Fire water retention - latest guidance for appropriate design

Pat Swords BE CEng FIChemE CEnv MIEMA, PM Group, Killakee House, Belgard Sq, Tallaght, Dublin 24, Ireland

This paper reviews the latest knowledge on preventing pollution from contaminated fire water. The application of such strategies, as controlled burn and appropriate retention of fire water potentially arising from both chemical storage and industrial processing facilities, are discussed. In particular, the latest guidance on how using risk based techniques, the potential for generation of large volumes of fire water should be minimised, which is then reflected in the resulting fire water retention sizing.

General

In November 1986 an estimated 1,350 tonnes of pesticides and agrochemicals in a Sandoz owned warehouse near Basel went on fire. The accident turned the River Rhine red, killed half a million fish and was one of Europe's worst industrial related environmental disasters. On a European level, the original 1982 Seveso legislation, on major accident hazards of certain industrial activities, was as a result updated by Directive 88/610/EEC to strengthen its applicability to the storage of dangerous substances or preparations. However, the issue of sizing suitable fire water retention for industrial facilities was not defined and remained the responsibility of the operator.

If we consider the European Environment Agency (EEA, 2010) in their report on “Mapping the impacts of natural hazards and technological accidents in Europe; An overview of the last decade”, then one would expect there to be a far greater understanding at European level relating to the sizing of fire water retention: *“The record of major accidents shows that few have ecological impacts (22 in 2003–2009). In the past few years the majority of major accidents were explosions, which usually have limited impact on the environment. The plumes of smoke from large fires do create widespread attention, but again have only limited impact on ecosystems. The main threat to ecosystems (as was the case in the 2005 accident at Buncefield, the United Kingdom) is the wastewater from fire extinguishing activities, which may pollute surface water or groundwater if not captured effectively”.*

In reality the EU’s Integrated Pollution Prevention and Control (IPPC) regime is now being revised based on the recent 2010/75/EC Directive on Industrial Emissions. The principle of compliance based on Best Available Techniques (BAT) will remain the same, although increasing weight will be given to the BAT conclusions in the Best Available Techniques Reference Documents for each industrial sector. These are the so-called BREFs, which are currently undergoing an update and revision by the EU’s IPPC Bureau in Seville and are available on its website. Currently in early 2014, the BREF on Common Waste Water and Gas Treatment / Management Systems in the Chemical Sector is in final stages of revision. This states in Section 3.1.5.4.1 on “Managing fire-fighting water and major spillages” that in deciding the appropriate level of containment, a risk assessment is helpful. However, it is short on specific detail:

“In many cases, primary and local containment (bunding) will prevent an incident from causing pollution. However, where local containment is not provided, or risk assessment indicates that additional security is required, e.g. to contain fire-fighting water run-off, which may amount to thousands of cubic metres, then remote containment systems may be employed. These may be used in isolation, or in combination with local containment, for anything from a small area covering part of a site, to a number of large individual installations. They may be required to protect both surface and foul water drainage system. The capacity needed for remote containment systems has to take into account:

- *the potential harm of the contaminated fire-fighting water (evaluation methods based on Risk -Phrases - as defined in Regulation (EC) No 1272/2008 - can be used as well as systems like the German VCI concept on fire-fighting water retention capacity, where hazard classes are defined)*
- *the primary capacity (i.e. the capacity of the vessel in which the material is stored or handled)*
- *the potential amount of rainfall during the emergency event*
- *fire-fighting and cooling water*
- *foam (as a fire-fighting medium)*
- *dynamic effects, such as initial surge of liquid or wind blown waves”.*

In practical terms, the provision of ‘thousands of cubic meters’ of fire water retention can be associated with both large capital costs and in the case of many existing industrial facilities, a lack of space in which to build it. There is therefore an imperative to risk assess from first principles such impacts in a scientific manner, in order to arrive at a practical solution, which can be more realistically implemented.

