

Australian Standard[®]

Fixed fire protection installations— Pumpset systems



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The following are represented on Committee FP-008:

- Association of Hydraulic Services Consultants Australia
 - Australasian Fire and Emergency Service Authorities Council
 - Australian Chamber of Commerce and Industry
 - Fire Protection Association Australia
 - Insurance Council of Australia
 - Pump Industry Australia
-

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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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Australian Standard[®]

Fixed fire protection installations— Pumpset systems

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PREFACE

This Standard was prepared by the Standards Australia Committee FP-008, Fire Service Pumps, to supersede AS 2941—2008.

Maintenance requirements for fire pumpsets are given in AS 1851, *Routine service of fire protection systems and equipment*.

The symbols used in this Standard comply with those given in HB 20, *Graphical symbols for fire protection drawings*, and have been developed from ISO Standards. The typical illustrations are in diagrammatic form only.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

The use of Notes in this Standard is of an advisory nature only. They provide explanations and guidance on recommended design considerations or technical procedures, as well as informative cross-references to other documents or publications.

This Standard incorporates a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number, and is printed in italics in a box. The commentary is for information and guidance.

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FOREWORD

This Standard sets out requirements for pumpset systems to suit various types of fire protection systems such that a reasonable degree of protection for life and property from fire may be achieved. These requirements are based on sound engineering principles, test data and field experience.

The performance characteristics for pumpsets have been aligned to be the same for hydrant systems, sprinkler systems and combined sprinkler and hydrant systems. The committee considered the use of pressure-relief valves and concluded that these are not an acceptable way to limit system pressures in cases where substantial variations to suction pressures are encountered. The use of variable speed drives is preferred where pressure-relief valves are installed as a fail-safe measure. Bore pumps are no longer considered acceptable as primary fire fighting water supplies; however, they are still acceptable water sources for suction tanks. The maximum water velocity in pipework has been aligned with other fire protection standards.

The electrical feed requirements for all fire system pumpsets have been revised in conjunction with the AS/NZS 3000 (Wiring Rules) committee, and will be aligned when the next revision is published. The main switch/circuit breaker for electric driver fire pumpsets is now required to be located in the electric fire pump controller. The requirements for batteries (starting, control and back up) and their respective battery chargers have been revised to ensure appropriate compatibility. Jockey and jacking pumps are now required to have their own independent limited functionality controllers. Specific requirements have been included for cases where a diesel-driven hose reel pumpset is provided as the sole source of fire protection for a building.

The emergency dual manual start solenoids for compression-ignition driven pumpsets are no longer required to be located on the diesel engine. Provision has been made for new technology LCD and plasma screens and indicators for pumpset controllers. The requirement for dual ECMs for electronically managed compression-ignition engines has been relaxed. The cooling system components and arrangement on compression-ignition engines has been clarified, along with fuel line and fuel tank requirements. As air-powered starting arrangements are very rarely required, reference to them has been removed from the Standard.

The conditions and procedures for shop testing and commissioning testing of pumpsets have been clarified, and additional examples of performance test data sheets provided.

NOTE: See Appendix F.

The section on siting and location of pumpsets (Section 11) has been enhanced to take into consideration health and safety requirements. For installations that require a pump house or pump room, a normative appendix (Appendix D) has been provided, with requirements that satisfy the Australasian Fire and Emergency Service Authorities Council (AFAC).

STANDARDS AUSTRALIA

Australian Standard**Fixed fire protection installations—Pumpset systems**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for totally independent pumpset systems for use with fixed fire protection installations, such as sprinkler, hydrant, water spray, and hose reel systems. It covers water supplies, pumps, drivers, fire pump controllers, and auxiliary equipment. Requirements for siting, installation and commissioning testing, including acceptance testing of electrical and compression-ignition drivers, are also included.

NOTES:

- 1 Some special fire pump installations (e.g. at petrochemical and petroleum plants and small rural installations) may require variations from the requirements of this Standard.
- 2 Examples of typical pumps covered by this Standard are shown in Figure 3.5.

1.2 OBJECTIVE

The objective of this Standard is to provide designers, manufacturers, installers and testers with minimum requirements for the design, manufacture, installation and commissioning testing of fire pumpsets.

1.3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

1319	Safety signs for the occupational environment
1345	Identification of the contents of pipes, conduits and ducts
1349	Bourdon tube pressure and vacuum gauges
1359	Rotating electrical machines—General requirements
1359.30	Part 30: Preferred outputs and frame sizes
1359.101	Part 101: Rating and performance
1692	Steel tanks for flammable and combustible liquids
1722	Pipe threads of Whitworth form
1722.2	Part 2: Fastening pipe threads
2118	Automatic fire sprinkler systems (series)
2129	Flanges for pipes, valves and fittings
2293	Emergency escape lighting and exit signs for buildings
2293.1	Part 1: System design, installation and operation
2304	Water storage tanks for fire protection systems
2417	Rotodynamic pumps—Hydraulic performance acceptance tests—Grades 1 and 2

AS	
2419	Fire hydrant installations
2419.1	Part 1: System design, installation and commissioning
2430	Classification of hazardous areas
2430.1	Part 1: Explosive gas atmospheres
2441	Installation of fire hose reels
2660	Hose and hose assemblies—Air/water—For underground coal mines
2700	Colour standards for general purposes
2700S	R13: Signal red
3570	Automotive diesel fuel
4118	Fire sprinkler systems
4118.1.6	Part 1.6: Components—Stop valves and non-return valves
60529	Degrees of protection provided by enclosures (IP Code)
60947	Low-voltage switch gear and controlgear
60947.2	Part 2: Circuit-breakers
60947.4.1	Part 4.1: Contactors and motor-starters—Electromechanical contactors and motor-starters
60947.4.2	Part 4.2: Contactors and motor-starters—A.C. semiconductor motor controllers and starters
AS/NZS	
1221	Fire hose reels
1668	The use of ventilation and airconditioning in buildings
1668.1	Part 1: Fire and smoke control in multi-compartment buildings
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
4331	Metallic flanges
4331.2	Part 2: Cast iron flanges
AS ISO	
7	Pipe threads where pressure-tight joints are made on the threads
7.1	Part 7.1: Dimensions, tolerances and designation
IEC	
60034	Rotating electrical machines
60034-12	Part 12: Starting performance of single-speed three-phase cage induction motors
60072	Dimensions and output series for rotating electrical machines
60072-1	Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080
60072-2	Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360
60072-3	Part 3: Small built-in motors—Flange numbers BF10 to BF50
ISO	
281	Rolling bearings—Dynamic load ratings and rating life
1940	Mechanical vibration—Balance quality requirements for rotors in a constant (rigid) state
1940-1	Part 1: Specification and verification of balance tolerances
15550	Internal combustion engines—Determination and method for the measurement of engine power—General requirements

1.4 DEFINITIONS

For the purposes of this Standard, the definitions below apply.

1.4.1 Circulation relief

Prevention of overheating by providing a flow of water to waste when the pump is operating with no discharge.

1.4.2 Controller

An enclosed group of devices (including a power disconnect device by which the conductors of a circuit can be disconnected from the source of supply) that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

1.4.3 Discharge head (assembly)

Part of the vertical line shaft pump assembly that supports the driver, pump and column, aligns the driver and pump, and changes the vertical flow to a horizontal direction.

1.4.4 Driver

An engine or motor used to drive a fire pump.

1.4.5 Duty point

Head (duty head) corresponding to the required flow (duty flow) for the particular application.

1.4.6 Duty speed

The speed at duty point (see Clause 1.4.5).

1.4.7 Dynamic shaft deflection

The distance by which the axial centre-line of the shaft deviates from the axial centre-line of the bearings under dynamic conditions.

1.4.8 Efficiency

The ratio of the energy delivered by the pump to the energy supplied to the pump shaft, that is, liquid power divided by applied power.

1.4.9 Fixed guard

Guard kept in place by means of fasteners (screws, nuts, etc.), making removal or opening impossible without using tools.

1.4.10 Hollow shaft

The hollow drive shaft fitted to electric motors or right-angle gear drives to accept the solid shaft of the pump.

NOTE: The hollow shaft design facilitates impeller adjustment within the bowl assembly and the installation of a non-reverse ratchet in the motor or gear drive.

1.4.11 Inertia base

A supporting base, isolated from the main structure, that increases the mass of the non-rotating parts to dampen any vibratory forces due to rotation.

1.4.12 Line shaft

A vertical shaft that transmits the power from a driver to a vertical turbine pump.

1.4.13 Listed

Refers to a product listed for fire protection duty by an internationally recognized testing laboratory or approval body.

NOTES:

- 1 A register of accredited products is issued by the CSIRO ActivFire Scheme.
- 2 The following are examples of internationally recognized testing laboratories or approval bodies:
 - (a) Factory Mutual Insurance Company (FM Global).
 - (b) Underwriters Laboratories (UL).
 - (c) Loss Prevention Council (LPC).
 - (d) Verband der Schadenverhütung (VdS).

1.4.14 Maximum allowable pump working pressure

The maximum working pressure for which a pump casing is designed.

1.4.15 Maximum flow

Pump flow at 130% of duty point.

