



GEGHA Initial Fire Protection System Study

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To	Owen Hobbs PM Hiringa	Contact No.	+61 429 200 177
Copy to	Steve Yeardley, Tim Lloyd-Smith	Email	ohobbs@hiringa.com.au
From	Patrick McCluskey, Mick George	Project No.	12625852
Project Name	Good Earth Green Hydrogen & Ammonia (GEGHA) – FEED		
Subject	Initial Fire Protection System Study		

1. Study description

This concept study shall be used to provide the basis for the initial fire water design scope undertaken by GHD based on the Work Health & Safety Regulations, Australian Standards and consultation with Fire & Rescue NSW (FRNSW) and the Rural Fire Service (RFS).

Water suppression has been the primary method of suppression established for the intended fire protection systems. However, the deployment of localised foam has also been considered.

The focus risk area of this study will primarily be the anhydrous ammonia storage tanks and hydrogen storage tanks.

1.1 Scope and limitations

1.1.1 Scope

The scope of works includes the initial assessment for the firewater requirements to the facility and its battery limits. The requirement for fire systems is subject to a Fire Risk Assessment and Fire Safety Study in accordance with the Hazard Industry Planning Advisory Papers (HIPAPS), FRNSW and RFS consultation.

The defined scope of work includes calculating various fire suppression systems including:

1. Fire hydrants and fire monitors
2. Deluge cooling water sprays systems
3. Gaseous suppression systems
4. Foam suppressions systems.

A summary of the bushfire planning requirements has also been outlined for the initial study.

GHD have not undertaken a review of the neighbouring solar farm fire system requirements.

1.1.2 Limitations

This technical memorandum has been prepared by GHD for Hiringa Energy Pty Ltd. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

1.2 Legislative requirements

The NSW Work Health and Safety Regulation 2017 requires a person conducting business or undertaking (PCBU) to manage risks to health and safety associated with using, handling, generating, or storing a hazardous chemical at a place of work. They are required to:

- Eliminate risks to health and safety so far as it is reasonably practicable; and
- If eliminating these risks is not reasonably practicable, risks should be minimised so far as is reasonably practicable.

To minimise risks, so far as reasonably practicable, one or more of the following needs to be considered:

- Substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk,
- Isolating the hazard from any person exposed to it,
- Implementing engineering controls.

It also requires that a PCBU to review, and as necessary revise, control measures implemented under the regulation. This is done to maintain a work environment that is without risks to health and safety, so far as reasonably practicable.

Division 9 of the Work Health and Safety Regulation 2017 requires a PCBU at a workplace to ensure that, where flammable or combustible substances are kept at the workplace, the substance is kept at the lowest practicable quantity for the workplace.

Furthermore, in accordance with Subdivision 3 of the WHS Regulation and the Managing Risks of Hazardous Chemicals in Workplace Code of Practice, there must be assurance that the fire protection and firefighting equipment:

- Is designed and built for the types of hazardous chemicals at the workplace in the quantities in which they are used, handled, generated, or stored at the workplace.
- Is compatible with firefighting equipment use by the primary emergency service organisation.
- Is properly installed, tested, and maintained.

When installing a fire protection system, the following also needs to be considered:

- The fire load of the hazardous chemicals and from other sources; and
- The compatibility of hazardous chemicals with other substances or mixtures at the workplace; and
- The compatibility of the equipment with equipment used by the primary emergency service organisation.

1.2.1 Major hazard facility

Based on the observed quantity of hazardous chemicals presented for the facility, the minimum threshold requirements for anhydrous ammonia exceed the level threshold requirements from Schedule 15 of the WHS Regulation.

The conceptual plot plan discloses evidence that the anhydrous ammonia quantities are approximately 600 tonnes. However, the final determination to deem the GEGHA facility a MHF shall be by the regulator and is a reviewable decision by the operator of the facility. Schedule 15 of the regulation has been referenced for anhydrous ammonia and hydrogen.

1.3 Bushfire planning

A suitable package of Bushfire Protection Measures (BPM) commensurate with the assessed level of risk associated with hazardous industry, and commercial and industrial development, as outlined in Sections 8.3.9 and 8.3.10 of Planning for Bush Fire Protection (PBP) will be required. The BPMs include provisions relating to Asset Protection Zones (APZ's), access, water supply, electricity and gas services, construction standards, landscaping and emergency evacuation.

To achieve deemed-to-satisfy acceptable solutions for APZ's and building construction Bushfire Attack Levels (BALs) for hazardous industry development, structures are to be positioned, and vegetation managed, such that the building can achieve a radiant heat exposure not exceeding 10 kW/m².

APZs provide protection from exposure, defensible space and hazard separation. APZs have been applied to meet the Special Fire Protection Purpose (SFPP) objectives of PBP. APZs are established between a building and vegetation hazard, and their calculation is based on vegetation and slope in accordance with Appendix 1 of the PBP.

A perimeter road is required to maintain access to the design principles for emergency service vehicles outlined in Appendix 3 of PBP including:

- Vertical clearance height of 4m to allow passage of emergency service vehicles.
- Perimeter roads to provide a minimum clear width of 8m.
- Property access including gates to the project site are to be a minimum of 4m wide.

Building work on bush fire prone land must comply with the requirements of the National Construction Code (NCC). The general practice for fire safety construction provisions of the NCC are taken as acceptable solution for Class 5 to 8 buildings. Building works for all buildings shall comply with construction requirements in AS 3959:2018 or the National Association of Steel Framed Housing (2014) Steel Framed Construction in Bush Fire Areas (NASH Standard).