Guidance from UK and Ireland

Fortunately, in particular in Central Europe, the guidance now available, once correctly applied, assists greatly in this area. However, if we first consider the available guidance in the United Kingdom, this is based around Pollution Prevention Guidance (PPG) notes produced jointly by the Environment Agencies for England, Wales, Scotland and Northern Ireland and available on their websites, in particular PPG 18 and PPG 28. PPG 18 is entitled Managing Fire Water and Major Spillages and while short on specifics, states in relation to fire fighting strategies and run-off management that:

> *"The Plan may consider fire fighting strategies and possible methods of reducing the amount of firewater run-off generated, for example by the use of sprays rather than jets, controlled burn and the possible re-cycling of fire-fighting water, where safe and practicable to do".*

This is clearly highly sensible, in that reduction at source should always be the first option. Indeed, along with the obvious methods of avoiding the fire outbreak in the first place and reducing its potential to spread, the fire should also be fought with the minimum amount of fire water. This naturally minimises the environmental impact. PPG 28 takes this concept a step forward in that it addresses more specifically the concept of controlled burn, and clarifies:

> *"The decision on how to conduct fire fighting operations is governed by the principles of common law relating to reasonableness. In practice, this means there are likely to be circumstances such as the protection of public water supplies, where it would be reasonable for the Fire and Rescue Service Incident Commander to decide to cease - or limit - fire fighting operations because the consequences of continuing would be worse than the destruction of property".*

A good example of the above was illustrated to PM Group during technical assistance work involving the EU accession of Croatia. The thermal power plant in Osijek, located not far from Vukovar, sustained in 1992 during the Croatia – Serbian war some extensive shelling. This set the tank farm ablaze and released an estimated 7,500 tonnes of heavy fuel oil. It was estimated that some 200 x 300 m of clay type soil in the area was contaminated at the time, but little dispersion occurred with no contamination of the River Drava, located just under a kilometre away, which is a major tributary of the Danube and a source of drinking water for the area. Currently there is no evidence of contamination and the tank farm has been rebuilt with two 10,000 m^3 storage tanks and one 20,000 m^3 tank and the power station returned to operation.

It is useful to contrast this with the situation at Buncefield. In Osijek, no fire fighting occurred, due to the shelling which was occurring, so there was in essence a complete burn-out scenario. While the fire and resulting explosion at the fuel depot at Buncefield North of London in 2005, was on a far larger scale, high volume pumps were used to extract 25 m^3/min of water from a reservoir 2.4 km from the fire, with six more high volume pumps deployed at various locations to serve as boosters. Following the accident the Environment Agency declared Buncefield a Major Accident to the Environment (MATTE), as the chalk aquifer under the site was contaminated to a distance of more than 3 km away. Currently the polluted groundwater is being pumped out through several boreholes and treated to remove fuel and fire fighting foam residues. This remediation work is costing € 1.1 million a year and will have to continue for many years (Nicholas, 2013). As regards lessons learnt, it was clear that a controlled burn strategy could have been more effectively applied and this led to a revision of PPG 28 on controlled burn by the Environment Agency.

In Ireland, the draft guidance produced by the Environmental Protection Agency (EPA, 1995), results in unrealistically large retention volumes, as it specifies an inclusion of at least 50 mm of rainfall over the total plant area. Indeed, there is no doubt that the adversarial 'common law' system in some Member States leads to a very conservative and non-specific level of guidance from the regulatory authorities. Fortunately, the 'civil law' system found in Central Europe leads to a more prescriptive and less adversarial approach and there is no doubt that the guidance there, which is addressed below, is far more useful in terms of allowing one to complete a risk assessment and size the necessary retention volume.

