facility and control e.g. for streaks, ice formation, smell and noises, resulting from a loss of sealing.
- Inspection of the facility with mobile leakage detectors or portable gas warning equipment.
- Continuous or periodic monitoring of the atmosphere through automatic functioning fixed installed measuring equipment with alarm function.

Suitable preventative maintenance can reduce the extent and frequency of the monitoring of the sealing.

4. Special Material and Construction Requirements for Plastic Piping Systems That Allow for a Reduction in Retention Requirements

4.1 General

For a piping system of plastic components the retention requirements are summarised by Table E.2 overleaf.

Table E.2: Requirements for plastic piping systems conveying liquids of WHC 2 and 3

	Piping System Type 1	Piping System Type 2	Piping System Type 3	Piping System Type 4
Connections	Non-disconnectable connections or connections of Type A		Connections of Type B	
Fittings	Fittings of Type A	Fittings of Type B	Fittings of Type A	Fittings of Type B
Retention for connections	Not Required	Not Required	Required	Required
Retention for Fittings	Not Required	Required	Not Required	Required

4.2 Design and Construction

The design of the piping system should follow recognised design standards for the appropriate operating pressures and temperatures, e.g. the German TRR 110. (Note: German standards referred to in this section are commonly used by manufacturers of chemical resistant plastic piping systems though BS 6464, I.S. EN 1452 also apply).

Pipes, pipe sections, flanges, gaskets, as well as fittings and other equipment components are to be manufactured from materials, which demonstrate sufficient mechanical properties for the lowest and highest expected temperatures and pressures. For piping systems out of GRP the following applies, TRR 110 No.5 in connection with AD Merkblatt N 1 No. 3.3. For design AD-Merkblatt N 1 No. 4.4 is to be considered. An estimation of the life of the system must be made. For piping systems from thermoplastic, suitable materials are those that comply with TRR 120 No.5. An estimation of the life of the system must be made. UV effects need to be considered for all plastic materials exposed to sunlight i.e. addition of suitable UV stabilisers or coatings.

Testing of the piping system and documentation of the testing is to be completed by a suitably qualified person.

Expansion bellows must be designed such that they are technically sealed and remain technically sealed. Expansion bellows serve as long term technically sealed if they are fitted with a surrounding jacket and leak detector, or compensators out of metallic components, designed to AD Merkblatt B 13, are used.

The fabrication, erection and testing of the piping system are to be completed by suitably qualified personnel. Welding is to be completed according to TRR 110 or TRR 120. Assembly instructions are to be correctly followed (e.g. screw tightness). A quality control system is to be followed. The piping system must be supplied with sufficient documentation e.g. TRR 521, which includes documentation for the testing of the system.

4.2.1 Non-Disconnectable Connections and Connections of Type A

These connections must be designed, installed and maintained such that for all foreseen process conditions they remain technically sealed.

- **Non-disconnectable connections:** Welded, glued and laminated connections can be considered as long term technically sealed non-disconnectable connections.

- **Flange Connections of Type A:** Long term technically sealed flange connections of Type A are those in which the connection is made in such a manner that the gasket cannot be pushed out of its seat. This is fulfilled by the use of smooth flange connections out of textile glass reinforced duroplastic according to TRR 110, No. 5.4 and with the use of smooth flange connections out of thermoplastic materials according to TRR 120, No. 5.3 as well as the use of the following gaskets, such as:

  - Armoured gaskets
  - Grooved O-ring seals
  - Rubber gaskets with metal inserts
- Connections with monitored sealing system.

Other engineering designs can be considered as long term technically sealed when they provide an equivalent level of sealing and are supported by sufficient documentation to demonstrate this.

4.2.2 Fittings of Type A

Fittings of Type A must be designed such that for all foreseen operating conditions they remain technically sealed.

Fittings of Type A are considered technically sealed when they have connecting flanges according to the section above and are equipped with particular sealing requirements on the valve spindles or bellows sealing. For fittings out of metallic components Section 3.2.2 of this Appendix serves.

Fittings of thermoplastic materials are of Type A if the sealing on the spindle or the bellows comply with the requirements in Section 3.2.2 of this Appendix. Additionally the regulations of TRR 120 need to be maintained for the fitting. These requirements need to be documented.