A Bush Fire Emergency Management and Operations Plan should be developed for the project and identify all risks and mitigation measures associated with the construction and operation. This should include:

- Detailed measures to prevent fires igniting.
- Works that should not be carried out during a Total Fire Ban (TFB).
- Availability of fire-suppression equipment, access and water.
- Storage and maintenance of fuels and other flammable materials.
- Notification of the local NSW RFS Fire Control Centre for any works that have the potential to ignite surrounding vegetation, proposed to be carried out during a bush-fire danger period to ensure weather conditions are appropriate.
- Appropriate bush fire emergency management planning.

1.4 Standards

Australian Standards have been combined with the National Fire Protection Association (NFPA) list of standards for fire system compliance. AS/NZS 2022 *Anhydrous ammonia - Storage and handling* provides initial guidance for the minimum level of fire protection systems to consider when establishing a fire safety protection method. However, fire protection systems will need to be addressed in a Fire Safety Study to establish the specific protection methods and requirements suitable for firefighting personnel and the facility. Consultation with FRNSW and development of an emergency management plan are essential when selecting the appropriate fire protection systems.

The relevant standards of compliance which have been used to develop this study have been outlined below and correspond to the initial concept for fire protection systems.

Table 1 Reference standards

Standard	Publication year	Title of Standard
WHS	2017	Work Health and Safety Regulation
Safe Work Australia	2023	Managing Risks of Hazardous Chemicals in the Workplace
NSW Rural Fire Service	2019	Planning for Bush Fire Protection
AS 1670.1	2018	Fire detection, warning, control, and intercom systems – System design, installation, and commissioning – Fire
AS 1670.5	2016	Fire detection, warning, control and intercom systems—System design, installation and commissioning Part 5: Special hazards systems
AS 1851	2012	Routine service maintenance of fire protection systems and equipment
AS 1940	2017	The storage and handling of flammable and combustible liquids
AS / NZS 2022	2003	Anhydrous ammonia - Storage and handling

Standard	Publication year	Title of Standard
AS 2118.1	2017	Automatic fire sprinkler systems – General
AS 2118.3	2010	Automatic fire sprinkler systems Part 3: Deluge systems
AS 2304	2019	Water storage tanks for fire protection systems
AS 2419.1	2021	Fire Hydrant installations – System design, installation, and commissioning
AS 2441	2005	Installation of Fire hose reels
AS 2444	2001	Portable fire extinguishers and fire blankets – Selection and location
AS 2941	2013	Fixed fire protection installations – Pumpset systems
AS 3959	2018	Construction of buildings in bushfire-prone areas
AS 4214	2018	Gaseous Fire-extinguishing systems
NFPA 2	2023	Hydrogen Technologies Code
NFPA 11	2024	Standard for Low-, Medium-, High-Expansion Foam
NFPA 13	2022	Standard for the Installation of Sprinkler Systems
NFPA 15	2022	Standard for Water Spray Fixed Systems for Fire Protection
NFPA 30	2024	Flammable and Combustible Liquids Code

2. Modelling parameters

The proposed facility has been assessed in accordance with the requirements AS / NZS 2022 and the relevant standards applicable to the fire protection systems. The parameters have been developed for fire protection systems appropriate to the hazard based on the risks anhydrous ammonia and liquefied hydrogen may present during a fire. These may include:

- a. Cylinders rupturing catastrophically (BLEVE).
- b. Localised heating of tanks may cause rupture.
- c. Ruptured cylinders and tanks may become projectiles.
- d. Released ammonia or hydrogen may ignite.
- e. Large volume of gas may be released relative to the volume of liquids.

2.1 Passive fire protection

One or more of the following means of fire protection and safety can provide heat protection and has been assessed in this study:

- a. Sufficient separation from the potential heat source to render thermal protection unnecessary.
- b. The use of radiation barriers.
- c. The use of cooling water, which may include.
 - i. Fixed traversing monitors at a setback distance.
 - ii. Fixed sprinkler or deluge water spray systems.
 - iii. Fire hydrants with hose cabinets adjacent them.
 - iv. Fire hose reels.

In addition to the nominated systems and media used, fire detection and alarm systems have also been considered for early detection, warning and activation of sub-systems.

2.2 Weather conditions

Weather conditions have been previously outlined in a separate GHD study *Consequence Modelling Results* dated May 15, 2024.

Prevailing winds and wind speeds do impact the intended use of various firefighting equipment. Performance of fire systems are required to account for wind intensity and direction.

2.3 Asset protection

The study will focus on the facility having a permanently charged fire hydrant system with fire monitors positioned throughout at selected locations. In addition, various processing equipment and storage areas have considered other measures of fire protection, such as deluge cooling water. Table 2 lists out the recommended fire protection system strategy which can be implemented.