German LöRüRl Guidance

It was not surprising that Germany, which bore the brunt of the pollution on the Rhein from the Sandoz fire, developed a building regulation by 1992 on fire water retention (LöRüRl, 1992): "Rules for the Calculation of Fire Water Retention Facilities with the Storage of Materials Hazardous to Water". This guidance was developed from the project group 'Fire Protection in Industry Buildings' from the expert commission 'Construction Supervision' at ARGEBAU, which is the working group of German provincial (Länder) ministries competent for construction. It was then adopted as a building code by each of the 16 Länder in Germany and remains in force to this date without any subsequent alteration.

The key aspect of the LöRüRl guideline is that it is risk based, with the primary consideration being the water hazard classification of chemical substances being stored. The German legislation (VwVwS, 1999) requires that installations for handling chemical substances, which constitute a hazard to water, must be built and operated in such a manner that no contamination of waters, or any other detrimental change in their properties can occur. To ensure this, substances used in such installations must be tested and classified for their water-hazardous properties.

The Federal Environment Agency (Umweltbundesamt) maintains a detailed classification list on its web site. It also provides the procedures for classification of the material directly from the eco-toxicity parameters and / or by the utilisation of the EU's Risk Phrases for Classification and Labelling of Dangerous Substances and Preparations. Indeed, there is also a simple classification rule for mixtures. All products sold in Germany have to be checked for the Water Hazard Classes (WGK) and the classification has to be noted in the Safety Data Sheet. There are three Water Hazard Classes (WGK):

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

The LöRüRl guideline only finds application if the storage quantity in each storage section exceeds 100 tonnes of WGK 1; or 10 tonnes of WGK 2; or 1 tonne of WGK 3. For this calculation, where a mixture of substances occurs; 1 tonne of WGK 3 is considered equivalent to 10 tonnes of WGK 2 and 1 tonne of WGK 2 is considered equivalent to 10 tonnes of WGK 1. The guideline then considers:

- The type of fire brigade (whether public fire brigade or a dedicated work's fire brigade).
- The fire protection infrastructure (fire detection, automatic sprinklers).
- The surface area of the storage section.
- The height of the stored goods, the density of storage and the storage quantity.
- The type of store (in the open air, in buildings and the number of floors in the building, in moveable drums, in moveable and fixed vessels)

There is a clear trend that if inherent safety is applied, such as improved fire detection and response, reduced size of storage section, etc. then there is a corresponding reduction in the size of the retention volume, which has to be provided. Note: A storage section is defined as part of a store, which:

- In buildings is separated from other rooms through walls and roofs.
- In the open is separated through corresponding distances or through walls.

Indeed, the maximum permissible size allowed for a storage section for WGK 1 materials, commensurate with the highest fire protection levels, is 4,000 tonnes or 4,000 m^2 of storage area. Furthermore, the key table in the LöRüRl guideline relates to the retention volume required for storage of WGK 1 materials up to a height of 12 m, where for the lowest level of fire protection, the corresponding retention volume for the largest storage section size (> 1,000 m^2) is 500 m^3. While the guideline does not specifically apply a rainfall allowance, with storage of material of WGK 2 the given values for the volumes in the table are to be multiplied by a factor of 1.5 and with storage of material of WGK 3 by a factor of 2. There is no doubt that this guideline, which over twenty years later is still in force, has stood the test of time. It was also formally adopted by the authorities in Luxemburg, while in practice it is also routinely used for completing fire water risk assessments in Austria and Switzerland.

In Switzerland, there are additionally the "Tank Farm - Guidelines for the Chemical Industry", published by the Basel Chemical Industry (TRCI, 2009). They are applicable to storage facilities and plant tank farms in the chemical and pharmaceutical industry and are listed as Engineering Rules by the Swiss Federal Office for the Environment (BAFU). They contain a good section on design of fire water and tank cooling requirements, which states that:

> *"Sufficient water should be available for tank cooling to operate the deluge spray system for 20 min at maximum capacity or, in case of a catastrophe, for up to 2 hours at 50% capacity, for bed foam blanketing at least 10 min".*

This reflects the trend in Central European guidance that the fire should be fought aggressively in the initial phase, over the two hour timeframe, but in excess of that other solutions, such as controlled burn should be utilised.

