Guidance Note: GN01

Firefighting Water Supply Considerations for Special Hazard & Dangerous Goods Sites

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FIREFIGHTING WATER SUPPLY CONSIDERATIONS FOR SPECIAL HAZARD & DANGEROUS GOODS SITES

1. Purpose

This Guidance Note (GN) is intended to provide guidance to designers, consultants, Building Surveyors, business operators and approving authorities on the Fire & Emergency Services (FES) Commissioner's requirements for firefighting water supplies at special hazard sites and dangerous goods sites where existing legislation and referenced standards do not provide prescriptive solutions.

2. Scope

The term "special hazard" refers to a site which has been deemed a special hazard in accordance with the provisions of the National Construction Code (NCC)/BCA Volume 1 Part E1.10., and as discussed in Australian Standard 2419.1 Clause 1.1 Scope, and Appendix H Special Hazards.

NCC / BCA Part E1.10 Provision for Special Hazards

Guidance because of,

a) The nature or quantity of materials stored, displayed or used in a building or on the allotment or
b) The location of the building in relation to a water supply for fire-fighting purposes.

DFES acknowledges that some sites may present special problems for firefighting which do not require consideration of an enhanced water supply and as such this GN may not be entirely applicable.

Special hazard and dangerous goods (DG) sites often contain increased fire loads or present challenging firefighting scenarios.

Special hazard and DG sites may include structures having an NCC occupancy classification. Where the site includes a structure that has an NCC Classification of 2 to 9, the provisions of NCC Part E1.10 "Provisions for Special Hazards" may apply.

Although the NCC references Australian Standard (AS) 2419.1 Fire hydrant Installations, most special hazard sites with high fuel loads or sites which present challenging firefighting scenarios are not within the scope of AS 2419.1 in respect of fire water flow rates and duration of supply. AS 2419.1 should however be used for all remaining aspects of a hydrant system design to ensure compatibility with fire service equipment and procedures, and to deliver an adequate and demonstrable level of quality.

Some DG sites require Licensing by the Department of Mines, Industry Regulation and Safety (DMIRS). It must be confirmed to DMIRS (usually by a dangerous goods consultancy) that **the firefighting provisions at a DG site is "appropriate"**, refer DMIRS (**Guide**) – Dangerous Goods Safety (Storage & Handling of Non-explosives) Regulations 2007 Part 6 Emergency Management. Depending on site use, there may also be a requirement to gain approval from the Department of Water and Environmental Regulation (DWER) where a premises is prescribed in Schedule 1 of the *Environmental Protection Regulations 1987*.

Australian Standard (AS) 1940 "The storage and handling of flammable and combustible liquids" Section 11, "Fire Protection", prescribes requirements for fire protection at certain DG sites, however the scope of AS 1940 is limited to combustible and flammable liquids. It is DFES' view that those requirements should be further analysed to ensure differing fire scenarios and the Fire Service resources available to respond to the site are considered.

Sites considered as special hazards by DFES may not necessarily be within the administrative control of DMIRS, for example a site storing or processing large quantities of rubber tyres, tall external racking systems for storage of boats, timber storage yards, etc. Such sites are generally controlled by Local Government, Department of Planning, and DWER. There are no specific fire hydrant system design requirements that are readily applicable in terms of total flow and duration of supply. Such fire hazards / sites will require a fit for purpose design which supports the likely actions of the responding fire service to achieve objectives. Consultation with the Fire Service should be a key element of the design process – DFES Built Environment Branch.

This GN provides points for consideration when determining the appropriateness of a fire water supply, however it does not provide a prescriptive compliance recipe as every site will be different and will require assessment by a suitably qualified person, e.g. Fire Engineer in conjunction with a Subject Matter Expert (SME) relevant to the risk (DG consultants etc.).

3. Issues

What is a “special hazard”?

In general terms a special hazard is any land or structure in the built environment that has a use that may potentially:

- Present greater than average strategic challenges to firefighters when responding to a fire.
- Prove difficult to control or extinguish a fire due to limited response availability.
- Prove difficult to control or extinguish a fire due to type of materials involved.
- Prove difficult to control or extinguish a fire due to the storage configuration.
- Prove difficult to control or extinguish a fire due to access restrictions (to firefighters and appliances).
- Present extraordinary hazards to occupants, neighbours, environment, and firefighters (pollution, explosion, engulfment, toxins, etc.).

An emerging industry is the recycling or remanufacturing of previously processed materials. This trend has resulted in an increase of potential special hazard sites as combustible materials may be stored in a manner that promotes rapid fire spread and or provides limited access to fire fighters, e.g. scrap metal yards, tyre recycling or storage yards (and buildings), plastics and paper recycling facilities, etc.