Table 2 Asset protection measures

Item	General Area / Equipment	Fire Protection Method	Mandatory*
	Overall site	– Fire hydrant system	– Yes
		– Fire water monitors	– No
		– Fire hose reel stations	– Yes
		– Foam hose reel stations	– No
1.	Anhydrous Ammonia Storage	– Deluge cooling water spray	– No
		– Automatic flame detection	– No
2.	HP H ₂ Storage Tanks	– Site infrastructure (overall site)	– Hydrants
		– Automatic flame detection	– No
3.	N ₂ Compressors	– Deluge spray system	– No
		– Automatic flame detection	– No
		– Site infrastructure (overall site)	– Hydrants
4.	Ammonia (NH ₃) compressors	– Automatic flame detection	– No
5.	H ₂ Compressors	– Site infrastructure (overall site)	– No
6.	PLC / MCC Room	– Inert Gaseous Suppression System	– No
		– Automatic smoke detection & alarm system	
7.	AUX Transformer & HV Switchgear	– Automatic smoke detection & alarm system	– No

Note 1*: Mandatory is considered as the minimum level of fire safety system required for the facility.

The selected areas may not necessarily require the indicated method of fire protection. However, they would likely be implemented based on the outcomes of a comprehensive risk assessment and discussion with FRNSW. These also may be substituted or eliminated based on the outcomes of a Fire Safety Study or fire risk assessment.

Equipment/Systems which have not been identified have been considered being protected by the localised fire hydrant or fire hose reel systems. Fire hydrants are typically operated by the attending fire brigade whilst facility personnel who are trained in fire management can use fire hose reels and fire monitors.

2.3.1 Solar Farm

Hiringa have indicated a solar farm will be developed outside the boundary fence of the production plant. The solar farm is likely to also contain battery energy storage systems (BESS), inverters and a control room. Fire protection requirements for the solar farm have not been assessed in this study but it should be noted that fire protection requirements need to be considered.

Guidance on solar farm fire safety requirements can be further evaluated and understood from the Design Guidelines and Model Requirements Renewable Energy Facilities and/or FRNSW Fire Safety Guideline for Large-scale external lithium-ion battery energy storage systems – Fire safety study considerations. These documents have been published by the Country Fire Authority Victoria & Fire & Rescue NSW.

2.4 Design basis

The following information presents the design basis for which the aforementioned fire protection systems have been based.

2.4.1 Fire system infrastructure

As no water authority supply main is present in the area, a static water supply tank has been considered for the purpose of this study. Without available pressure or flow to operate various selected systems, fire pumps will need to be included for system operability.

- Static water supply capacity and duration shall be based on a (concept) credible fire scenario or fire risk assessment.
- Fire protection pump sets shall be based on the hydraulic demand of the most onerous fire scenario pressure and flow requirements (considering the simultaneous operation of the required number of systems). The largest flow and pressure demand will be accounted for.

Fire detection control and indicating equipment will also be applicable to the facility for the automatic detection of alarms and notification to emergency dispatch centres. Control equipment will typically pick-up localised field devices and interface with automatic deluge water spray systems and/or gaseous suppression systems.

Gas detection devices will also be situated across the facility to provide continuous monitoring if hazardous gases.

For the purposes of early site definition and this study, it is assumed that the facility has no fire protection systems in place.

The fire system will look to be supplemented from proposed raw water fire tanks and fire water pumps. A combination of above ground and below ground pipework distributed around the facility has been considered.

2.4.2 Fire hydrant system

A fire hydrant system has been implemented based on the open yard area of the process risk, the flammable storage, and the process equipment. Typically, the water supply requirements in accordance with AS/NZS 2022 requires a minimum of 120 minutes, however AS 2419.1 requires a 240-minute supply.

In this instance, the latter will be considered for the proposed static water supply. The hydrant system will be calculated simultaneously with the selected design number of fire water monitors and deluge cooling as part of the strategy. However, monitors will adopt 120 minutes of water supply, referencing the AS/NZS 2022 demand requirement.

The development of the open yard hydrant assessment requires the aggregate area of process risk equipment and buildings to be calculated. Based on the plot plan configuration, the total aggregate protected area has been approximately calculated as 4,052 m². Table 3 & 4 (below) provide the required performance criteria referenced from AS 2419.1 which shall apply. Hydrant systems may be upgraded at the discretion of FRNSW or stakeholders e.g., additional number of fire hydrants required.

Table 3 Aggregate open yard protection

Yard area m ²	Number of hydrant outlets to flow
>3 000 ≤ 9 000	2

Table 4 Hydrant conditions

Fire hydrant type	Minimum flow rate (L/min)	Minimum pressure (kPa)
External fire hydrants	600	700

Fire hydrant type	Minimum flow rate (L/min)	Minimum pressure (kPa)
<i>Note: when boosted by a fire brigade, 600 L/min shall also apply.</i>		

Appendix B provides a rationalised fire scenario, with aggregate area calculations being reduced to be <3000m². This will identify the need for one single fire hydrant outlet to flow for hydraulic analysis.

2.4.3 Fire water monitors

The fire hydrant system will also be supplemented with fire water monitors strategically located around the facility. Although locations should be discussed with FRNSW, they have been indicatively located based on the asset risk and safe operational distances to the risks.

Monitors will take into consideration wind intensity and direction to confirm the actual selected spray trajectories. Spray trajectory will be defined by the selected data, pressure and flow required to provide a practical reach to the risk. For the purposes of providing a design basis for fire water monitors, the following data has been sourced from the vendor SKUM. Refer to Table 5 and Figure 1 (below).

Table 5 Fire monitor parameters

Skum FJM 80 Manual	Values
Water Capacity	1000 L/min
Design Pressure	780 kPa
Range at 780 kPa	50 metres (under still wind conditions)

Monitors will be supplied from the same reticulating pipework as the fire hydrant system and be provided with an independent manually operated isolation valve. Motorised gear operated valves can also be considered.

