EPA Firewater Retention Guidance (FINAL DRAFT)

Contents

1 Introduction

1.1 General Introduction

This Guidance Note is produced by the Environmental Protection Agency (EPA), and is intended to provide guidance to operators of EPA Licensed sites in relation to firewater retention requirements. The document is primarily written for EPA licensed sites regulated under the Environmental Protection Agency Act, 1992 (as amended), but is sufficiently broad in scope to accommodate other industrial facilities who may wish to use this guidance document for reference. The information in the Guidance Note should be used by all facilities; particularly those that, in the event of an accident, have the potential to give rise to major pollution. It should be noted that this information is provided for guidance purposes only and each site must be considered on an individual basis taking account of site-specific characteristics.

The Guidance Note is comprised of nine sections, plus appendices. Following this brief introduction, firewater retention qualifying criteria are discussed in Section 2 and the need for a risk assessment is discussed in Section 3. In Section 4, the three firewater retention calculation methods are described. Section 5 describes the different types of retention facilities, while Section 6 contains a brief discussion of fire-fighting strategies and actions following a fire event. Sections 7 and 8 discuss the Firewater Risk Assessment Report, and Section 9 contains a list of References.

There are also 4 no. appendices as follows:

Appendix A: Firewater Risk Assessment User Tool Guide - in conjunction with this guidance document a Microsoft Excel-based tool has been developed to guide users through the risk assessment process (see Section 3.2 & Appendix A).

Appendix B: Warehouse Retention Calculation Details (Method 1) – as outlined above, three. firewater retention calculations methods are described. This appendix provides additional supporting information on Method 1 (see Section 4.2 & Appendix B).

Appendix C: Worked Examples of Firewater Retention Calculation Methods – a worked example of each of the three retention calculation methods are provided in this appendix.

Appendix D: Risk Management Programme – the typical firewater retention conditions of a standard EPA licence include the requirement to prepare and implement a risk management programme (see Section 1.3 and Appendix D).

1.2 Requirement for Firewater Retention Facilities

Many industrial facilities possess the potential to cause adverse environmental impacts due to the use of potentially polluting substances. In the event of a fire, the loss of containment of such substances along with the fire-fighting water run-off generated, can lead to significant environmental incidents including the contamination of rivers, streams, groundwaters, soils and effluent treatment works. Environmental impacts can be severe and have long lasting effects.

The consequences of an incident involving firewater run-off are determined by;

- The chemical composition of the site inventory,
- The quantity of site inventory,
- The volume of firewater run-off produced,
- Rainwater and/or storm water which may become contaminated during the incident,
- Fire-fighting suppression agents which may themselves contain potentially polluting substances.

Types of sites which typically require arrangements for firewater run-off retention include sites involved in the processing and storage of chemicals, fuels, pharmaceuticals, waste, and certain types of food and drink production.

1.3 Legal Framework

1.3.1 Environmental Liability

There are several EU Directives that set the legal framework for environmental liability. The Environmental Liability Directive (2004/35/EC) aims to prevent and remedy environmental damage and to reinforce the 'polluter pays' principle, making site owners that cause environmental damage legally and financially liable for the damage caused, and the subsequent remediation. There is an incentive for site owners to proactively assess environmental risks and manage them to prevent environmental damage from occurring. Furthermore, the Directive requires facilities to initiate preventative measures where there is an imminent threat of environmental damage occurring. Any holder of an authorisation from the EPA is strictly liable for any environmental damage and must legally cover the costs of any subsequent remediation. The Directive is transposed into Irish law via the European Communities (Environmental Liability) Regulations, 2008 (S.I. No. 547/2008). Further information is available in Environmental Liability Regulations – Guidance Document (EPA, 2011).

1.3.2 COMAH / Seveso Sites

The Chemicals Act (Control of Major-Accident Hazards involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015), implemented in Ireland, the Seveso III Directive (Directive 2012/18/EU).

These regulations require owners of facilities where dangerous substances are present, in quantities equal to or in excess of defined thresholds, to take all measures necessary to prevent major accidents and to limit the consequences for both human health and the environment of such accidents. Facilities can be classified as either upper or lower tier COMAH sites (sometimes referred to as Seveso sites) depending on the quantities of dangerous substances stored. Such facilities generally require firewater retention, due to the large quantities of dangerous substances present on site.

Section 2 provides information on facilities that by default will require firewater retention facilities due to the nature and quantity of substances stored on site, and by way of their proximity to sensitive environmental receptors.

1.3.3 Licensing

The Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013 (S.I. No. 137 of 2013) and The European Union (Industrial Emissions) Regulations 2013 (S.I. No. 138 of 2013) transpose into Irish law Directive 2010/75/EU Industrial Emissions (Integrated Pollution Control).

The Regulations provide for various procedural matters in relation to the integrated licensing by the EPA of Industrial Emissions Directive (IED) activities specified in the First Schedule to the Environmental Protection Agency Act 1992, as amended. Integrated Pollution Control (IPC) activities are also governed by the Environmental Protection Agency Act 1992, as amended.

The Regulations lay down rules on integrated prevention and control of pollution arising from industrial activities. They also lay down rules designed to prevent, or where that is not practicable, to reduce emissions into air, water and land, and to minimise the generation of waste, to achieve a high level of protection of the environment. IED/ IPC licensed facilities must comply with Best Available Techniques (BAT) conclusions[1] and BAT Guidelines for their sector[2].

The EPA grants licences and is also the enforcement agency responsible for monitoring compliance. The EPA is prohibited from granting a licence, or a revised licence, unless it is satisfied that including, among other things that:

- emissions from the activity will not cause significant environmental pollution,
- necessary measures will be taken to prevent and to limit the consequences of incidents, and accidents, and to remedy those consequences.

[1] Reference documents under the IPPC Directive and the IED (BREFs) http://eippcb.jrc.ec.europa.eu/reference/

[2] Environmental Protection Agency Best Available Techniques Guidance Documents http://www.epa.ie/pubs/advice/bat/

In this regard, the EPA recommends that all EPA Licensed facilities undertake a firewater risk assessment. Conditions relating to the requirement to carry out a firewater risk assessment are contained in many licences.

It is acknowledged that there are some variations in the wording of licence conditions; in all cases licensees should check the wording of the licence conditions in conjunction with this guidance document, prior to commencing the assessment.

Typical firewater retention licence conditions of a standard EPA licence are outlined below:

3.10 Fire-water Retention

3.10.1 The licensee shall carry out a risk assessment to determine if the activity should have a fire-water retention facility. The licensee shall submit the assessment and a report to the Agency on the findings and recommendations of the assessment within six months of the date of grant of this licence.

3.10.2 In the event that a significant risk exists for the release of contaminated fire-water, the licensee shall, based on the findings of the risk assessment, prepare and implement, with the agreement of the Agency, a suitable risk management programme. The risk management programme shall be fully implemented within three months of date of notification by the Agency.

3.10.3 In the event of a fire or a spillage to storm water, the site storm water shall be diverted for collection. The licensee shall examine, as part of the response programme in Condition 3.9.X above, the provision of automatic diversion of storm water for collection. The licensee shall have regard to any guidelines issued by the Agency with regard to firewater retention.

3.10.4 The licensee shall have regard to the Environmental Protection Agency Draft Guidance Note to Industry on the Requirements for Fire-Water Retention Facilities when implementing Conditions 3.10.1 and 3.10.2 above.

2 Firewater Retention Qualifying Criteria

This section sets out qualifying criteria, which if met, generally obliges an EPA licensed site, to provide firewater retention, if required in their licence. Facilities not meeting the qualifying criteria, set out in this section, need to perform a firewater risk assessment as described in Section 3 to determine the requirement for retention. The method for calculating the required retention volume is explained Section 4.

There are two qualifying criteria:

1. Environmentally Hazardous Substance Storage Thresholds,
2. Environmental Receptor Criteria.

If a site meets either of these criteria firewater retention is generally required.

If a site does not meet these criteria, then a firewater risk assessment in accordance with Section 3 should be completed to determine whether firewater retention is required.

2.1 Qualifying Criteria Thresholds

2.1.1 Environmentally Hazardous Substance Storage Thresholds

The first qualifying criterion is the quantity of substances on site that possess environmental H-Statements as defined in the Classification, Labelling and Packaging 'CLP' Regulation (EC) No. 1272/2008. The CLP/GHS uses a system of Hazard Statements (H-Statements) which describes the nature of the hazard associated with a substance or mixture. The H-Statements can be summarised by groups relating to their physical, health and environmental hazards. H-statements are further discussed in Appendix A, while detailed information on this subject can be obtained from the Health & Safety Authority website[3]

Only substances with environmental H-Statements are considered for this qualifying criteria assessment. These H-statements fall within the following range;

- H400 - H499 Environmental hazards (e.g. Toxic to Aquatic Life, Harmful to Aquatic Life)

Table 2.1 specifies the storage thresholds of specific environmental H-Statements which will lead to the requirement for firewater retention. **Facilities storing substances with these H-Statements, at or above the stated thresholds, will require firewater retention facilities, due to the nature and quantities of hazardous substances.**

Note: These qualifying thresholds can act as a useful guide for operators to manage the storage and segregation of substances on site. Further advice on segregation of chemicals is provided in the UK Health and Safety Executive Guide '*HSG 71 Chemical warehousing -The storage of packaged dangerous substances*'[4]

It is also noted that more than one H-Statement may apply to a substance; and other (non-environmental) H-Statements may apply to substances stored on site, such as the following:

- H200 – H299 Physical hazards (e.g. Flammable, Corrosive, Explosive),
- H300 – H399 Health hazards (e.g. Toxic, Harmful).

Applicable H200 series H-Statements are considered in the Risk Assessment methodology in Section 3, under 'Significance of Fire Event'. However, qualifying criteria are based on the potential environmental impact only.