An important preparation that can be made is meeting the operational needs of those who respond to and are tasked with dealing with fire incidents.

Figure 1: Tyre fires can present challenging firefighting scenarios

Figure 2: Gas Plant Fire. Challenging Firefighting Scenario

4. Fire Water Supply Capacity – What are the Requirements

It is generally appreciated by industry that fire water supplies at special hazard and/or DG sites will often need to be enhanced to meet DFES' operational requirements, however determining an effective water supply for a special hazard or DG sites is not possible using a purely prescriptive (deemed to satisfy) approach.

There are several regulatory documents that confirm an enhanced water supply needs to be considered, for example:

- **Australian Standard 1940-2004 "The storage and handling of flammable and combustible liquids"** doesn't prescribe fire water quantities for higher end storage quantities at DG sites, instead it requires a "Fire Safety Study" be undertaken which should include consideration of water supplies. However, there is no guidance provided in the standard for the undertaking of Fire Safety Studies.
- **NCC / Building Code of Australia Part E1.10 "Provisions for special hazards"** The NCC recognises that some building uses will present special problems for fire-fighting and confirms that additional provisions should be made. The NCC / BCA provides no prescriptive guidance on what the additional provisions are to be.
- **NCC / Building Code of Australia - Performance Requirement EP1.3** states as a performance requirement:

- A fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to—
  - Fire-fighting operations
  - The floor area of the building and
  - The fire hazard.

- **Australian Standard 2419.1 Fire Hydrant Installations, Part 1: System design, installation and commissioning** does contain prescribed firefighting water supply requirements; however, the standard clarifies in the scope that the standard is not applicable (except for design guidance) to special hazards. It makes reference to Appendix H in the standard for guidance; however, whilst Appendix H in the standard confirms there should be further consideration given to pressure, flow rates, and duration of water supply, it also does not offer any prescriptive solutions.

5. DFES Specific Obligations

Below is an extract as part of the Fire Brigades Act relevant to this GN. It is included to provide clarity of the obligations of the FES Commissioner when responding to a special hazard or DG site incident, so they can be considered in the design and approvals processes.

Fire Brigades Act 1942
Part VI General powers and duties of Minister and FES Commissioner

s. 25

25. Functions of FES Commissioner

Subject to this Act, the functions of the FES Commissioner under this Act are —

(a) to take, superintend and enforce all necessary steps for preventing and extinguishing fires and protecting and saving life and property from fire; and

(b) to take all practicable measures —

(i) for protecting and saving life and property endangered by hazardous material incidents; and

(ii) for confining and ending such an incident; and

(iii) for rendering the site of such an incident safe;

5.1 Clarification of the FES Commissioner's Obligation

"To take, superintendent and enforce all necessary steps for preventing and extinguishing fires and protecting and saving life and property from fire".

5.2 Objectives

Whilst compliance with acts, regulations, codes, standards etc. are typically the primary objectives of Fire Engineers, Building Surveyors, Dangerous Goods Consultants, Hydraulics Services Consultants, Site Operators and Architects, there are underpinning objectives within those requirements that should be treated as the design objectives by designers, consultants and regulators.

The functions of DFES as a response agency to incidents are very much dependent on the underpinning objectives of relevant legislation being adequately considered during design stages.

5.2.1 Prevention

The importance of taking appropriate measures to reduce the likelihood of the outbreak of fire or the escalation of a fire to a catastrophic level in a special hazard or DG site cannot be overstated. There are several standards and codes of practice in place that prescribe prevention measures at special hazard and DG sites and these are generally closely adhered to by professional DG site operators. Conversely, there are operators who may be completely unaware of the special hazard they have created and subsequently take little or no additional measures to manage it.

5.2.2 Extinguishing Fires

Extinguishing a fire that involves materials which inherently resist extinguishment by application of water or are stored in a manner which makes extinguishment difficult, e.g.

- Oxidising agents
- Very low temperature ignition properties
- High heat retention materials
- Exist in a high vapour pressure state
- Deep fire seats in piled storage
- Vertical configuration or large area of stored materials, etc.

The above typically require a water-based fire attack much longer than that required to extinguish a fire in or around a factory or warehouse that has an average fire load and is stored in a readily accessible arrangement.

A longer (than 4 hour) water duration may not be the only element critical to achieve the FES Commissioner's extinguishment responsibility, in many cases keeping certain materials, vessels, and neighbouring properties cooled for lengthy periods may be necessary to avoid increased losses or a catastrophic event.