Values provided are based on still wind conditions.

FJM-80 monitor range of jet

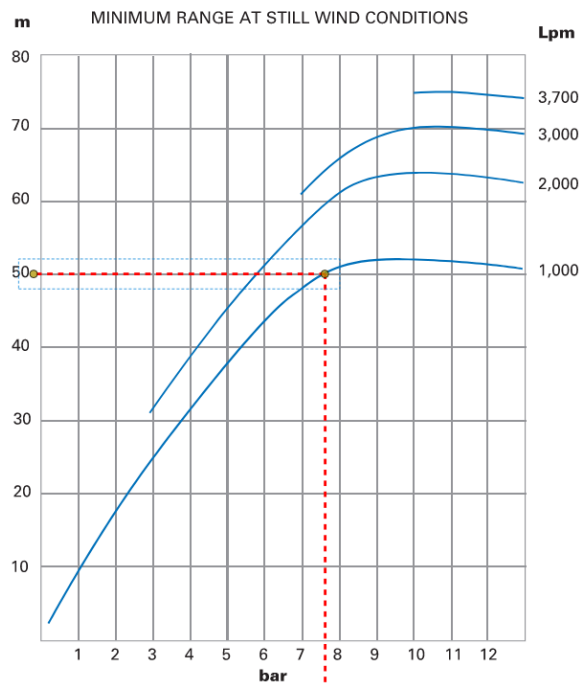


Figure 1 Skum Data Sheet extract – FJM-80 monitor

2.4.4 Deluge cooling

Deluge water spray systems for cooling purposes has been considered for the anhydrous ammonia storage tanks and various field equipment where likely ignition sources from valves, seals or piping connections may occur.

The requirement for deluge water spray systems align with AS/NZS 2022 guidelines. The design of these systems will be based on the requirements of NFPA 15 for surface cooling to the ammonia (NH₃) storage vessels and related NH₃ and H₂ equipment.

The H₂ bullet storage tanks have not been considered in this study requiring deluge water spray. However, the outcomes of a detailed Fire Safety Study may consider this risk item requiring cooling protection.

The following design criteria will be implemented for vessels and equipment in the following table.

Table 6 Vessels

Application rate	Duration
10.2 L/min/m ²	60 minutes*

**Note 1: 60 minutes is the suggested water supply duration, however, this can be modified for a lesser supply duration requirement. AS/NZS requires 120 minutes.*

Water spray would be applied to the vessel surfaces, both top and bottom, to allow water cooling to the total area of the horizontal NH₃ tanks at the nominated application rate from open medium velocity type nozzles.

Table 7 Pumps & compressors

Application rate	Duration
20.4 L/min/m ²	60 minutes*

Equipment handling flammable liquids or gases will typically have seals, shafts and other critical parts enveloped by directed water spray.

2.4.4.1 Egress protection

In the case of protection of personnel across the site, and egress paths are deemed within the risk area, deluge water spray systems may also be considered for egress protection.

Egress protection has not been included in this study.

2.4.5 Gaseous suppression system

An Inert gaseous suppression system has been considered for the PLC/MCC switchroom enclosure. National Construction Code (NCC) requirements do not indicate the need to protect such a structure, however, for the purposes of this study, the enclosure has considered a suppression system interfaced with an automatic fire detection system.

The design basis for the enclosure protection will be based on Energised Electrical Equipment (Higher Hazard Class A). The inert suppression selected will be IG-55 or IG-541 with a higher hazard class A design concentration selected in accordance with the requirements of AS 4214.

3. Study assumptions

3.1 Fire scenario

For the purposes of this initial fire water study, the fire scenario for the facility will consider the anhydrous ammonia storage tanks on fire with three anticipated modelling inputs to determine fire infrastructure requirements.

1. Cooling water applied to all three storage tanks.
2. Two fire hydrants operating.
3. Two fire water monitors operating.

All three applications will be considered to operate simultaneously in the event of a fire, taking into consideration automatic or manual detection of a NH₃ fire with FRNSW/RFS operating a minimum of two fire hydrants and two fire monitors.

Individual components have been presented in the following sections.

3.2 System performance criteria – fire water

The following design criteria will be applicable to the NH₃ storage tanks, and the information presented from Table 8.

The assumed surface area for each individual NH₃ storage tank as calculated at approximately 297m². The calculation method applied will be density multiplied by the total surface area to determine the approximate flowrate.

Table 8 Deluge cooling system performance criteria

Hazard area	Design criteria	Duration	Est. flowrate	Fire water requirement
NH ₃ Storage tanks	<ul style="list-style-type: none"> – 10.2 L/min/m² over the surface area of each NH₃ tank (30m x 3m). – Medium velocity nozzle selected. – Cooling water application only 	60 minutes, with 15% safety margin	9,100 L/min (3,030 L/min per tank)	628 kL

The fire hydrant system performance has been assessed based on the aggregate area of process risk and buildings across the facility. The calculation method aligns to the prescriptive requirements of the standards

Table 9 Fire hydrant system performance criteria

Hazard area	Design criteria	Duration	Est. flowrate	Fire water requirement
Open yard storage	<ul style="list-style-type: none"> – Aggregate area of process risk and buildings to facility – Aggregate area: 4,052m² 	240 minutes	1200 L/min (2 hydrants @ 600 L/min)	288 kL

For the purpose of this project, and hazardous risk considered, fire monitors have been included into the design and form part of the fire scenario operations.