[3] http://www.hsa.ie/eng/Archived_Material/FAQs/Chemical/CLP_Regulation.html

[4] http://www.hse.gov.uk/pubns/priced/hsg71.pdf

Table 2.1: *Storage Thresholds of Substances with Environmental H-Statements*

Hazard Statement	Hazard Details	Storage Quantity (tonnes)[5]
H400 H410	Very toxic to aquatic life Very toxic to aquatic life with long lasting effects	1
OR		
H401 H411	Toxic to aquatic life Toxic to aquatic life with long lasting effects	10
OR		
H402 H412	Harmful to aquatic life Harmful to Aquatic Life with Long Lasting Effects	100
OR		
H413	May Cause Long Lasting Harmful Effects to Aquatic Life	1,000

2.1.2 Environmental Receptor Criteria

Firewater retention will generally be required for facilities which have a direct storm water pathway to any one of the following types of receiving waters:

- Municipal drinking water intake points,
- Designated bathing waters,
- Salmonid rivers,
- Designated shellfish waters,
- Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Natural Heritages Areas (NHA).

2.1.3 Sources of Information

- The EPA have developed a free online mapping viewer 'Geoportal' which provides information on all the above including the location and quality of Ireland's rivers, lakes, estuaries and coastal waters as per the requirements of the Water Framework Directive (2000/60/EC). The location and quality of designated bathing waters is also provided along with the location of shellfish and salmonid rivers. The EPA Geoportal website is available at http://gis.epa.ie
- A list of salmonid rivers is contained in the - European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293) - www.irishstatutebook.ie.
- A list of recognised Shellfish Waters in Ireland was first published in Schedule 3 of S.I. No. 268/2006 - European Communities (Quality of Shellfish Waters) Regulations 2006. Further additions to this list were published in Schedule 1 of S.I. No. 55/2009 - European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009, and Schedule 1 of S.I. No.

[5] The multiplying factor of 10 between the categories is based on the CLP Methodology for Aquatic Life Hazard Classification and Labelling for 'substances'. Further information is available from the European Chemicals Agency https://echa.europa.eu/support/guidance.

464/2009 - European Communities (Quality of Shellfish Waters) (Amendment) (No. 2) Regulations 2009 - www.irishstatutebook.ie.

- Information on the location of Special Areas of Conservation (SAC) and Special Protection Areas (SPA) is available from the website of the National Parks & Wildlife Service – www.npws.ie

2.2 Qualification

If a site qualifies based on the above criteria, firewater retention is generally required. The firewater retention calculation methods are described in Section 4. However, it is advised that Section 3 on risk assessment is reviewed with respect to 'site separation', as this is relevant to the retention volume calculation, as well as to the risk assessment.

If a site does not qualify based on the above criteria then the risk assessment should be carried out, as per Section 3.

3 Firewater Risk Assessment (FWRA)

Holders of EPA licences are legally obliged to comply with the conditions of their licence, and hence must comply with the specific conditions relating to firewater retention. Typical firewater related conditions are outlined in Section 1.3.3.

If a facility does not automatically qualify for firewater retention (as outlined in section 2) then in order to establish the requirement for firewater retention, and to determine the appropriate type of retention, a risk assessment must first be carried out.

A comprehensive risk assessment is critical to ensuring that all risks are identified. A risk assessment workshop should be held with the relevant site personnel, and external experts if necessary, to identify the potential hazards of firewater run-off generation from industrial facilities.

Before and/or during this workshop other relevant site assessments should be reviewed, such as

- Environmental Liabilities Risk Assessment (ELRA),
- Bund Integrity Assessment,
- Control of Major Accident Hazard (COMAH) assessment (where applicable),
- Assessments/ documentation relating to fire compartmentalisation, etc.

It should be ensured that the firewater risk assessment aligns with, and does not contradict the information provided in relevant site assessments.

The flowchart in Figure 3.1 provides an overview of the risk assessment process.

Reminder: Facilities meeting the qualifying criteria in Section 2 are obliged to provide firewater retention.

3.1 Site Separation

If required, prior to commencing the assessment, the site could be logically divided into distinct assessment areas based on distance and/or fire containment properties e.g. is the packaged goods warehouse adequately separated from the production plant, such that fire spread can be ruled out? It cannot automatically be assumed that a fire will remain in only one area of the site, therefore robust reasoning with supporting documentation for discounting fire spread to other areas must be provided. The two basic methods of fire spread are direct flame impingement and radiation. Other methods, including explosion and the flow of flammable liquid to other areas of the site, also need to be considered.

Compartmentalisation is used to restrict the spread of fire within buildings by utilising walls and/or floors of fire resisting construction. The same method is also used to prevent the spread of fire between buildings that are close together. Suitably designed and installed sprinkler systems can also assist in limiting the rate of heat release and hence limit fire spread.

- Fire rated walls and structures prevent the spread of fire. These are generally rated to resist fire for a specific time-period, i.e. 1 & 2 hours.
- Space Separation: The likelihood of fire spreading across an open space between buildings, and the consequences if it does, depends on:
    - the size and intensity of the fire in the building concerned,
    - the distance between the buildings, and
    - the fire protection given by their facing sides,
    - Appropriate distances retained between areas of flammable material storage on sites to prevent the spread of fire. Several guidance documents including *HSG 51 The storage of flammable liquids in containers* and *HSG 176 The storage of flammable liquids in tanks* both published by the UK Health and Safety Executive (HSE) provide advice in this area.

In carrying out the site separation exercise explanation of and justification for the 'assessment areas' chosen must be provided. As a conservative default, facilities can be separated into different 'assessment areas' based on a minimum of 2-hour fire walls/floors (unless otherwise demonstrated it must be assumed that a fire could last up to (if not exceeding) 2 hours) or a minimum of 15m separation distance (conservative separation distance prescribed in HSG 176).

Note: If the separation of parts of a site into individual assessment areas cannot be justified with adequate supporting documentation, then they must be assessed together.

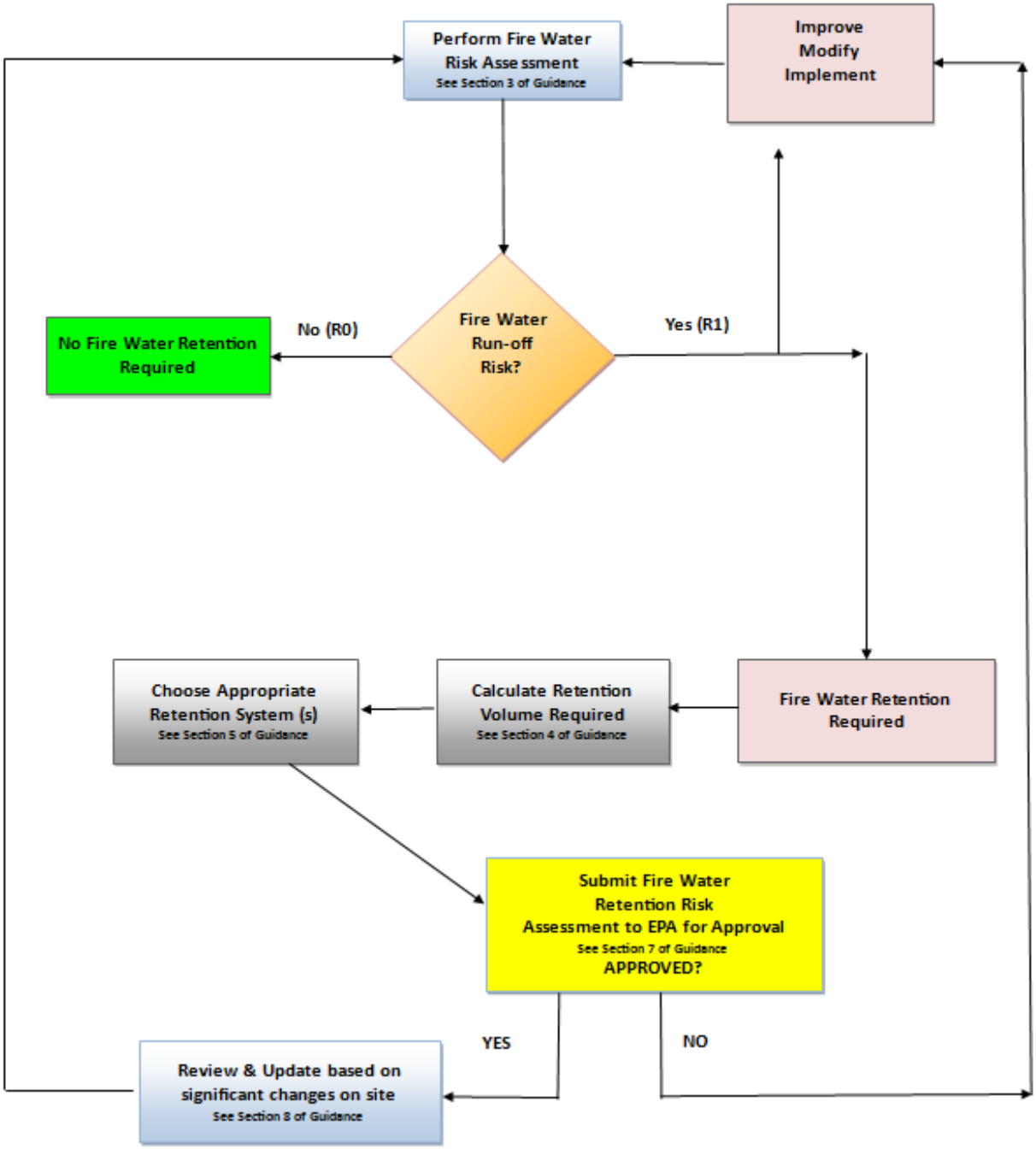

Figure 3.1: *Overview of Firewater Risk Assessment Methodology*

3.2 Firewater Risk Assessment Methodology

The methodology for this assessment has been developed with reference to the VCI (German Chemical Industry Association) Firewater Retention Guidance. This assesses the risk (R) of firewater run-off to the environment based on the significance (S) of a fire event that could cause the generation of substantial quantities of firewater, and the potential environmental hazard (H) due to the generation of firewater run-off.

Each assessment area from the site separation exercise, if appropriate, is evaluated against the three risk assessment topics as illustrated in Figure 3.2;

1. Significance of Fire Event (S),
2. Environmental Hazard Potential (H),
3. Firewater Run-off Risk (R).

A description of each step of the risk assessment process is provided in the following sections. A comprehensive step-by-step and interactive FWRA Tool (Excel-based) has been developed to guide users through the risk assessment process. The FWRA Tool is available for download from the website of the EPA – www.epa.ie.

