Table D.5 — Supplement to Figure D.5

Item no. in Figure D.5	Comment
1	A single reticulated water supply is shown providing automatic inflow to the lower-level reduced-capacity water storage tank. In this circumstance, to improve the redundancy of the system, consideration should be given to providing an additional reticulated water supply to the lower-level tank or increasing the volume of the tank. Increasing the volume brings the added benefit of increasing the duration of the water supply to the upper-level tank should the reticulated water supply fail.
2, 3 and 4	The provision of a compartmented water storage tank (or two tanks), the pipe manifold and two automatic starting full-duty fire hydrant pumps aligns with an N + 1 redundancy approach.
5	In the event of the on-site pumps failing, the fire brigade booster assembly provides an additional level of redundancy to the lower levels of the building.
6, 7 and 8	Two water supplies are provided from the full-duty fire hydrant pumps to Pressure Zone B and the upper level water storage tank. The redundant pathways provided by the installation of ring mains and the duplication of the pressure-reducing valves continues the N + 1 design approach. All rising pipe, carrying pressures above those required by the internal fire hydrants should be located outside the fire stair, as failure of high-pressure piping during a building evacuation would have significant consequences for any building occupants within the stair and fire brigade intervention activities.
9	Designated test facilities within each pressure zone support the long-term reliability of the fire hydrant system.
10	The upper level tanks provide a duplicate gravity supply to three upper pressure zones of the building. Therefore, the gravity supply provided adds an additional level of redundancy to the fire hydrant system in the event of the on-site pumps failing.
11, 12 and 13	As with Items 2, 3 and 4, the provision of a compartmented water storage tank (or two tanks), the pipe manifold and two automatic starting full-duty fire hydrant pumps align with an N + 1 redundancy approach.
14	The simple failure of a float valve modulating flow into an on-site water storage could have significant consequences for the continuing operation of the fire pumps drawing from the tank. To address this issue and to ensure an N + 1 design approach is applied, two hydraulic float valves arranged in series should be installed. Similar analysis should be applied to all component parts. An additional benefit to the duplication of float valves is that it also offers a level of protection from localized flooding should a valve fail.

Appendix E
(informative)

Special hazard areas

E.1 General

Where special hazards are identified within a building, open yard, or industrial site, the requirements of this document may not appropriately address the risks associated with these hazards, particularly flow rates and the fire hydrant locations. This appendix provides limited, general guidance only on some of the processes, commodities, storage configurations and structures associated with special hazards, some of the standards and codes applicable to this specific area of risk and some considerations for providing a fire hydrant system for the special hazard identified within the building or site.

NOTE Refer to the NCC for requirements relating to special hazards and the installation of additional smoke hazard management provisions.

E.2 Hazards

For the purpose of this document, special hazards are characterized by their ease of ignition, explosive tendencies, high fire load, and difficulty of access.

The following examples highlight particularly hazardous processes, commodities, configurations and geometry:

(a) Processes —

- (i) chemical plants;
- (ii) oil refineries; and
- (iii) explosives factories.

(b) Commodities —

- (i) flammable gases such as, acetylene, hydrogen, liquefied petroleum gas (LPG), liquefied natural gas (LNG);
- (ii) flammable and combustible liquids such as, alcohols (e.g. ethanol and methanol), diesel, petrol, thinners, turps;
- (iii) flammable solids such as, aluminium phosphide, calcium carbide, magnesium, potassium, sodium, sulfur, and nitrocellulose;
- (iv) oxidising agents such as ammonium nitrate, sodium nitrite;
- (v) miscellaneous dangerous goods such as lithium batteries, ammonium nitrate fertiliser; and
- (vi) expanded and unexpanded plastics, foam plastics.

(c) Configuration of storage —

- (i) high piles;
- (ii) stacked timber;

(iii) coal heaps;

(iv) grain and sugar silos; and

(v) storage tanks or pressure vessels.

(d) Geometry of structures —

(i) process towers;

(ii) cooling towers;

(iii) conveyors; and

(iv) wharves.

