WATER SUPPLIES FOR FIRE SERVICES – V6

Whilst this paper has evolved to cover issues additional to water supplies, I have kept the name for ease of circulation. Version 6 of this paper includes significant changes to Versions 3 and 4 as follows:-

1. It is divided into sections so that readers can focus on the relevant issues, these sections are
   - 1 - Introduction
   - 2 - The Queensland legislation, the National Construction Code (NCC) Building Code of Australia BCA) and referenced Standards.
   - 3 – Water Supplies
   - 4 – Systems design requirements
   - 5 – The tanks and pump room
   - 6 – Acceptance testing and building certification
2. BCA 2016 “concessions” for fire hose reels and fire hydrants in farm buildings.
3. Details of fire hose reel water supplies where no municipal water main is present.
4. The BCA 2015 omission of fire hose reels in Classes 2, 3 and 4 occupancies.
5. AS2118.1 2019 edition changes to water supplies flagged.
6. BCA 2019 adoption of AS21181. 2019 edition flagged.
7. BCA 2019 requirements for sprinklers in 4 storey (and greater) residential buildings flagged.

The design advice for fire pump rooms has now been published in a separate paper entitled ***“The Design of Fire Pump Rooms”.***

1 – INTRODUCTION

The increasing use of Design and Construct (D & C) contracts both as main contractors and services contractors invariably result in both non-conforming and poor design of fire safety systems. For the end Client, it is usually impossible to be certain that the installed systems comply with the relevant Legislation and Standards. Building Certifiers and QFES Building Approval Officers rely on the relevant certification in the Form 15 (design) and Form 16 (installation) provided and it is FSCS’s experience that the quality and veracity of this certification is highly doubtful.

This paper, based on many years’ of observations, is formulated to provide advice to Clients, Developers, Architects, Certifiers, Consulting Engineers and QFES Building Approval Officers so that at the building approval stage, time delays, cost overruns and subsequent “finger pointing” is avoided.

Invariably it has been found that the building designs fail to make provision (explicit and / or spatial) for fire services such as fire water storage tanks, pump rooms, power supplies, ventilation and fire services access.

This paper based on the 2016 edition of the BCA , concentrates on multi-storey Class 2, 3 and 5 buildings with associated Class 7a car parks and minor Class 6 retail occupancies because this mix of occupancies is predominant in Queensland. Note that the BCA advises that minor Class 6 (shops) occupancies need not be considered separately provided that they are part of and not less than 10% of the predominant Classification. This makes it easy for office and residential buildings to have small gift shops / cafes etc. located on the Ground Floor without fire separation from an entrance lobby.

This paper is sectioned in the order that I believe has the most impact on the design, with advice to the Architect being the primary aim. Note however that this paper does NOT purport to replace the BCA or relevant Australian Standards and it is important that the Services Consultants, as well as the Architect, be fully conversant with the BCA. It is too late and costly for the design team to rely on the Building Certifier to do their work. Often, with inexperienced Architects or Building Designers, the engagement of a BCA Consultant at a very early stage of design has advantages.

2 – LEGISLATION, CODES AND STANDARDS

To properly understand, implement and certify the range of water based fire services in buildings, the following should be not only referenced but also use in the acceptance testing and certification.

Queensland Legislation

The following Queensland Legislation is referenced in this paper:-

Workplace Health and Safety Act 1995

Workplace Health and Safety Regulation 2008.

Workplace Health and Safety Queensland Code of Practice 2011

Building Code of Australia

The BCA forms the prescriptive and performance requirements for fire services in a building and advises that if a design meets the Performance Requirements, then the prescriptive or "Deemed to Satisfy" (DtS) requirements are met.

The BCA references a number of Australian Standards, the relevant ones for this paper are listed below. The design of the fire services and the provision for space and facilities within the building is based on these Standards and whilst Hydraulic, Mechanical and Electrical Consultants are responsible for the detailed design of the fire services, FSCS considers it imperative that the Architect has a good understanding of the design isssues. A building design that does not address the system requirements can result in significant cost and time overruns.

The BCA allows Alternative Solutions to be developed using a "Fire Engineering" process when or where the prescriptive BCA requirements cannot be met. The process assesses the proposed building design to address compliance with the Performance Requirements of the BCA or compares the proposed building with a comparable DtS building.

The process for Alternative Solutions can be costly with fees for the Fire Engineer, Building Certifier and Queensland Fire and Emergency Service (QFES) Building Approval Officers.

The use of Alternative Solutions as a cost saving measure is discouraged by the Regulatory Authorities

Australian & Other Standards

The Australian Standards related to the fire services design include the following. These Standards contain critical design data addressing location and spatial requirements that the Architect or Consultant must make provision for. :-

- AS1345 - Identification of the contents of pipes, conduits and ducts
- AS/NZS 1680.2.2 – Interior and workplace lighting
- AS1851 – 2112 – Routine Service of Fire Protection Services and Equipment
- AS2118.1 – Automatic fire sprinkler systems. Part 1: General requirements. **See Note 1 below**.
- AS/NZS2293 – Emergency luminaires and exit signs. Part 1 - System design, installation and operation
- AS2304 2011 – Water Storage Tanks for Fire protection Systems
- AS2419.1 – Fire hydrant installations. Part 1: System design, installation and commissioning.
- AS2441 – Installation of fire hose reels.
- AS2941 – Fixed Fire protection Installations – pumpset systems.
- AS3000 – Wiring Rules.
- NFPA 20 - Standard for the installation of stationary pumps for fire protection

Note 1 2019 edition of AS2118.1, due to be adopted in the BCA in May 2020 now deletes references to "grades" of water supply. However for the purposes of this paper with the exception of domestic sprinkler systems in residential buildings up to and including 4 storeys in height, there is no difference in the determination of water supply quantities and reliability.

4 - WATER SUPPLIES

As well as domestic use, water supplies for buildings are required to serve required fire protection systems which include fire hose reels, fire hydrants and automatic fire sprinkler systems.

Every building with a ***required*** water based fire protection system will require space either within or outside the building to house the equipment associated with the system. Typically they include the following:-

- Fire hose reel; enclosures; and
- Fire hydrant enclosures or external protected space; and
- Fire pump room; and
- Fire water tank(s); and
- Fire Brigade Boosters and enclosures; and
- Fire sprinkler control valve enclosure; and
- Fire Indicator Panel (FIP) location.

And for high rise buildings, either a ***fire control centre*** or ***fire control room*** dependant on height.

The provision of these facilities falls within the Architect's and / or Services Consultant's remit and this paper is designed to provide sufficient advice as what is required or where to source such information. Fire protection water supplies are sourced from the municipal reticulated water supply and to be consistent with the relevant Australian Standards, hereinafter called the "town" or "municipal" main. A connection from the town main supplies, either directly or by means of on site storage tanks provides the water supply for the fire systems. Note that where storage tanks are provided, one or more pumps are installed.