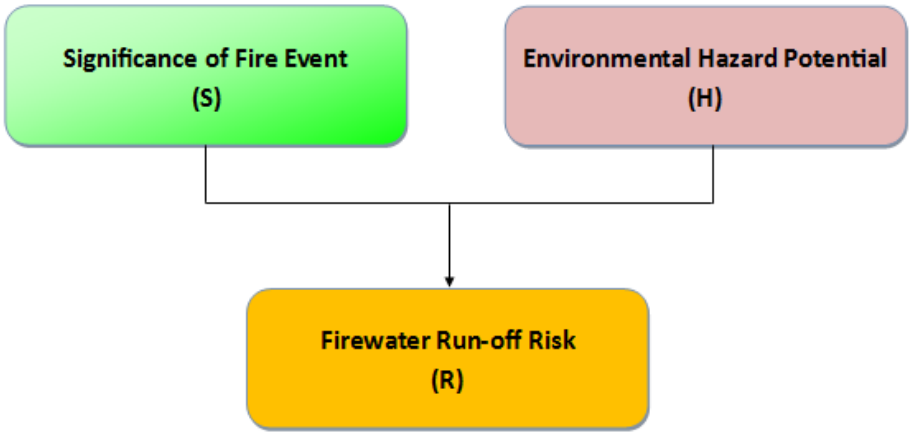

Figure 3.2: Risk Assessment Methodology Flowchart

3.2.1 Risk Assessment Tool

The FWRA Tool can be used to determine the requirement for firewater retention and to calculate the retention volume required for the site/ site assessment areas. The FWRA Tool aims to provide a consistent approach to the risk assessment process. Users are required to enter specific information about site activities in relation to the fire prevention and protection measures, quantities and categories of hazardous substances, and current retention in place if applicable. Information required for input to the FWRA Tool can be gathered from many sources including Safety Data Sheets (SDSs), various installation and commissioning engineering reports for the fire systems, environmental impact assessments (EIAs), annual environmental reports (AERs), etc.

The required inputs to the tool are as follows:

Significance of Fire Event (S)

- Quantities and Types of Flammable and Combustible Materials,
- Is fire detection in place?
- Are sprinklers in place?

Environmental Hazard Potential (H)

- Quantities and Types of 'Hazardous to the Aquatic Environment' Materials (H400, H401, H402, H410, H411, H412, H413).

3.2.2 Significance of Fire Event (S)

The significance of a fire event will depend on the fire load and the detection and mitigation measures in place. The FWRA Tool requires input of types and quantities of flammable and combustible materials in each area, as well as information regarding fire detection and protection measures in place.

Table 3.1: Evaluation of the Significance of a fire event

Significance (S)	Description
S 1	Low Significance
S 2	Medium Significance
S 3	High Significance

Note: More details on significance are provided in section 1.2 of the FWRA Tool User Guide (appendix A)

3.2.3 Environmental Hazard Potential (H)

The Environmental Hazard Potential (H) is influenced by the following criteria;

- Properties of hazardous substances stored,
- Quantity of hazardous substances stored.

Table 3.2: Evaluation of Hazard Potential (H)

Hazard Potential (H)	Description
H 1	Low Hazard Potential
H 2	Medium Hazard Potential
H 3	High Hazard Potential

Note: More details are provided in section 1.3 of the FWRA Tool User Guide (appendix A)

3.2.4 Overall Firewater Run-off Risk (R)

Table 3.3: Evaluation of the Firewater Run-off Risk (R)

	H 1	H 2	H3
S 1	**R 0**	**R 0**	**R 1**
S 2	**R 0**	**R 0**	**R 1**
S 3	**R 0**	**R 1**	**R 1**

The firewater retention risk ratings, and the associated minimum retention requirements are described as follows;

Table 3.4: Retention Measures required for Firewater Run-off Risk Levels

Risk	Minimum Firewater Retention Measures Required
R0 **No Risk**	No dedicated firewater retention required.
R1 **Risk of Environmental Contamination**	Firewater run-off must be retained within the operational site. The retention can be provided by means of the site's drainage system and other suitable infrastructure which is not exclusively foreseen for firewater retention (e.g. storm water attenuation ponds / tanks in waste water treatment plants*****). All elements of the site infrastructure to be used for firewater retention (including shutoff valves) must be regularly inspected and tested, to ensure functionality and impermeability. The retention facility/ facilities must remain impermeable for the duration of the incident up to the removal of the firewater run-off. The documented available retention capacity in the existing site infrastructure must be monitored and maintained. Automatic shut-off valves must be maintained and tested. Diversion of firewater to retention facilities must be automatic on activation of the site fire alarm. Onsite bunds cannot be used to provide firewater retention unless the content of a bund is directly involved in the fire event.

***Where a firewater retention facility solution, outside of a dedicated firewater tank or pond is proposed (e.g. WWTP tanks or storm water attenuation facilities), an explanation is required of how this would affect the continued operation of the site during and after the fire event.**

4 Retention Capacity Calculation

4.1 Calculation Methods

Due to the range of activities and infrastructure at a typical industrial site, a wide range of retention capacity calculation methodologies are available.

Three methodologies are set out in this guidance document. The applicability of each method is dependent on the characteristics of the area being evaluated and the availability of accurate data about the area and the associated fire protection measures.

Each method aligns with ISO/TR 26368:2012 “Environmental damage limitation from fire-fighting run-off” issued by the ISO (the international organisation for standards), a worldwide federation of national standards bodies.

The following quantities should be determined as a basis for the calculation;

a) The volume of contaminated firewater run-off likely to be produced for the whole site, or for each separate assessment area identified for the risk assessment (e.g. Process Area, Tank Farm and Warehouse). Suitable methods to determine these volumes are described in the following sections. **Note:** As per Section 3.1, if the separation of parts of a site into individual assessment areas cannot be justified, including providing the necessary supporting documentation, then they must be assessed together.

b) The expected volume of rainfall contribution during the fire event. See Section 4.6.2.

The largest volume of firewater run-off determined for (a) is then combined with (b) to determine the total retention volume required.

The largest retention volume calculated for any site/site assessment area is the overall retention volume to be provided.

Method 1: Warehouse Retention Calculation – this method is based on the Swiss Federation Firewater Retention Practical Guide[6]. It considers the size of the warehouse (m^2), the storage density, and the fire protection measures in place. The FWRA Tool has a calculation module built in that assists in the determination of required firewater retention capacity in warehouse situations.

Method 2: Tank Farm / Process Plant Retention Calculation – this method is based on inventory, fire protection measures, estimated extinguishing time and local containment. This method requires significant information on the design of the tank farm or process plant fire protection measures, and assessment expertise with regard to the applicable guidance documents.

Method 3: General Retention Calculation – this method is based on the worst-case firewater volumes that could be generated. It is to be used if Methods 1 or 2 are deemed to be inappropriate or the required information or expertise is not available. The FWRA Tool has a calculation module built in that assists in the determination of firewater retention capacity for this method.

4.2 Method 1: Warehouse Retention Calculation

A suitable firewater run-off calculation methodology for warehouse storage is a risk-based approach based on the Swiss Federation Firewater Retention Practical Guide. This method provides an opportunity for a reduction in firewater retention volume required for the site, if fire protection measures, such as sprinklers are provided to control and limit the fire area. This method should only be used by facilities that can provide evidence that the design of the installation meets an appropriate design standard and for which up-to-date maintenance records are available. See Section 4.4 for notes on appropriate design standards.

The fundamental assessment factors that this method depends upon are the following;

- The fire protection measures (e.g. fire detection, sprinkler type – in rack, roof level),
- The fire hazard associated with the stored materials,
- The quantity of non-combustible materials,

[6] “Löschwasser-Rückhaltung Leitfaden für die Praxis” http://www.praever.ch

- The storage methodology (racking, piled, heights),
- The density of stored materials and equipment,
- The warehouse area,
- Rainwater contributions (see Section 4.6.2) (R_W),

See Appendix B for further details.

4.3 Method 2: Tank Farm / Process Plant Retention Calculation

Tank Farms and Process Plants usually store flammable materials and so should be designed in accordance with recognised standards and guidelines. In the event of fire in tank farms or process plants, the immediate objectives are to (1) rapidly and effectively fight the fire and (2) protect other equipment or tanks which may be exposed to excessive heat to prevent the fire spreading.

4.3.1 Guidance on Tank Farm or Process Plant Inventory Contribution to Firewater

The loss of 100% capacity of tanks in the tank farm or process plant in a fire situation may need to be considered based on the level of fire protection measures in place.

Where automatic fire-fighting systems are in place, which are designed and installed to an appropriate standard (see Section 4.4), only the volume of the largest vessel needs to be included in the firewater volume calculation.

In the absence of automatic fire-fighting systems, the inventory of all tanks or process equipment needs to be included in the calculation.

4.3.2 Guidance on Firewater Volume Calculation

Based on the above information, a generalised calculation approach is required to calculate the firewater run-off retention required for a process plant or tank farm area, and should take into account;

- Inventory (liquids & solids) that could be released in a fire scenario **(V_T),**
- Fire-fighting water & foam from the following sources **(W_E)**
    - Automatic fire-fighting systems,
    - Fire Brigade contribution,
    - Consideration needs to be given to the expansion rates of any foam that will be used. The SDSs and specification sheets for any foam concentrate should be checked for the relevant information.
- Extinguishing period based on design standard or systems specifications,
- Cooling Water (based on design standards or systems specifications / discussions with local fire brigade) **(W_F),**
- Rainwater contributions (see Section 4.6.2) **(R_W),**
- Local containment (bunding) available surrounding the area of fire only e.g. Tank Farm Bund. (It is not permitted to include bunding volumes not directly affected by the fire, i.e. it is not permissible to distribute contaminated firewater to other bunded areas of the site for temporary storage) **(E).**

The estimated volumes from the above data should be quantitatively assessed to calculate the required retention volume using the following formula. **All quantities and values used in the calculation must be set out and fully justified.**

$$V_R = V_T + W_E + W_F + R_w - E$$

Where,

V_R = Firewater Retention Required

V_T = Volume of Process / Product Contribution (e.g. Largest Tank only)

W_E = Extinguishing Medium (Water & Foam) (including Fire Brigade resources)

W_F = Cooling Water for Adjacent Tanks

R_w = Rainwater Contribution (see Section 4.6.2)

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

4.4 Note on Fire Protection Verification

The accuracy and reliability of Methods 1 & 2 and other parts of the risk assessment process are based on users providing authentic information in relation to their fire protection measures, including sprinklers.