Guidance from Province of Hessen

There is also the indisputable fact that while the LöRüRl guideline is extremely useful for circumstances where one is storing dangerous substances, it is not written for the circumstances of production plants or similar processing facilities. Although it is recognised that one could use it in an analogous type manner. However, by 2011 there was a direct calculation method developed by the German province (Land) of Hessen (Hessenweit abgestimmte Empfehlung, 2011) for industrial sites based on empirical data or assessment of the fire load.

In the first case empirical data exists on the typical amount of fire water to be applied and the percentage which evaporates. This derived from the guidance issued in 1988 by working group of the German professional fire brigade managers (AGBF) on fires in industry and commercial buildings. In relation to the necessary extinguishing water at the investigated fires where no automatic systems were installed, for fire areas of less than 100 m^2, an extinguishing rate of 10 l / min/m^2 was evaluated. For fire area of 100 – 200 m^2 the extinguishing rate sank to 3 l /min^2 and remained up to 2,400 m^2 as a constant. 70% of the fires, for which the fire surface area was larger than 200 m^2 and less than 600 m^2, were extinguished within a maximum of 90 minutes. Furthermore, based on research by the fire research centre of Karlsruhe, it can be assumed that half of the applied extinguishing water evaporated. Given this, the following calculation formula can be derived for fire surface areas of 200 to 600 m^2:

Retention volume (m^3) = Fire surface area (m^2) x 0.135 *(1)*

(For a fire surface area of 200 – 600 m^2)

For fires with surface areas greater than 600 m^2, the extinguishing phase lasted with 65% of cases for longer than 90 minutes, therefore an extinguishing time of a minimum of two hours must be applied and correlates with the time frame for which the extinguishing water must be safely provided. In this timeframe, it is also possible to apply additional measures for fire water retention. As a result one derives:

Retention volume (m^3) = Fire surface area (m^2) x 0.18 *(2)*

(For a fire surface area of larger than 600 m^2)

It is accepted with this method that it is a strongly unified calculation method, for which particular risk factors, such as high fire load, are not considered. If there is a presence of particularly flammable water hazardous materials, combustible building components or other particular combustible material, then the second calculation method based on the calculation of fire load is recommended. In this case the fire load of the building itself and its contents are assessed in GJ and related to the heat binding capacity of water (2.6 GJ/m^3). For each fire compartment the mobile fire load Q_m (products, storage media, equipment objects, etc) and the immobile fire load Qi (building fire load, insulation, cladding, etc) are to be considered.

Q_{tot} [Gj] = Q_m [GJ] + Q_i [GJ] *(3)*

The fire loads can be investigated in an analogous manner to DIN 18230, while if there are a number of fire compartments within the relevant object, the determining condition is the fire compartment with the highest fire load. Furthermore, it can be assumed that only half of the extinguishing water reaches the fire and is available for extinguishing. Therefore, for the necessary water for fire fighting, what is calculated in the above manner must be doubled. Half the applied water is associated with heat transfer and evaporation, the other half remains as contaminated fire water and must as a consequence be retained. For the necessary fire water retention volume R_{fw} the evaluated fire load Q_{tot} is divided by the heat binding capacity of water (note units used):

R_{fw} [m^3] = Q_{tot} [GJ] / 2.6 [GJ/m^3] *(4)*

The same guidance recognises that there are additional factors of influence on the retention volume. Firstly, the same correction factors are applied as in the LöRüRl guideline, namely a factor of 1.5 for WGK 2 and a factor of 2 for WGK 3. It is also recognised that the presence of automatic sprinklers prevent the spread of a fire. According to the industry construction regulation, an extinguishing quantity of 96 m^3/h, provided over the hour, suffices with the presence of an automatic fire extinguishing system.