1.4.16 Net positive suction head (NPSH)

The total inlet head plus the head corresponding to the atmospheric pressure minus the head corresponding to the vapour pressure.

NOTE: 'NPSH' and 'total inlet head' are referred to in the reference plane. The two references to NPSH are as follows:

- (a) *Net positive suction head required (NPSHR)* A function of pump design, which is available from the pump manufacturer.
- (b) *Net positive suction head available (NPSHA)* A function of the system in which the pump operates and which can be calculated for any installation.

1.4.17 Nominal size (DN)

A numerical designation of size that is common to all components in a piping system, other than components, designated by outside diameters or by thread size.

NOTE: The nominal size is designated by DN followed by a number. The nominal size cannot be measured, and should not be used for the purposes of calculation. It should be noted that not all piping components are designated by nominal size; for example, steel tubes are designated and ordered by outside diameter and thickness. It is a convenient round number for reference purposes and is loosely related to manufacturing dimensions.

1.4.18 Non-reverse ratchet

A mechanism installed to prevent reverse rotation of the pump-driver assembly.

1.4.19 Oil-lubricated vertical turbine pump

A turbine pump in which the vertical line shaft is enclosed and the shaft bearings are lubricated with oil.

1.4.20 Pressure relief

The prevention of over-pressurization of the system to which the pump is connected.

1.4.21 Pump manufacturer

An entity that designs, manufactures, tests and certifies a pump as compliant with this Standard.

1.4.22 Pumpset

An assembly comprising a pump, a driver, a coupling and ancillary components on a common mounting base together with an integral or separate fire pump controller.

1.4.23 Pumpset manufacturer

An entity that designs, manufactures, tests and certifies a complete assembly of pump, driver and controller as compliant with this Standard.

1.4.24 Recirculation

The phenomenon of flow reversal at the suction or discharge tips of the impeller vanes, which occurs when the capacity of the pump has been reduced by throttling.

1.4.25 Reference plane

The horizontal plane through the centre of the circle described by the external point of the entrance edges of the impeller blades.

NOTE: For double-inlet pumps, the plane is taken through the higher centre.

1.4.26 Relevant authority

An independent agency authorized by legislation or regulation to issue determinations, orders or other instructions in respect of any subject covered by this Standard.

NOTE: Where compliance with this Standard is not a requirement of a relevant authority but is a requirement of a body such as an insurance company or association, then that body, or its nominees, may perform the functions of the relevant authority for the purposes of this Standard.

1.4.27 Sealed (VRLA) battery

Valve regulated (sealed) lead acid batteries that allow a small amount of venting but where the electrolyte cannot be tested or topped up.

1.4.28 Total discharge head

The reading of a gauge at the discharge flange, converted to metres of liquid and corrected to the pump centre-line, plus the velocity head at the point of gauge attachment.

1.4.29 Total head (of a pump)

The algebraic difference between the total discharge head and the total suction head.

1.4.30 Total suction head

The reading of a gauge at the suction flange, converted to metres of liquid and corrected to the pump centre-line, plus the velocity head at the point of gauge attachment.

1.4.31 Variable speed control

A speed control system used to limit the total discharge head by reducing the pump driver speed from duty speed; that is, the speed at duty point at minimum inlet pressure.

1.4.32 Velocity head

The kinetic energy per unit mass of the liquid in movement. It is expressed by—

$$\frac{V^2}{2g}$$

where

V = mean velocity of the liquid in the section considered, in metres per second

g = acceleration of freefall, in metres per second squared

1.4.33 Water-lubricated vertical turbine pump

A vertical turbine pump in which the line shaft bearings are lubricated with pumped water.

SECTION 2 WATER SUPPLIES

2.1 GENERAL

The suitability and dependability of the source of water shall be determined prior to the selection of pumping equipment.

2.2 ACCEPTABLE SOURCES OF SUPPLY

Sources of supply shall comply with the requirements of the Standard applicable to the system served by the pumpset.

NOTES:

- 1 Standards applicable to systems served by the pumpset are the AS 2118 series, AS 2419.1 and AS 2441.
- 2 Bores are no longer considered acceptable primary water supplies for fixed fire protection installation pumpset systems and should not be used.

2.3 QUALITY OF WATER

If the water contains dissolved or suspended matter likely to cause accumulation, pump materials shall be selected with due regard to the quality of water. See Clause 4.1.2 for materials of construction.

2.4 FLOODED SUCTION

Fire protection pumps shall be supplied with flooded suction for intake of water. Priming tanks or vacuum systems shall not be used.

NOTE: The need for flooded suction arises due to difficulties encountered in the automatic priming of pumps installed under suction lift conditions.

2.5 SUCTION

2.5.1 Suction size

The size of the suction pipe for single or multiple pumps (arranged to operate simultaneously) shall be such that, with all pumps operating at maximum flow, the net positive suction head available (NPSHA) at the pump inlet shall be at least 1.0 m in excess of net positive suction head required (NPSHR) under all supply conditions. The NPSHA shall be reduced by 0.1 m at the pump installation for each 100 m above sea level.

NOTES:

- 1 For pipe sizes see Clause 3.6.2.
- 2 High-flow, high-speed centrifugal pumps typically have high-end NPSHR requirements. When such pumps are drawing maximum flow from water storage tanks at minimum effective water level, it is generally recommended that NPSHR be less than 7.0 m.

2.5.2 Devices on suction piping

With the exception of a listed gate valve for isolation purposes, no device that can adversely affect the performance of the pump shall be installed in the suction piping.

NOTE: Prohibited devices include check valves, butterfly valves, globe valves and flow switches. This does not preclude the use of backflow prevention devices required by the relevant authority.

Valves within 15 pipe diameters of the pump inlet shall not be of the butterfly valve type.

Where the water supply is obtained from an open source such as a pond or wet pit, a compatible, corrosion-resistant strainer shall be attached to the suction inlet and shall have a free area of not less than four times the area of the suction entry.

Individual openings in the strainer shall be not greater than the pump impeller passage width, up to a maximum allowance of 8 mm by 8 mm.

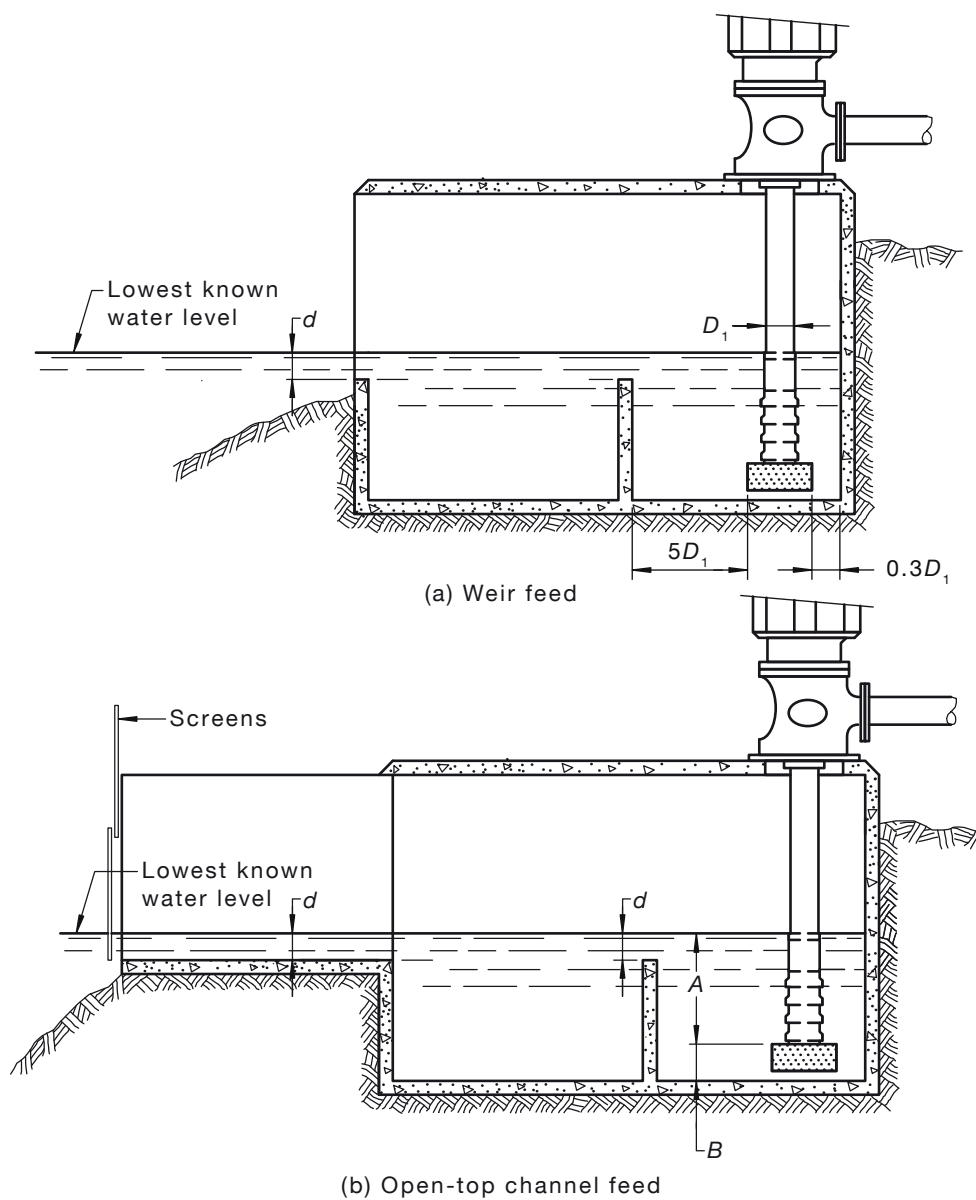
2.6 SUPPLY FROM NATURAL SOURCES

2.6.1 General

Where the suction pipe draws from a suction chamber fed from a virtually inexhaustible natural source, such as a river, channel, lake or similar water body, the design and dimensions specified in Table 2.1, Figure 2.1 and Clauses 2.6.2 to 2.6.7 shall apply.