Sprinkler and deluge systems are designed to extinguish or control fires based on the relevant hazards present in particular scenarios. Sprinkler systems in Ireland are generally designed and installed to European (EN) and British Standards (BSI). An increasing number of systems are also installed to American Standards; e.g. NFPA (National Fire Protection Association). The standards set out requirements for testing and maintenance. The end users have a responsibility to arrange a specialist to carry out this work. Documentation verifying that systems are designed, inspected and maintained to an appropriate standard should be available on site at all times, and upon request by the EPA.

4.4.1 Note on Fire Protection Standards and Guidelines

Water may not be effective as an extinguishing medium for fires involving flammable liquids. Water is used in fire-fighting at tank farms to control fire and to protect adjacent tanks and associated equipment from the fire. More commonly, fire-fighting foam application systems are used to extinguish flammable liquid fires. In relation to fire-fighting, several different methods are available including foam blanketing and deluge systems, fixed monitors, foam pourer systems etc.

Depending on the type of fire protection measures in places, the following guidance documents and standards are used to determine application rates and time periods for supply of firewater, foam and cooling water;

- BS 5306 (all parts), Fire protection installations and equipment on premises,
- EN 12845:2015 Fixed fire-fighting systems. Automatic sprinkler systems. Design, installation and maintenance,
- EN 13565-2:2009 Fixed fire-fighting systems - Foam systems - Part 2: Design, construction and maintenance,
- Energy Institute Model Code of Safe Practice Part 19: Fire Precautions at Petroleum Refineries and Bulk Storage Installations.
- IChemE & BP Process Safety Series; Liquid Hydrocarbon Storage Tank Fires: Prevention and Response,
- HSG 176: The storage of flammable liquids in tanks (UK Health and Safety Executive, 1998)
- Tank Farm Guidelines for the Chemical Industry published by the Basel Chemical Industry and available in English (TRCI, 2009),
- NFPA 13: Standard for the Installation of Sprinkler Systems,

Large internationally recognised insurance companies also publish guidance on appropriate fire protection methods with data usually taken from one of the internationally recognised standards organisations (e.g. ISO, BSI, and NFPA).

The amount of water likely to be used by fixed fire-fighting systems should be determined based on the equipment in situ. Assistance should be sought from the manufacturer, servicing company, and also the insurer to obtain this information, if not available on site.

Additional firewater produced by the fire brigade on site must also be taken into account (see Section 4.6.1).

4.5 Method 3: General Retention Calculation

Some facilities may incorporate areas that are used for processing, warehouse type storage and also some aspects of a tank farm. If appropriate it may be possible to utilise the previous methods (Methods 1 & 2) on a case by case basis combining them as required.

If site areas do not fall within the scope of the other methods described, or if there is insufficient information and/or expertise to use those methods, then the calculation of firewater retention required must be determined based on a more conservative general approach.

General Assumptions for this method include;

- Loss of all Process / Product material stored in area
    - The volume of product may need to be calculated using an appropriate measurement of density. Density information is usually available on the Safety Data Sheet (SDS) of any substance. In the case of waste the density will need to be determined. EPA guidance is available on bulk waste density measurement in the Municipal Waste Characterisation[7] guidance document. The US EPA[8] has also produced conversion factors that could be used as guidance.
- 6 Hour Fire Fighting Scenario; This is the conservative time-period and must be used unless otherwise agreed with the local Fire Authority.

  If deemed appropriate, based on the fire load and set-up of the site, the local Fire Authority can advise a shorter firefighting scenario period but not less than 90 minutes. Evidence of consultation with the local Fire Authority must be provided with all submissions.
- Consideration needs to be given to the expansion rates of any foam that will be used. The SDSs and specification sheets for any foam concentrate should be checked for the relevant information.
- Rainwater Contribution

$$V_R = V_P + W_E + R_w - E$$

Where,

V_R = Firewater Retention Required

V_P = Full volume of Product Loss

W_E = Extinguishing Medium (Water/Foam) (including Fire Brigade resources)

R_w = Rainwater Contribution

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

The FWRA Tool has a calculation module built in that assists in the determination of firewater retention capacity using this method.

[7] https://www.epa.ie/pubs/reports/waste/wastecharacterisation/EPA_municipal_waste_characterisation.pdf

[8] https://www.epa.gov/sites/production/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf

4.6 Other Considerations

4.6.1 Local Fire Brigade Resources

Consultation with the local fire authority shall take place to determine the resources in terms of personnel and equipment that will be sent to the site in the event of a fire. The quantity of firewater that the Fire Brigade is likely to bring to site and what is available to the site locally e.g. fire hydrants and onsite storage, the realistic delivery rates that its pumps are capable of, should be discussed during the consultation. Consideration should also be given to post incident cooling water application which the fire brigade may consider essential in some situations.

4.6.2 Rainwater Contribution

Provision for additional retention volume due to rainwater that occurs during the fire event must be considered.

The 1 in 10 year 24-hour rainfall event data should be used to determine the rainfall that could coincide with a fire event. Rainfall return period tables, for any location, are available on request from the Met Éireann website. The rainfall data used should correspond to the location of the site, or as close as possible (e.g. Dublin rainfall data cannot be used for a site in Galway, or vice versa).

The actual rainwater to be retained should be determined on a case-by-case basis and should consider the site's surface area and storm water drainage design, as some facilities can isolate parts of the site e.g. car park run-off can be segregated from building run-off.

All assumptions made in relation to calculation of rainwater contribution should be fully documented and justified.

Any bunds and drains on site should be inspected in accordance with the site's licence conditions to ensure that they are kept free of rainwater. This inspection regime should be followed as per the site's licence conditions as a minimum, but more frequent inspections should be carried out during periods of heavy rainfall.

5 Design of Firewater Retention Facilities

All potential retention methods as outlined above must be automatically activated in the event of a fire. Reliance on manual intervention to deploy retention is not acceptable. All retention ponds/tanks etc. shall be maintained empty or at least to a point where the required retention capacity is available.

Note on Testing of Retention Facilities: Licensees are reminded of the requirement to test the integrity of all retention facilities every three years or as required by the conditions of their licence.

5.1 Dedicated Firewater Retention Ponds

This is the most effective and suitable measure for retaining firewater. Ponds shall be rendered impermeable by the use of an appropriate liner and integrity-tested in line with the requirements of the site's licence (integrity testing is usually required every 3 years). All site drainage systems shall divert automatically to the firewater retention pond on activation of the site fire alarm system.

5.2 Lagoons or Storm Water Ponds

Storm water management is a requirement for most facilities. Storm water attenuation ponds or lagoons are used to control the flow of storm water from large paved/roofed areas to rivers and streams and can usually accommodate up to, and including, a 1 in 100-year storm event. The ponds minimise hydraulic loading and flooding of downstream water courses and lands, and are generally required in accordance with local development plans and planning conditions, as applicable. The ponds are generally lined to ensure that they do not interfere with the groundwater in the surrounding area. If being used for the dual purpose of firewater retention, then the outlet is usually fitted with an automatic valve linked to the fire detection system.

Additional measures may be required to manage the levels of water in the pond during normal operations if used for firewater retention. Integrity testing shall be carried out on lagoons and storm water ponds in accordance with site maintenance schedule and to ensure compliance with licence conditions. The appropriateness of the liner to contain contaminated firewater shall be assessed. Ponds and lagoons shall be kept clean and free of plant debris.

5.3 Tanks

Specially designed tanks for retaining potentially contaminated effluent may be available, some of which are fitted with equipment to remove detergents, hydrocarbons, debris, grit and chemicals prior to being pumped into an onsite waste water treatment plant (WWTP). Spare capacity in such tanks may be available for firewater retention.

The tanks can be either above or below ground and need to meet specific design criteria based on an appropriate risk assessment to ensure impermeability.

Equalisation tanks associated with onsite WWTPs may be considered as possible retention systems, but many such facilities operate at or very close to their capacity and additional retention capability would be limited.

5.4 Bunding

The use of bunds can be considered for the retention of firewater in some circumstances. The primary purpose of a bund is to contain material spills, overflows or flange leakage in process areas and to contain the contents of a tank in the event of a tank rupture. Accepted practice is to design the bund such that 110% of the volume of the largest tank will be contained within the bunded area. In calculating the firewater retention volume that needs to be provided, the available bund volume in that area can be subtracted from the total required. However, to take an available bund volume into account in the calculation it must be reasonably foreseeably that firewater will be generated/captured in the bund during a fire event.

Other bund options include designing and constructing buildings with built-in bunds using under floor design, up-stands, door thresholds and ramps.

Note: Bunds should be emptied and repaired if necessary as soon as possible after a fire event to reinstate the available bunding capacity of the area. Firewater should not be pumped

to other site bunds for storage – bunds can only be utilised where the firewater is generated in the bund during the fire event. Under normal operating conditions, bunds must be regularly inspected and emptied of uncontaminated rainwater, to maintain available capacity.

5.5 Drainage System

The drainage system for a large site can be complex since it may incorporate storm water, foul sewage, process effluent prior to treatment, underground sumps/tanks, or concrete compartments. Individual or interlinked pipe work may be considered when assessing retention capacity if (1) it undergoes regular hydrostatic integrity testing and maintenance, in accordance with licence requirements and (2) automatic shut-off valves linked to the site's fire detection system, are installed on all drainage outlet points.

5.6 Automatically Activated Systems

Several new automatic systems have become available in recent years and may be appropriate for some facilities under certain circumstances.

These are systems with which the necessary retention volume is assured after the implementation of technical measures, which are automatically activated and set into operation. Examples are automatically applied firewater barriers, which in the case of fire detection are automatically steered into position.

- Fire detector (smoke) activated extinguishing barrier, e.g. in a storage section an automatic barrier, such as at a door, can be activated into position,
- Automatic drain balloons, which can be inflated in the drainage system to seal it and thereby create a retention volume in the pipework,
- Liquid driven spill barrier. The firewater as it runs out automatically raises the spill barrier, without any external energy being required.