Table 10 Fire monitor system performance criteria

Hazard area	Design Criteria	Duration	Est. flowrate	Est. volume
NH ₃ Storage tanks	<ul style="list-style-type: none"> – Similar application as fire hydrants. – Focus on NH₃ & H₂ areas. 	120 minutes	3,000 L/min (2 monitors @ 1,500 L/min) Windage loss applied	360 kL

AS/NZS 2022 indicates a minimum water supply duration of 120 minutes. However, supply duration for monitors can be modified considering fire hydrants provide a minimum 240 minutes of water supply as an individual component.

3.2.1 Estimated water quantity – Primary supply

Based on the preliminary volume figures from Section 3.2, the collective fire water component is assessed by each suppression methods estimated water volume as a combined water supply.

The estimated water supply quantity for the purposes of this study is approximately 1.276 ML. This component of water can be distributed into two separate tanks each holding 50% of the combined volume.

The primary water supply estimate has been based on a conservative approach for water being available on-site. A primary water supply enables the attending fire brigade to deliver the required firefighting pressure and flow.

We have also undertaken an analysis with providing a secondary water supply serving a reduced-capacity primary water tank supply. The basis of this analysis will consider the local raw water supply to the north of the facility. Refer to Appendix A.

3.2.2 Pump capacity

Based on high level hydraulic calculations, fire pumping capacities have considered the fire scenario operating simultaneously. An approximate fire pumping capacity will be the following items:

- i. 2 of fire hydrants
- ii. 2 of fire monitors
- iii. Deluge cooling to all three NH₃ tanks

The estimated pumping capacity is 15,000 L/min @ 900 kPa. Fire systems are typically limited to 1200 kPa.

3.2.3 Fire brigade booster assembly

A booster connection shall be provided from the static water tanks complete with both FRNSW metropolitan connections and RFS connections. These connections typically require large bore suction assembly, complete with NB150 isolation valve, and NB65 small bore connections.

The fire brigade booster would be arranged so that water can be drawn from the static water tanks and pumped through a tanker into the system to supplement system flow and/or pressure.

3.3 Gas suppression

For the purpose of this study, gaseous suppression has been considered for the proposed PLC / MCC Room. The implementation of a suppression system will be based on asset protection using an inert gas fire suppressing agent that is electrically non-conductive and has a density similar to air.

The proposed inert gas flood system is to extinguish the fire by reducing the residual oxygen concentration to a level that will no longer support combustion.

The PLC / MCC room is considered a Class A & C Hazard, which involves electrical and electronic hazards.

The following calculations have been undertaken at desktop level to articulate the number of cylinders required, based on the class of fire stated, and utilising a commonly available inert gas (i.e. IG-541).

Table 11 Gas suppression system performance criteria

IG-541	Values
Estimated room volume	278m ³
Room Temperature	21°C
Maximum room strength	500 Pa (Based on a brick/block work construction)
Risk Class	High Hazard Class A – Energized Electrical Equipment
Design concentration	41.7%
Final agent concentration	44.07%
Discharge time	120 seconds
Qty 300Bar Cylinders	4 x 300 Bar, 140 Litre Cylinders (80 litre cylinders are available but account for 7 in total).

3.3.1 Inert Gas Suppression

The selection of an inert gas is suited for typical Class A fires and generally is non-reactive with other substances.

IG-541 is an inert gas mixture consisting nominally of 52% nitrogen, 40% argon and 8% carbon dioxide. The mixture is a colourless and odourless composition designed to be within the physiological thresholds suitable to humans.

Activation of the suppressant agent is typically through automatic fire detection and alarm systems programmed to inhibit gas to the enclosure risk. Manual pull stations are also installed for localised release of the agent.

Additional IG-541 cylinders may be kept locally to replenish/replace faulty or used cylinders due to lead time constraints in the sudden loss of primary cylinders.

Various other forms of inert gases are available ranging from IG-55 (50% nitrogen & 50% argon) and IG-100 (100% Nitrogen). These are all inert suppression agents applicable to sensitive enclosure risk fires,

3.4 Foam suppression

For the purpose of this study, automatic foam suppression systems have not been considered. However, we have accounted for foam hose reel stations with the ability to produce 240 L/min of foam solution at a minimum pressure of 400 kPa.

The foam hose reel stations will be equipped with a fixed foam concentrate supply tank containing synthetic fluorine free foam (SFFF), a 38mm hose connection and proportioning equipment. Connection of the water supply will be from the proposed reticulated hydrant system.

Foam stations should be equipped with suitable aspirating foam nozzles or suitable fog type nozzles for use with water and/or SFFF for intended use by attending emergency response teams. Water by-pass options may be fitted to fight localised fires where foam solution is not required.

The following assessment has been considered with reference to AS 1940 for the provision of foam-making equipment for flammable storage.

Table 12 Foam suppression system performance criteria

Foam suppression	Values
Minimum flow rate	240 L/min
Minimum pressure	400 kPa
Duration	20 minutes supply
Foam proportioning	3% (dependent on vapour pressure)
Foam concentrate volume	144 Litres (each tank)

The water capacity required for the proposed foam stations is negligible in the overall system demand requirements.

Additional foam stocks should be kept locally for replenishment and/or additional resource deployment.

3.5 Automatic fire detection and alarm systems

For the purpose of this study, the site will be provided with an automatic fire detection and alarm system to provide early detection and automatic response for emergency response call out.