E.3 Factors to be considered

Where a fire hydrant system is being designed for a special hazard area, consideration should be given to the following:

(a) Pressure, flow rates, and duration of water supply required to address the specific hazard.

(b) Possible use of supplementary water from sources such as cooling water basins.

(c) Protection of pipework and equipment from possible explosion.

(d) Protection of pipework against corrosion.

(e) Access of firefighters to the fire risk.

(f) Availability of hardstand for firefighting appliances.

(g) Provision of equipment such as monitors, water spray systems, fog systems and foam systems.

(h) Automatic and/or remote control of installed monitors, water spray systems, or the like.

(i) Location of isolating valves.

(j) Location of hydrants.

NOTE For special hazards located in designated open areas, the regulatory authority may require an increase in separation distances.

E.4 Hazard analysis and additional considerations

When analysing the hazards associated with a special hazard area, consideration should be given to the following:

(a) The provisions of the NCC.

(b) Undertaking a risk assessment of the potential fire scenarios in accordance with the processes detailed in ISO 31000.

(c) Consulting with the relevant regulatory authority.

(d) Consulting with the relevant fire service or fire brigade.

(e) Referring to the applicable Australian Standard (e.g. AS 1940, AS/NZS 1596, AS/NZS 2022, AS/NZS 3833 or AS 3846).

NOTE Refer to the relevant state or territory authority for legislation on work health and safety.

Appendix F
(informative)

Fire brigade operations and equipment — Design considerations for fire hydrant systems

F.1 Scope

This appendix provides information and guidance on fire brigades, fire brigade pumping appliances, fire brigade operations and firefighting strategies used when controlling or extinguishing fires in buildings. An understanding of these aspects is considered fundamental to designing a fire hydrant system that meets the operational needs of the attending fire brigade and the design requirements of this document.

F.2 Introduction

F.2.1 Firefighters

In Australia, depending on which fire service has jurisdiction in an area, a fire station may be staffed by full-time firefighters, part-time or retained firefighters, volunteers, or a combination of these.

Fire stations staffed with full-time firefighters are found in all major metropolitan areas and in selected large regional cities and towns across Australia.

Fire stations staffed by part-time or retained firefighters or volunteers are typically found in regional cities and towns.

F.2.2 Response capability

The number and type of fire brigade pumping appliances and the number of firefighters available to respond to a fire incident will depend on the fire service that has jurisdiction and the location of the fire in its area of jurisdiction.

Typically, if a fire incident occurs in a metropolitan area, a large and comprehensive response incorporating multiple fire brigade pumping appliances and numerous firefighters is available if required. In regional centres and towns, a similar response is not possible due to the limited resources available. In some regional centres and towns, additional resources (i.e. fire brigade pumping appliances and firefighters) may be sourced from neighbouring towns and areas.

F.2.3 Equipment

To undertake firefighting operations, the attending firefighters carry a range of equipment. This equipment and their approximate weights are detailed in Table F.1.

Table F.1 — Typical equipment used by fire brigade

Equipment	Weight
Firefighting uniform	9.5 kg
Self-contained breathing apparatus	12.0 kg
One length of 70 mm hose (non-percolating)	16.5 kg
One length of 38 mm hose (non-percolating)	7.8 kg
One 70 mm firefighting branch	4.4 kg
One 38 mm firefighting branch	2.1 kg
One standpipe	8.3 kg

F.2.4 Implications for design

The design of a fire hydrant system should take into account the fire brigade within that area (i.e. metropolitan, country, or rural), the staffing provided (i.e. full-time, part-time or volunteer) and the response capability available (i.e. number and type of pumping appliances available within the area).

NOTE Refer to the NCC for further information on the provision of a fire hydrant system appropriate to the needs of the attending fire brigade.

Due to the weight of equipment required to be carried wherever possible, the distance from an external fire hydrant to a hardstand should be minimised.