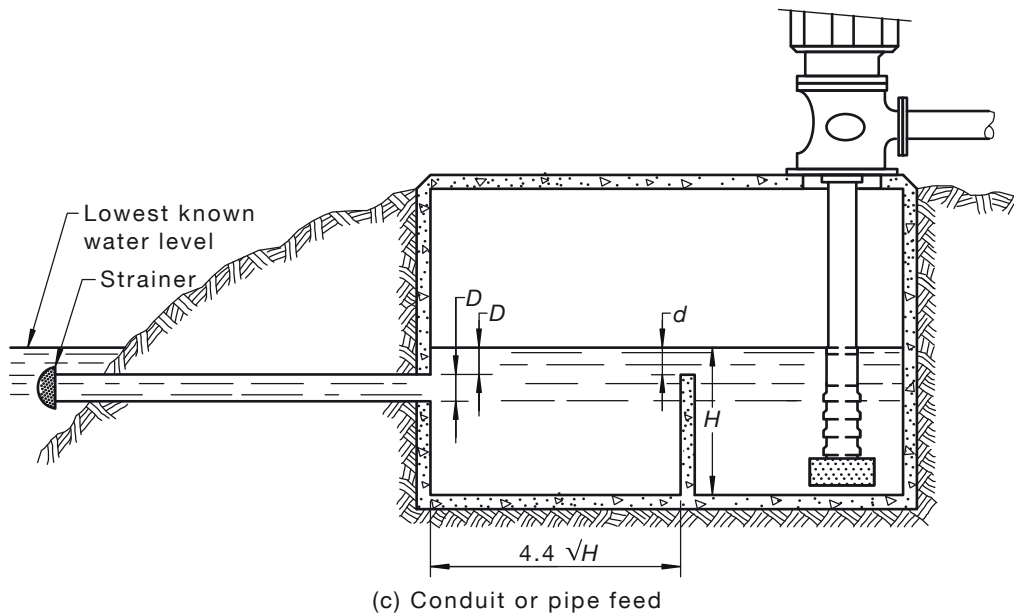
TABLE 2.1
MINIMUM SUBMERGENCE AND CLEARANCE

millimetres		
Nominal diameter of suction pipe	Dimension A	Dimension B
65	250	80
80	310	80
100	370	100
150	500	100
200	620	150
250	750	150
300	900	200
350	1050	250
400	1200	300



DIMENSIONS IN MILLIMETRES

FIGURE 2.1 (in part) MINIMUM DIMENSIONS FOR SUPPLIES FROM INEXHAUSTIBLE SOURCE



DIMENSIONS IN MILLIMETRES

LEGEND:

d = depth of water
 D1 = internal diameter
 A = suction head

B = clearance from suction inlet to bottom of suction chamber
 D = diameter of feed pipe
 H = depth of water in settling chamber

FIGURE 2.1 (in part) MINIMUM DIMENSIONS FOR SUPPLIES FROM INEXHAUSTIBLE SOURCE

2.6.2 Slope of inlet

Pipes, conduits and beds of open topped channels shall have a continuous downward slope towards the jackwell or suction pit of at least 1:125.

2.6.3 Diameters of pipes

The diameters of feed pipes or conduit shall be determined from the following formula:

$$D_1 = 21.68 Q^{0.357}$$

where

D_1 = internal diameter, in millimetres

Q = maximum flow rate of pump in litres per minute (see Clause 3.1)

2.6.4 Depth of inlet

The top of the pipe or conduit inlet shall be not less than one diameter below the lowest known water level.

2.6.5 Depth of water

The depth (d) of water in open channels or weirs, and above the weir between the settling chamber and suction chamber, shall be not less than that shown in Table 2.2 for the corresponding width (W) and maximum flow rate of the pump (Q). Each suction inlet shall be provided with a separate suction and settling chamber.

The total depth of open channels and weirs shall be sufficient to accommodate the highest known water level of the water source.

TABLE 2.2
MINIMUM DEPTH OF WATER AND WIDTH OF OPEN CHANNELS
AND WEIRS FOR CORRESPONDING INFLOWS

250 (mm)		Depth (<i>d</i>)		1000 (mm)	
		500 (mm)			
Width (W)	<i>Q</i> (l/min)	Width (W)	<i>Q</i> (l/min)	Width (W)	<i>Q</i> (l/min)
88	280	82	522	78	993
125	497	112	891	106	1687
167	807	143	1383	134	2593
215	1197	176	1960	163	3631
307	2064	235	3159	210	5647
334	2342	250	3506	223	6255
410	3157	191	4482	254	7825
500	4185	334	5592	286	9577
564	4953	361	6340	306	10 749
750	7261	429	8370	353	13 670
1113	12 054	527	11 415	417	18 066
1167	12 792	539	11 816	425	18 635
1500	17 379	600	13 903	462	21 411
2000	24 395	667	16 271	500	24 395
4500	60 302	819	21 949	581	31 142
		1000	29 173	667	38 916
				2000	203 302

2.6.6 Dimensions of suction and settling chambers

The dimension of the suction chamber and the location of suction pipes from the walls of the chamber, their depth below the lowest known water level, and their clearance from the bottom shall comply with the requirements of Figure 2.1.

The settling chamber shall have the same width and depth as the suction chamber and a length not less than $4.4 \sqrt{H}$ where H is the depth of the settling chamber in metres.

2.6.7 Inlet screen

Inlet screens shall comply with the following requirements:

- (a) *Pipe or conduit* The inlet to a pipe or conduit feeding the settling chamber shall be fitted with a strainer with an aggregate-clear opening not less than five times the cross-sectional area of the pipe or conduit. Individual openings in the strainer shall not allow a 25 mm diameter sphere to pass through. Provision shall be made for removal of the strainer for cleaning.
- (b) *Weir and open top channels* Weirs and open top channels feeding the settling chamber shall be fitted with a removable screen of wire mesh or perforated metal plate with an aggregate-clear opening below water level of 150 mm^2 for each litre per minute of the maximum flow output of the pump (Q). Two screens shall be provided, one in use with the other in a raised position, ready for interchange when cleaning is necessary. The screens shall be of sufficient strength to withstand the force applied by the water should they become obstructed.

NOTE: Consideration should be given to the method of isolation of the settling chamber for periodical cleaning and maintenance.

- (c) *Suction inlet drawing direct from source* Where the suction inlet draws directly from the source, a walled area not smaller than that required for suction chambers (see Clause 2.6.6) shall be provided. Where the wall extends above the surface of the water, apertures shall be provided and fitted with screens complying with the requirements of Clause 2.6.7(b). Where the top of the wall is below the surface of the water level, a screen shall be fitted between the top of the wall and the highest known water level. Such screens shall provide an area not less than that required by Clause 2.6.7(b) at the lowest known water level.

Provision shall be made for access to the screens for cleaning.

SECTION 3 GENERAL REQUIREMENTS FOR FIRE PROTECTION PUMPSETS

3.1 PERFORMANCE CHARACTERISTICS

The performance characteristics of pumpsets for fixed fire protection systems shall be such that they provide the duty flow at the duty head and that the pressure falls progressively with an increase in rate of flow. Centrifugal pumps shall be capable of providing maximum flow (130% of duty flow) at not less than 80% of duty head.

NOTE: For typical pump characteristic curves, see Figures 3.1, 3.2, 3.3 and 3.4.

The following requirements apply:

- (a) For sprinkler systems, the duty head shall be the hydraulically most remote demand point + 50 kPa (see Figure 3.1).
- (b) For hydrant systems, the duty head shall be the duty demand point (see Figure 3.2).
- (c) For combined sprinkler and hydrant systems, the duty flow shall be the hydrant duty demand flow plus the sprinkler hydraulically most remote demand flow at the highest duty pressure of the two (ensuring it is at least 50 kPa above the sprinkler demand point) (see Figures 3.3 and 3.4).
- (d) For systems for accommodation buildings of up to four storeys in accordance with AS 2118.4, the following requirements apply:
 - (i) *Sprinkler system only* The head shall be the hydraulically most remote demand point + 50 kPa.
 - (ii) *Sprinkler plus hydrant* As for Item 3.1(c) above.
 - (iii) *Sprinkler plus hydrant plus hose reel plus domestic demand* As for Item 3.1(c) above, with the applicable addition flows added (see Figures 3.3 and 3.4).