The deployment of various field devices is typically configured back to a centralised Fire Detection Control and Indicating Panel, with various field Sub Fire Detection Control Indicating Equipment panels configured on the distributed network.

Typical network infrastructure needs to include a fire rated transmission path, either in copper or fibre optic cable.

Automatic deluge cooling systems have been considered for the purpose of this study and will require an automatic detection system to initiate cooling water, via flame detection and/or wet pilot line detection methods.

Gas suppression systems will also require an automatic detection system to initiate gas discharge. This is typically through aspirated smoke detection systems and/or fixed point-type smoke detectors.

Normally, for external exposed equipment, such as the NH₃/H₂ storage tanks, Triple IR Flame Detectors are generally configured on two independent loops to initiate a pre-alarm and full alarm function. Programming of devices can be completed in combinations suitable to the environment.

Various other process equipment identified from Table 1 will utilize a mixture of:

- Gas detectors
- Flame detectors
- Smoke detectors (enclosed environment only).

4. Infrastructure

4.1 General

Critical fire system infrastructure will be required for the intended fire protection systems, and configured to allow for compliance, redundancy, maintainability and operability.

4.1.1 Fire water tanks

Fire water tanks should typically be constructed from concrete or steel and provide a sufficient amount of water volume for the most onerous fire scenario calculated.

Fire water tanks need to be configured so that, during maintenance, not less than 50% of the required minimum volume is available at all times. For the purpose of this study, two 50% water storage tanks have been considered to allow for adequate maintainability. Both tanks will be manifolded together, allowing balancing between tanks as well as supporting pump suction capabilities.

- Based on the water capacity calculated, each tank has been theoretically assessed to withhold 638 kL each.
- The total static water supply effective capacity is estimated to be 1.276 ML kL.

Fire water tanks shall be placed in a suitably accessible area for fire brigade operations and away from hazardous equipment and materials.

4.1.2 Fire water pumps

Dedicated fire pumps will be required to boost the intended systems pressure and flow, drawing water from the static fire water tanks. For the purpose of this study, two diesel engine driven pumps each capable of providing the duty requirements would be required.

If a preference for an electric pump is required as part of the arrangement, at least one of the pumps needs to be supplied by an automatic start emergency power generator.

The redundancy of the two-pump system arrangement allows for one pump to be offline, when configured in a parallel arrangement, during a maintenance period.

In addition to fire pumping operations, the fire brigade would also be able to increase the available fire water delivery by operating the stand-by pump and boosting the fire flow with their appliances.

- Based on the fire scenario, theoretical pump calculations estimate a duty requirement of 15,000 L/min @ 900 kPa.
- Parallel pump arrangements will support amplified flow conditions.
- Pumps will be automatic start operation and be manually shutdown.

Fire pumps should be co-located near to the static fire water tanks, protected from hazardous equipment, fire exposure, and be installed within an enclosure. Fire pump enclosures should be constructed of non-combustible materials or provided within a purpose-built enclosure.

4.1.3 Fire detection system

The fire detection and alarm system is typically placed on a networked infrastructure system. A dedicated main control panel will host the primary controls and be connected to supplementary field panels throughout its distributed network.

The core network infrastructure typically is a fire rated fibre optic cable, forming the main backbone of the fire network.

The main fire control panel is configured to contain Alarm Signalling Equipment (ASE), which transmits a fire alarm condition signal to a preferred Monitoring Service Provider. The sole purpose of this equipment is to monitor and transmit an alarm signal from either a fire detector, fire protection system operation or change in isolate valve status (pending the fire protection system design).

Fire pump control panels will also be linked to the fire system control architecture.

4.1.4 Pipework and valves

The pipe system reticulation would be a mixture of above ground and below ground where applicable. The routing will typically form a ring and sub ring main design.

Pipes above ground are typically carbon steel with flanged or roll groove fittings and supported of fixed steel structures. Generally mechanical fittings for pipe supports are used.

Below ground pipework typically consists of HDPE, using electrofusion welding for connections. Other forms of below ground pipework may be used such as ductile iron cement lined (DICL) or PVC. Both latter options require concrete thrust blocks and encasement to support their typical socket connections.

Gaseous suppression system pipework and fittings require a pressure rating of 3000lbs and must be of galvanized finish or wrought steel.

A combination of above ground valves may be used across the facility and will range from various operational types for their intended application.

4.2 Design life

The service design life shall be met as a minimum fore fire services plant, equipment and associated devices. All components relevant to the fire services should be checked and verified during their standard testing regimes.

The following table provides standard design life expectancy with adequate maintenance systems undertaken. Design life is a guide only and should be verified by applicable vendors.

Table 13 Fire system design life

Component	Estimated design life
Pipework in general	30 years
Fire pumps, motors and control panels	25 years
Fire detection system devices	10 years
Control indicating panels	10 – 15 years
Valves - general	20 years
Water storage tanks	30 years
Gas suppression cylinders	10 years
Ancillary plant and equipment	20 years

Appendix A

Fire water supply alternatives

A-1 Reduced-capacity water tanks

Alternative fire water supplies have been considered to reduce the estimated water volume of 1.276 ML for the primary water supply on-site for fire hydrants and fire monitors. Provided the use of the raw water dam, approximately 700 m north of the proposed GEGHA facility as a secondary raw water supply, reduced-capacity water tanks have been considered to use as the primary on-site water supply.

The secondary water supply can be shared to meet the performance criteria for both fire hydrants and monitors. The automatic inflow rates are chosen in accordance with AS 2419.1 and AS/NZS 2022.