The fire hose reel, fire hydrant and fire sprinkler systems require specified (by reference to the relevant Australian Standard), water flow rates and pressures. Flow rates are expressed as either litres per second (l/s) or litres per minute (l/m), either can be used. Pressures are expressed as kilopascals (kPa) or metres head. Volumes are expressed as either litres or m^3 (cubic metres).Note that 10kPa is approximately 1 metre head.

The traditional process for determining the available flows and pressure in the town main was to attach one or more McCrometers (flow measuring equipment) to underground "spring" hydrants in the street and measuring the flows and pressures available. For the layman, spring hydrants in the street are identified by reflective blue markers in the middle of the street at approximately 90m intervals in urban areas.

FSCS has revised its paper "**Fire Hydrant Flow Testing – V2**" which explains this and details the problems with reliance on the results. This paper can be downloaded from the FSCS web site **http://fscs-techtalk.com** .

For sprinkler systems, Clause 4.10 of AS2118.1 has always required that the water supplies "*shall be capable of furnishing, under normal conditions, at all times of the day and night, the minimum pressure and flow requirements laid down in Clauses 0.3, 10.2 or 11.2 as appropriate*". The results from a single flow test cannot be relied on and accepted by Certifiers and QFES.

Both AS2419.1 AS2118.1 require that water supplies shall be provided for both hydrant and sprinklers systems operating simultaneously and often, where the town main appeared to provide copious flows, designers would assume that a single (allowable) connection could supply multiple system requirements simultaneously. This process of determining available flows and pressures should no longer be used because it only provides the availability at a single point in time and is unreliable.

The ongoing reduction in flows and pressures is the result of both deteriorating water mains and increased demand. In times past excessively high pressures in the water mains have resulted in major losses through the deteriorating and leaking / bursting of pipe and the "spigot and socket' pipe joints, accordingly all water suppliers have reduced the residual pressures in their water mains to a point where fire systems that previously were able to function without pumps, are now required to have both pumps and tanks.

Whilst industrial facilities on large lots have the capacity to accommodate fire pump enclosures remotely from the building(s) being protected, most other buildings will require fire pump rooms to be incorporated into the primary structure.

Subsequent to the privatisation of water supplies to the community, the establishment criteria for water supply for fire services have radically changed. No longer can Consultants and Systems Designers access flow test results from the spring (underground) street hydrants, but are now required to seek this information from the water supply provider.

This provider is required to provide their estimate of flows and pressures available for fire services in a building. However there will always be a rider to that information as to the legal minimum that they are obliged to supply and additional advice as to reliance on the information provided.

Accordingly this paper is formulated to provide advice for projects within Queensland (although other States and Territories have similar issues) to determine the water supplies for fire services such as sprinkler systems, fire hydrants and fire hose reels.

Each of the State water supply providers such as Unitywater has to implement the various planning schemes outlined in the Department of Natural Resources & Mines document entitled "***Planning Guidelines for Water Supply and Sewerage, April 2010***" document and the water supply provider need only supply water as per the policy and table of flows and pressures reproduced below.

Flow Provision is the flow that the network analysis calculates as being available under the policy directives and will vary dependent on the type of development, and the capability of the community to resource fire protection.

Maximum Residual Pressure is the pressure that the network analysis calculates as being available.

Minimum Residual Pressure is 12 metre head or 120kPa, being the residual pressure which will maintain a positive pressure on the suction side of the fire authority appliance when operating at the minimum fire flow.

Note that the **Flow Provision** and **Minimum Residual** pressure are guaranteed. However the ***Maximum Residual Pressure*** is not guaranteed as discussed later.

Item	Description
Flow Provision – General Urban Category (Section 5.7.6)	
Residential building (3 storeys and below)	15 L/s for 2 hour duration
High Density Residential building (greater than 3 storeys)	30 L/s for 4 hour duration
Commercial / Industrial building	30 L/s for 4 hour duration
Risk Hazard building	Refer to 'Risk Assessment' provision below
Flow Provision – Small Community Category (Section 5.7.6)	
Residential buildings (up to 2 storeys)	7.5 L/s for 2 hour duration*
Non-Residential buildings (up to 2 storeys)	15 L/s for 4 hour duration*
Other buildings	Refer 'General Urban' category above
Residual Pressure (Section 5.7.7)	
Minimum Residual Pressure – In the main at the hydrant / dedicated fire service	12 metres head
Maximum Residual Pressure – In the main at the hydrant	65 metres head (> 65m requires QFRS consultation)
Minimum Pressure – Elsewhere in the supply zone during a fire event	6 metres head

The upshot of this policy is that the Architect or Hydraulic Consultant will have to request a "Network Pressure and Flow Data" request from their water supply provider.

The five SEQ water service providers that have worked together to develop the SEQ Code are:

Gold Coast City Council, Logan City Council, Queensland Urban Utilities, Redland Water and Unitywater (Sunshine Coast). The Unitywater website for downloading the Network Pressure and Flow Data request form is http://unitywater.com/forms.aspx

Reproduced below is a letter from Unity Water to FSCS providing information for a recent FSCS project. It is reproduced to highlight the typical flows and pressures available (for the subject site) and the impediments that might result on a project.

Careful examination of this letter indicates that for the subject residential (>3 storey) building, Unitywater's analysis is that they can provide 30litres/second (l/s) of water at a residual pressure of 49m (~490kPa).

However it should be noted that they only guarantee a 12m residual head.

Table 1 in the letter is consistent with the Government policy and for the purposes of this paper it should be noted that multistorey residential or commercial developments are limited to a flow of 30l/s, regardless of inclusions such as car parks. The calculated residual pressure will vary dependant on site location. Note the suggestion in the letter recommending getting advice from a consultant.

Unitywater
Serving you today, investing in tomorrow.

RECEIVED 5 MAR 2014

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1300 0 UNITY (1300 086 489)
www.unitywater.com
ABN: 89 791 717 472

[redacted]

Rick Foster
Fire & Security Consulting Services
17 McKenna Court
NOOSAVILLE QLD 4566

3 March 2014

Dear Mr Foster

Network Pressure and Flow Data – Request for information – [redacted]

I refer to your application received by Unitywater on 26 February 2014 in which you request pressure and flow data for the above property

Minimum Standard of Service
In accordance with Queensland Government Guidelines Unitywater designs, constructs, operates and maintains its water supply network to provide the following minimum standard of service a 2/3 of the calculated maximum hour demand on the peak day:

Table 1 –*Minimum Standard of Service*

Type of Use	Flow Available from Unitywater's Water Main for Fire Fighting Purposes (litres/second)	Residual Head in Water Main Servicing the Use (metres)
Residential including multi – storey residential dwellings of less than 3 storey	15	12
Commercial that is ancillary to residential use	15	12
Multi-storey residential greater than 3 storey	30	12
Commercial and or Industrial	30	12

Unitywater does not guarantee that fire fighting flow will be available at all times on the grounds that components of Unitywater's water supply infrastructure may be shut down temporarily for planned maintenance or to repair bursts or damage caused by others.