APPENDIX F

REQUIREMENTS FOR EXISTING UNDERGROUND PIPING

(AS SET OUT IN TRWS 130)

The following requirements apply for materials hazardous to waters, WHC 1 to 3:

Due to copyright reasons it is not possible to access these regulations free of charge over the internet. The relevant sections as an unofficial translation are available on purchase of this guide direct from the EPA or alternatively the original German language text can be sourced directly from ATV-DVWK.

APPENDIX G

TESTING OF VESSELS AND PIPING SYSTEMS

1. INTRODUCTION

While piping systems and vessels are tested prior to entry into service, it is necessary to ensure that the same integrity applies through their period of usage. This is achieved by the testing of the system as defined in the intervals specified in Sections 7 and 8.

For systems that operate under pressure the most applicable method of integrity testing is that of pressure testing. It should be noted that under the duty of care defined in the Safety, Health and Welfare at Work Act of 1989 the operator of systems that operate under pressure has to ensure the safety of such systems. While with the exception of boilers specific maintenance programmes for pressurised systems are not defined by Irish guidelines, they are addressed by other member states, such as the UK Health and Safety Executive Approved Code of Practice ‘L122 Safety of pressure systems’ or the German Pressure Vessel Act (Druckbehälterverordnung), Section 5. Therefore testing completed as part of an environmental compliance programme can contribute to the necessary maintenance programme for pressure systems.

This Appendix provides general guidance on suitable testing methodologies, pointing out some of the main critical features of a testing programme. Specific details will depend on the actual site conditions, such as the materials of construction and engineering codes for those materials. The goal of the testing programme is that the system, i.e. vessel or piping, is suitable for use at the time of testing and that no safety and environmental limitations apply to its further usage up to the point at which the testing is repeated. All test results are to be suitably recorded and available for inspection on request by the EPA.

2. TESTING OF PIPING SYSTEMS

Piping systems can be differentiated between those that operate under pressure, such as a pumped transfer system, and those that are non-pressurised, such as a gravity drainage system. For all piping systems with the exception of gravity sewerage systems a general pipework inspection is required every five years. This should be completed by personnel suitably qualified in the design and construction of piping systems. The general inspection should include a documented inspection for outer corrosion, proper pipe supports, function of safety devices, etc.

2.1 Pressure Testing of Piping Systems

Pressure testing can be completed with water or other suitable fluid at 1.3 times the design pressure, with a minimum of 0.13 bar. Alternatively compressed gas, usually air or nitrogen, can be used at 1.1 times the design pressure. The steps below form the basis of a suitable pressure test procedure:

- From the general pipework inspection determine if the condition of the pipework is sufficient for the safe completion of the pressure test. Any deficiencies should be corrected prior to testing.
- Determine the design pressure of the piping system and survey the pipework to determine that all pipework components are suitable to withstand the test pressure. This would consider the pressure rating of instrumentation and their maximum operating range, the presence of

safety valves and bursting discs, flexible hoses, bellows, in-line equipment, etc. Piping items which are not suitable for the test pressure should be removed or blocked off, all other items should be left in place for the pressure test.

- All flanges, threaded and welded joints should be exposed for the pressure test. This may require the removal of insulation.

- Prior to the pressure test the piping should be blown or flushed out to remove any possible accumulation of foreign material from the system.

- The section of pipework to be tested should then be sealed using blanks or blind flanges. Test gauges should be installed for recording of the pressure test. For hydrostatic testing the static head shall be added to the specified test pressure when the gauge is installed at the low point.

- Only personnel associated with the test shall be allowed in the immediate area. Signs should be posted and all affected parties notified to this effect. This is of particularly importance with the pneumatic testing of piping systems due to the hazard associated with the stored energy in the compressed gas.

- For a hydraulic test the system is filled with water or another suitable liquid, taking care to eliminate all air pockets by keeping vents open until liquid flows from them. For this purpose the pipework should be designed with high point vents and low point drains. The system is then pressurised to the required test pressure. The testing shall be considered satisfactory if no leakage is discovered on the piping or any joints, or if no excessive sweating due to porosity is discovered on piping or joints. The pressure shall be maintained long enough for a thorough examination of all joints, but not less than two hours. After completion of the test the system should be completely drained and purged with dry air to remove all liquid.