All potential retention methods as outlined above must be automatically activated in the event of a fire. Reliance on manual intervention to deploy retention is not acceptable.

Note on Testing of Retention Facilities: Licensees are reminded of the requirement to test the integrity of all retention facilities every three years or as required by the conditions of their licence.

6 Fire-Fighting Strategies

Several strategies exist that may assist the fire-fighting operations and may reduce the amount of firewater run-off generated.

6.1 Fire Fighting Tactics

The Fire Brigade is trained in the appropriate fire-fighting techniques for different fire scenarios. Examples include using sprays or foam, rather than jets of water to extinguish certain types of fire. During the development of emergency plans, the local Fire Authority should be consulted in relation to the fire hazards present, so that appropriate techniques and equipment are incorporated into the plans.

6.2 Controlled Burn

ISO/TR 26368:2012 *Environmental damage limitation from fire-fighting water run-off* recognises the use of controlled burn. The justification for this strategy, in addition to environmental considerations, include circumstances where the fire fighters may not know how to extinguish the fire, and where the risks associated with active fire-fighting are too great for the fire fighters.

As ISO/TR 26368:2012 documents, the choice of this tactic requires complex decision making by the fire management team, which in this context it is important to consider:

- What effect fighting the fire with water or foam may have in terms of potentially contaminating water resources, fisheries, aquatic fauna and flora,
- Whether there is a realistic possibility of managing a controlled burn, without attempting extinguishment, considering the accompanying risks of short-term air pollution and longer-term pollution of land and water if the smoke plume comes to ground level, and the risk of fire spread to adjacent structures,
- Whether it is possible to minimise adverse health effects on humans, as this takes priority over environmental concerns.

The local Fire Authority should be consulted with a view to pre-planning responses to likely scenarios including the scenario of allowing the fire to burn itself out. This will include determining the realistic performance of nearby hydrants, the response of the fire brigade and appliances in an emergency, and plans for the minimisation of contaminated firewater, as appropriate. If controlled burn is being considered this information must be included in the risk assessment report to be submitted to the Agency.

6.3 Treatment & Disposal

Contaminated firewater collected on site must be analysed to determine the options for proper disposal. If adequate treatment is available on site, final disposal via normal licensed outlets may be permissible. Consultation with local authority/ municipal waste water treatment plant operators will be required to facilitate this. Approval of this approach should be granted by the relevant authority prior to release. There should be preliminary plans in place for disposal of contaminated firewater as part of the site's emergency planning arrangements.

7 Firewater Risk Assessment Report

Following completion of the firewater risk assessment, including firewater retention calculations as applicable, the completed FWRA Tool must be submitted to the Agency, together with a supporting Firewater Risk Assessment Report.

The report should contain the following elements at a minimum:

- Details and justification of the chosen separation distances/areas on site for the purposes of the risk assessment,
- Justification of designation of H226 flammable liquids as combustibles based on flashpoints and operating temperature, as applicable (see Appendix A),
- Detailed descriptions of fire detection and automatic fire protection measures,
- Full details of calculation method chosen,
- Details of consultation with Local Fire Authority and summary of proposed fire-fighting strategies,
- Details of rainwater volume based on regional rainfall data applicable to the region in which the site is located,
- Details of existing and/or proposed firewater retention systems,
- Risk Management Programme, (Appendix D),
- Post fire event treatment and disposal plans for retained firewater,
- Any assumptions made during the assessment or calculation steps,
- Summary of the Risk Assessment results.

8 Review and Update of the Firewater Risk Assessment

All firewater risk assessments should be updated in the event of significant site changes such as:

- Changes in inventory,
- Changes in applicable separation distances or fire compartments,
- Changes to site risk area/assessment areas,
- Changes to site drainage or containment systems.

Any updates to the Firewater Risk Assessment must be submitted to the Agency for approval.

9 References

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21. UK Health & Safety Executive, HSG 71 Chemical warehousing -The storage of packaged dangerous substances
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Appendix A
FWRA Tool User Guide

1 FWRA Tool User Guide

1.1 Introduction TAB

A FWRA Tool (Excel-based) has been developed to provide a consistent approach to the risk assessment process. The FWRA Tool is available for download from the website of the EPA – www.epa.ie.

In order to carry out the risk assessment the user is required to input the necessary information in both the 'Significance of Fire' Tab and also the 'Hazard Potential' Tab, for each assessment area. A separate file of the FWRA Tool should be used for each assessment area. Once the inputs are complete the requirement, or otherwise for retention is assessed and displayed automatically in the Firewater Run-off Tab.

Where it is calculated that an assessment area requires retention to be provided, an appropriate retention calculation method is selected with reference to Section 4 of the guidance document. The appropriate Calculation Method Tab is then used to assist with the calculation.

The largest retention volume calculated for any site area is the overall retention volume to be provided.

Preliminary Note on H-Statements;

An important element of the FWRA Tool is the need to understand the characteristics of the substances stored on site. The Classification, Labelling and Packaging 'CLP' Regulation (EC) No. 1272/2008 on the classification, labelling and packaging of substances and mixtures, introduces the United Nations Globally Harmonised System (UN GHS) for classification and labelling of chemicals into Europe.

The CLP/GHS uses a system of Hazard Statements (H-Statements) which describes the nature of the hazard in a substance or mixture. The H-Statements can be summarised by groups relating to their hazard as follows;

- H200 - H299 Physical hazards (e.g. Flammable, Corrosive, Explosive)
- H300 - H399 Health hazards (e.g. Toxic, Respiratory Hazard, Harmful to Humans)
- H400 - H499 Environmental hazards (e.g. Toxic to Aquatic Life, Harmful to Aquatic Life)

Substances may possess H-Statements from more than one group i.e. it may have both physical and environmental hazards (e.g. Diesel H226 & H411). The relevant SDS will provide information in relation to the H-Statements of substances.

The following paragraphs provide guidance on correctly inputting the necessary data into each Tab.

1.2 Significance of Fire Event TAB

1.2.1 Fire Detection and Alarm System

It should be confirmed if the assessment area has fire detection in situ. All systems should be designed, installed and maintained to I.S.3218:2013 *Fire Detection and Fire Alarm Systems for Buildings - System Design, Installation, Servicing and Maintenance* or an equivalent recognised standard.

1.2.2 Automatic Fire Protection

It should be confirmed if the assessment area is protected by an automatic fire protection system. This may be in the form of a sprinkler, fixed water spray, foam water or deluge system. All systems should be designed, installed and maintained to an appropriate standard (see Section 4.4 of the guidance document).

1.2.3 Fire Load - Flammables

The quantities of flammable materials processed or stored in the assessment area should be input in the relevant cells

In relation to flammable liquids, the applicable physical hazard statements are as follows:

- If the flashpoint is < 23°C and the initial boiling point is ≤ 35°C; the substance is classified as an extremely flammable liquid Category 1 with Hazard Statement: **H224** "Extremely flammable liquid and vapour"
- If the flashpoint is < 23°C and initial boiling point is > 35°C; the substance is classified as a highly flammable liquid Category 2 with Hazard Statement: **H225** "Highly flammable liquid and vapour"
- If flashpoint is ≥ 23°C and ≤ 60°C; the substance is classified as a flammable liquid Category 3 with Hazard Statement: **H226** "Flammable liquid and vapour".
- If the flashpoint ≥ 60°C and ≤ 93°C; the substance is classified as a combustible liquid Category 4 with Hazard Statement: **H227** "Combustible Liquid".

Note: The H226 Flammable Liquids and Vapour classification has a very wide flashpoint range (23°C - 60°C) and the fire risk associated with each end of the scale is widely divergent. To account for the lower fire risk associated with flammable liquids which are not stored at temperatures close to their flashpoints, a liquid can be entered into the FWRA Tool as a combustible liquid if it meets the following criteria.

Any H226 flammable liquid processed or stored at 15°C (or more) below the flashpoint stated on the relevant SDS, can be entered as a combustible liquid. This is based on reference to the *Non-binding guide to good practice for implementing the European Parliament and Council Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres*[1] which effectively states that where flammables mixtures are stored at 15°C or more below their flashpoints, then adequate safety is provided in terms of maintaining the substance below the lower explosion/flammable limit.

Example

Diesel is classified as H226. Its flashpoint is circa 56°C. It is typically stored on sites at ambient temperature. If ambient temperature is conservatively taken as 30°C, then the diesel is stored at 26°C below its flashpoint. Therefore, it is very difficult to ignite it and it has a low likelihood of initiating a fire. Thus, the quantity of diesel stored in the assessment area can be entered into the H227 "Combustible liquid" cell.

1.3 Hazard Potential TAB

1.3.1 Environmental Hazard Statements

Users should input the quantity of materials processed or stored in the assessment area which possess an environmental hazard statement. The SDSs should be checked for the relevant information. The environmental hazard statements of relevance are:

- H400 Very toxic to aquatic life,
- H401 Toxic to aquatic life,
- H402 Harmful to aquatic life,
- H410 Very toxic to aquatic life with long lasting effects,
- H411 Toxic to aquatic life with long lasting effects,
- H412 Harmful to aquatic life with long lasting effects,
- H413 May cause long lasting harmful effects to aquatic life.

If an environmental hazard statement is not assigned to a material, then the Water Hazard Classification (WGK) rating for that material should be inputted to the FWRA Tool (see section 1.3.2 and 1.3.3 below). Some materials including food products are not classified as dangerous substances according to EU Regulations, but they are hazardous to waters if unintentionally released - the WGK rating addresses this hazard.

[1] http://bookshop.europa.eu/en/non-binding-guide-to-good-practice-for-implementing-the-european-parliament-and-council-directive-1999-92-ec-on-minimum-requirements-for-improving-the-safety-and-health-protection-of-workers-potentially-at-risk-from-explosive-atmospheres-pbKE6404175/

1.3.2 Water Hazard Classification Rating (WGK)

There are three water hazard classes (WGK) for chemicals under the German Federal Water Act. Non-hazardous to waters can only be claimed if there is sufficient data to support it.