The current type of use for this property is Multi-storey residential greater than 3 storey. Hence, in accordance with Table 1 above, the Minimum Standard of services that applies is 30 litres/second at 12m residual head.

Current Dynamic Model Data
Unitywater's current dynamic water supply model indicates the following under a demand condition of 2/3 of the estimated maximum hour demand on the peak day in Year 2031.

Table 2 *--Estimated Available Flow and Pressure to 2031*

Assessment Node	Node Location	Water Main Diameter *(mm)*	Estimated RL at Assessment Node
N002877	Cnr of No 8	150	20.35
Background Demand *(litres/second)*	**Static Head *(m)***	**Fire Flow Demand *(litres/second)***	**Residual Head *(m)***
2.3	60	30	49

Unitywater reserves the right, at any time, to change the operating pressures within the water supply network, but not below the Minimum Standard of Service stated in Table 1.

Unitywater accepts no liability whatsoever for changes in the operating pressure of this water supply network and the consequent impacts on any fire suppression system within the subject property. It shall be the property owner's responsibility to ensure that any fire suppression system operating on the property complies with the relevant requirement of the Building Code of Australia and that this system is regularly tested for compliance with the relevant standards. Any upgrade of the fire suppression system required due to changes in the operating pressure of the water supply network will be the property owner's responsibility.

Suggested Approach to Design of Fire Suppression System
It is suggested that the owner of the property consult with a qualified and suitably experienced hydraulic designer to consider the risks associated with designing a fire suppression system for the subject property based upon the output from Unitywater's current dynamic water supply model. Unitywater may alter the operating pressure of the network at any time.

It is suggested that this risk should be balanced against the cost of designing and installing a fire suppression system that would provide the desired level of performance when supplied with water from Unitywater's mains at the Minimum Standard of Service stated in Table 1.

It may be beneficial to consider providing space and conduits on the subject property that could be utilised for installation of storage tanks and or pumping equipment and associated electrical equipment in the instance that an upgrade of the fire suppression system was necessary in the future.

Further Information
Should you require clarification of the foregoing please contact Unitywater on 1300 086489 during business hours or by email to Asoka.Kiriella@unitywater.com.

Yours sincerely,

Michael Lukin
Manager Network Planning
Unitywater

[redacted]

4 - SYSTEM DESIGN REQUIREMENTS

The Architect should make judgment as to the requirement in the BCA of certain systems in a building; the following provides advice in interpreting Parts E and H in the BCA covering the following systems.

- **Fire Hose Reels**. BCA Part E1.4 advises that certain buildings with some exceptions require the installation of fire hose reels. Notable exceptions include:-
  - As from BCA 2016, Part H3 advises that a *farm building* (see definition in the BCA) need not be provided with fire hose reels if portable fire extinguishers are provided.
  - In classes 2 and 3 residential accommodation, FSCS has long held the view that untrained residents would find difficulty in using a fire hose reel in the confines of a stair / lift lobby and within an apartment. There is also the issue that when unsuccessfully trying to use a hose reel, it would be abandoned leaving the hose through the doorway thus rendering the fire door ineffective! As from BCA 2015, the BCA has recognised this issue and no longer requires the provision of fire hose reels in Class 2 and 3 buildings.
  - Class 9c aged care buildings. These are sprinkler protected and whilst trained staff are on hand, their time will better spent evacuating the occupants from the fire scene.
  - Class 8 electricity substations.
  - Corridors and classrooms in primary and secondary schools. Again, whilst trained staff are on hand, their time will better spent evacuating the occupants from the fire scene.

  Whilst AS2441 and the BCA mandate the installation of fire hose reels, neither document provides guidance as to the quantity of water required or the required time of use.

Some time ago Fire and Security Consulting Services (FSCS) was consulted on the required water supplies for fire hose reels. This enquiry was generated after a request from both Queensland Fire and Rescue Service, and a Private Certifier to me as to what is the requirement for storage capacity. The project was a Class 6 shop / restaurant with a floor area >500m^2 requiring fire hose reels under the BCA.

In a rural area where there was no reticulated water supply and no Fire Brigade *able to attend in* accordance with the relevant Act –no fire hydrant system was required but under the BCA where the fire compartment floor area is =/> 500m^2, fire hose reels were! This is not an unusual situation in rural areas for occupancies like country pubs etc. However the BCA

The BCA requires fire hose reels designed and installed in accordance with AS2441 and Clause 6 in that Standard specifies the design requirements for the water supply including number of hose reels operating and the flow rate per hose reel at the specified inlet pressure.

From this data the designer can size the pump if required or assess the capacity of the town main so that the design requirements can be met.

However Clause 6.1 also stares that "where the normal water supply cannot achieve the required flow and pressure or is unreliable, a pump and / or water storage facility shall be installed ……."

As stated before, one can size the pump but AS2441 does not provide any time for the flow to be maintained. This is unlike AS2419.1 (fire hydrants) and AS2118.1 (fire sprinklers) which provide flows, pressures and time / capacity requirements. Therefore AS2441 was remiss in not quantifying the capacity requirements.

The fire hose reel system is a first aid appliance for untrained occupants and as such cannot be construed to be effective and therefore a Fire Engineer cannot reasonably determine flow and duration based on floor area, fire loads and fire duration.

Consequently, FSCS contacted Standards Australia which provided an answer which is appended to this paper. Note that this answer was in relation to the 2005 edition of AS2441. Note that in May 2009, Amendment 1 to AS2441 was issued. One would have assumed that the water quantity or operating period would have been addressed in that Amendment. It was not!

The advice from Standards Australia was that a 2 hour supply **shall** be provided. Note that I have used the word "shall" instead of the word "should. On another occasion I had reason to ask Standards Australia for their definition and their answer is below.

A clause containing a mandatory requirement is expressed by a 'shall', meaning that the content of the clause, table or illustration must be complied with in order to satisfy application of the Standard.

Where the expression 'should' is used, typically in a note, a commentary panel or an informative appendix, this indicates a recommendation or advice but is not a mandatory requirement. The note in a standard is information that the reader needs to be aware of when considering the requirement and may either act on it or set it aside. A commentary panel, similar to an informative appendix, is provided for background information and often explains how and why the committee arrived at a particular decision when drafting the clauses.

Reference to AS 1851-2005 confirms the foregoing where definitions for shall and should are contained in Clauses 1.5.15 and 1.5.16.

Returning now to the 2 hour supply, Table 6.1 in AS1441 requires, where 19mm hose reels are installed, a flow rate of not less than 0.33litres/ second (l/s) from each of the two most hydraulically remote hose reels. This results in a storage capacity of 4,752 litres.

Where a 25mm hose reel is required as specified in Table 9 of AS2441, i.e. a "High Hazard" unsprinklered occupancy, 25mm hose reels are required and in that case a water supply of 5,904 litres is required.