- For pneumatic testing a relief valve needs to be installed and set at 110% of the test pressure. The pressure is then gradually brought up to the smaller of 1.7 barg or 25% of the test pressure. A soap suds test of all welds, valve shafts and connections is made at this point. If the system is satisfactory the pressure is gradually increased in incremental stages of about 10% of the test pressure until the test pressure is reached. The system is then held at the test pressure for two hours. All joints are inspected for leaks with soap suds test while the pressure gauge is monitored for loss of pressure. On completion of the test the system is then vented.

- The pressure testing should be witnessed and documented by a suitably qualified person. Sample record sheets for pressure testing are provided at the end of this Appendix.

- Any leaks or defects found during the testing shall be repaired and the lines re-tested to the originally specified test pressure.

- After testing, any items which were removed should be replaced and all blanks and blind flanges used in the test should be removed.

2.2 Non-Destructive Testing (NDT)

NDT testing and wall thickness measurements can be used as a substitute for pressure testing. NDT testing methods generally comprise:

- Dye penetration test to detect surface irregularities such as corrosion pitting.
- Ultrasound testing to detect weld irregularities or other subsurface defects.
- X-ray testing to provide a cross-sectional examination of a weld or other critical area.
- Wall thickness measurement to determine rate of wear on system.

NDT testing and wall thickness measurements should be done at critical points, such as at pipe elbows where erosion effects are to be expected. The choice and extent of NDT testing is to be agreed with a suitably qualified person after the general pipework inspection. All NDT testing is also to be completed by suitably qualified personnel with specific NDT training and equipment.

2.3 Testing of Non-pressurised Systems (Trade Effluent and Sewerage Gravity Drainage)

Non-pressurised systems generally comprise underground gravity sewerage systems.

2.3.1 Standards

The testing of underground gravity sewers shall be carried out in accordance with recognised and current engineering codes of practice. The following is a non-exhaustive list of such standards:

Standard	Title
I.S. EN 752 parts 1-4	Drain and Sewer Systems Outside Buildings
BS 8301	Code of Practice for Building Drainage
I.S. EN 1610	Construction and Testing of Drains and Sewers
I.S. EN 1053	Plastic Piping Systems / Thermoplastic Piping Systems for Non-Pressure Applications. Test Methods for Water tightness
pr EN 13508	Establishment of the Condition of Drain and Sewer Systems Outside Buildings

Note: BS 8301, while still current, has been largely superseded by I.S. EN 752.

Although the codes listed above primarily deal with the testing of newly constructed sewerage systems, the testing methodology and safety issues described in the codes should be followed in the testing of existing systems.

2.3.2 Frequency of Testing

The tests, listed below, should be carried out once every three years on all underground gravity trade effluent and foul sewerage systems unless written agreement is received from the EPA to do otherwise.

2.3.3 Testing Documentation

A record must be made of all testing on a standard test sheet. The sheet should include details of the testing procedure and results obtained. The sheet should also contain details of remedial actions taken, in the event of initial test failure, as well as details of the follow-up successful test. All testing must be witnessed by a suitably qualified person who must sign and date all test sheets. The test sheets must be filed together and available for inspection by the EPA.

2.3.4 Testing of Pipelines and Connections

2.3.4.1 Leak Tightness Test

All pipelines shall be tested for leak tightness to ensure that no leakage is occurring from the pipeline.

Any section of pipeline which fails a leak tightness test must be repaired or replaced without due delay. Following completion of the remedial works, the pipeline must again be subjected to a leak tightness test to confirm that the remedial works have been successful.

Pipelines may be tested for leak tightness using either an air test or a water test.

Water Tightness Test

Where a water test is used, the pipeline shall be filled with water to attain a maximum test pressure of 50 kPa and a minimum test pressure of 10 kPa measured at the top of the pipe. Testing shall preferably be from manhole to manhole but subject to the maximum test pressure not being exceeded. Thus steeply graded sewers may have to be tested in a number of sections between manholes. A period of at least 1 hour shall be allowed for soakage before testing begins. Over a testing period of 30 minutes, the test pressure shall be maintained by topping up with water. The amount of water added during the test period shall be noted and the pipeline will be deemed to have passed the test if the amount of water added over the 30 minutes is less than 0.15 l/m^2 of wetted internal surface.