C3.1(A) *Pumpsets serving combined sprinkler and hydrant installations have to be selected in accordance with the duty point specified as calculated by the fire protection system designer with due regard to the pressure and flow requirements of the combined installation.*

A pump shall not exceed 140% of its duty head at shut-off point or at any other point along its characteristic curve.

NOTE: In certain cases involving multistage pumps, the relevant authority may waive this requirement.

Where two or more pumpsets operate in parallel, the pump performance characteristics shall be compatible.

The net pump shut-off (churn) pressure plus the maximum static suction pressure, adjusted for elevation, shall not exceed the pressure for which the system components are rated. Pressure-relief valves shall not be used for this purpose.

C3.1(B) *In cases of high suction pressure variations, e.g. town mains, either a variable speed pressure limiting controller or suction tank or tanks should be provided.*

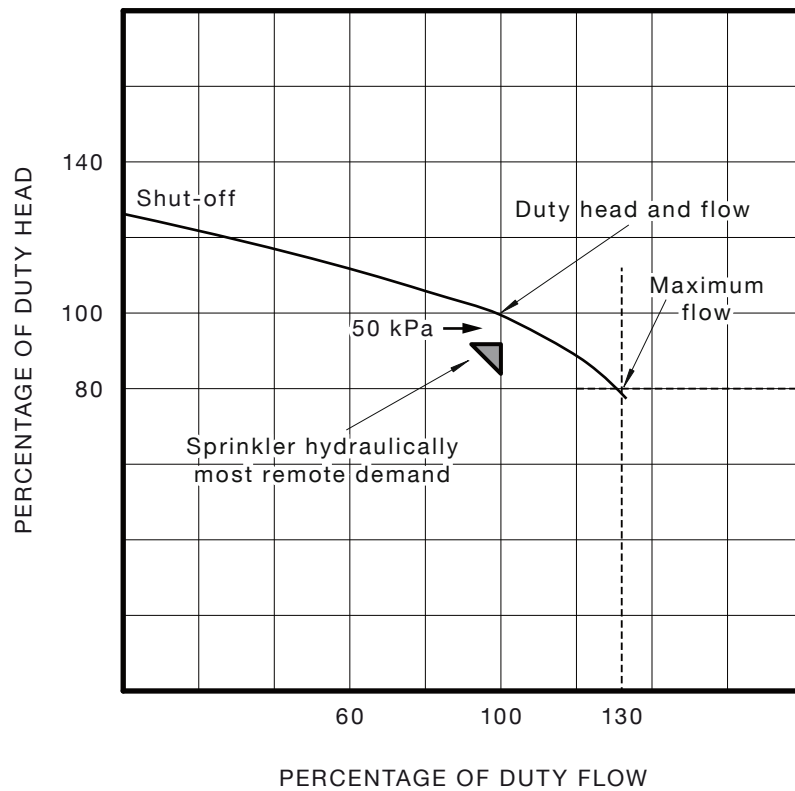


FIGURE 3.1 TYPICAL PUMP CHARACTERISTIC CURVE—SPRINKLER SYSTEMS

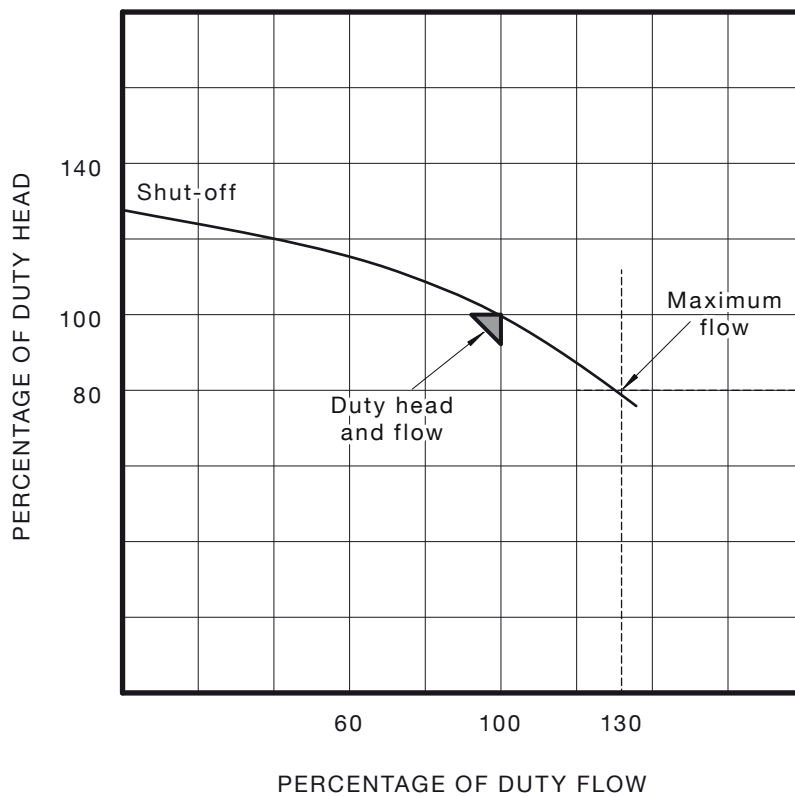


FIGURE 3.2 TYPICAL PUMP CHARACTERISTIC CURVE—HYDRANT SYSTEMS

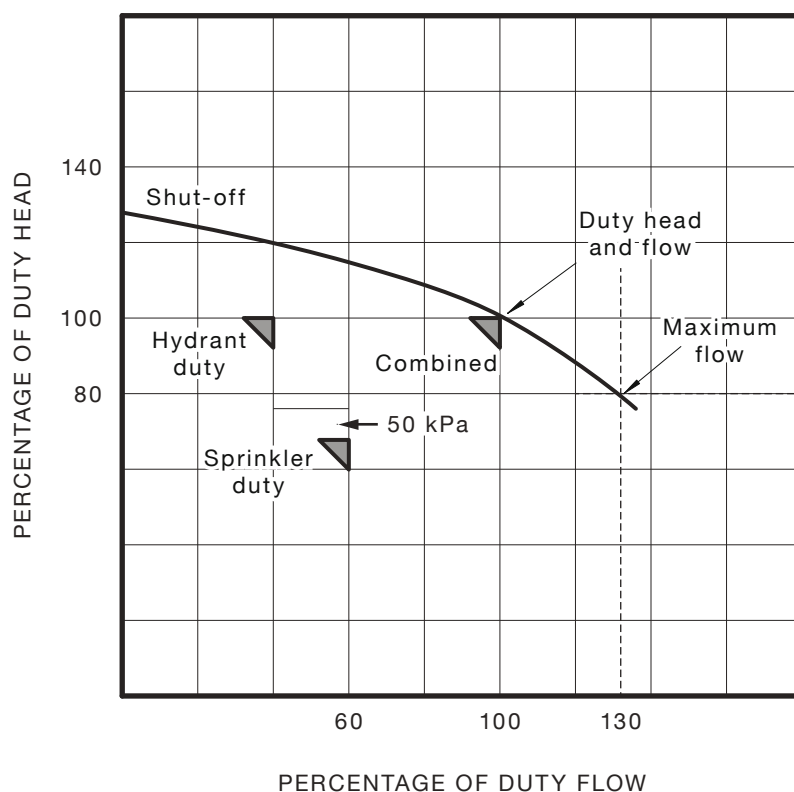


FIGURE 3.3 TYPICAL PUMP CHARACTERISTIC CURVE—COMBINED SPRINKLER AND HYDRANT SYSTEMS (HYDRANT SYSTEM DESIGN DRIVEN)

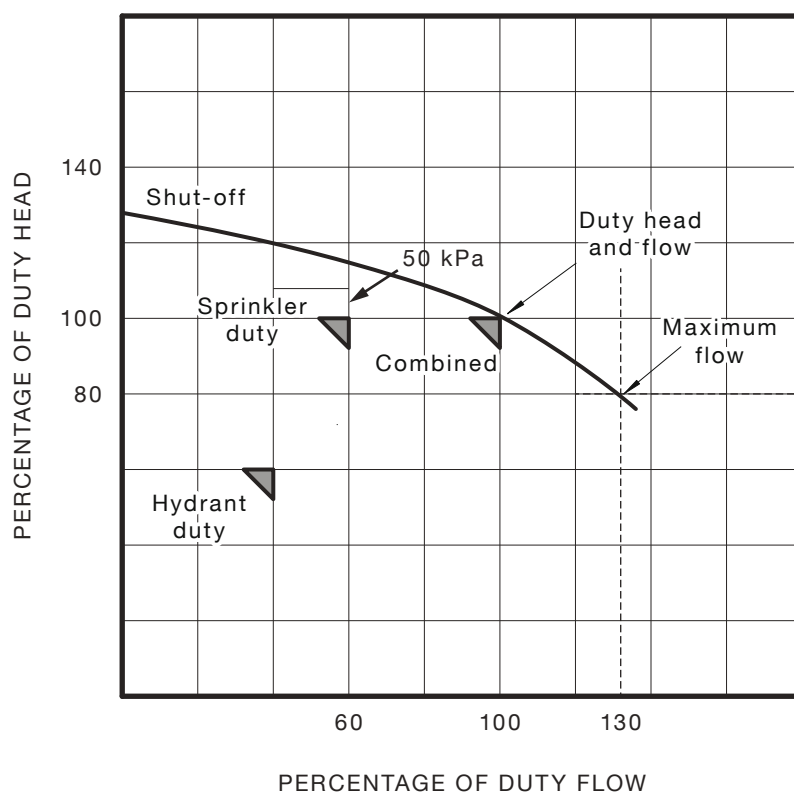


FIGURE 3.4 TYPICAL PUMP CHARACTERISTIC CURVE—COMBINED SPRINKLER AND HYDRANT SYSTEMS (SPRINKLER SYSTEM DESIGN DRIVEN)

3.2 PUMP TYPES

3.2.1 Fire protection pumps

Fire protection pumps, with the exception of positive displacement pumps used for water mist and foam injection systems, shall be centrifugal and selected from the following types:

NOTE: Typical pump types are illustrated in Figure 3.5.