- WGK 1: low hazard to waters;
- WGK 2: hazard to waters;
- WGK 3: severe hazard to waters;

Note: It is not required to enter the quantity of material in both sections. Priority should be given to entering an environmental hazard statement first.

Examples

Diesel is classified as H411 and WGK 2. The quantity of diesel stored in the assessment area should only be entered into the H411 entry cell in the FWRA Tool.

Ethanol has no environmental hazard classification but is classified as WGK 1. The quantity of ethanol stored in an assessment area should be input in the WGK 1 entry cell in the FWRA Tool.

1.3.3 Identification of Hazard Statements and Water Hazard Classification Rating

The European Chemicals Agency (ECHA) has developed a comprehensive database[2] on chemical safety. The database covers hazardous properties, classification and labelling information for the chemicals included, and provides information on how to use them safely.

The GESTIS Substance Database [3] contains information for the safe handling of hazardous substances at work. The database provides information on important physical and chemical properties as well as special regulations e.g. GHS classification and labelling per CLP regulation (pictograms, H phrases, P phrases) and WGK ratings for most substances.

Examples of Flammable & Environmental Hazard Statements and WGK classifications for some commonly used substances on industrial sites are provided in Table A1.

[2] https://echa.europa.eu/

[3] http://www.dguv.de/ifa/gestis/gestis-stoffdatenbank/index-2.jsp.

Table A1: H-Statements and WGK Classifications of Typical Substances

Substance/Material	Flammable or Environmental H-Statements	Water Hazard Class (WGK)
Acetic Acid	**H226:** Flammable liquid and vapour	1
Acetone	**H225:** Highly flammable liquid and vapour	1
Aqueous Ammonia	**H400:** Very toxic to aquatic life	2
Chlorine	**H400:** Very toxic to aquatic life	2
Chromic Acid	**H410:** Very toxic to aquatic life with long lasting effects	3
Copper Sulphate	**H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	3
Cyclohexane	**H225:** Highly flammable liquid and vapour **H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	2
Diesel	**H226:** Flammable liquid and vapour *(Diesel can be considered combustible liquid for FWRA Tool as per Appendix A, Section 1.2.3) **H411:** Toxic to aquatic life with long lasting effects	2
Ethanol	**H225:** Highly flammable liquid and vapour	1
Heptane	**H225:** Highly flammable liquid and vapour **H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	2
Hydrochloric Acid	No environmental or flammable H-Statement assigned	1
Isopropanol	**H225:** Highly flammable liquid and vapour	1
Isobutanol	**H226:** Flammable liquid and vapour	1
Methanol	**H225:** Highly flammable liquid and vapour	1
Methyl tert-butyl ether (MTBE)	**H225:** Highly flammable liquid and vapour	1
Phenol	**H411:** Toxic to aquatic life with long lasting effects	2
Sodium Nitrite	**H400:** Very toxic to aquatic life	2
Tetrahydrofuran	**H225:** Highly flammable liquid and vapour	1
Toluene	**H225:** Highly flammable liquid and vapour	2
Trichloroacetic Acid	**H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	2

Substance/Material	Flammable or Environmental H-Statements	Water Hazard Class (WGK)
Trichloroethylene	**H412:** Harmful to aquatic life with long lasting effects.	3
2,2,4-Trimethylpentane	**H225:** Highly flammable liquid and vapour **H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	2
Zinc Chloride	**H400:** Very toxic to aquatic life **H410:** Very toxic to aquatic life with long lasting effects	3

1.3.4 Biological Oxygen Demand (BOD)

As mentioned previously, some substances including food products are not classified as dangerous substances per EU Regulations, but they are hazardous to waters if unintentionally released. If organic substances enter a watercourse, they decay. This process removes oxygen from the water and in severe cases of contamination, aquatic life can be killed through oxygen starvation rather than direct poisoning. The Biological Oxygen Demand (BOD) is an indication of this potential.

Examples of typical BODs are; Milk (4% fat) is in the range of 120,000mg/l of BOD, which increases to 400,000mg/l for cream. To put this in context, the value for domestic sewage is 300 to 400mg/l.

If any of these types of products are processed or stored in the assessment area, then the quantity should be input in the relevant cell in the FWRA Tool.

Example:

A $100m^3$ whole milk tank in a dairy, the BOD loading would be:

BOD load on kg = 100 X 120,000 x 10^{-3} = 12,000kg

To put this BOD loading into perspective, a standard 'population equivalent' for sewage is 0.06kg BOD/person/day. Thus, a $100m^3$ milk tank has the equivalent daily BOD loading of a small city of some 200,000 inhabitants. Therefore, it would be unacceptable in the event of a tank failure or loss of containment in a fire event for this discharge to reach unprotected aquatic environments.

1.3.5 Plant Protection (Pesticides)

Pesticide is a broad term, encompassing plant protection products (e.g. weedkillers), biocidal products and certain veterinary medicine products. Plant protection products are pesticide products used to protect crops and plants from harm caused by diseases, insect pests, weeds and other harmful organisms. Biocidal products are pesticide products that are not used in agricultural production. They cover a diverse range of uses and are used widely in the food industry to disinfect surfaces and machinery and to preserve materials.

Pesticides include organic insecticides, herbicides, fungicides, nematocides, algicides, rodenticides, slimicides, related products and their relevant metabolites, degradation and reaction products.

Plant protection products have been listed by the EPA as potentially dangerous pollutants that may pose a significant risk to the water environment. Even the smallest environmental release of these product types can have detrimental effects on both drinking water supply and the aquatic environment.

If any of these types of products are processed or stored in the assessment area, then the quantity should be inputted in the relevant cell in the FWRA Tool.

Further information is available in the EPA Guidance - *EPA Drinking Water Advice Note No. 13: Pesticides in Drinking Water.*

1.3.6 Genetically Modified Organisms (GMO)

Genetically Modified Organisms are those organisms *'in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination'*[4]. Where GMOs comprise bacteria, viruses, viroids and animal and plant cells in culture they are referred to as Genetically Modified Micro-Organisms or GMMs.

The EPA is the authority in Ireland that implements GMO Regulations on:

- The contained use of Genetically Modified Organisms
- The deliberate release of Genetically Modified Organisms into the environment
- The transboundary movement of Genetically Modified Organisms.

To use GMOs for purposes of R&D (in university or hospital laboratories), or for production/manufacturing (in industrial facilities), users are legally obliged to submit a notification to the EPA in accordance with the requirements of the Contained Use legislation, seeking the Agency's consent before commencing work with GMOs. The Irish Statutory instrument *S.I. No. 73/2001 - Genetically Modified Organisms (Contained Use) Regulations, 2001* states that in the case of laboratories and plant growth facilities – contaminated run-off protection is required for GMO Groups 3 & 4. The classification in accordance with Directive 2009/41/EC.

The uncontrolled release of any GMOs group 3 and/or 4 could have adverse effects on human health and the environment. Therefore, if GMOs group 3 and/or 4 are handled or stored in the assessment area, then the quantity should be inputted in the relevant cell in the FWRA Tool.

1.3.7 Non–Hazardous & Hazardous Waste Facilities

Fire is an ever-present possibility at most waste management sites, as many wastes are readily combustible. There have been several high-profile fires at waste management facilities in Ireland in recent years.

If the site in question is a Waste Facility, then this should be confirmed in the relevant cell in the FWRA Tool. Input options are Hazardous, Non-hazardous, N/A.

Further information on fire safety at non-hazardous waste facilities is provided in the EPA's Guidance Note: *Fire Safety at Non-Hazardous Waste Transfer Stations*.

1.4 Firewater Run-Off TAB

The Firewater Run-off TAB will display a summary of the results of the Significance of Fire Event (S) and Hazard Potential (H) TABs in terms of low, medium or high risk and ultimately concludes if the "assessment area" requires firewater retention to be provided.

If it is concluded that firewater retention is required, the most appropriate calculation method should be chosen. Guidance on the most suitable method to use has been provided in Section 4 of this document while examples of each method are included in Appendix C.

The maximum volume calculated of all the assessment areas which require retention, is then the volume that needs to be provided.

The following section provides instruction on what inputs the FWRA Tool requires for the applicable methods.

1.5 Method 1: Warehouse Retention Calculation TAB

This method should only be used by facilities that can provide evidence that the design of the fire detection and sprinkler system installations meet appropriate design standards, and for which up-to-date maintenance records are available (see Section 4.2 of the guidance document).

The FWRA Tool will automatically populate the flammable and combustible material quantities from the Significance of Fire Event TAB.

The following additional inputs are required to be entered in the relevant cells in the FWRA Tool.

[4] http://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

- Floor Area of Warehouse (m^2)
- Quantities of Aerosol & Oxidising Materials not already classified (Tonnes)
- Quantity of Non-Combustible Material (Tonnes)
- Type of Warehouse Storage (Non-racked / Racked & related Heights)

The FWRA Tool will then automatically calculate the required retention volume. The methodology behind this is described in Appendix B.

Note on non-combustible materials

A non-combustible material is a material that, in the form in which it is stored and under the conditions anticipated, will not ignite, burn, support combustion or release flammable vapours, when subjected to fire or heat. Examples of non-combustible materials include Hydrochloric Acid (HCl), Sodium Hydroxide (NaOH), empty glassware etc. Any non-combustible materials stored in the assessment area should be reviewed against the relevant Safety Data Sheets and confirmed as 'non-combustible' before being included in the relevant cell in the FWRA Tool.

1.6 Method 2: Tank Farm/Process Plant Retention Calculation TAB

This method should only be used by facilities that can provide evidence that the design of the fire detection and sprinkler system installations meet an appropriate design standard and for which up-to-date maintenance records are available. Section 4.3 of the guidance document provides a description of the calculation method.

Supporting data and calculations can be inputted to this TAB in a free field format or embedded into the TAB as appropriate, for inclusion in the submission. An example of this method is included in Appendix C.

1.7 Method 3: General Retention Calculation TAB

If site areas do not fall within the scope of the other methods described, or if there is insufficient information and/or expertise to use those methods, then the calculation of firewater retention required must be determined based on a more conservative general approach. Section 4.5 of the guidance document provides a description of the calculation method.

The following inputs are required to be entered in the relevant cells in the FWRA Tool.

- Max Flow of Local Hydrants (l/min).