Figure A.1 illustrates two potential configurations to deliver the minimum required flow rate for a minimum duration of 240 minutes to meet the performance criteria for fire hydrants. The chosen automatic inflow rate of the secondary water supply is subject to change based on the available raw water from the dam.

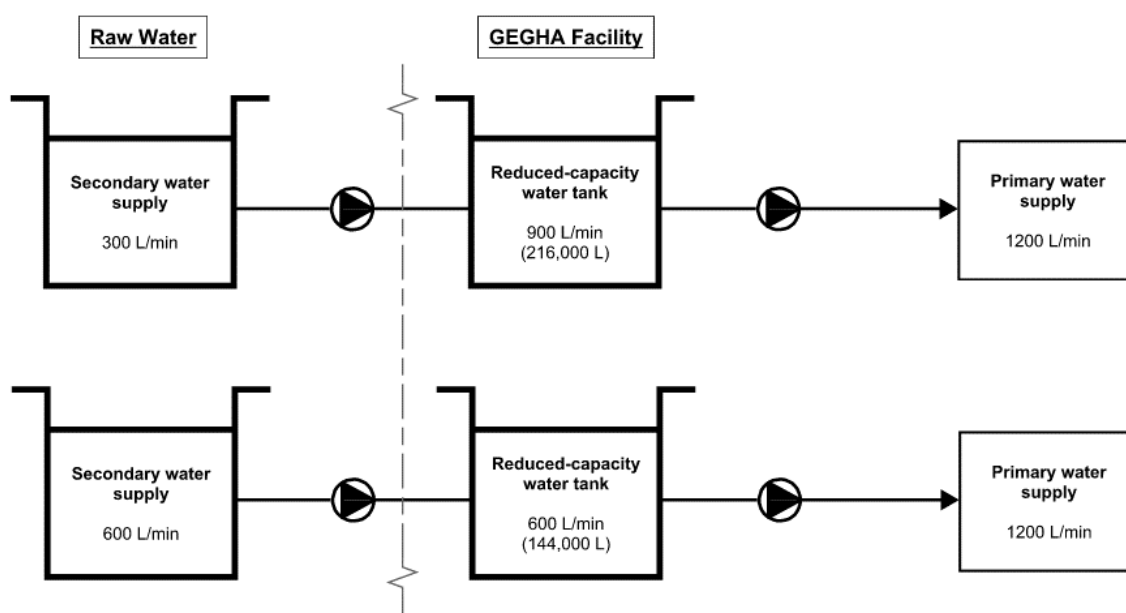


Figure A.1 Secondary automatic inflow rates and respective reduced-capacity water tank volumes for fire hydrants

Similarly, the estimated supply flowrate and volume requirement for fire monitors are also dependent on the automatic inflow rate to deliver the minimum required flow rate for a minimum duration of 120 minutes as shown in Figure A.2.

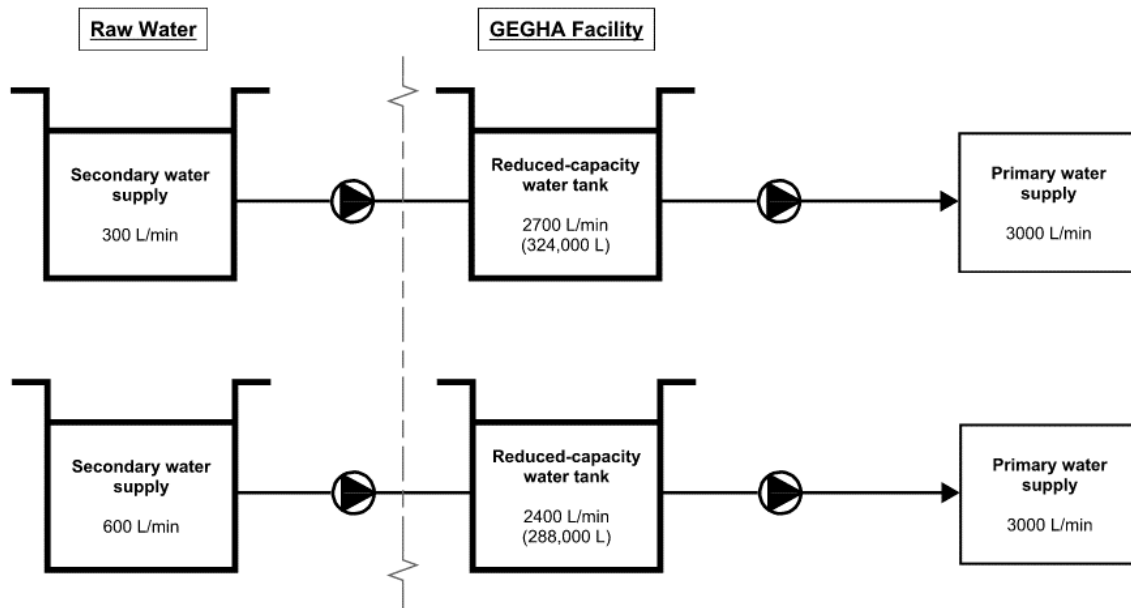


Figure A.2 Secondary automatic inflow rates and respective reduced-capacity water tank volumes for fire monitors

The reduced flowrates are tabulated in Table A.1 and assumes only one pump is responsible for providing the inflow rate to meet both fire hydrant and monitor requirements.