- (a) Single-stage, end-suction, horizontal or vertical shaft pump.
- (b) Axially split case, horizontal or vertical shaft pump.
- (c) Multistage, single-outlet or multi-outlet, horizontal shaft pump.
- (d) Turbine, vertical shaft pump.
- (e) Electro-submersible, multistage turbine pump.

NOTE: The use of electro-submersible pumps for fire service is not recommended.

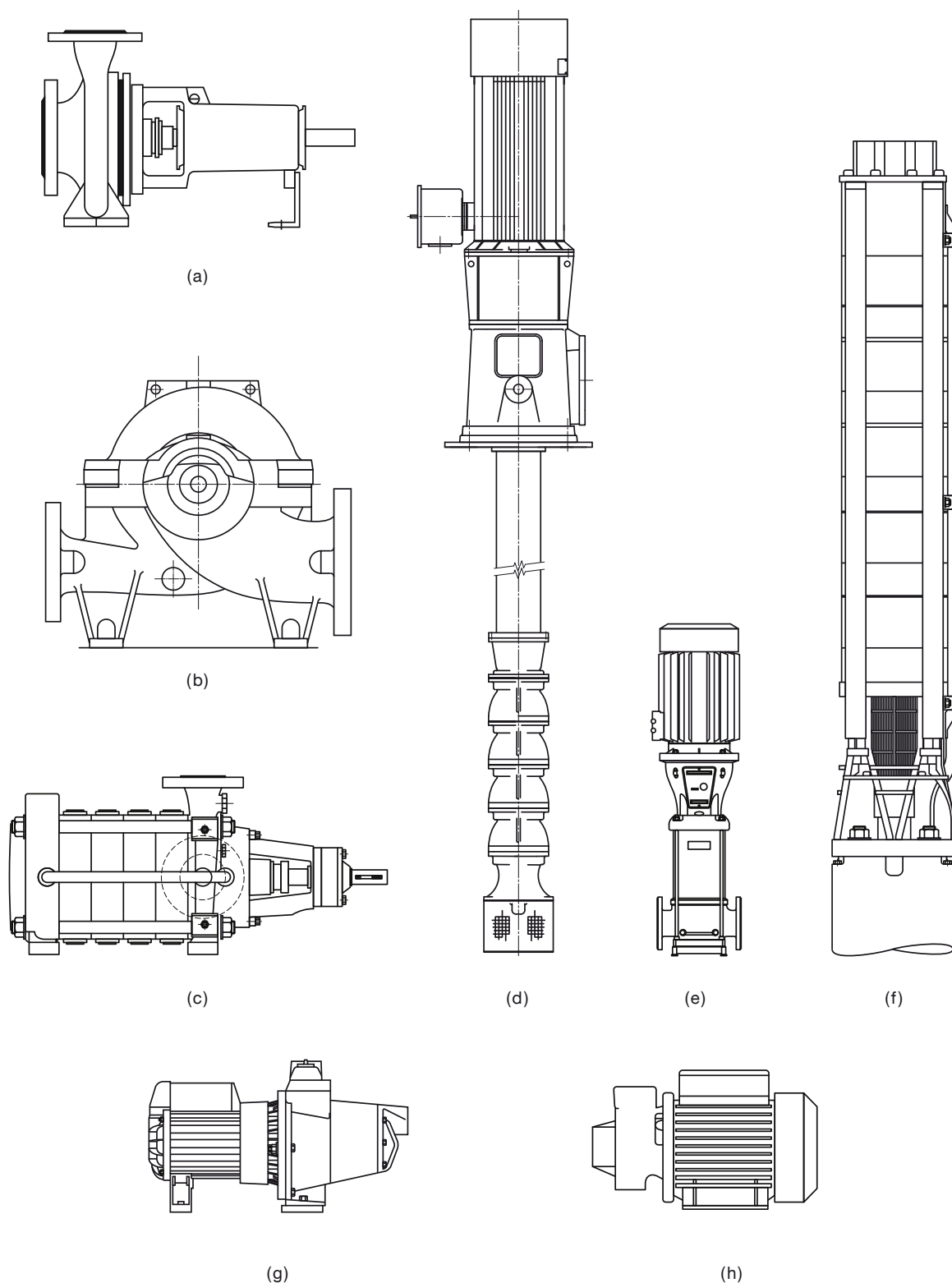
3.2.2 Ancillary pumps

Pressure maintenance (jockey or jacking) pumps and fire hose reel pumps shall be—

- (a) centrifugal type;
- (b) regenerative turbine type;
- (c) jet-assisted centrifugal type; or
- (d) multistage centrifugal type, horizontal or vertical mounted motor.

NOTES:

- 1 Regenerative turbine pumps and jet-assisted centrifugal pumps should not be used on towns' main fed systems.
- 2 Typical pump types are illustrated in Figure 3.5. See also Sections 5 and 6.



- (a) Single-stage, end-suction, horizontal centrifugal type.
- (b) Axially split case, horizontal centrifugal type.
- (c) Multi stage, single-outlet or multi-outlet, horizontal centrifugal type.
- (d) Turbine, vertical shaft, multistage type.
- (e) Multistage vertical centrifugal type.
- (f) Electro-submersible multistage turbine type.
- (g) Jet-assisted centrifugal type.
- (h) Regenerative turbine type.

FIGURE 3.5 TYPICAL CENTRIFUGAL PUMP TYPES

3.3 TYPES OF DRIVERS

Pump drivers shall be of the following types:

- (a) Electric motor (see Section 8).
- (b) Compression-ignition engine (see Section 9).

NOTE: Guidelines for the selection of drivers of adequate power are given in Appendix A.

3.4 PUMP/DRIVER CONNECTION

Each pump shall be flexibly coupled to a single driver. The coupling, or drive shaft with universal joints, shall be rated to the maximum driver output over the potential speed range and be such that either the pump or the driver can be removed separately without disturbing the other. Couplings shall be of a type that cannot disengage in service and continue to function in the event of failure of any flexible element.

Chain drives, belt drives, clutch drives, elastomeric drives or fluid drives shall not be used except for positive displacement pumps.

Dual-drive pumpsets shall not be used.

Centrifugal pumps shall not be connected to the driver through a gearbox except where a right-angle drive is necessary.

NOTES:

- 1 Couplings shall be fully enclosed by fixed guards that are tight fitting (to prevent access by hands and/or fingers) and of sufficient strength to resist low velocity impacts from persons and high velocity impacts from broken parts. The Principles set out in AS 4024.1601 with reference to AS 4024.1, AS 4024.1101, AS 4024.1201 and AS 4024.1202 may be used for guidance in the design and construction of the guard.
- 2 A torsional vibration analysis may be required for high powered and/or low speed compression ignition driver conducted on all applications to ensure the driveshaft system as described will not cause damage.

3.5 BASEPLATE

Unless it is impracticable, the pump and driver shall be mounted on a common baseplate, which shall be mounted on a concrete plinth as specified in Clause 11.7 (see Note 1 below). Provision shall be made for drainage of gland leakage to avoid corrosion of the baseplate or its supporting structure.

NOTES:

- 1 Attention should be given to baseplate stresses that may be encountered in transport.
- 2 Anti-vibration mounts may be provided where the operation of the pumpset would give rise to the transfer of vibration. Where anti-vibration mounts are used, they should be rubber, spring or of the seismic-retaining type. Inertia bases may also be used.
- 3 Where anti-vibration mounts are provided, consideration should be given to the provision of flexible connections on the pump suction and discharge piping (see Clause 3.6.7).

3.6 PIPEWORK

3.6.1 Pressure consideration

3.6.1.1 Pressure applied

The minimum design pressure of the discharge pipe work and components within the pump installation shall be based on the maximum pump suction pressure plus the pump churn pressure. The minimum design pressure of the suction piping shall be 1000 kPa or as required by the installation design, whichever is higher. The suction pipe work, where appropriate, shall also be capable of resisting negative pressures, as for a tank feed installation.

3.6.1.2 Hydrostatic pressure test

All new pump installations, components and piping downstream of the pump up to the connection to the ring main or single feed main shall be capable of withstanding, for a period of 2 h without loss of pressure, a hydrostatic test pressure of 1400 kPa or 400 kPa in excess of the maximum static working pressure, which is pump churn plus maximum suction pressure, whichever is greater.