There has been some discussion regarding Table 6.1 in respect to whether the discharge in column 2 relates to each hose or the two hoses. FSCS is of the opinion that the answer lays in the first sentence of Clause 6.1 which states: - The *supply of water to **the hose** assembly shall be sufficient to enable the hose to deliver the minimum demand as given in Table 6.1*.

The singular use of the words ***the hose*** indicates that each hose is required to have the specified flow.

The water is required to be stored in a suitable tank with the pump meeting the requirements of *AS2941 – Fixed fire protection installations – pumpset systems*.

In regard to the tank, as of May 2016, the Australian Standard AS2304 (2011) *Water storage tanks for fire protection systems* has not been adopted by the BCA nor any of the fire protection Standards. Accordingly there is no requirement to meet that Standard.

Steel or concrete tanks are both non-combustible and therefore used. It is evident that poly and fibreglass tanks are not suitable as they are manufactured from combustible material and therefore lack the heat resistance needed, see Figure 1 below.

Figure 1 – Poly Tank after the 2009 Black Saturday fires in Kinglake

The link below leads to research produced by Bushfire Cooperative Research Centre. Bushfire CRC joined with the CSIRO to examine the performance of rainwater tanks in a simulated bushfire. The tests indicate that steel tanks are the best performers under all exposure conditions.

Bushfire CRC Update: Tanks on Trial for Home Defence *sourced from: www.bushfirecrc.com*

Bushfire CRC: Research and Investigation Into the Performance of Rain Water Tanks in Bushfires *sourced from: www.bushfirecrc.com*

- **Fire Hydrants.** BCA Part E1.3 advises that buildings with a floor area >500m^2 require hydrants. Note the proviso that this only applies where a fire brigade is available to attend a fire. The QFES website provides clarification of this which is included in the paper entitled "***QFRS Interpretations and Guidelines***" on the FSCS web site. For ease of access, it is reproduced below.

  The Building Code of Australia (E1.3) required the installation of a fire hydrant system to serve a building having a total floor area greater than 500m2 and where a fire brigade is available to attend a building fire. QFRS interprets the words "where a fire brigade is available to attend" to refer to a situation where:

  A fire brigade is staffed by:

  - *QFRS permanent fire-fighters, or*
  - *QFRS Auxiliary fire-fighters, or*
  - *A combination of (i) and (ii), or*
  - *Fire-fighters from a private fire service who are trained in structural fire fighting techniques and have a pumping appliance available (example – Hamilton Island), and*

  Whilst the Hydraulic Consultant will carry out the design, it is useful here to introduce the Architect to the design principles of a fire hydrant system so that pump and tank sizes can be determine and therefore space allowed in the building.

  Accordingly the Architect needs to determine the need for a fire hydrant system. Should this be the case it is necessary to refer to AS2419.1 (2005) table 2.1 reproduced below where the flow rates are prescribed. It is known that the 2005 edition is soon to be superseded but the public comment draft indicates no change to Table 2 .1 below.

AS2419.1 2005 **TABLE 2.1**

NUMBER OF FIRE HYDRANT OUTLETS REQUIRED TO DISCHARGE SIMULTANEOUSLY ACCORDING TO BUILDING CLASSIFICATION AND FLOOR AREA

Building classification (see BCA)	Fire compartment floor area m^2	No. of fire hydrant outlets required to flow simultaneously (Note 1)
2, 3, 5 and 9 (1 or 2 storeys contained)	≤1 000	1
2, 3, 5 and 9 (1 or 2 storeys contained)	>1 000 ≤5 000	2
2,3,5 and 9 (3 or more storeys contained)	≤500	1
2,3,5 and 9 (3 or more storeys contained)	>500 ≤5 000	2
6, 7 and 8 (Note 2)	≤500	1
6, 7 and 8	>500 ≤5 000	2
All classes sprinklered	>5 000 ≤10 000	2
All classes sprinklered	>10 000	3
All classes unsprinklered	>5 000 ≤10 000	3
All classes unsprinklered	>10 000	3 plus one additional fire hydrant for each additional 5 000 m^2 or part thereof

In the table above, reference is made to “No (number) of fire hydrants required to flow simultaneously”. Note that each hydrant has a nominal required flow of 10 l/s (litres/second).

In the majority of cases covered by this paper and based on the current (2005) edition of AS2419.1, it is expected that pump(s) will be required and hydrant performance is required to be as follows. Note that the flow rates are that for each hydrant required under AS2419,1 Table 2.1:-

- Table 2.2 - attack Hydrant – unassisted (no pump), 10l/s at 350kPa (250kPa in NSW).

  If a pump is required then the performance shall be as per the “attack” hydrant.

- Table 2.3 – attack hydrant without the use of a Fire Brigade pumping appliance, 5l/s at 700kPa. Note that the system shall be designed such that with a Fire Brigade pumping appliance, the performance shall be 10l/s at 700kPa; that means the hydrant piping system shall be capable of accommodating that flow.

The residual operating pressures are required for the most remote hydrant.

Where the water supply is drawn from the municipal main, only a single diesel driven fire pump is required.

Area coverage for internal hydrants is required such that all portions of the building floor plate (including open balconies and the like) can be reached with a 10m hose stream from a 30m hose located as discussed below, Note that unless otherwise approved by QFES, hydrants can only serve the floor level at which they are located.

Coverage from external hydrants permits the use of 60m of hose.

In Class 2, 3 and 5 occupancies the location of internal fire hydrants is required to be in the fire isolated stairs (where required under BCA D1.2) and the stair landing design should be such that it can accommodate the hydrant without impeding egress, Figure 2 below shows a typical arrangement.

Note also that permanent test drains (pipes) discharging to open space are required to be provided at each of the most remote (highest and furthest) fire hydrant to facilitate flow testing. The number of fire hydrant test drains shall be equal to the number of fire hydrants required to flow simultaneously as specified in AS2419.1 table 2.1 above.

Figure 2 – Hydrant in Fire Isolated Stair

In a Class 7a car park, the location of internal fire hydrants is required to be in the isolated stairs. Where the fire isolated stairs serving a car park discharge into ***open space***, an eternal fire hydrant may be used with the approval of QFES. That has advantages in that the coverage for external fire hydrants is that all areas can be reached with a 10m hose stream from a 60m hose located as discussed below. Designers should note that this arrangement requires the hose to be run down the stairs and the length of hose within the stairs should be allowed for, Figure 3 below shows the length of hose contained within two common types of stair design.

Note that an external fire hydrant requires the same level of protection as described later for the Booster and shown in Figure 4 below.