In regional towns and centres where resources are typically limited, consideration should be given to the number of fire brigade pumping appliances and firefighters available to respond to a fire incident. For example, in a regional centre provided with only two fire brigade pumping appliances, the provision of a fire brigade booster assembly will enable the attending fire brigade to use the limited resources available more effectively.

F.3 Fire brigade operations

F.3.1 General

Figure F.3.1 below provides a simplified representation of how fire brigade operations are conducted at a fire incident.

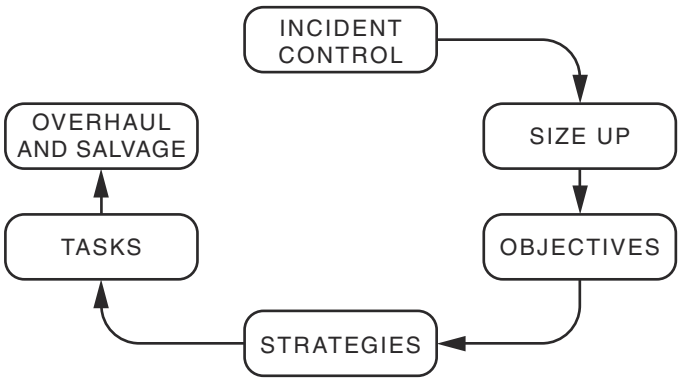


Figure F.3.1 — Incident control cycle

F.3.2 Incident control

Unless lives are at risk, the first priority at a fire incident is to establish an incident command point. The incident command point may be either internal or external to the building depending on the type

of building, the fire safety systems installed within the building, and the location and size of the fire. When established, other priorities of the fire brigade incident command include:

(a) Taking control of the incident, evaluating the situation, identifying risks, and developing an action plan to bring the incident to its conclusion.

(b) Tactically deploying the available firefighters and resources.

(c) Continually gathering and monitoring information from the fire ground to enable fire ground strategies and tactics to be evaluated and modified as required.

(d) Providing support to firefighters (e.g. additional resources, food, or fuel).

Depending on the size and complexity of the fire incident, control of the fire incident can be expanded to include multiple levels involving other members of the fire brigade or contracted as required.

F.3.3 Size up

F.3.3.1 General

Upon establishment of an incident command point, an initial size up of the incident is conducted. Some factors to be considered include:

(a) The characteristics of the building.

(b) The exposure(s) threatened by the fire.

(c) The location of the fire.

(d) The best means of extinguishing the fire.

(e) The assistance required.

As part of this initial size up, the risks associated with the fire incident are identified and strategies to mitigate these risks are developed. For example, a risk typical to all building fires is the presence of electricity, so a typical mitigation strategy would be to isolate the electrical supply or part of the power supply if safe to do so.

F.3.3.2 Building

In the size up of the building, some factors to be considered include:

(a) Whether all building occupants are accounted for.

(b) The type of building occupancy and its characteristics (e.g. type of construction, compartmentation within the building, location of access and entry points, and available fire safety systems).

(c) Any hazards associated with the building (e.g. gas or LPG supplies and storage).

(d) The potential for structural collapse.

F.3.3.3 Exposures

In the size up of risks to exposures, some factors to be considered include:

(a) Internal exposures — protection of the internal parts of the building threatened by the growing fire.

(b) External exposures — protection of other occupancies, adjacent to or adjoining the building that are threatened by the growing fire.

(c) The risk of air and water pollution due to the products of combustion released at all fires.

F.3.3.4 Location

In the size up of the fire, some factors to be considered include:

(a) The location of the fire.

(b) The most appropriate means of accessing the fire.

(c) The characteristics of the fire (i.e. how rapidly it is growing, whether it is growing vertically or horizontally, and the amount of smoke and heat being produced).

(d) The personnel protective equipment (PPE) required by firefighters.

(e) The likely means of fire spread (e.g. radiant heat, convection, conduction, flying embers and direct flame impingement).

(f) The effect of the fire and fire suppression techniques on the building structure.