This relates with surface areas of up to 2,500 m^2 to a halving and with larger areas a quartering of the extinguishing requirement on the basis that 96% of all fires are extinguished by sprinkler plants, in which with 70% only four or fewer sprinkler heads are opened. On this basis it can be assumed, that the fire surface area will not exceed a size of 400 m^2, which therefore leads to a capping of the necessary fire water retention requirement. Indeed a capping to an area of 400 m^2 appears as logical. Hence, on average a sprinkler head provides 10 l min/m^2 of water for which the above calculation formula could be applied up to an area of 400 m^2 and for larger areas by applying the value of 400 m^2. This value correlates with the CEA, European insurance and reinsurance federation, recommendation that the fire compartment is predominately to be equipped with automatic fire extinguishing.

In a similar manner the time frame for beginning the fire fighting determines the spread of the fire and thereby the fire surface area. A recognised works fire brigade must be able to deploy within five minutes to the fire location; under such circumstances the fire dispersion and resulting fire surface area is reduced. The investigations of the German professional fire brigade managers (AGBF) in 1988 have shown that with the presence of a works fire brigade the fire surface area can be limited to a size of 400 m^2 and therefore this caps the volume of fire water retention required. However, these circumstances do not apply to higher fire dispersion velocities, such as by an explosion or detonation with a consequential fire. Whether such circumstances apply, has to be determined by risk assessment, if not the 400 m^2 can be applied.

Association of Cantonal Fire Insurers (VKF)

This Swiss association, which publishes in German and French, has a publication on the evaluation of fire compartment sizes in relation to industrial and commercial buildings (VKF, 2007). The fire hazard (B) is defined as the product of all the relevant hazards (P), divided by the product of all the protective factors (M). The potential hazard (P) can be evaluated from:

- The hazard from the contents is derived from; the mobile fire load (q) by the flammability (c) by the smoke formation (r).
- The hazard from the building is derived from the immobile fire load (i) by the gross area factor of the fire compartment (g).
- The multiplication of two above leads to P

B = P / [N xT] where: *(5)*

N are the normal measures, such as fire brigade, internal hydrants, reliability of fire water supply, distance to hydrants, accessibility of the building / fire compartment.

T comprises the technical measures, such as fire detection and alarm, sprinklers, double protection (fire detection and sprinklers).

The effective fire risk R_e is derived by multiplication of B above by an activation factor A. This factor relates to the operational components which are present, such thermal, electrical, mechanical and chemical. In addition sources of hazards including those from human behaviour, such as the system, the maintenance, discipline with hot work, smoking, etc. An acceptable fire risk is $R_a = 1.0$ and a sufficient fire safety occurs where $R_e \leq R_a$.

Clearly there is sophistication in this process, in particular the detailed table for the recommended values in MJ/m^2 for the fire load of different types of installations, such as in the chemical industry, offices, wood processing, food processing, etc. In addition the factors (c), (r) and A above are provided. Similarly data is provided on the heating value in MJ/kg for a wide range of materials ranging from solvents to foodstuffs to plastics. There is no doubt that this comprehensive data finds application in assessing the fire load requirements Q_{tot} previously described in the Hessen methodology.

Planning and Construction of Fire Water Retention – German VdS Guideline

In March 2013 the German insurance industry (VdS, 2013) published a comprehensive risk based guideline, VdS 2257, in relation to assessing fire water retention requirements based on the type and quantity of combustible materials, the fire detection systems, the type of fire brigade and the fire protection technical infrastructure. The scope of the guideline includes all hazards / risk in connection with the occurrence of contaminated fire water from industrial and commercial operations and installations, which is independent of the type and quantity of the material present. Note: Both production as well as storage facilities are included in this scope. The following are the functional steps of the VdS 2257 guideline:

- A hazard and risk analysis in Section 3 of the guidelines, which considers the material hazards and fire properties of the operational materials, construction materials, etc.
- If with the occurrence of a fire contaminated fire water can arise in a hazardous quantity, the necessary fire water can be calculated according to Section 4.
- In order to avoid and control the damage from contaminated fire water organisational measures should be examined, which are described in Section 5.2.
- If the organisational measures are insufficient, technical or constructional measures for fire water retention are to be foreseen (Sections 5.3 and 5.4).
- The requirements for erecting and installing, as well as inspection and maintenance, of fire water retention facilities are described in Section 6.
- The measures in case of an accident are described in Section 7.
- The measures for analysis and aftercare / disposal of the contaminated fire water are addressed in Section 8.