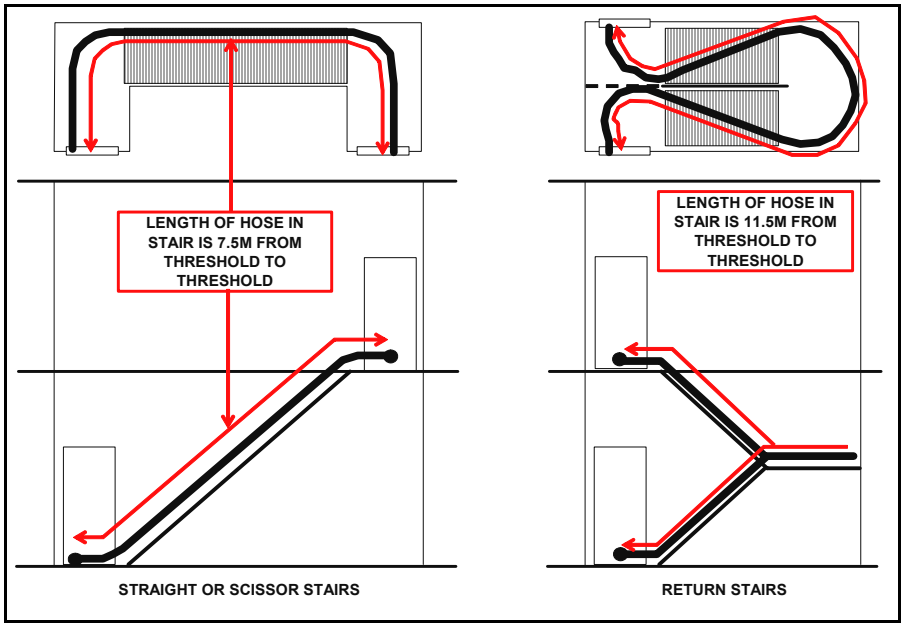

Figure 3 – Hose Length in Stairs

Note that under certain circumstances addressed in AS2419.1, external hydrants are permitted to serve the upper storeys in buildings, in that case the hose has to be laid in the stairway and the length limitations in Figure 3 should be used.

Figure 4 – Protection of External Hydrant

The next stage will be to analyse the required flows and pressures for the hydrant system. , AS2419.1 table 2.1 for a floor or ***fire compartment*** area of **=/>**500m^2 requires 2 operating hydrants (20l/s) but when the floor or ***fire compartment*** area is **<**500m^2 there is only a requirement for one operating hydrant (10l/s).

A Class 7a car park, if >500m^2 and **<**5,000m^2 will require 2 operating hydrants and if **<**500m^2, only one operating hydrant (10l/s).

Where the car park is **>**5,000m^2, it can safely be assumed that it will be sprinkler protected and AS2419.1 table 2.1only requires 2 operating hydrants (20l/s).

For the purposes of this paper and assuming that a residential or office building of more than three stories with a basement car park is the subject project, the water supply provider will have advised that 30l/s is available, this will adequately cover the 2 operating hydrants (20l/s).

The next stage will be to determine the available pressure at the most hydraulically remote hydrant, for a multi storey building this will be at the top floor or, if accommodating plant rooms and the like, the roof level. Note that when all the ***required*** hydrants are operating simultaneously, a residual pressure of 350kPa is required.

For a multistorey building the water pressure will reduce with the combined losses due to static head and friction. Therefore for a seven storey building with an effective height of ~24m, the combined losses for a flow of 20l/s will be ~450kPa and for a three storey building ~250kPa. See page 19 for a guide to the calculation of pump power.

When you get the Network Pressure and Flow Data it will provide sufficient information to make a judgment as to whether a booster pump is required.

Assuming that the water supply provider has advised that a Maximum Residual Pressure of 500kPa is available (which is probably common in urban areas), it is apparent that even for a three storey building, the pressure loss of 250kPa will result in a residual pressure of 200kPa, less than the 350kPa required.

Accordingly and unless otherwise advised by the Hydraulic Consultant, a hydrant booster pump and pump room will be required.

Even if the water supply provider can provide higher pressures, it must be cautioned that the estimate provided by the water supply provider is ***not guaranteed***, ***only 12m or ~120kPa is guaranteed***. Therefore the Architect should, in conjunction with the Client and the Hydraulic Consultant, decide whether to omit the provision of a booster pump. This is a risky strategy because water supply providers are increasingly reducing town main pressures to reduce leakage rates.

FSCS advises that as a minimum, the provision of a pump room in the building is made together with power supplies etc. This will enable, if residual pressures are reduced, the cost efficient retro-fitting of a pump.

As from BCA 2016, Part H3 advises that a *farm building* (see definition in the BCA) with a floor area greater than 500m^2 and located where a fire brigade is available to attend a fire (see above) must be provided with fire hydrant system except that the 4 hour duration of the water supply need

only be 2 hours or, a minimum total capacity of 144,000 litres. Supply from bores, rivers, dams etc. are permitted. Part H3.9 also specifies maximum and minimum distances between the building, tank, fire appliance and booster.

Regardless of whether a pump is installed or not, a Fire Brigade Booster is required to be provided. AS2419.1 2005 provides the requirements which are summarised below. This should be sufficient for the Architect to allow for space and location.

- A space 2.5m wide by 1.0 metre in depth and accessible along its entire width from the front.
- Located at street level within 8m of a location for a Fire Appliance.
- If within or affixed to the main building, within site of the main entrance and separated from the building with construction of FRL 90/90/90 extending not less than 2m either side of and 3m above the upper hose connections.
- If remote from the building, within site of the main entrance, adjacent to the principal entrance to the site and not less than 10m from the building.
- If closer than 10m to the building, protected with a masonry wall of FRL 90/90/90 extending not less than 2m either side of and 3m above the upper hose connections.
- Not less than 10m from liquefied petroleum gas (LPG) and other combustible storage.
- Not less than 10m from any high voltage electrical distribution equipment such as transformers etc. “High voltage is defined in AS3000 as “exceeding 1,500v AC or 1,000v DC. Obviously 240v AC and 415v AC supplies are not included. See **Note 1** below.

Note 1 - Solar photovoltaic panels generate voltage between 400v and 600v DC. The Australian Standards do not required remotely controlled isolators at the solar panel location and therefore the down feeds through the building to the main switchboard are always live.

Figure 5 below shows the protection required for an external booster. Note at the right there is an external fire hydrant to serve the car park.

Figure 5 – External Booster Protection

Note that it is NOT necessary to have a “red box” to house the booster, stainless steel enclosures with hinged doors or even masonry structures are acceptable as long as they have the necessary signage as per Figures 6 and 7 below.

Figure 6– Stainless Steel Booster Cabinet

Figure 7 –Enclosure with Roller Shutter – referred to in Coolum Beach as "The Taj Mahal"

For testing internal hydrants, a 150mm test drain is required to be provided at the hydraulically most disadvantaged (remote / highest) hydrant. This is usually in the fire isolated stair.

For Sprinklers, the current BCA adopts the 1999 edition of AS2118.1. As noted on page 2 of this paper, the 2019 edition of AS2118.1 is due to be adopted by the BCA in May 2019.