5.2.3 Protecting and Saving Life and Property from Fire

Saving people from the effects of fire is DFES' top priority. Site designers and operators may assume a successful rescue of life will occur early in a fire brigade response to an incident, well before water supply depletion becomes a consideration. Whilst this can be true in average circumstances, such assumptions are concerning when adapted into the design and operation of special hazard and DG sites.

When considering that a catastrophic event can occur at any stage of an incident due to a shortage of cooling water, this can result in a significant life risk in the vicinity of the incident including neighbouring properties and communities. It is reasonable to conclude that water duration is relevant to the FES Commissioner's obligation of protecting lives.

The protection of property from a fire at a special hazard or DG site is also a major consideration, not only for the interests of the site operator and employees, but also for the protection of neighbouring properties and the environment.

5.3 Other Points Requiring Consideration

There are other factors that need to be considered when determining an adequate water supply at a special hazard or DG site. The following points should not be considered exhaustive, they are provided as examples of further consideration for site designers or operators.

5.3.1 Location of Site

The geographical location of a special hazard or DG site is a key point when considering the adequacy of water supplies due to:

- Volunteer Fire Stations are not permanently staffed and crews.
- Response times to a site are longer than those in the metropolitan area.
- On arrival at an incident, fire development is likely to be more advanced.
- The likelihood of a timely extinguishment of the developing fire is reduced.
- A special hazard or DG site fire incident may see a focus on preventing the fire from spreading to adjacent farming or wooded property or a neighbouring town site.

5.3.2 Limitations of a Volunteer Fire Service Response

- Number of specialised HAZMAT/CBRN trained personnel.
- Number of personnel qualified in structural firefighting.
- Limited specialist equipment.
- Immediate fire ground HAZCHEM advice – dependent upon connectivity.
- No availability of aerial fire appliances.
- Limited pumping capabilities, (on-site pumps required).
- Lack of or limited availability of off-site water supplies.
- Limited availability of manpower.

- Limited rest opportunities for crews at prolonged incidents in more remote locations.

5.3.3 DFES Application Considerations

The types of appliances deployed to a fire at a special hazard or DG site will have a bearing on the volume of water required for firefighting operations.

For example, if a fire occurs in a used tyre storage yard that hasn't applied the appropriate fire separation practices to limit fire spread (refer GN02), this may result in the use of an aerial appliance, as getting water to the fire seat using hand lines may not be possible. It should be noted that aerial appliances are currently only located in the metropolitan area.

The significance of this is that aerial appliances can potentially apply water onto the fire at a rate of 70 litres/second. When considering there may be other appliances simultaneously drawing from the water supply at 20 litres/second, resulting in a total drawdown on the supply of approximately 90 litres/second.

5.3.4 Protection of the System

It is important to consider several incident scenarios, e.g., explosion, collapse, etc. to ensure the firefighting water supply and reticulation systems are adequately protected.

There is little point providing a good water supply at a site if it is unavailable due to an incident that it has been installed to protect.

Additionally, simple installation oversights can impact systems. For example, it may have been analysed that an 8 hour water supply is required, however if the diesel tank at the stand-by fire pump set only holds a 4 hour supply then the enhanced supply is compromised. Consider all designs systematically.

5.3.5 Availability of Water Supply

The geographical location of an existing or proposed site can have a significant bearing on the design and cost of a fire water supply.

If there is no water supply agency main in the vicinity or the main serving the site has a poor performance, then this will influence the size of water storage tanks. Note, it may be acceptable to reduce tank sizes based on the amount of reliable automatic infill to a tank to achieve the required duration. It should also be considered that where there is no publicly accessible mains in the vicinity, all water for firefighting will need to be transported to the site, including top ups from regular system testing / maintenance.

Operators of DG related businesses may change location into larger or more commercially suitable (existing) premises but neglect to ensure the existing water

supply is appropriate to the hazard they introduce to the building and neighbourhood. It is important that due diligence processes include an assessment of fire water.

6. How Much Water Should Be Provided

The quantity of water required is dependent on several interdependent factors and is not quantitatively prescribed in this GN. This calculation should be conducted by a hydraulic consultant in conjunction with the GN.

The water requirements will vary when considering:

- How fire will develop?
- How long it will burn?
- What is the appropriate water usage strategy ? Protect or extinguish ?
- Who and or what systems are using it ?

Even though sites can seem similar in many ways, the appropriate answers to the above questions vary from one site to another.

There are numerous points that need to be considered when determining adequacy of a water supply, the following should be used for initial guidance. An analysis by a suitably experienced Fire Engineer that considers all requirements should determine accurate design requirements.