(g) The most effective cut-off points and means of extinguishing the fire.

F.3.3.5 Extinguishment

In the size up of the fire some factors to be considered include:

(a) The type of fuel burning.

(b) The most appropriate extinguishing agent.

(c) The adequacy of the water supply serving the building or site.

(d) How to most effectively use the fire hydrant system provided

(e) The most appropriate means of ventilating the fire.

(f) Any special hazards associated with the fuel that is burning.

F.3.3.6 Assistance

In the size up to effectively resource the fire, some factors to be considered include:

(a) The need for additional firefighters.

(b) The need for additional fire brigade pumping appliances.

(c) The need for specialist fire brigade pumping appliances (e.g. aerial appliances, foam appliances or CO_2 appliances).

(d) The need for specialist advice (e.g. electrical or network utility operator).

F.3.4 Objectives

On all fire grounds the primary objectives of the attending fire brigade are:

(a) To save saveable lives.

(b) To save saveable property.

(c) To protect the environment.

In all instances, the primary objective of any fire brigade intervention activity is to locate and rescue any reported building occupants.

F.3.5 Strategies

The following firefighting strategies are available to achieve the stated objectives:

(a) *Offensive* — An offensive firefighting strategy aims to contain the fire to the area of origin within the building. The decision to undertake this choice of strategy and commit firefighters to an internal fire attack is determined by the internal fire conditions. Should the prevailing internal conditions be identified as tenable to firefighters wearing personal protective equipment (PPE) during the initial size-up, an offensive firefighting strategy will be adopted.

Where an offensive firefighting strategy is adopted, the hose lines attached to a fire brigade pumping appliance will be pressurized by the pumping appliance to provide a pressure of 700 kPa at the nozzle of any firefighting hose branch. Internal firefighting is typically conducted using smaller diameter fire hoses (e.g. 38 mm).

(b) *Defensive* — A defensive firefighting strategy typically aims to contain the fire to the building of origin (i.e. the efforts of the attending fire brigade are aimed at protecting adjoining or adjacent buildings). The decision to undertake this choice of strategy and not commit firefighters to an offensive internal fire attack is determined by the internal fire conditions. Should the prevailing internal conditions be identified as untenable to firefighters wearing PPE during the initial size-up and the risks involved in an offensive strategy are too high, a defensive firefighting strategy will be adopted.

Where a defensive firefighting strategy is adopted, lower pressures are normally provided at the nozzle of any firefighting branch; however, significantly higher flow rates are also provided and larger diameter fire hoses are typically used (e.g. 65 mm or 70 mm).

F.3.6 Tactics

To achieve the stated objectives, the following firefighting tactics will be prioritized:

(a) *Rescue* — save and protect people's lives, including those of firefighters.

(b) *Exposure* — confine the fire to the compartment or building of origin.

(c) *Containment* — stop the spread of fire.

(d) *Extinguish the fire* — deploy resources to overwhelm the fire.

(e) *Overhaul* — totally extinguish all pockets of fire.

(f) *Ventilation* — planned and systematic removal of heat and fire gases.

(g) *Salvage* — commence damage control operations as soon as possible during fire attack.

These tactics represent a hierarchical framework for decision making where resources are assigned to deal with each tactical priority before committing resources to the next. Where resources are available and circumstances permit, firefighters may be assigned to more than one tactical priority at the same time.

F.3.7 Tasks

F.3.7.1 General

Once the strategic and tactical priorities for the fire incident have been established, some of the tasks to be undertaken include:

(a) Door entry — forcible entry into the building;

(b) Breathing apparatus operations;

(c) Operation of the fire brigade booster assembly; and

(d) Deployment of fire hose lines.

F.3.7.2 Fire ground sectoring

Each side or floor of the building will be allocated a sector name to facilitate fire brigade intervention and control of resources.

For low-rise buildings, each side of the building is allocated a sector name. Typically, the front of the building is designated as Sector A, with other sides named Sector B, Sector C, respectively in a clockwise direction. A diagrammatic example of fire brigade operations using sectoring is shown in Figure F.3.7.2. Each sector is then assigned a "Sector Commander A, B, C", as applicable.