BCA Part E1.5, (**see Note 1 below**) lists the building occupancies that are required to have sprinkler protection, these include:-

- Buildings with an effective height >25m; and
- Buildings with high hazard storage or where high hazard processes are conducted. Table E1 in the BCA specifies the processes and the areas, volumes and heights of storage; and
- Basement (enclosed) car parks accommodating 40 or more vehicles. Note the term "vehicles" in the BCA. The QFES may include registered motorcycles in the number of vehicles. A basement car park with 39 "car" spaces" and 1 motorcycle space may trigger the requirement for sprinklers; and!
- Class 6 retail occupancies with a floor area +/> 3,500m^2, and
- Class 9c age care buildings. AS2118.4 – Automatic fire sprinkler systems – Part 4 – Residential provides the necessary design and application details; and
- Certain "large isolated buildings"; and
- Atria; and
- Certain areas in theatres and public halls including deluge **§** systems comprising open sprinklers installed to protect proscenium curtains.

Note 1 As flagged on page 2, the ABCB (Australian Building Codes Board) has flagged the inclusion of Classes 2 and 3 residential occupancies up to and including four storeys in height as requiring fire sprinklers. This requirement is to be included in the DtS (deemed to satisfy) requirements of the 2019 BCA.

. The FPAA (Fire Protection Association Australia) has produced a design document titled "101D – Automatic Fire Sprinkler System Design and Installation – Domestic Water Supply" which should be referenced when determining water supply arrangements.

§ A deluge system consists of a number of open spray nozzles fitted into a network of pipes through which water, supplied under pressure from a suitable supply, is brought to bear on a fire or used as cooling.

The distribution pipework for the system is normally dry with the water being retained by means of an automatic deluge valve or manual valve on the supply connection. Operation of the valve feeds water into the distribution system to allow for the simultaneous operation of all nozzles on the system.

Whilst conventional sprinkler systems are designed using ""Control Mode" ǂ sprinklers, there is an increasing use of "Suppression Mode" ¶ sprinkler systems for property protection in large warehouses with rack storage. The use of suppression mode sprinklers can negate the use of "in rack" sprinklers which are often prone to damage.

ǂ Control mode sprinkler systems in accordance with AS 2118.1 and NFPA13 can be at least expected to control a fire at the point where 50% of the design sprinklers are operating, at which point the fire size can conservatively be assumed to maintain a constant heat release rate (HRR)

¶ Suppression mode sprinkler systems, sometimes called Early Suppression Fast Response (ESFR) systems provide fire suppression by the early detection and discharge of large quantities of water early in a fire's development.

AS2118.1 references both NFPA 13 and the FM Global Property Loss Prevention Data Sheets 2.2, 8.1 and 8.9. Accordingly, by reference, an ESFR system is permitted under the BCA where AS2118.1 (1999) is the adopted Standard.

The FSCS paper entitled "***ESFR Systems V2***" on the FSCS web site provides additional comprehensive information.

Certain glazed assemblies and walls as detailed in the BCA require the installation of "wall wetting" sprinklers. These systems, using specially designed sprinklers discharge waste on to the surface of windows, glazing and walls to reduce the incidence of heat flux (radiant heat. AS2118.2 - Automatic fire sprinkler systems – Wall wetting sprinklers (drenchers) provides the necessary design and application details.

However the FSCS paper entitled "***Wall Wetting Sprinklers and Drenchers V2***" provides some cautionary advice as to the suitability of certain often used sprinklers.

Whilst the Hydraulic Consultant will carry out the design, it is useful here to introduce the Architect to the design principles of a sprinkler system so that pump and tank sizes can be determined and therefore space allowed in the building.

AS2118.1 categorises the various areas in a building according to the hazard classification. For the purposes of this paper where Class 2, 3, 5 and 7a occupants exist, calculations can be made as to the quantity of water required. Note that Class 2 and 3 residential buildings exceeding 25m effective height will still be designed to AS2118.1.

The Class 2 and 3 residential (exceeding 25m effective height) and the Class 5 office occupancies are a "Light Hazard" "LH" category with a design density of water discharge equal to 6 sprinkler heads each discharging 48litres per minute. This results, after applying a typical "hydraulic gain" **§** of ~15% a total flow of ~331litres per minute. For the 60 minute supply requirement, this equates to ~20,000 litres.

The Class 7a car park is an Ordinary Hazard Group 2" "OH2" category with a design density of 5mm/'min (5 litres/minute/m^2) over a design area of 144m^2. This results in, after applying a typical "hydraulic gain" **§** of ~15%, a total flow of ~828 litres per minute or 13.8l/s. For the 60 minute supply requirement, this equates to ~49,680 litres.

§ The FSCS paper "Hydraulic **Gain in Sprinkler System Design (V2)" on the FSCS** web site **http://fscs-techtalk.com** discusses this issue and provides a design example.

As the Australian Standards require the sprinklers and hydrants to operate simultaneously the most cost effective design is to have the fire hydrant system supplied from the town main and the sprinkler system from a tank supply.

As an example and when reviewing the water supply available and the hydrant requirement, it is obvious that with a 20l/s hydrant demand and a 13.8l/s sprinkler demand, the total water demand of 33.8l/s will be greater than the 30l/s available. In this case we must provide a tank supply.

Whilst the current (2018) edition of the BCA under Specification E1.5 requires certain "grades' of water supply, the 2019 edition of AS2118.1 requires a single defined water supply and it is considered that the 2019 edition of the BCA will make suitable amendments to Specification E1.5.

As calculated previously, a typical LH sprinkler system water supply would be in the order of 20,000 litres or $20m^3$ when hydraulically calculated. However to comply with the required *Grade* of supply, a 25,000 litre or $25m^3$ capacity should be used.

Also as calculated previously, a typical OH2 car park sprinkler system water supply would be in the order of 50,000 litres or $50m^3$ when hydraulically calculated. This is consistent with AS2118.1section 10.2.2.3 which stipulates a minimum tank capacity of 50,000 litres or $50m^3$ is required.

There are circumstances where the flow availability advised by the water supply provider can be used partially by say the hydrant system drawing directly from the town main and the residual available supply being used as “make up” into a tank for a sprinkler system supply. This can reduce the tank size. Advice from the Services Consultant, or more reliably, from a sprinkler contractor should be sought before embarking on a course of tank size reduction!

5 – THE TANKS & PUMP ROOM

There are two instances where a pump is required:-

1. Where either a sprinkler or hydrant "booster pump" is installed drawing from the town main.
2. Where the design contemplates separating the sprinkler and hydrant systems with one or the other drawing from a tank.

It should be noted that the water supply provider may reject connection of a pump drawing directly from the town main. This is often because of the town main being subjected to suction resulting in the residual pressure dropping below 12m (120kPa). A minimum pressure in town mains is essential to prevent ground water ingress contaminating the potable water. The water supply provider always prefers leakage out of the main to potential contamination.

Should it be determined that an on site tank water supply and pump is required, a suitable space on the Ground Floor or in the basement car park should be provided. Otherwise the tank and pump room can be located outside and if within 10m of the building, have an appropriate FRL.