Air Test

Where an air test is used, suitable airtight plugs shall be used at both ends of the pipeline. Air shall be pumped into the pipeline to achieve a pressure of approximately 1.1 kPa and shall be held for approximately 5 minutes. The pressure shall then be adjusted to the test pressure of 1kPa and held for a testing period of 5 minutes. If the pressure drop measured after the testing period is less than 0.25 kPa, then the pipeline will be deemed to have passed the test. The equipment used for measuring the pressure drop shall have an accuracy of 0.025 kPa. The accuracy of the measurement of time shall be 5 seconds. Concrete pipes may be damped prior to testing.

2.3.4.2 Visual Test

All pipelines shall also be subjected to a visual test by means of a CCTV Survey to ensure that no blockages or other defects are developing in the drains which may impair its performance. The CCTV survey can also be used to determine the location and nature of leakages identified during the water tightness test.

The CCTV Survey must be carried out by suitably qualified personel who must provide a report on the condition of the pipework in accordance with the method set out in the WRC “Manual of Sewer Condition Classification” latest edition. The CCTV film shall be in colour. The report shall include still photographs of any defects or blockage encountered.

All blockages shall be removed and all defects repaired without due delay.

2.3.5 Testing of Underground Chambers

Underground chambers, including manholes, inspection chambers, petrol interceptors, grease traps and septic tanks, shall be tested for leak tightness.

Inspection chambers and manholes may be tested by means of an infiltration test when it is known with certainty that the surrounding ground contains a high water level. Otherwise an exfiltration test shall be used. All other structures shall be tested by means of an exfiltration test.

Should a chamber fail the leak tightness test, the source of the leak shall be found and repaired. Following completion of the remedial works, the chamber must again be subjected to a leak tightness test to confirm that the remedial works have been successful.

Prior to testing, the inside of all chambers shall be cleaned and all outlet pipes shall be sealed by means of inflatable stoppers. A safe means of removing the stoppers, without entering the chamber, must be provided.

2.3.5.1 Infiltration Test

This test involves measuring the volume of water entering the chamber by infiltration over a known period. The maximum infiltration rate shall not exceed 1 l/m^2h over the internal surface area of the walls of the entire chamber.

2.3.5.2 Exfiltration Test

This test involves filling the chamber with clean water to the required test level. The test level for shallow (less than 1.5 m depth) manholes and inspection chambers shall be underside of cover level. The test level for manholes and inspection chambers of depth greater than 1.5 m, shall be at least 1.5 m. All other chambers shall have a test level at least 0.5 m above the invert of the highest connection to the chamber or the average ground water level whichever is the greatest.

The chamber shall be filled with clean water and allowed to stand for an absorption period, topping up as necessary. The absorption period shall be determined by the supervising engineer and will depend on the condition of the manhole. After the absorption period, the drop in water level shall be measured over a 30 minute period and if the drop is less than 5 mm, the chamber will be deemed to have passed the leak tightness test.

3. TESTING OF VESSELS AND TANKS

Section 8.4 requires the operator of a facility to ensure the integrity of the primary containment (vessels and tanks) and functionality of the associated safety equipment. In many respects this will be similar to the testing for piping systems outlined above.

3.1 Testing of Pressure Vessels

Guidance on inspection and testing of pressure vessels can be obtained from EU member state legislation and codes of practice as discussed in the introduction section of this Appendix. In general the inspection period is related to the size of the pressure vessel, the operating pressure and the hazardous properties of the material stored. For compliance with this guidance note the minimum requirement is an internal inspection every five years accompanied by a pressure test every ten years.

The inner inspection of the vessel surfaces shall be completed by a qualified vessel inspection engineer. The internal pressure bearing surfaces should be visually inspected with simple aids such as mirrors. Where visual inspection is not possible, such as inaccessible wall components, then those areas should be assessed by analogy to areas with similar process demands.

If the visual inspection is insufficient to determine the vessel integrity, then this can be expanded or replaced by:

- Inspection with special equipment or,
- NDT testing of sections of the vessel where damage is known or suspected, or,
- a pressure test.

In addition to the inspection of the walls of the pressure vessel the safety equipment, in particular the safety relief systems, shall be tested for their functionality.

Pressure testing, carried out as a minimum of every 10 years, shall be completed in a manner similar to that for piping systems described in the previous sections. If, for operational reasons, pressure testing is not deemed to be possible or suitable, then this can be substituted by NDT testing.