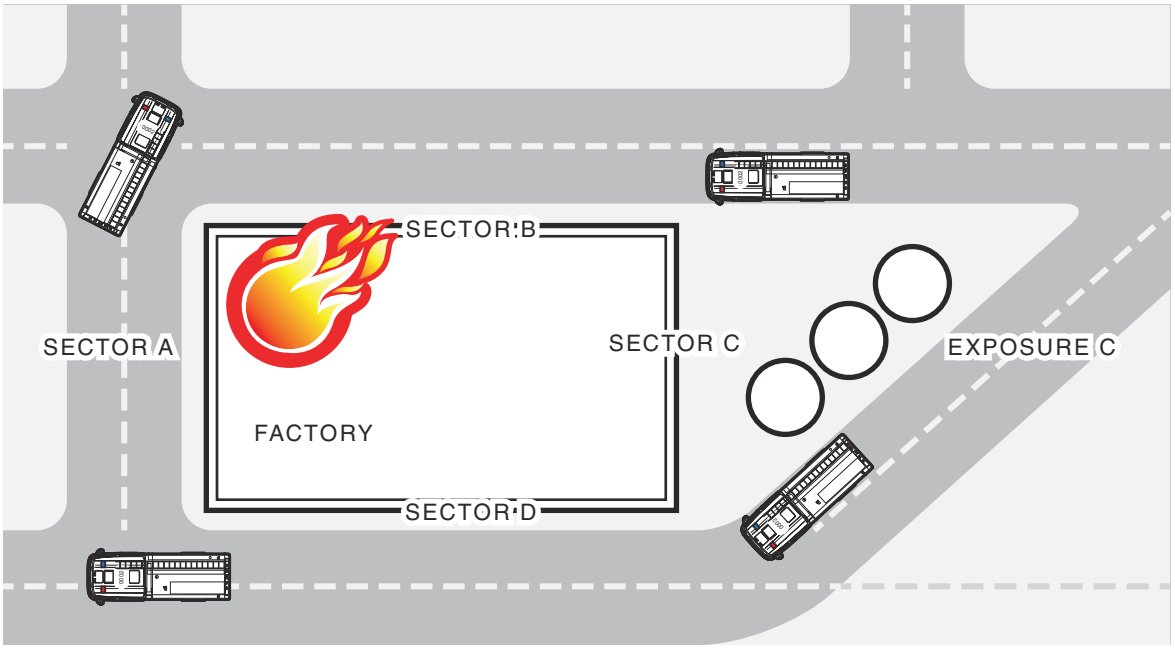


Figure F.3.7.2 — Sectoring during fire brigade operations

For multi-level buildings, the building's floor numbering or naming system will be used to sectorise the building and identify the locations where firefighters are operating. Each floor level involved in the control of the fire is then assigned a "Sector Commander floor level 1, 2, 3", as applicable.

Fire brigade activities undertaken in each of the building's sectors and the fire conditions at those locations are regularly communicated to the incident command point.

F.3.7.3 Firefighting operations — Low-rise buildings

After an initial size-up of the fire incident has been conducted, a determination of whether additional resources are required will be made. The number of firefighters and resources required will reflect the size and complexity of the fire scenario confronted.

Where a small fire is identified, this may be extinguished by the first arriving appliance in attendance using either an on-board high-pressure hose or a small-bore (38 mm) layflat hose that is pressurized by the on-board appliance pump with water supplied from an on-board tank.

Where internal firefighting is required in a low-rise building, layflat firefighting hose connected to either an external attack fire hydrant, an internal attack fire hydrant or a fire brigade pumping appliance will be used. Supply to a fire brigade pumping appliance will typically be from either a street hydrant or feed fire hydrant. To facilitate safe and effective firefighting of a fire internally, a pressure of

not less than 700 kPa would be provided at the firefighting branch by either the fixed on-site pump or by the fire brigade pumping appliance.