Tanks

For hydrant systems, a 4 hour water supply is required, for a 20litre/second demand; this equates to a total of 288,000 litres or a tank of 288m^3 capacity, for a flow of 10l/s, this is 144,000 litres or 144m^3. Two tanks are required, each being of 50% capacity such that one can be isolated for maintenance / cleaning without compromising the hydrant system.

Obviously if the water supply provider permits a hydrant booster pump to draw from the town main and its capacity to supply the required flow is confirmed, then no tanks are required.

For hose reel systems where there is no town main, a tank of 2,000 litres capacity as previously discussed is required. Alternatively and if a hydrant tank is provided, then the required 2,000 litres can be provided from that tank.

For sprinkler systems, Class 2 and 3 residential and the Class 5 office Light Hazard occupancies and for the 60 minute supply requirement, a tank capacity of ~20,000 litres is required.

For Ordinary Hazard Group 2" "OH2" occupancies such as car parks and for the 60 minute supply requirement, this equates to ~50,000 litres.

For other circumstances, the tank(s) and allowable "make up" from the town main are as described previously under the section on sprinkler system design.

Tank capacities referred to in this paper the effective capacities which do not take into account the air gap above the infill pipe and the distance between the bottom of the tank for the vortex plate. The tank capacity should be increased to allow for these features and generally FSCS would allow for 300mm being added to the nett tank height Figure 8 below shows this arrangement.

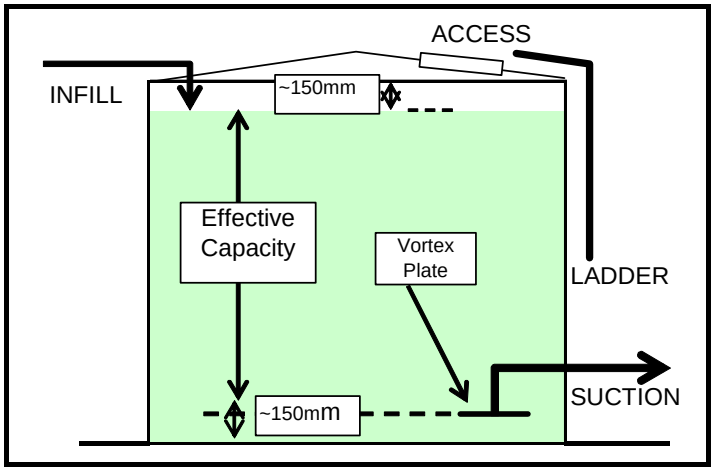

Figure 8 – Tank Details

FSCS is frequently consulted regarding the type of construction used for tanks, many installations use tanks "built in" to the concrete structure but this is not cost effective and leads to significant

installation and maintenance problems due, amongst other things, leakage. Figure 13 later in this paper shows a “leaky” pump room and tank.

Suction and fill pipes are difficult to cast into the concrete sides and it is usually impossible to design the tank so that a manhole provided for cleaning access can be located on the top of the tank. FSCS has been consulted midway through a project where the top of the tanks were the Ground Floor slab, in that case we had to cut an opening in the sides and fabricate bolted access hatches – see Figure 9 below.

Figure 9 – Bolted Access Hatch

Consequently FSCS recommends the use of circular steel tanks complying with *AS2304 2011 – Water Storage Tanks for Fire protection Systems,* installed within a separate room off the car park as shown in Figure 10. These tanks are delivered in modular form with the components being able to be transported through normal doorways and subsequently assembled on site. This has been found to be the most cost effective solution because these tanks are common in the fire protection industry.

Designers should be aware that the maintenance requirements for tanks in AS2304 require that steel tanks shall be emptied annually for inspection. Where liners are present, the additional work associated with the annual service and likely replacement of liners will incur significant costs. Accordingly FSCS recommends that tanks without liners should be used, usually epoxy lined, as currently used in the industry.

Because of the requirement for all tanks to be drained and cleaned annually, the sprinkler system supply shall incorporate a connection, via a “RPZ” backflow preventer to the town main supply for use during tank maintenance and cleaning. This can be costly and complicated and FSCS recommends that sprinkler system water supplies shall be in two tanks, each of 50% capacity allowing for uninterrupted protection. This is in concert with AS2419.1, the hydrant Code which has a similar requirement. Consequently Figure 10 shows two tanks.

Based on the above, a sprinkler system with a supply requirement of 50,000 litres (suitable for Light Hazard offices and Ordinary Hazard Group 2 for the car park) can be in two 5.4m diameter x 2.5m high tanks. These dimensions fit neatly into a car park area with a slab to slab height of 3.5m and still leave sufficient height for an access hatch at the top of the tank as shown in Figure 9.

It is preferable that a separate location for required tanks is provided

Pumps & the Pump Room

It should be remembered that the pump room is a working environment and Occupational Safety and Health Regulations apply.

AS2419.1 (Fire hydrant installations) and AS2941 (Fixed fire protection pumpset systems) provide details on the requirements for pump rooms. AS2419.1 also has a mandatory requirement for a weatherproof pump room.

FSCS is of the opinion that these should be seen as guidelines only and that the appropriate designers and Consultants should apply the necessary Codes and Standards in terms of the environmental conditions considering that, as previously discussed, the pump room is a working environment and Occupational Safety and Health Regulations apply.

In addition to the AS2419.1 and AS2941 requirements referenced above, QFES have published additional guidelines for fire service pump enclosures and tanks at:-

https://www.fire.qld.gov.au/buildingsafety/guidelines.asp

This paper has incorporated such details as necessary but Consultants are encouraged to view the QFES site. Additionally, in designing the building to accommodate tanks and a pump room, the Architect should allow for the location, access and spatial requirements and their associated services as described in the FSCS paper ***"The Design of Fire Pump Rooms"*.**

FSCS provides the following advice in respect to pump room design. It should be noted that this is advice only but it is based on the BCA, Australian Standards and relevant Occupational Health and Safety Codes.

Accordingly FSCS reinforces this by advising that the following location, access and spatial objectives should be achieved.

- The required FRLs bounding the compartments.
- Independent access for the Fire Brigade directly from the outside of the building. Should independent access not be feasible, access from a basement car park via the required egress stair may be acceptable subject to an Alternative Solution being formulated. In that case a stair lobby would be required in the basement typically as shown in Figure 10. The door to the pump room should be a fire door with smoke seals. Note that intumescent smoke seals will NOT function in a sprinklered area because they will not get hot enough to expand. Accordingly "cold" smoke seals should be used.
- A maintenance access door from the car park. FSCS has frequently seen pump rooms constructed where the only way to install the fire pumps is to dismantle them, take each part down the stairs and then reassemble. This process is very costly because after reassembly the factory test certificate may be void and an on site test carried out. Later, if and when pump replacement is contemplated, the reverse has to be carried out.