6.1 Duration of Firefighting Water Supply

The duration of a water supply and the peak flow rates must be configured to match the likely duration of the fire event and support DFES objectives, in particular the extinguishment of the fire and the site being rendered safe.

The following is an initial scan of what needs to be considered:

- Does the scope of AS2419.1 preclude use of that standard?
- Would the provisions of NCC/BCA Part E1.10 likely apply?
- Is a 4 hour water supply (as prescribed by AS2419.1) adequate to deal with the likely duration of a fire considering type, volume, and storage arrangement of content?
- Is the 90 minute supply as prescribed in AS1940 a realistic interpretation of what will be required to handle an incident at a potential flammable liquids fire?

As an example only, the 1981 Institute of Petroleum - Refining Safety Code states that for a major process fire, the fire water flow rates required will be in the order of 208 to 416 litres per second to permit foam generation and cooling sprays. These flow rates are not available from water supply agency mains. Consumer mains in Western Australia typically only provide between 10 - 40 litres/second, depending on location. Water agency mains are primarily intended for domestic flows. They are not generally designed to provide firefighting water.

Considering flow rates mentioned in the Institute of Petroleum document above, to meet the AS1940 prescribed duration of 90 minutes at flammable liquid storage facilities, it is conceivable that the on-site water storage capacity would need to be around two million litres.

Where there is a structure involved and the AS2419.1 prescribed 4 hour supply is to be additionally provided, then the total water storage capacity required to provide a flow rate of 200 litres/second is around 2.8 million litres.

The scale of these storage capacity figures should prompt designers and site operators to consider the adequacy of a typical AS2419.1 prescribed 288,000 litres supply at a special hazard or DG site.

6.2 Quantification of Flow & Volume Required Using Established Data

The Australasian Fire and Emergency Service Authorities Council (AFAC) Fire Brigade Intervention Model (FBIM) provides guidance to designers on the efficacy of water used on different materials having different heat release rates (HRR) in respect of what flow is needed to achieve decay in fire development. Whilst it is very much a generalised guide when using the fire load density values listed in the International Fire Engineering Guidelines, (Download PDF Copy) it can reasonably be used by designers or site operators to gain an appreciation of what is needed as a minimum to permit the Fire Service to commence working.

7. Assessment Tools

The following information is largely based on the methodology for determining water supply flow rates for various materials to achieve a continuing fire decay phase. This is a broad-based approach and a more in depth analysis using “known or accurately quantified values” at a site is required.

7.1 Fire Size on Arrival of Fire Service

The estimated fire size on arrival of the Fire Service and the corresponding HRR will have a bearing on the quantification of required water supplies. There is guidance in the FBIM for a Fire Engineer to make a reasonable judgement of this.

Once estimated, the fire size and the HRR can then be used as the basis for determining a water supply requirement based on the established heat absorption capacity of water.

Initial determinations based on a given water supply will provide 1 of 3 possible results:

- Fire continues to grow.
- Fire reaches a steady state.
- Fire goes into a decay phase.

Theoretically, a continued decay may be achieved where the cooling capacity of the water reaching the fire is equal to, or exceeds, 110% of the HRR.

7.2 Objective – Extinguish or Control

Extinguishment is the preferred objective for many reasons, however a Fire Engineer may present an argument that a steady state (water controlled) fire will achieve a desired objective.

This argument may be put in the context of; ***the highly flammable fuel contained within a structure will be consumed within a short time, and as such the fire will not break out of the compartment or cause structural collapse before the majority of the fuel is consumed.***

A designer may alternatively conclude that due to a high and sustained peak HRR that an automatic fire sprinkler system is an appropriate measure.

It is expected that for a scenario such as a tyre storage facility fire, an approach based on achieving a steady state until fuel is consumed would not achieve the objective due to the propensity of tyres to burn for a very long time, possibly measured in numbers of days if not extinguished. It would also be in the interest of the property owner, property insurer and environmental regulators that a fire is extinguished as quickly as is reasonably possible.

7.3 Internal and External Fire Scenarios

The efficacy of the water used varies considerably depending on the fire environment. There are several factors that will influence fire development within a structure that may not apply to an open-air fire. There are also environmental influences on the efficacy of water used on an external fire, e.g. wind, no smothering steam assisting, see figure 3.

Figure 3: Significant Effect of Wind on External Attack

In theory, for an internal fire, a hose stream delivering 5 Litres / second will achieve an extinguishing capacity of 8 MW, however an external fire will require a hose stream delivering 10 litres / second to achieve an extinguishing capacity of only 5.25 MW, see Tables 1 & 2.