Where a larger fire is identified, additional resources may be required for strategic deployment around/throughout the building to control the spread of fire and to protect any exposures under threat by fire.

At a large fire, multiple hose streams using larger diameter hoses (up to 70 mm) and aerial appliances using high discharge monitors are likely to be deployed. In such operations, large volumes of water are needed. If water is not available on site or immediately adjacent to the site, it will be obtained from sources further afield, such as street fire hydrants in other locations or reservoirs and, if necessary, relayed through additional pumping appliances and layflat hose to the fire location.

The organizing, command, and control of the fire incident and the resources available will be undertaken by a single fire brigade officer or through the establishment of a hierarchical structure using multiple fire brigade officers, depending on the size of the fire.

F.3.7.4 Firefighting operations — High-rise buildings

Fires in high-rise buildings often pose special challenges to the attending fire brigade because of the time taken to get firefighters and resources to the fire floor. Typically, the attending fire brigade travel to the level below the fire floor, often by taking control of the firefighter lift within the building. The first arriving firefighters, carrying small diameter layflat hose and forced entry equipment, then travel to the fire floor by the fire stair, connect the hose to the internal fire hydrant on the floor and then enter the fire floor under the protection of a charged line of hose and possibly a firefighting hose stream. To facilitate safe and effective firefighting of a fire internally, a pressure of not less than 700 kPa is provided at the firefighting branch by either the fixed on-site pump or by the fire brigade pumping appliance.

F.3.8 Overhaul and salvage

At the conclusion of a fire incident or when the fire is under control, activities aimed at ending the fire incident are initiated. Some of the tasks undertaken include —

(a) removal of water from the building;

(b) reduction of water damage;

(c) extinguishment of spot fires; and

(d) protection of stock.

F.3.9 Implications for design

In reviewing a fire hydrant system design, some questions to be asked include:

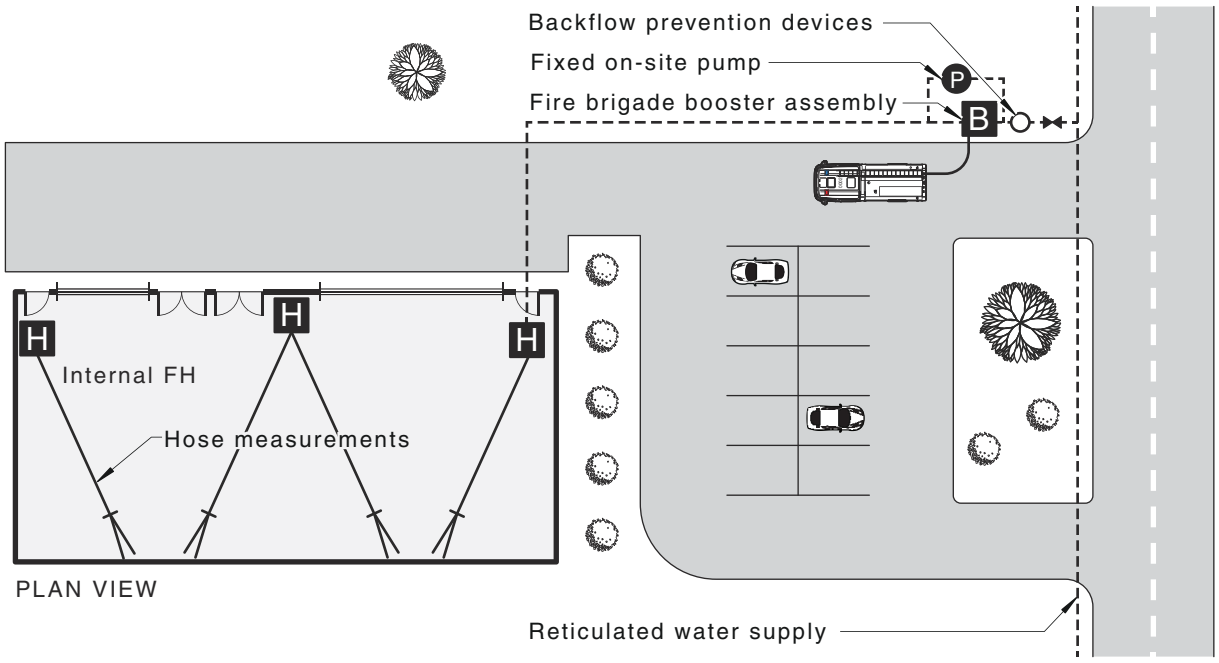
(a) Does the fire hydrant layout allow for offensive and defensive firefighting operations to be undertaken?