  If the flow rates of the hydrants on site or adjacent to the site are unknown these should be tested or the information requested from the relevant Local Authority or County Council.

- Total Firewater/Foam to be provided by local Fire Brigade (m^3).

  The local fire authority should be consulted to determine what resources including extinguishing water they will send to the site in the event of a fire.

- Total Firewater/Foam stored on site (m^3).

  The full volume of any dedicated firewater storage tank and fire-fighting foam inventory should be entered. Consideration needs to be given to the expansion rates of any foam that will be used. The SDS and specification sheets for any foam concentrate should be checked for the relevant information.

- Total Volume of material stored in area (m^3).

  The full volume of the materials contained in the assessment area should be entered, including both solids and liquids. Where the volume of solid materials is not known the density of the material should be used to calculate the volume – see Section 4.5 for guidance.

- Area of Site which shares common drainage with the Assessment Area (m^2)

  The total hard standing area of the applicable site area should be calculated and input.

- Rainwater Contribution.

  The 1 in 10 year 24-hour rainfall event for local area (m). The Met Éireann website provides this data free of charge for any location in Ireland.

The FWRA Tool will then automatically calculate the required retention volume. An example of this method is included in Appendix C.

Appendix B
Warehouse Retention Calculation Details (Method 1)

1 Warehouse Retention Calculation Details

This method is based on the Swiss Federation Firewater Retention Practical Guide (see Section 4.1 of the guidance document). The retention volume required for warehouses is dependent on the fire safety protection measures and the storage strategy, the fire hazards of the stored substances, mixtures and other materials as well as the size of the fire compartment/assessment area.

1.1 Fire Protection Measures

Two fire protection concepts are defined for this method:

a) Fire protection measures - Fire detection and alarm system only

b) Fire protection measures - Fire detection, alarm system and sprinklers

Note: Facilities with neither fire detection or sprinkler protection are not permitted to use this calculation method.

1.2 Fire Hazard Category (F)

The various fire hazards which can arise from the materials stored are to be identified per the GHS (Globally Harmonised System) as per their properties by means of H-Statements. Table B1 provides information on the fire hazard categories are determined based on a substances flammable category.

Note: The relevant substances and their quantities are captured in the FWRA Tool, as per the instructions in Section 1.5 of Appendix A.

1.2.1 Determination of the Fire Hazard Category for Mixtures of Materials

Note: The fire hazard category is automatically calculated in the FWRA Tool following input of the necessary data, as per the instructions in Section 1.5 of Appendix A.

For mixed storage > 1,000kg

The storage quantity of the material(s) with the highest fire hazard category (e.g. F1/F2) is calculated. If the storage quantity is over 100kg then this fire hazard category is to be used in the estimation. If the quantity amounts to a weight of less than 100kg then the next fire hazard category (e.g. F3/F4) applies to the total quantity of materials.

For mixed storage < 1,000kg

The storage quantity with the highest fire hazard category (e.g. F1/F2) is calculated. If the quantity is over 10% of the total stored quantity, then this fire hazard category is to be used in the estimation. If the quantity amounts to a weight of less than 10%, then the next fire hazard category (e.g. F3/F4) applies for the total quantity of materials.

Table B1: Fire Hazard Category (developed from the Swiss Federation Guide)

Fire Hazard Category Classification				
Class	**Category**	**Text**	**H-Statement***	**Fire Hazard Category (F)**
Flammable Liquids	Flam. Liq.1	Extremely flammable liquid or vapour	H224	F1/F2
	Flam. Liq.2	Highly flammable liquid of vapour	H225	F1/F2
	Flam. Liq.3	Extremely flammable liquid of vapour	H226	F1/F2
Flammable Solid	Flam. Sol.1	Flammable Solid	H228	F1/F2
	Flam. Sol.2			F1/F2
Combustible materials (without GHS Classification)	N/A	Flashpoint > 60° C - 100° C	H227	F3/F4
		Flashpoint > 100° C		F3/F4
		Non-Combustible		F5/F6
	Flam. Gas.1	Extremely Flammable Gas	H220	F1/F2

Fire Hazard Category Classification				
Class	**Category**	**Text**	**H-Statement***	**Fire Hazard Category (F)**
Flammable Gases	Flam. Gas.2	Flammable Gas	H221	F1/F2
Aerosol	Cat .1	Extremely Flammable Aerosol	H222	F1/F2
	Cat .2	Flammable Aerosol	H223	F1/F2
Oxidising gases	Ox. Gas 1	May cause or intensify fire	H270	F1/F2
Oxidising liquids and Solids	Ox. Liq.1	May cause fire or explosion; strong oxidiser	H271	F1/F2
	Ox. Sol. 1			F1/F2
	Ox. Liq. 2	May intensify fire; oxidiser	H272	F3/F4
	Ox. Sol. 2			F3/F4
	Ox. Liq. 3			F3/F4
	Ox. Sol. 3			F3/F4

*Per the Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and preparations.

1.3 Determine the storage density per fire compartment

The total quantity of stored materials and equipment in a fire compartment (storage density) can greatly influence the effective volume of extinguishing water. It therefore must be considered in the calculation.

The storage density per assessment area is derived from the total quantity of stored material divided by the area in m^2. The storage density factor is then determined from Table B2. This factor is then applied to the retention volume obtained in the next step.

Note: The storage density factor is automatically calculated in the FWRA Tool following input of the necessary data as per the instructions in Section 1.5 of Appendix A.

Table B2: Storage Density Factor (from the Swiss Federation Guide)

Storage density per fire compartment and related factors		
Storage density per fire section	**Factor**	**Typical type of use**
≤ 100 kg / m^2	0.5	Production, Labs
≤ 500 kg / m^2	0.8	Storage
≤ 1,000 kg / m^2	1	Storage
> 1,000 kg / m^2	1.2	Storage

1.4 Determine the preliminary retention volume required

In Table B3, the preliminary retention volumes are listed based on the fire compartment area, the fire hazard and the fire protection facilities. They are based on the 'Insurance Europe'-guideline "storage of hazardous materials".[1] Where the fire compartment area lies in between those listed in the table, the next highest area is conservatively used (see worked example in Appendix C).

[1] Guidance from the Comité Européen des Assurances (CEA), now called Insurance Europe. A version of this document is available in French at: http://www.apsei.org.pt/media/recursos/documentos-de-outras-entidades/CEA-incendio/Entrepots_de_Matieres_Dangereuses.pdf . Insurance Europe is an international not-for-profit association and a representative body with a due governance and diligence process.

Note: The preliminary retention volume is automatically calculated in the FWRA Tool following input of the necessary data as per the instructions in Section 1.5 of Appendix A.

Table B3: Preliminary Firewater Retention Required (from the Swiss Federation Guide)

Theoretical Firewater Retention in m^3										
Area of fire section	No Sprinklers Fire detection and Alarm			Sprinklers and fire detection and alarm						
				Stacking height < 6 m			Stacking height < 12 m		Stacking height > 12 m	
				Non-racked storage	Racked storage / high bay racked storage					
In m^2	F1/F2	F3/F4	F5/F6	F1-F4	F1–F4	F5/F6	F1-F4	F5/F6	F1-F4	F5/F6
50	50	25	10	25	15	5	15	5	25	10
100	100	50	20	45	30	10	35	15	50	20
150	180	90	40	70	50	20	60	20	80	30
200	290	140	60	90	60	20	90	40	120	50
250	390	200	80	110	80	30	130	50	170	70
300	530	270	110	160	110	50	210	90	260	110
400	790	400	160	180	120	50	230	100	280	120
500	990	500	200	210	140	60	250	110	300	130
600	1,190	590	240	240	160	70	260	110	320	140
700		690	280	260	180	80	280	120	320	140
800		790	320	290	190	80	300	130	320	140
900		890	360	320	210	90	320	140	320	140
1,000		990	400	340	230	100	320	140	320	140
1,100		1,090	440	370	250	110	320	140	320	140
1,200		1,190	480	390	260	110	320	140	320	140
1,300		1,290	510	390	260	110	320	140	320	140
1,400		1,390	550	390	260	110	320	140	320	140
1,500		1,490	590	390	260	110	320	140	320	140
1,600		1,580	630	390	260	110	320	140	320	140
1,700		1,680	670	390	260	110	320	140	320	140
1,800		1,780	710	390	260	110	320	140	320	140
1,900		1,880	750	390	260	110	320	140	320	140
2,000		1,980	790	390	260	110	320	140	320	140
2,100		2,080	830	390	260	110	320	140	320	140
2,200		2,180	870	390	260	110	320	140	320	140
2,300		2,280	910	390	260	110	320	140	320	140
2,400		2,380	950	390	260	110	320	140	320	140
3,600		3,560	1,430	390	260	110	320	140	320	140
3,700		3,660	1,470	390	260	110	320	140	320	140
4,800				390	260	110	320	140	320	140
4,900				390	260	110	320	140	320	140

Fire compartment size acceptable

Consider introducing more fire compartments

Fire compartment size too large

For fire compartment areas of > 4,800 m^2, the minimum retention volume is to be agreed with the agency.

1.5 Calculating the required retention volume in the FWRA Tool

The required retention volume is derived by multiplying the preliminary retention volume by the storage density factor.

The methodology inherently factors in both the release of firewater and stored materials. Additional allowances for stored materials are not required.

Note: The preliminary retention volume is automatically calculated in the FWRA Tool following input of the necessary data as per the instructions in Section 1.5 of Appendix A.

There are some scenarios where this method will not be allowed due to fire compartment (assessment area) size or lack of fire protection in place. The FWRA Tool will indicate if the parameters entered are allowable before calculating the required retention volume.

Appendix C
Firewater Retention Volume Estimation - Worked Examples

Method 1 – Warehouse Retention Calculation

Example: Racked Storage of Cleaning Solvent Containers in Warehouse

Relevant Information:

- Storage of 300,000 kg of cleaning solvent in containers,
  - Classification of Material – H410, H227,
  - Flashpoint of material > 60ºC (F4),
- Storage of 100,000kg Non-Combustibles – empty Glass Bottles,
- Racked storage (10m height) in its own fire compartment,
- Area 750 m^2,
- Warehouse Fire Protection Systems,
  - Fire detection and alarm system designed, installed and maintained to IS3218:2013,
  - Sprinkler protection in place designed, installed and maintained to BS EN12845:2015.