3.2 Testing of Atmospheric Tanks

As these tanks cannot be pressurised pressure testing of such systems is therefore not possible. Instead the primary method of testing should be an external inspection for evidence of leakage followed by an internal visual inspection. Where corrosion is to be expected or obvious corrosion damage has occurred this should be accompanied by wall thickness measurement to demonstrate the integrity of the system for the period up to the next inspection. For concrete systems the visual inspection should focus on the presence of cracks or other defects that could impact on the integrity of the system.

For large concrete tanks used as aeration systems in biological waste water treatment plants it may not prove possible to take these out of service to complete the necessary visual inspection. An alternative testing protocol, such as the use of localised groundwater monitoring, can be substituted with agreement of the EPA inspector (refer to methods for inspection of slurry tanks given in Section 10).

3.3 Testing of Overfill Protection

The requirement for overfill protection is specified in Section 8.3. The functionality of the associated safety equipment has to be tested at the same time as the integrity of the primary containment (vessels and tanks). For overfill protection this usually comprises an electronic level sensor with a high level interlock to the fill valve. Testing of this system should be based on:

- A calibration check of the level sensor.
- A loop check to determine that all components of the loop are functional.
- A test of the interlock, which closes the fill valve on tank high level.

4. SAMPLE RECORD SHEETS FOR PIPELINE PRESSURE TESTING

Client: **ABC Chemical Company**	Client Project No.:
Project: **API Manufacturing Facility**	Contractor Project No.: **999999-xx**
Project Description: **Primary API Manufacturing**	
Test Description: **Main Solvent Header**	Test Pack No.: **TP-001**
Hydrostatic/ Pneumatic/ Service: **Hydrostatic**	

Test Boundaries			
Line / Iso Number	Sheet	Line / Iso Number	Sheet
TSD 00001	**01**	**------------**	**------------**
TSD 00002	**02**	**------------**	**------------**
------------	**------------**	**------------**	**------------**
------------	**------------**	**------------**	**------------**
------------	**------------**	**------------**	**------------**
------------	**------------**	**------------**	**------------**
------------	**------------**	**------------**	**------------**
Vessels / Equipment Within Test Boundary:		**N/A**	
System Design Pressure: **11.2** bar g			

Test Conditions				
Test Medium:	Water	Chlorine Content (ppm):	**< 30**	
Test Media / Material Temp	Min (°C): **2°**	Max (°C): **15°**	Actual (°C): **8°**	
Ambient Temperature:	Min. (°C): **9°**		Actual (°C): **11°**	
Test Pressure:	Min.: **15.1 barg**	Max.: **18.5 barg**	Actual: **16.6 barg**	Relief Valve Setting: **20 barg**
Holding Time:	Min.: 120 mins		Actual: **120 mins**	

Test Gauge No.:	**Date Last Calibrated:**	**Test Gauge Range:**	
PI – 123	**1st December 2002**	Low: **0**	High: **25 barg**
-------	----------	Low:----------	High:---------
------	--------	Low:-------	High:--------

Client: **ABC Chemical Company**			Client Project No.:
Project: **API Manufacturing Facility**			Contractor Project No.: **999999-xx**
Pre-Test Inspections / Release			
NDT, PWHT, PMI (if required) Complete / Accepted (Contractor Inspector Signature / Date):	**10 % RT Complete and Accepted**		
Pre-Test Walkdown Complete & Release to Test:			
Checked By	**Contractor**	**Engineer**	**Client**
Signature:			N/A
Date:			N/A
Test Acceptance			
Checked By	Contractor	Engineer	Client
Signature:			N/A
Date:			N/A
Comments/Notes			
Verification of Line Restoration			
Checked By	**Contractor**	**Engineer**	**Client**
Signature:			N/A
Date:			N/A

Form Completed By [print name]:	Signature:	Date:

APPENDIX H

SUMMARY OF SWISS METHOD FOR INTEGRITY TESTING OF FULL SLURRY VESSELS

BY KIND PERMISSION OF SWISS ENVIRONMENT AGENCY, BUWAL. THIS IS AN UNOFFICIAL TRANLATION OF THE AUTHENTIC GERMAN LANGUAGE VERSION, AN AUTHENTIC FRENCH LANGUAGE VERSION IS ALSO AVAILABLE.