The tables below provide a general guide to the results achieved using various water flow rates on various fire sizes and the different results achieved. The results are heavily dependent on the fire being in either an internal or external environment.

Table 1: Effect of Internal Fire Attack

EFFECT OF INTERNAL FIRE ATTACK					
Applied Water (L/s)	**HRR (MW)**	**110% HRR**	**90%HRR**	**Cooling Capacity (MW)**	**Result**
5	**5**	**5.5**	**4.5**	**8**	**Decay**
10	**10**	**11**	**9**	**16**	**Decay**
20	**30**	**33**	**27**	**32**	**Constant**
20	**40**	**44**	**36**	**32**	**No Effect**
30	**40**	**44**	**36**	**48**	**Decay**
30	**50**	**55**	**45**	**48**	**Constant**

Table 2: Effects of External Fire Attack

EFFECT OF EXTERNAL FIRE ATTACK					
Applied Water (L/s)	**HRR (MW)**	**110% HRR**	**90%HRR**	**Cooling Capacity (MW)**	**Result**
10	**5**	**5.5**	**4.5**	**5.25**	**Constant**
20	**10**	**11**	**9**	**10.5**	**Constant**
30	**10**	**11**	**9**	**15.75**	**Decay**
40	**15**	**16.5**	**13.5**	**21**	**Decay**
40	**30**	**33**	**27**	**21**	**No Effect**

8. Verification

Following an analysis of the required water supply, the result may be discussed with DFES to verify that the analysis has realistically accounted for a DFES response and that the assumed DFES equipment used, including pumping and aerial appliances, is accurate.

A determination of water supplies required may also be an element of a Fire Safety Study/Analysis undertaken by consultants and engineers operating in this field. It is

important for the integrity of the study/analysis that it reflects a realistic response as closely as possible to ensure all interdependent considerations are valid for the site.

9. Major Hazard Facilities – Dangerous Good Sites

The information provided in this GN should not be considered as the only factors requiring consideration. Regulatory requirements may require a more in-depth approach, e.g., Australian Standard 1940 2004 requires a Fire Safety Study to be undertaken for certain significant sites. For further guidance on the development of a fire safety study you are encouraged to reference NSW Government Fire Safety Study GNs.

10. Conclusion

Whilst DFES acknowledges that not every special hazard or DG site will require extensive increases in volumes of water due to the nature of the hazard or DGs stored, it is important that consultants, designers, approvers, and operators acknowledge that there will be situations where professional design and operation of special hazard and DG sites will require a firefighting water supply capacity above generic quantities prescribed in codes and standards.

KEY MESSAGE

- Firefighting water supplies must be adequate for the circumstances
- Fire systems at special hazard or DG sites should not be considered as an adjunct to the facility that needs to be complied with, but as an integral part of business
- Consult with DFES early in concept design stages
- Don’t think compliance is the only objective
- The FES Commissioner has a duty to respond to the site, the site has a duty to respond to the FES Commissioners operational requirements
- Don’t regard standards as maximum requirements
- A compliance benchmark in a standard may not necessarily translate to compliance in respect of meeting DMIRS (& DFES) requirements of adequacy/safety
- A compliance benchmark in a standard does not necessarily translate to meeting the site owners / operators’ requirements for business sustainability
- Check the available water supplies when considering suitable locations to build or occupy
- Preventative measures will not prevent fires in absolute terms, but can significantly decrease the likelihood and impact

11. References

National Construction Code/BCA, ACT, Australia. Australian Building Codes Board

Australian Standard 1940. Storage and Handling of Flammable and Combustible Liquids

Australian Standard 2419.1 Fire Hydrants Installation – Part 1: System, design, installation and commissioning

DMIRS Dangerous Goods Safety (Storage and handling of Non-explosives) Regulations 2007 — Guide

HIPAP 2: Fire Safety Study GNs January 2011

State of New South Wales through the Department of Planning

1981 Institute of Petroleum - Refining Safety Code

Australasian Fire Authorities Council - Fire Brigade Intervention Model V2.2 Oct 2004

International Fire Engineering Guidelines 2005

12. Legislation

Building Act 2011

Building Regulations 2012 (as amended)

Fire Brigades Act 1946

Dangerous Goods Safety Act 2004

Dangerous Goods Safety (Explosives) Regulations 2007

Dangerous Goods Safety (General) Regulations 2007

Dangerous Goods Safety (Major Hazard Facilities) Regulations 2007

Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007

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Should the information provided in this Guidance Note require further clarification, please contact DFES Manager Critical Infrastructure/Heavy Industry (08) 9395 9300.

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