Summary of FWRA Tool Results:

- Significance of Fire Event - **S3 (High)**
- Environmental Hazard Potential – **H3 (High)**
- Firewater Run-Off Risk – **R1**

Firewater Retention Required

Calculation:

Warehouse method is appropriate as documentation and certification of the design, installation and maintenance of both the fire detection and alarm system are available for inspection.

1. Calculation of the storage density and evaluation of the corresponding factors

Total quantity of substances, mixtures and objects in compartment	400,000kg
Area of compartment	750m^2
Storage density for this compartment	400,000kg / 750m^2 = 533.3 kg/m^2
According to Table B2, Appendix B:	Storage density per fire compartment ≤ 1,000 kg/m^2 = **Factor 1**

2. The preliminary firewater retention volume according to Table B3 (Appendix B) is between **280-300m^3.** The upper limit of the range, i.e. 300m^3 is conservatively selected.
3. Calculation of the necessary firewater retention volume: The required retention volume is derived multiplying the preliminary retention volume by the storage density factor.

   Factor (1) x 300 m^3 = **<u>300 m^3</u>**

   Compartment Size Acceptable (Table B.3 Appendix B)

Rainwater Contribution:

The Warehouse is situated in the Midlands.

The site has hard standing total area of 6,000m^2.

The maximum volume of rainfall to be included is based on the 1 in 10 year 24-hour rainfall event. Data for a 1 in 10 year, 24-hour rainfall event in the Midlands area was available from Met Éireann with a value of 47.7mm returned.

The calculated volume of rainfall over the site is therefore 286.2m^3.

Therefore, **<u>586m^3</u>** of firewater retention is required on site.

Note: The FWRA Tool can also perform this calculation.

Method 2 - Tank Farms & Process Plants

Example: Manufacturing Site - Process Plant 'Building A'

Relevant Information:

- Building A contains 8 No. x 6.5 m^3 Process Reactors (H225, WGK2, ρ = 1000 kg/$m^{3)}$,
- Storage of approx. 16 No. x 200 litre Drums in Plant (H225, WGK1, ρ = 1000 kg/m^3),
- Reactors and piping system are contained within own fire compartment. Shut off valves prevents any connection with tank farm located in other part of site,
- Area 1,000 m^2,
- Assessment of Volumes of Substance:
  - H225: 55.2 tonnes,
  - Flashpoint of materials: 23ºC - 31ºC (F2),
  - WGK 2: 52 tonnes,
  - WGK 1: 3.2 tonnes,
- Fire Protection Systems
  - Fire detection and alarm system designed, installed and maintained to IS 3218:2013,
  - Sprinkler protection in place designed, installed and maintained to BS EN12845:2015,
  - There is a dedicated firewater/sprinkler tank on site with 700m^3 capacity. The tank is fed from the local authority water main,
  - Delivery rate of hydrants ring is 1,200L/min.

Summary of FWRA Tool Results:

- Significance of Fire Event - **S3 (High)**
- Environmental Hazard Potential – **H2 (Medium)**
- Firewater Run-Off Risk – **R1**

Firewater Retention Required

Calculation:

The Tank Farm & Process Plant method is appropriate as documentation and certification of the design, installation and maintenance of both the fire detection and alarm system is up to date and available for inspection upon request by the Agency.

$$V_R = V_T + W_E + W_F + R_w - E$$

Where,

V_R = Firewater Retention Required

V_T = Volume of Process / Product Contribution

W_E = Extinguishing Medium (Water & Foam)

W_F = Cooling Water for Adjacent Tanks / Buildings

R_w = Rainwater Contribution

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

V_T = Volume of Process / Product Contribution

Due to the presence of an automatic fire protection system, only the volume of the largest vessel needs to be included for product contribution, hence only the contents of one 6.5 m^3 reactor is included.

In a fire situation, it is reasonable to assume the loss of contents of all drums: 3.2 m^3.

Therefore, process / product contribution is 9.7m^3.

W_E = Extinguishing Medium (Water & Foam)

Automatic fire-fighting systems:

Foam Sprinkler Deluge System designed according to BS EN12845:2015 and BS EN 13565-2:2009. It is designed to deliver 6l/min/m^2 for 30 minutes to the whole area (1000m^2), so in a worst case scenario 180m^3 of foam deluge could be generated.

Fire Brigade Contribution:

Fire Tenders 2 x 1.8m^3 = 3.6m^3

Fire hydrant supply 1,200l/min x 90 minutes = 108m^3

90 minutes based on High Hazard Process as per BS EN12845:2015.

Total: 180 + 108 + 3.6 = 291.6m^3

W_F = Cooling Water for Adjacent Tanks

Cooling water would be provided from the hydrant supply calculated above – confirmed with the Fire Brigade. There are no other buildings or tanks close to the building that required cooling.

R_w = Rainwater Contribution

Process Plant Building A is situated in North-eastern part of the country.

The site has hard standing total area of 8,000m^2,

The maximum volume of rainfall to be included is based on the 1 in 10 year 24-hour rainfall event. Data for a 1 in 10 year, 24-hour rainfall event in the North-east was available from Met Éireann with a value of 53mm returned.

The calculated volume of rainfall over the site is therefore 424 m^3.

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

There is a 50 m^3 underground tank and 15m^3 industrial sized gullies trenches within Process Plant Building A. Therefore, a volume of 65m^3 in total is available directly in the building.

$$V_R = 9.7 + 291.6 + 0 + 424 – 65$$

$$V_R = 660.3$$

Therefore, **660m^3** of firewater retention is required on site.

Method 3 – General Approach

Example: Municipal Waste Storage Building

Relevant Information:

- 8000m^2 building contains compacted municipal waste in non-racked storage,
- Storage of approx. 700 tonnes of waste,
- Area of site: 12,000 m^2,
- Licensed Waste Facility (Non-Hazardous),
- Fire Protection Systems
  - Fire detection and alarm system – no record of design specification, tested annually,
  - No automatic fire protection system,
  - Hydrant ring main.

Summary of FWRA Tool Results:

- Significance of Fire Event - **S3 (High)**
- Environmental Hazard Potential – **H2 (Medium)**
- Firewater Run-Off Risk – **R1**

Firewater Retention Required

Calculation:

The conservative General Approach method is appropriate as there is no available evidence of design in accordance with an appropriate standard.

$$V_R = V_P + W_E + R_w - E$$

Where,

V_R = Firewater Retention Required

V_P = Full volume of Product Loss

W_E = Extinguishing Medium (Water & Foam)

R_w = Rainwater Contribution

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

V_P = Volume of Product Loss

Loss of Inventory: 700 tonnes x 330kg/m^3 (density) = 2,121m^3

W_E = Extinguishing Medium (Water & Foam)

Automatic fire-fighting systems: N/A

Fire Brigade Contribution:

Fire hydrant supply 1,500l/min x 6 Hours = 540m^3

Fire Tenders 4 x 1.8m^3 = 7.2m^3

Water Tenders 2 x 10m^3 = 20m^3

Total: 567.2m^3

R_w = Rainwater Contribution

A site situated in the Midlands.

The site has hard standing total area of 12,000m^2.

The maximum volume of rainfall to be included is based on the 1 in 10 year 24-hour rainfall event. Data for a 1 in 10 year, 24-hour rainfall event in the Midlands area was available from Met Éireann with a value of 47.7mm returned.

The calculated volume of rainfall over the site is therefore 572.4 m^3.

E = Retention Volume Directly Available (i.e. capacity at area on fire only)

There is no retention available in Waste Storage Building.

$$V_R = 2,121 + 567.2 + 572.4$$

$$V_R = 3,260.6$$

Therefore, **3,260m^3** of firewater retention is required on site.

Note: The FWRA Tool can also perform this calculation.

Appendix D
Risk Management Programme

1 Introduction

A completed risk assessment report shall be submitted as part of the site's FWRA assessment. The site will be required to prepare an effective programme of risk management to control fire and run-off contaminated firewater into the environment. The site may submit the risk management programme at the same time as the risk assessment report. It is recognised that control measures will be dictated by the site requirements and characteristics. The fire risk and associated pollution risk at a site will be significantly impacted by the implementation of an effective risk management programme. In such cases, the volume of firewater to be retained and the method of retention can be adjusted to account for such control measures.

1.1 Information required to complete a risk management programme

A risk management programme should include some or all the following procedures:

- Construction of a fire retention facility,
- Alteration, where possible, to the process, infrastructure or procedures (cleaner technologies, waste minimisation, increased cleaning and maintenance),
- Substitution of a potentially polluting raw material,
- Installation of pollution control equipment, structures or procedures,
- Alteration of storage arrangements for potential pollutants,
- Implementation of a new or revised fire safety system,
- Implementation of emergency response procedures,
- Establishment of emergency management structures, delegation of staff responsibilities and provision of fire awareness and response training,
- Developments of a review/audit process to regularly monitor the implementation of risk management measures and ensure their continuing effectiveness.

1.2 Examples of Fire Control and Protection

The following is a partial list of Active Fire Control Systems as a reference to users of this document; this is not a definitive listing. The use of any of these controls as part of a Risk Management Programme will be specific to each site and is not a guarantee of adequate fire control or protection:

- Retention facilities,
- Segregation,
- Site Separation (Compartmentalisation)
- Quantity limits,
- Process and storage arrangements,
- Spill containment & drainage (to prevent releases into public drains and watercourses)
- Fire safety systems,
- Operation controls and procedure,
- Transportation on-site,
- Bunding, construction of dwarf wall around buildings not requiring vehicular access,
- Emergency containment equipment (absorbent, ramps, sand bags and drain protectors).

A partial listing of active fire protection systems includes:

- Automatic Sprinklers,
- Isolating valves,
- Deluge systems,
- Maintenance of systems,
- Public/private firefighting units,
- Fire mains and hydrants,

- Pipe sizing,
- Gas suppression,
- In-house fire fighting capability (Emergency Response Teams)
- Smoke and heat detection system,
- Zoning,
- Roof venting.

A partial listing of passive fire protection systems includes:

- Explosion resistance,
- Explosion relief,
- Adequate site drainage,
- Fire retardants.