3.6.2 Pipe sizes

Pipe sizes shall be selected such that the velocity within the pipe at maximum flow does not exceed the following:

NOTE: See Clause 2.5.1.

- (a) Suction 4 m/s.
- (b) Discharge 4 m/s.

NOTE: This water velocity is in the pipework only and does not apply to pump entry and exit velocities.

The size of the last 600 mm of the suction pipe shall be not less than the suction inlet of the pump.

3.6.3 Reducers

Reducers on the suction side of pumpsets shall be mounted such that the collection of air within the reducer is precluded. Reducers on the discharge side of pumpsets shall be either concentric or eccentric.

3.6.4 Flanges

With the exception of pipework flanges connecting to the pump flange, pipe flanges shall comply with AS 2129 or AS/NZS 4331.2.

3.6.5 Screwed joints

The threads of screwed joints shall comply with AS ISO 7.1 or AS 1722.2 or other approved national Standards.

3.6.6 Grooved or shouldered joints

Grooved or shouldered joints shall be of a type listed for fire protection duty.

3.6.7 Flexible connections

Where installed, flexible connections on pump suction and discharge piping shall be of the metallic type.

For vibration-isolated mounted pumps, only braided flexible connections shall be used.

3.6.8 Support of suction and discharge piping

Suction and discharge piping shall be supported on either side of the pump flanges to remove pipe loads acting on the pump casing.

3.7 VALVES

3.7.1 Non-return valve

A non-return valve shall be installed upstream of the isolation valve in each pump discharge assembly.

3.7.2 Pump-isolating valves

Pump-isolating valves shall be of the multi-turn type and shall comply with the requirements of AS 4118.1.6. They shall be installed on the outlet side adjacent to the non-return valve and on the inlet side of each pump, except that butterfly valves shall not be installed on the inlet side. Valves within 15 pipe diameters of the pump inlet shall not be of the butterfly valve type.

3.7.3 Air release valves

A valve shall be installed to automatically release air from fire protection pumps that are likely to have air entrapped within the casing or column.

3.7.4 Circulation-relief valve

3.7.4.1 General

Each pump type listed in Clause 3.2.1 shall be fitted with a circulation-relief valve to provide sufficient flow to protect the pump from overheating and recirculation damage when operating with no, or low, discharge. Provision shall be made for discharge to waste or back to suction tank.

NOTES:

- 1 This Clause does not apply to compression-ignition engine-driven pumps where engine cooling water is taken from the pump discharge, provided the flow through the heat exchanger satisfies the pump manufacturer's minimum flow specification.
- 2 When a pump is operating and discharging only through the circulation-relief valve, the temperature increase of the discharged water should not be greater than 15°C above the pump inlet water temperature.

3.7.4.2 Sizing of circulation-relief valve

The circulation-relief valve shall be—

- (a) hydraulically operated;
- (b) direct-acting spring-loaded; or
- (c) of the solenoid-controlled type.

The size of the circulation-relief valve shall be 19 mm for a duty flow rate of up to 9500 L/min and 25 mm for a duty flow from 9501 L/min up to 19 000 L/min. For higher duty flow rates or high pressure pumps and vertical turbine pumps, the circulation-relief valve sizing shall be determined from the manufacturer's specified minimum flow requirements through the pump.

3.7.4.3 Pressure setting

The pressure setting for the circulation-relief valve shall be below the shut-off pressure at minimum expected suction pressure.

3.7.5 Pressure-relief valves

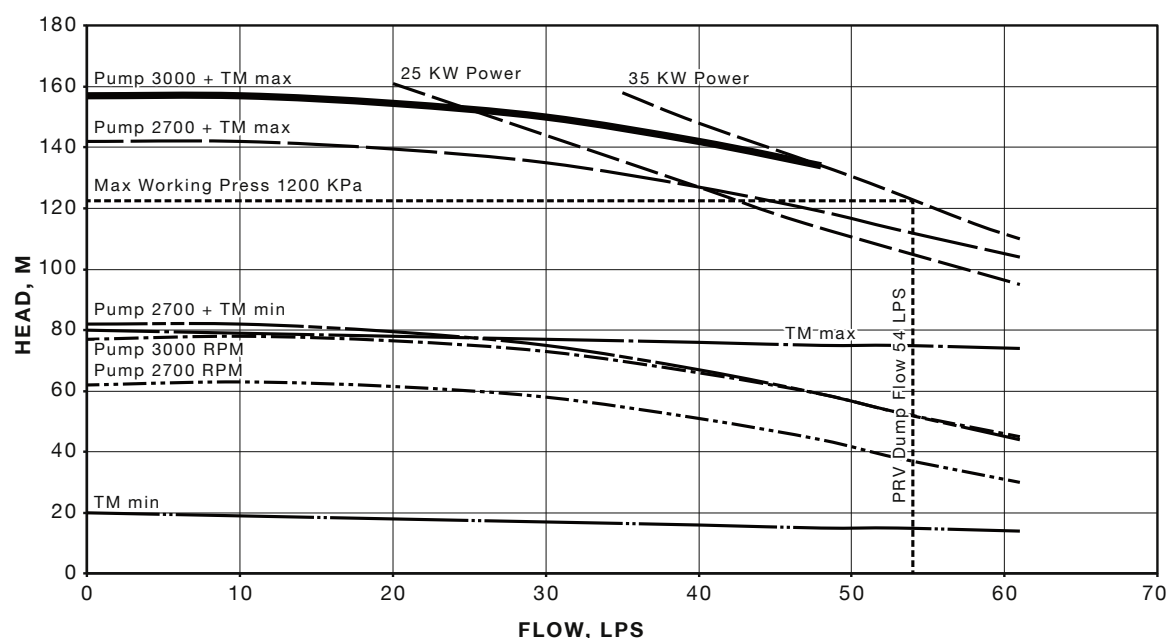
3.7.5.1 General

Where required, pumpsets listed in Table 3.1 shall be fitted with a modulating relief valve to prevent excess pressure on the system. The pressure-relief valve shall be sized to dump the flow the pumpset can produce at maximum system working pressure with the power available (see Figure 3.6). The sizing of the pressure-relief valve and its associated pipework shall be determined from the pressure-relief valve manufacturer's specified maximum flow rate.

NOTE: Where the pump is supplied from a town main or other pressurized supply, this additional pressure has to be taken into account when determining the quantity of water to be passed by the pressure-relief valve.

C3.7.5.1 As shown in Table 3.1, the intent of this Standard is to minimize the use of pressure-relief valves by designing fire systems of lower pressure or selecting pumps with lower shut head pressures than the pressure rating of system components utilized. It is recognized that water supplies of fluctuating suction pressures are commonly used and therefore variable speed controls are allowed. All variable speed-controlled units should be fitted with pressure-relief valves in the event of the driver going to full speed due to failure of the variable speed controller.

Pressure-relief valves should not be used to limit or reduce the total churn pressure of a pump to meet the pressure rating of system components (see Clause 3.1). All compression-ignition drivers should be fitted with over-speed shutdown devices to eliminate the need for pressure-relief valves to avoid over-pressurization due to any uncontrollable speed increase conditions (e.g. governor failure).



NOTE: Figure 3.6. shows a typical fire pump performance curve at 2700 rpm, driven via a compression-ignition engine of 32 kW at 2700 rpm for a fire system demand of 20 L/s at 80 m. Maximum engine power rating is 35 kW at 3000 rpm. System maximum working pressure is 1200 kPa (122.5 m). To determine the maximum pressure-relief valve (PRV) dump flow rate, draw a horizontal line at 1200 kPa (122.5 m) to intersect the pump power 35 kW curve, then draw a vertical line down to indicate the flow required (54 L/s). PRV size: Minimum 54 L/s at 1200 kPa (122.5 m).

FIGURE 3.6 PRESSURE-RELIEF VALVE SIZING

3.7.5.2 *Valve type*

The pressure-relief valve shall be of the hydraulically operated, pilot-controlled type. Pressure-relief valves of the direct-acting spring-loaded type are not permitted.

Backpressure shall not affect the set point of the valve. Each valve shall be actuated by line pressure through the pilot-control system.

Each main valve shall open quickly to maintain a steady system pressure, then close gradually to control surges, and reseal driptight within $\pm 5\%$ of its pressure setting. External packing glands shall not be fitted.

NOTE: A typical pilot-control valve would take the form of a direct-acting, adjustable, spring-loaded diaphragm valve designed for modulating service to permit flow when the controlling pressure exceeds the spring setting.

The construction of the valve shall be such that the internal components can be inspected without dismantling the pipework.

3.7.5.3 *Pressure setting*

The pressure-relief valve shall be set to prevent the maximum system working pressure being exceeded.

3.7.5.4 *Location*

Where fitted, pressure-relief valves shall be installed on piping taken off between the pump discharge flange and any discharge non-return or isolating valve. Isolation valves shall not be fitted upstream or downstream of pressure-relief valves.

3.7.5.5 *Discharge*

Where multiple pressure-relief valves are installed, they shall not be manifolded. Each pressure-relief valve shall have its own discharge to waste or water source, independent of flow-measuring discharge piping.

Discharge from the pressure-relief valve shall not be returned to the pump suction pipe. If the discharge cannot be returned to the water source, it may be taken to waste.