Clearly Sections 3 and 4 are is of most interest to design engineers. These are themselves broken down into the following steps:

- The evaluation of the material properties, including a qualitative assessment of the combustion by-products, i.e. pollutants can arise from the operational materials, from the extinguishing materials and possibly can arise from combustion by-products.
- Evaluation of the combustion properties, such as flashpoints, heating values, fire spread velocities, quantity / fire load.
- Evaluation of further relevant criteria, such as operational environment (water protection area, ecosystem), extinguishing medium (foam materials), drainage system, fire protection technical infrastructure, construction related conditions for the retention of arising fire water (e.g. cellar, bunds, wastewater treatment plant / drainage).

- Hazard and Risk analysis / evaluation. This is first completed in a coarse matter by a Matrix approach to determine if measures for fire water retention have to be applied. If a predominately medium and high evaluation of the material hazard potential occurs it is necessary to complete then the more extensive evaluation of the fire properties as well as further criteria.
- Fire water retention should be therefore foreseen, if with the total evaluation a hazard potential manifests itself, which through the available operational and / or organisational measures cannot be compensated.

The actual calculation of the contaminated fire water is based on a similar approach to that described previously for Hessen and for ease of use is contained in a calculation sheet VdS 2557a, which can be downloaded from the web and filled in. The relevant formula is based on:

$V = \{(A_{tat} \text{ x SWL x BAF x BBF}) + M\} / BSF$ where: *(6)*

- V [m^3] is the calculated volume of contaminated fire water to be retained
- A_{tat} [m^2] is the actual surface area of the fire section
- SWL [m^3/m^2] is the specific water input
- BAF is the fire section area factor [dimensionless as provided in VdS 2257]
- BBF is the fire load factor [dimensionless as provided in VdS 2257]
- M [m^3] is the quantity of all liquid production, operational and storage related materials with or without a WGK classification in each of the fire sections being considered.
- BSF is the fire protection factor [dimensionless as provided in VdS 2257]

Indeed, what is of importance to note is the conclusion of Section 4 in that if the evaluated fire water volume exceeds 1,000 m^3, it is strongly recommended to reconsider the evaluation, with the limiting of the fire section areas and the installation of stationary fire extinguishing systems.

Options for Fire Water Retention

Clearly the design basis for calculating fire water retention has greatly evolved in Central Europe. Equally so are the possibilities for implementing such a retention volume. The Hessen guidance in Annex 3 identifies that such facilities can be divided on the basis of their functionality into groups. For new facilities it is fundamentally required that systems of Group I and II are applied, as these require neither organisational nor personnel related additional measures to guarantee their application. Group I, the self-acting effectively constructed systems comprise:

a) Construction of the storage area as a bund (alternatively with door threshold, ramps)

b) Construction of the storage area as a bund in under-floor design

c) Retention volume in a suitable cellar floor with free drain down

d) Drain system or drainage area / slope area into adjacent bund.

Group II systems comprise automatically activated stationary technical systems. These are systems with which the necessary retention volume is guaranteed after the implementation of technical measures, which are automatically activated and set into operation. Examples are automatically applied fire water barriers, which in the case of fire, and its detection by such as smoke or heat detectors, are automatically steered into position.

a) 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.

b) Liquid driven spill barrier. The fire water as it runs out automatically raises the spill barrier, without any external energy being required.