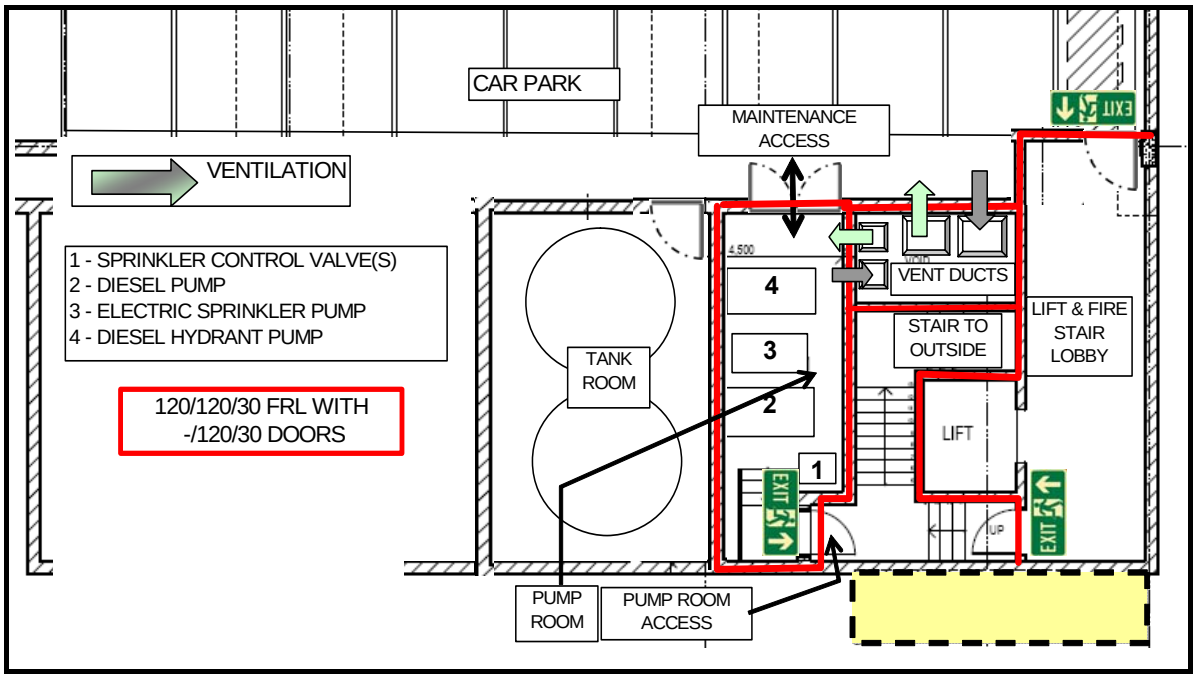

Figure 10 – Fire Pump Room & Tanks

6 – ACCEPTANCE TESTING & BUILDING CERTIFICATION

Acceptance testing of the installed systems is likely to proceed in a more orderly fashion if the systems installers cooperate to ensure that all necessary interfaces

Whilst acceptance testing procedures for sprinkler and hydrant systems are addressed in the relevant Australian Standards, there are a number of critical details in the pump room that warrant attention.

For hydrants, the testing of flow(s) for internal hydrants is usually conducted by QFES using their own McCrometer device(s) discharging into the 150mm drain in the fire isolated stair as discussed earlier. It is imperative that this test be conducted by the contractor prior to QFES attendance. In both cases observe the correct use of the McCrometer and residual pressure gauge as discussed earlier and detailed in the FSCS paper "**Fire Hydrant Flow Testing – V2**".

Note that this testing is not acceptable for the determination of available water supply.

For external hydrants, the contractor test should also address the McCrometer use and additionally, FSCS suggests that the contractor adopt the FPA (Fire Protection Association".

FSCS recommends that the 150mm hydrant test drain in the fire isolated stair be connected to the property "rainwater harvest" tank to save water. Likewise, when testing external hydrants, the discharge should be directed to the rainwater harvest tank or if not provided into a road tanker of appropriate size. Such tankers can be hired from rural water providers.

Note that the current standards for sprinkler system testing contemplate discharge back into the storage tank(s).

The FSCS paper entitled "***Building Certification***" on the FSCS web site provides guidance on the required Form 15 (design) and Form 16 (installation) certification that designers and installers are required to provide.

---------- End of Document---------

I trust that this paper provides useful information for Architects, Design Consultants and Builders in the design and installation of water based fire services.

QFES Building Approval Officers and Building Certifiers may also fine the information contained herein useful when assessing designs and acceptance testing.

Richard A Foster

Mechanical and Fire Safety Engineer

RPEQ Mechanical – 7753: Accredited by Board of Professional Engineers as a Fire Safety Engineer

Principal – Fire and Security Consulting Services

Version 6 amendments marked with a left margin revision bar and addresses minor typographical and grammatical errors, changes to AS2118.1 and forecast changes to BCA 2021.

Version 6– May 2019

APENDIX A

STANDARDS AUSTRALIA RESPONSE REGARDING FIRE HOSE REELS

Standards Australia Limited
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STANDARDS Australia

U:\FP-0007\LrRickFoster
07 March 2008

Mr Rick Foster
Fire Safety Engineer
Fire and Security Consulting Services
17 Mckenna Court
NOOSAVILLE, QLD 4566.

Dear Mr. Rick

Enquiry on AS 2441 and Interpretation of the Committee

This regards your enquiry on AS 2441 dated 24th September 2007. The FP-007 Fire hose reels Committee has considered your comment carefully and agreed on the following **'interpretation'** of AS 2441.

Background:

Enquiry on what water storage (appropriate volume or supply time) is required under Clause 6.1 of AS 2441 for hose considering following situations:

1. Site requires, under the BCA, to have a fire hose reel installed;
2. The site has no reticulated water supply;
3. AS 2441 requires a pump and/or water storage facility to be installed where the normal water supply cannot achieve the required flows and pressures or is unreliable;
4. No provision is in AS 2441 for a minimum storage volume or supply time for the water to the Reels and

Interpretation – AS 2441 – Installation of Fire Hose Reels:

The 2005 revision of AS 2441, in Clause 6.1, requires that "Where the normal water supply cannot achieve the required flow and pressure or is unreliable, a pump and/or water storage facility shall be installed to provide the minimum demand as specified in Table 6.1".

However, no provision has been made in AS 2441 for either the minimum volume of water that needs to be "stored", or the minimum time for which the hose reel(s) are required to be able to operate.

The question has been asked of Standards Australia what should be the minimum volume or supply time, for a project that, under the BCA, requires a hose reel to be installed but there is no reticulated water supply available.

Following discussions on the practicality of fire hose reels, and their use as first aid fire appliances, it is considered appropriate that where a water storage facility is required to meet compliance with AS 2441, that the supply shall be such that the installed hose reels meet the minimum discharge rates of Table 6.1 for a minimum of 2 hours.

----------End of interpretation----------

Yours sincerely

Ahshanur Rashid
Project Manager

On behalf of FP-007 Fire Hose Reel Committee