Table A.1 Secondary supply and reduce-capacity tank flowrates

Secondary supply flowrate	Fire hydrant supply flowrate	Fire monitor supply flowrate
300 L/min	900 L/min	2700 L/min
600 L/min	600 L/min	2400 L/min

Estimated reduced water quantity

The estimated water volumes for the fire hydrants and monitors are based on the performance criteria in accordance with AS 2419.1 and AS/NZS 2022 are outlined in Table A.2.

Table A.2 Summary of performance criteria for fire hydrants and fire monitors

Fire equipment	Duration	Est. flowrate
Fire hydrant	240 minutes	1200 L/min (2 hydrants @ 600 L/min)
Fire monitor	120 minutes	3000 L/min (2 monitors @ 1500 L/min)

Assuming that the secondary water supply is only meant to reduce the on-site water volume for the fire hydrants and monitors, the estimated combined volumes are presented in Table A.3 for different automatic inflow rates and using the above performance criteria. The estimated volumes also assume that the inflow rate will suffice both requirements for the fire hydrants and monitor.

For the purpose of this analysis, deluge cooling water has not been reduced and will remain as per the figures identified in Table 8.

Table A.3 *Estimated volumes for reduced-capacity water tanks*

Secondary water supply flowrate	Est. fire hydrant water	Est. fire monitor water	Est. combined volume
300 L/min	216 kL	324 kL	540 kL
600 L/min	144 kL	288 kL	432 kL
Deluge Cooling			628 kL

The estimated total volume of fire water needed is calculated based on the following equipment running simultaneously:

- i. 2 of fire hydrant
- ii. 2 of fire monitors
- iii. Deluge cooling system to all three NH₃ tanks

This results in a 1.168 ML capacity for the primary water supply based on a secondary inflow rate of 300 L/min, combining 216 kL (hydrants), 324 kL (monitors) and 628 kL (deluge cooling) of fire water. Similarly, the 1.06 ML capacity is based on a 600 L/min inflow rate, combining 144 kL (hydrants), 288 kL (monitors) and 628 kL (deluge cooling) of fire water. The total volume can be distributed into two tanks each containing 50% of the combined volume.

Inflow rates may vary depending on the selection of a booster pump to refill the primary water storage tank within the given flowrate requirement (i.e., secondary inflow rate may be increased beyond 600 L/min therefore further reducing the fire water tank component).

Depth, water quality, quantity and salinity levels need to be verified prior to selecting a suitable secondary flowrate where the primary water supply component can be reduced or further offset.

Appendix B

Rationalised hydraulic scenario

B-1 Rationalised performance criteria

An effort to rationalise the fire system performance has been undertaken to identify pumping capacity and total volume reduction of the fire system infrastructure (water supply / pumps). For the purpose of this separate analysis, the fire scenario for the facility will still reference the NH₃ storage tanks on fire with two anticipated modelling inputs to determine the fire infrastructure requirements.

1. Cooling water applied to all three water storage tanks.
2. One fire hydrant operating.

Both applications will be considered to operate simultaneously in the event of a fire, taking into consideration automatic or manual detection of a NH₃ fire with FRNSW/RFS operating a minimum of one fire hydrant.

Individual components have been presented in the following sections with context further referenced in Section 3.2

Table B.1 Rationalized deluge cooling system performance criteria

Hazard area	Design criteria	Duration	Est. flowrate	Fire water requirement
NH ₃ Storage tanks	<ul style="list-style-type: none"> – 10.2 L/min/m² over the surface area of NH₃ tank (30m x 3m). – Cooling water application only 	60 minutes, with 15% safety margin.	9,100 L/min (3,030 L/min per tank)	628 kL

The fire hydrant system performance has been re-assessed based on a reduction of aggregate area of process risk and buildings across the facility. The calculation method still aligns to the prescriptive requirements of the standards.

Table B.2 Rationalized fire hydrant system performance criteria

Hazard area	Design criteria	Duration	Est. flowrate	Fire water requirement
Open yard storage	<ul style="list-style-type: none"> – Aggregate area of process risk and buildings to facility. – Aggregate area: 2,700m² 	240 minutes	600 L/min (1 hydrant @ 600 L/min)	144 kL

Estimated water quantity – Primary supply

Based on the preliminary volume figures from the tables above, the collective fire water component is assessed by each suppression methods estimated water volume as a combined water supply.

The estimated water supply quantity for the purpose of the rationalised scenario is approximately 772 kL. This component of water can be distributed into two separate tanks each holding 50% of the combined volume.

Reduced capacity tanks have not been accounted for due to a single fire hydrant scenario. Reduced capacity may apply to deluge cooling with further analysis required.



Pump capacity

Based on high level hydraulic calculations, fire pumping capacities have considered the fire scenario operating simultaneously. An approximate fire pumping capacity will be the following items:

- i. One (1) of fire hydrant
- ii. Deluge cooling to all three (3) NH₃ tanks

The estimated pumping capacity would be 9,700 L/min @ 900 kPa. Fire systems are typically limited to 1200 kPa.

Fire monitors have been excluded in this hydraulic summary.

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GHD Pty Ltd | ABN 39 008 488 373

Contact: Patrick McCluskey, Senior Industrial Fire Protection Engineer | GHD
 145 Ann Street, Level 9
 Brisbane, Queensland 4000, Australia
 T +61 7 3316 3000 | F +61 7 3319 6038 | E bnemail@ghd.com | ghd.com

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