The return to the water source shall be sized so that the backpressure on the valve does not exceed the pressure setting determined in accordance with Clause 3.7.5.3.

Where discharge from a pressure-relief valve is returned to a reservoir, it shall enter at a point remote from the pump suction in accordance with AS 2304.

TABLE 3.1
INSTALLATION OF CIRCULATION-RELIEF AND PRESSURE-RELIEF VALVES

Pumpset driver type	Circulation-relief valve	Pressure-relief valve
Electric	Always required	Not required
Electric with variable speed drive	Always required	Always required
Compression-ignition—Air/radiator cooled	Always required	Not required
Compression-ignition—Heat exchanger cooled	When required by Clause 3.7.4.1	Not required
Compression-ignition—Air/radiator cooled with variable speed drive	Always required	Always required
Compression-ignition—Heat exchanger cooled with variable speed drive	When required by Clause 3.7.4.1	Always required

3.8 VISIBILITY OF DISCHARGE

A flow indicator shall be fitted, except where discharge from pressure-relief valves and circulation-relief valves is visible to the operator when at the pumpset.

3.9 PRESSURE GAUGES

3.9.1 General

Pressure gauges shall comply with AS 1349. They shall have a dial not less than 100 mm in diameter, be graduated in kilopascals and be of the liquid filled type.

3.9.2 Discharge pressure gauge

A pressure gauge shall be connected to the pump discharge together with a gauge cock. The gauge shall measure pressure to at least twice the duty head of the pump but not less than 1000 kPa.

The discharge pressure gauge shall be—

- (a) located in a section of pipe complying with Clause 3.6.2;
- (b) located at least two diameters downstream of the discharge flange or end of divergence; and
- (c) located at least one diameter upstream of any bends or divergences in the discharge piping.

3.9.3 Suction pressure gauge

A compound pressure and vacuum gauge shall be connected to the pump suction together with a gauge cock.

The suction pressure gauge shall—

- (a) be located in a section of pipe complying with Clause 3.6.2;
- (b) be located at least two diameters upstream of the pump flange inlet or divergence; and
- (c) have two diameters of straight pipe upstream following a sudden contraction, bend, valve or other discontinuity of cross-sectional area.

NOTE: If gauges are installed in the inlet and outlet flanges of the pump, then it has to be recognized that the algebraic sum of the two gauge readings, adjusted to pump datum and after allowance for velocity head at the gauge point, may not be a true indication of the head generated by the pump due to turbulence.

3.10 FLOW-MEASURING DEVICES

3.10.1 General

Each pump type listed in Clause 3.2.1 shall incorporate means for measuring rate of flow. The flow control valve shall be located downstream of the flow-measuring device.

NOTES:

- 1 Meters, manometers and similar instruments need not be permanently installed.
- 2 For typical flow-measuring devices and installation see Figures 3.8, 3.11, 3.12 and 3.13.
- 3 The flow control valve should be a globe valve.

For multiple pump installations, each pump shall have an independent flow measurement connection complete with isolating valve installed between the pump non-return valve and the pump discharge isolating valve and shall be arranged as shown in Figure 3.11.

3.10.2 Capacity

The flow-measuring device and pipework shall be capable of measuring a flow of not less than 110% of pump maximum flow. When more than one pump is required to satisfy the system demand, the flow-measuring device and pipework shall also be capable of measuring not less than 110% of the maximum required combined flow. The inside diameter of the flow test piping shall be indicated on the pipe.

3.10.3 Discharge

The flow-measuring device shall not discharge into the pump suction.

Where practicable, flow measurement water shall be returned to the storage tank(s). If returned to the storage tank(s), the discharge shall enter at a point remote from any pump suction in accordance with AS 2304.

3.11 STARTING AND CONTROL

3.11.1 Arrangement

Fire pumpsets shall be arranged for automatic and manual starting. Except for overspeed shutdown for compression-ignition drivers, stopping arrangements shall be manual only.

3.11.2 Automatic pump starting

Pressure transducers may be utilized to supplement the required pressure switch(es). Refer to Appendix G for pressure switch arrangement.

3.11.3 Warning sign

A warning sign, in accordance with AS 1319, with the words: 'DANGER: THIS PUMP STARTS AUTOMATICALLY', shall be provided for fixing securely on each pumpset.

NOTE: Typical warning signs are set out in Appendix B.

3.12 ELECTRICAL REQUIREMENTS

3.12.1 General

The electrical installation associated with fire pumpset systems shall comply with the AS/NZS 3000 provisions intended to achieve a secure supply. When required to operate during emergency conditions, it shall not be capable of being inadvertently disconnected by—

- (a) supply arrangements that maintain segregation and separation of control and protection; and
- (b) wiring systems that maintain circuit integrity under fire conditions (see Appendix C).

The application of these provisions to the different pumpset systems covered by this Standard (AS 2941) is detailed in the relevant parts of this Standard and summarized in Table 3.2 below.

C3.12.1 An alternative distribution board (DB) arrangement may be provided, resulting in some simplification of ancillary fire services (see Figure 3.7) where fire service control equipment having battery backup is grouped with other fire-related equipment, including a fire control centre.

TABLE 3.2
ELECTRICAL REQUIREMENTS FOR FIRE PUMPSETS

Pumpset	Is this equipment regarded as safety service/emergency equipment for electrical installation purposes?	Supply arrangement		Wiring system—Supply to controller		Wiring system—Controller to driver
		General: Separate/segregated main switch/CB at MSB for each item	Alternative: Segregated/dedicated circuit from supply side of DB for each item	Dedicated circuit for each item	Circuit integrity under fire (e.g. WS system)	Circuit integrity under fire, (e.g. WS system)
Hydrant-sprinkler—Diesel driver	YES	PERMITTED	PERMITTED SUBJECT TO: - Control battery backup - DB supplied directly from MSB - Marking at DB and MSB to avoid inadvertent/extended disconnection	REQUIRED	NOT REQUIRED WS system permitted but only mechanical protection required by location and/or enclosure	NOT APPLICABLE Diesel driver
Hydrant-sprinkler—Electric driver	YES	REQUIRED	NOT PERMITTED	REQUIRED	REQUIRED WS5X (2 hr) classification or equivalent	REQUIRED WS5X classification or equivalent
Residential sprinkler—Diesel driver	YES	PERMITTED	PERMITTED SUBJECT TO: - Control battery backup - DB supplied directly from MSB - Marking at DB and MSB to avoid inadvertent/extended disconnection	REQUIRED	NOT REQUIRED WS2X (30 min) system permitted but only mechanical protection required by location and/or enclosure	NOT APPLICABLE Diesel driver
Residential sprinkler—Electric driver	YES	REQUIRED	NOT PERMITTED	REQUIRED	REQUIRED WS2X (30 min) classification or equivalent	REQUIRED WS2X classification or equivalent

(continued)

TABLE 3.2 (continued)

Pumpset	Is this equipment regarded as safety service/emergency equipment for electrical installation purposes?	Supply arrangement		Wiring system—Supply to controller		Wiring system—Controller to driver
		General: Separate/segregated main switch/CB at MSB for each item	Alternative: Segregated/dedicated circuit from supply side of DB for each item	Dedicated circuit for each item	Circuit integrity under fire (e.g. WS system)	Circuit integrity under fire, (e.g. WS system)
Fire hose reel—Diesel driver	YES Applies where fire hose reels are the sole fire protection system or where required for special hazards.	REQUIRED Unless exception is being applied*	PERMITTED SUBJECT TO: - Control battery backup - DB supplied directly from MSB - Marking at DB and MSB to avoid inadvertent/extended disconnection	REQUIRED	REQUIRED Unless exception is being applied*	
Fire hose reel—Electric driver	YES	REQUIRED Unless exception is being applied*	NOT PERMITTED Unless exception is being applied*	REQUIRED	REQUIRED Unless exception is being applied*	
Jacking and jockey pressure maintenance	NO Refer to Clause 5.2(h) to determine performance requirement	NOT REQUIRED May be supplied hardwired from general purpose circuit in pump room	NOT REQUIRED May be supplied hardwired from general purpose circuit	NOT REQUIRED	NOT REQUIRED	