A Unified Process for the Periodic Integrity Testing of Slurry Vessels

Georges Chassot, BUWAL, Department of Water Protection and Fisheries in co-operation with Thomas Eberle, Kehrsatz

Legislative basis for the periodic inspection
Art. 15 GSchG, Art. 28G SchV:
Slurry vessels must be periodically inspected.
Storage systems must be sealed and functional.
The Canton authorities are responsible for the completion of the inspections.

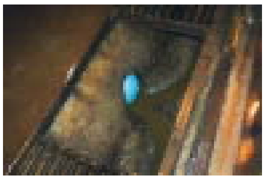
"Guidance for Water Protection in the Agricultural Sector":
Existing slurry vessels can only be utilised if they are sealed.

The nature of the problem
Along with the traditional procedure (emptying fully, cleaning, visual inspection and if required repair and/or integrity testing with a partly or fully filled vessel) a unified method is needed for a standardised and rational implementation of the legislation, that reflects the real circumstances of the agricultural sector.

Unified Integrity Testing
A Process in 5 steps for measuring the level of slurry in a vessel and demonstrating the measurable losses

1. Operational Acceptance
Which vessels are suitable for this method of measurement? Construction Criteria: No visible damage; uptake of the inlets; accessibility and sealing possibilities near to the vessel inlets. Process technical conditions: No thick flowing slurry (thinning in the ratio 1:2 – 1:3). Measurement technical criteria: No slurry with a floating layer.

2. Preparation of the slurry vessel
Safety barrier, diversion of the surface run-off, protection from rain, installation of the measurement instrumentation.



All inlet piping to the vessel must be completely sealed. Example blocking ballon in the flume.

3. Sealing of the inlets.

Waste water from the milking chamber and associated rooms as well as household wastewater must be caught in the sealed supply piping and diverted to the public sewer or sucked into a vacuum tanker.

Vacuum transfer of the household waster water. It is recommended to consumption during the measurement period

4. Measurement of the slurry level over 24 hours
Supervision of the measurement instrument, the reference vessel and the water condition in the sealed off inlets

5. Disassembly and cleaning of the instrument
Preparation of a report documenting the results for the attention of the Canton authorities. The paper chart is to be included as an enclosure.
The measurement instrument is to be appropriate for a draw-off opening of the slurry vessel.

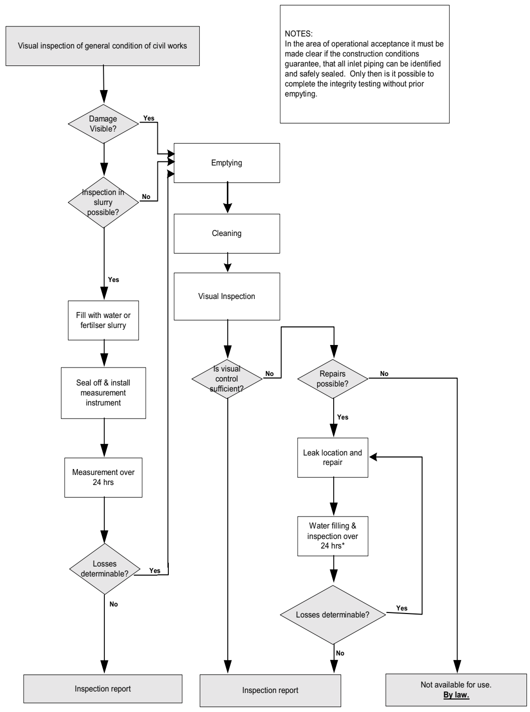
The measurement registers any changes in the level of the slurry over 24h with a measurement accuracy of 0.1 mm and records the results on a paper chart.

Time Requirement for the Preparation: 8-13 hrs for each operating unit.
Compared to the traditional procedure, this is a reduction in the time requirement by a half.

Cost: The cost will vary depending on the number of vessels that must be considered for measurement. According to practical test, cost per vessel lies between 1,000 and 1,500 CHF (1.5 CHF~1 Euro).

With existing underground vessels the integrity testing should always include a technical measurement examination, as the outside walls and piping connections cannot be visually inspected from the outside.

Flow schematic for the procedure for periodic inspection of existing slurry vessels
Operational Acceptance:



BUWAL 2002, Peridiosche Dichigkeitskontrolle von Güllebhältern. Anwendung eines vereinfachten verfahrens. Praxishife. VU-2000-D. 30 S.

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