Group III systems comprise non-automatically activated stationary technical systems, which are systems in which the necessary retention is only guaranteed after the implementation of organisational and technical measures.

a) Manual swinging barriers. In the case of emergency, these can be manually swung into their functional state, although this can be problematic as it requires entry to the area of hazard. Furthermore, outside of operational hours, the barriers should be put into position.

b) Manual insertable barriers. As above, but lifted rather than swung into place.

Group IV systems are mobile systems, in which the necessary retention volume is only functionally ready following the organisational and technical measures. The fire water retention system must first be brought to the point of use, for example:

a) Mobile tube system, such as a double tube, which are filled with water at the relevant location. The static force of the retention system is guaranteed by the weight of the water in the filled hose. However, such systems are both labour and time consuming.

b) Drain covers, which prevent the ingress of liquids into the drainage network. However, this doesn't necessarily guarantee a retention volume.

c) Drain balloons, which can be inflated in the drainage system to seal it and thereby create a retention volume. However, in strong waste water flows the setting of these balloons can be problematic.

Figure 1: Manual Swing Barrier at door and application of double tube mobile system

Note: Not only are there a number of companies now providing such products but the VdS has also issued a guideline, VdS 2564-1, on the requirements and testing methods for stationary fire water retention barriers (VdS, 2004).

Conclusions and Future Developments

What this article demonstrates is that there is an established and rational methodology now available for designing and implementing a risk based approach to retention of potential contaminated fire water. In particular the emphasis should be placed on controlling the size of the relevant plant / storage section and the application of systems for the rapid detection and commencement of fire fighting. This inherent safety approach not only reduces potential material loss, but also reduces the potential for environmental harm, thereby also reducing the requirements in relation to collection and storage of contaminated fire water. Indeed, for situations where it is unavoidable that there is a large fire load, such as in a solvent or fuel tank farm, then consideration should be given to strongly fighting the fire for the first two hours and if this is then unsuccessful, to then consider a controlled burn-out strategy. Experience has repeatedly shown that while the plumes of smoke from large fires do create widespread attention, they only have limited impact on ecosystems, a position which is very different from what the impact of large volumes of contaminated fire water can do.

There is no doubt that for many industrial installations, the construction of fire water ponds of thousands of cubic meters, based on a 'knee jerk' reaction to the fire water risk and the potential for simultaneous occurrence of extreme rainfall events, is simply not an option. The above analysis has already demonstrated how this is not risk proportionate and in particular regard has to be given to the developing situation with regard to the Environmental Liabilities Directive 2004/35/EC. This Directive is a framework to prevent and remedy environmental damage to protected species and habitats, water and land. While its implementation to date has been fragmented, coupled with a general lack of understanding of it by, industry, the general public and environmental NGOs, its scope and breath is very wide.

The principle behind the legislation is rather simple: An operator whose activity has caused the environmental damage or imminent threat of such damage should be held financially liable, in order to induce operators to adopt measures and develop practices to minimise the risks of environmental damage, so that their exposure to financial liabilities is reduced. Certainly in terms of the potential for fire water to occur in conjunction with an extreme rainfall event, a 'happy medium' has to be found between the costs of pollution prevention related to the worst case possible environmental incident and the insurance costs associated with the resulting environmental liabilities if that incident were to occur.

In other words if the cost of building retention for the extreme event is orders of magnitude above that of the cost of environmental liability insurance, then certainly the preferred approach for the operator is clear. In addition, it also has to be considered that the premium for the environmental liability insurance will be based on evaluation of the potential environmental incident, such as the sensitivity of the receptor, the nature of the facility, the fire prevention and mitigation procedures of the facility and the track record of the operator. However, equally for a high hazard facility in a sensitive location, the insurance premium will be large, such that increased investment in retention facilities to reduce the risk would be appropriate. This actually is the core aim of the legislation.