(b) Does the fire hydrant layout provide attending fire brigade personnel with ready access to a fire hydrant as they approach and progressively move through or around a building?

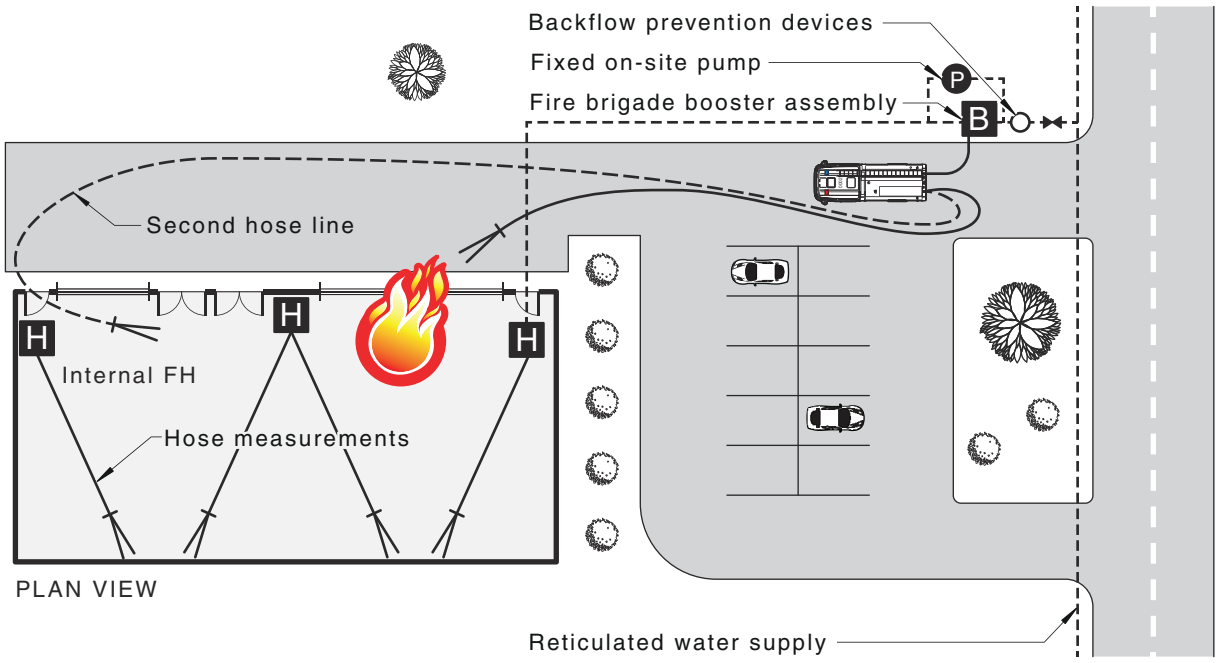
(c) Does the fire hydrant layout locate the first feed fire hydrant or fire brigade booster assembly in a position that may be readily seen by the attending fire brigade upon approach to the building?

(d) Are the fire hydrants in the design located as far as practicable from the risks associated with the building?

Figure F.3.9 and the following text provide a discussion on fire hydrant system designs and fire brigade operations.



(a) Low-rise building internal fire hydrant system design



(b) Low-rise building internal fire hydrant system design — Operational impact