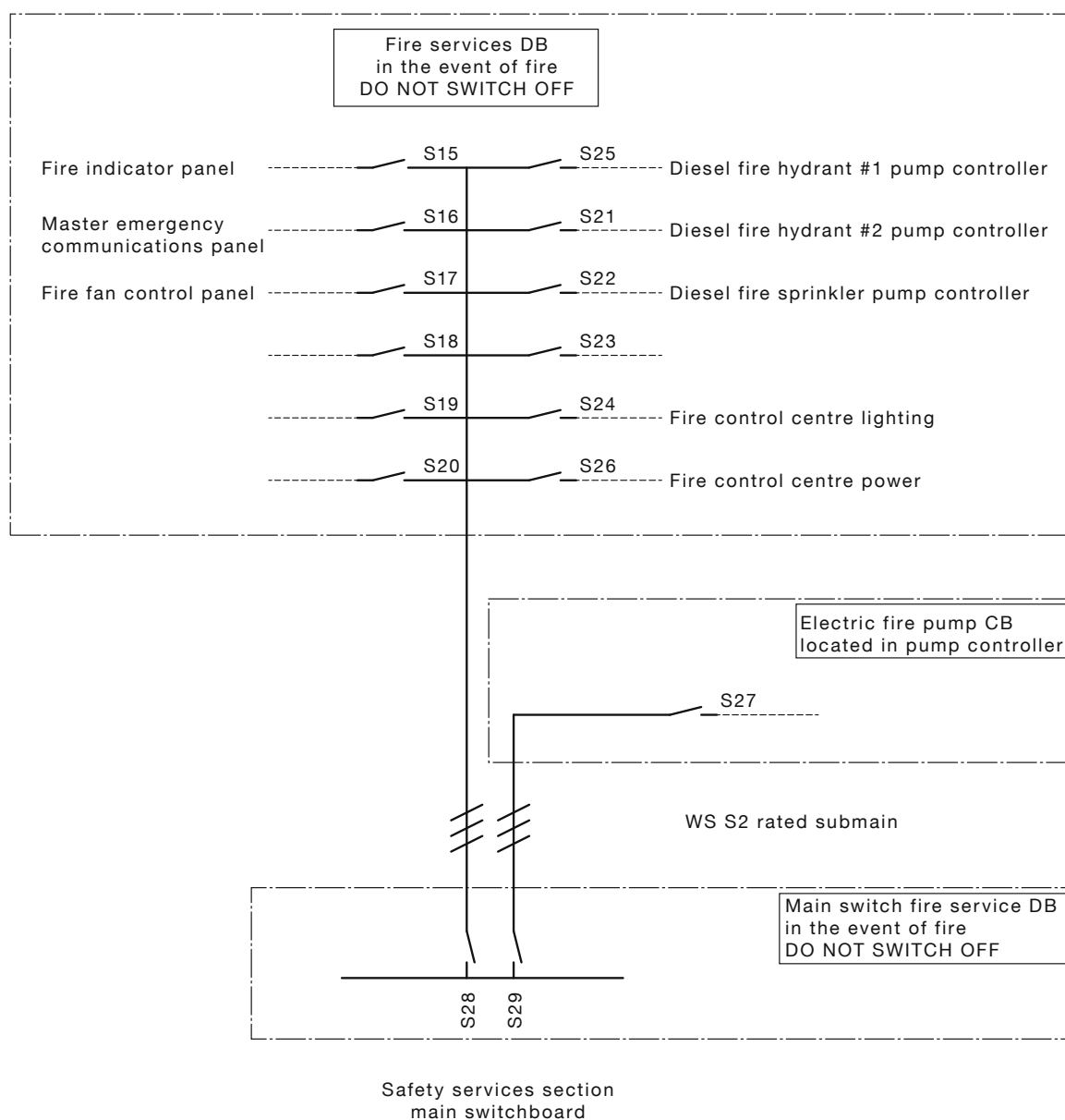
LEGEND:

CB = circuit breaker

MSB = main switch board

WS = wiring system rating

* Exception would normally depend upon a hydrant pump system being on site. If a fire hydrant pumpset is also installed, then the hose reel pump driver is exempt from the power supply requirements.



LEGEND:
DB = distribution board
CB = circuit breaker

FIGURE 3.7 ALTERNATIVE FIRE SERVICES DISTRIBUTION

3.12.2 Electronic component rating

All semiconductors and discrete components shall be industrial grade rated and shall have an operating temperature range of 0°C to 55°C.

3.12.3 Alternative power supply

Where an electric fire pumpset is supplied by a dedicated compression-ignition generator, a separate continuous power source shall be provided for the controller.

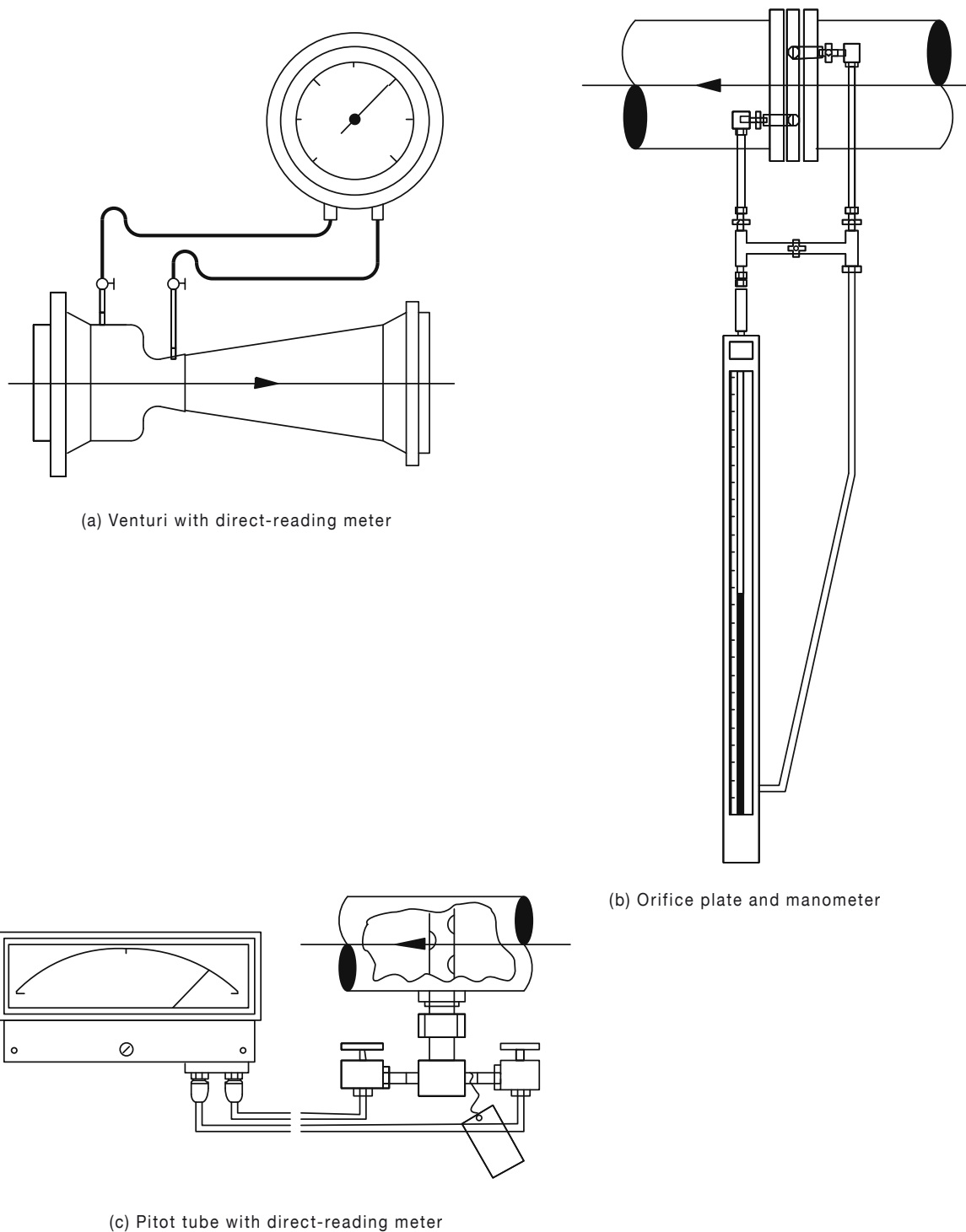


FIGURE 3.8 TYPICAL FLOW-MEASURING DEVICES

3.13 MARKING

3.13.1 Method of marking

Durable, corrosion-resistant identification plates shall be securely affixed in positions where they can be readily seen. Lettering on the identification plates shall be engraved or embossed.

3.13.2 Pumpset

An identification plate shall be affixed to each pumpset baseplate. It shall include, as a minimum, the following information:

- (a) Manufacturer's name and address.
- (b) Duty flow.
- (c) Duty speed.
- (d) Duty pressure.
- (e) Pumpset serial number.
- (f) Maximum power required.
- (g) Maximum test flow.

3.13.3 Pump

An identification plate shall be affixed to the pump. It shall include, as a minimum, the following information:

- (a) Manufacturer's name and address.
- (b) Pump serial number.
- (c) Model or type designation.
- (d) Number of stages.
- (e) Impeller diameter.

3.13.4 Driver

Drivers shall be marked as follows:

- (a) *Compression-ignition engine* An identification plate shall be affixed to the engine. It shall include, as a minimum, the following information:
 - (i) Manufacturer's name.
 - (ii) Model number.
 - (iii) Serial number.
 - (iv) Rated power output and speed.
- (b) *Electric motor* The identification plate on an electric motor shall comply with AS 1359.101.

3.13.5 Controller

An identification plate shall be affixed to the fire pump controller cabinet. It shall include, as minimum, the following information:

- (a) Manufacturer's name and address.
- (b) Identification number.
- (c) Electrical rating in volts, kilowatts, amperes, frequency and phases, as appropriate.

3.13.6 Battery

An identification plate shall be attached to the battery enclosure or cover. It shall include the following information as applicable:

- (a) Voltage.
- (b) Cold cranking amperage (CCA) (compression-ignition engine).
- (c) Rated capacity in A/h at the 20 h rate.
- (d) Boost absorption charge voltage.
- (e) Float charge voltage.