Indeed in a recent article in the German process safety magazine Technische Sicherheit (Wunderlich, 2013), it was explained how the insurance industry, in this case Aon Risk Control, Claims & Engineering, has a European wide applied, computer supported system adjusted to the relevant legal framework to determine the so called 'environmental priorities'. This system uses the evaluation of diverse geo-information systems, telephone audits with employees, as well as chosen documentation from companies. On this basis the evaluated characteristic factor for the facility, material and activity risk can be coupled to a risk factor for the environmental surroundings. An operating company then receives a clear priority list with the highest, medium and lowest environmental risk of their locations. Naturally this feeds into such decisions as environmental investment or insurance coverage.

As the European Court has consistently ruled in a wide variety of cases; "the principle of proportionality is one of the general principles of European Union law, it requires that measures adopted by Member States do not exceed the limits of what is appropriate and necessary in order to attain the objectives legitimately pursued by the legislation in question; when there is a choice between several appropriate measures recourse must be had to the least onerous, and the disadvantages caused must not be disproportionate to the aims pursued".

If we go back to the beginning of this article and the reference to the 2010/75/EC Directive on Industrial Emissions, this requires in Article 11 in relation to the general principles governing the basic obligations of the operator:

> *Member States shall take the necessary measures to provide that installations are operated in accordance with the following principles; ….. the necessary measures are taken to prevent accidents and limit their consequences.*

Clearly, in compliance with the principle of proportionality, the requirement is to limit the consequences of accidents by appropriate means, as opposed to ensuring that the consequence of potential accidents is reduced, through incurring very heavy expenditure, to near zero levels. As this article demonstrates, there is now a clear knowledge basis on how this can actually be pragmatically implemented.

References

EEA (European Environment Agency), 2010, "Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade". Available on the website of the EEA

EPA (Environmental Protection Agency), 1995, "(Draft) Guidance Note to Industry on the requirements for fire-water retention facilities". Available on the website of the Irish EPA.

Hessenweit abgestimmte Empfehlungen - Vollzug des Gebotes zur Rückhaltung verunreinigter Löschmittel im Brandfall (Hessen wide agreed recommendations - Full implementation of the requirement for retention of contaminated fire water), 2011. Available on the website of the German State environmental agency of Hessen

LöRüRl - Richtlinie zur Bemessung von Löschwasser-Rückhalteanlagen beim Lagern wassergefährdender Stoffe (Guideline for the evaluation of fire water retention with the storage of water hazardous materials), 1992. Available on the website of the State environmental agencies in Germany.

Nicholas, M, Whitfield, A, 2013, "The Buncefield Accident and the Environmental Consequences for Fuel Storage Sites and other Sites in the UK, Regulated under the Seveso Directive". Chemical Engineering Transactions, 31: 457-462

TRCI "Tank Farm Guidelines for the Chemical Industry", 2009. Available on the website of the Swiss environment agency (BAFU).

VKF Vereinigung Kantonaler Feuerversicherungen – Bewertung Brandabschnittsgrössen, Sicherheitsnachweis bei industriellen und gewerblichen Nutzungen, Berechnungsverfahren, (Association of Cantanol Fire Insurers – Evaluation of fire section sizes, safety information for industrial and commercial use, calculation methodology), 2007. Available on the website of the VKF.

VdS 2557 Leitlinien zur Schadenverhütung der deutschen Versicherer – Planung und Einbau von Löschwasser – Rückhalteeinrichtungen (Guideline for loss prevention of the German Insurers – Planning and construction of fire water retention facilities), 2013. Available on the website of the VdS.

VdS 2564-1 VdS Richtlinien für Löschwasser Rückhalteanlagen - Bauteile und Systeme (Regulations for fire water retention facilities – Construction components and systems), 2004. Available on the website of the VdS.

Wunderlich, M 2013, "Grundlagen eines effektiven Umwelthaftungsmanagements" (Fundamentals of an effective management of environmental liabilities). Technische Sicherheit, Juni 2013: 43-46