SANS 10252-1 (2012) (English): Water supply and drainage for buildings Part 1: Water supply installations for buildings

BLANK PAGE

ISBN 978-0-626-26988-3

SANS 10252-1:2012

Edition 3

SOUTH AFRICAN NATIONAL STANDARD

Water supply and drainage for buildings

Part 1: Water supply installations for buildings

Published by SABS Standards Division
1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
www.sabs.co.za

Table of changes

Change No.	Date	Scope

Foreword

This South African standard was approved by National Committee SABS SC 138G, *Water and sanitation – Equipment and systems – Plumbing components*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in May 2012.

This document supersedes SANS 10252-1:2004 (edition 2).

This document is referenced in the Regulations of the Water Services Act, 1997 (Act No. 108 of 1997), the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), and the Trade Metrology Act, 1973 (Act No. 77 of 1973).

Reference is made in the introduction and 6.1.1.1 to the "relevant national legislation". In South Africa this means the Water Services Act, 1997 (Act No. 108 of 1997).

Reference is made in the introduction, 3.1, 3.1.47, 4.2.1.1, the notes to 4.2.1.1, 5.1.9.2, and 8.1 to the "relevant national legislation". In South Africa this means the National Building Regulations Act, 1977 (Act 103 of 1977).

Reference is made in 5.4.6.1.4, 8.4.6.6, A.1, A.2.1, and A.3.1 to the "relevant national legislation". In South Africa this means the Occupational Health and Safety Act, 1993 (Act No.85 of 1993).

SANS 10252 consists of the following parts under the general title *Water supply and drainage for buildings*:

Part 1: Water supply installations for buildings.

Part 2: Drainage installations for buildings.

Annex D forms an integral part of this document. Annexes A, B, C and E to J (inclusive) are for information only.

Introduction

NOTE Drawings included in this part of SANS 10252 are of a schematic nature and should not be accepted as working drawings for installation purposes.

Legislation for water installations for buildings

Water Services Regulation

The relevant legislation (see foreword) enables the Minister of Water Affairs to prescribe compulsory national standards relating to consumer installations. In this regard it defines

- as any end user who receives water services from a water services institution, including an end user in an informal settlement, and

- a consumer installation as a pipeline, fitting, or apparatus installed or used by a consumer to gain access to water services and includes a meter attached to such pipeline, fitting or apparatus.

Clause 14 of Regulation R509 (8 June, 2001), issued in terms of the relevant national legislation (see forward), states the following:

Consumer installations other than meters

Every consumer installation shall comply with SANS 10252, Water supply and drainage for buildings and SANS 10254, The installation, maintenance, replacement and repair of fixed electric storage water heating systems, or any other similar substituting re-enactment or amendment thereof if the consumer installation is of a type regulated by either standard.

Building Regulation

The relevant national legislation (see foreword) does not contain any provisions that relate to water installations in buildings other than those pertaining to fire installations (see part W (*Fire installation*) of the National Building Regulations). Therefore, consumer installations are regulated by this part of SANS 10252 and SANS 10254.

This document establishes general principles for the design, installation and testing of water installations.

This page is intentionally left blank

Contents

Contents (*continued*)

Contents (*continued*)

Contents (*concluded*)

Water supply and drainage for buildings

Part 1:
Water supply installations for buildings

1 Scope

1.1 This part of SANS 10252 establishes general principles for the design, installation and testing of water installations for buildings.

1.2 This part of SANS 10252 is not applicable to water installations related to:

a) air-conditioning systems;

b) industrial processes;

c) specialized plants (including water softening plants);

d) high temperature (exceeding 80 °C) water heating systems; and

e) automatic sprinkler installations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

AS 2845.3, *Water supply – Backflow prevention devices – Part 3: Field testing and maintenance of testable devices.*

AS/NZS 2845.1, *Water supply – Backflow prevention devices – Part 1: Materials, design and performance requirements.*

AS/NZS 3500.1:2010, *Plumbing and drainage – Part 1: Water services.*

ASTM A 240, *Standard specification for chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels and for general applications.*

ASTM A 312, *Standard specification for seamless, welded, and heavy cold worked austenitic stainless steel pipes.*

ASTM A 403, Standard specification for *wrought austenitic stainless steel piping fittings.*

EN 10250-4, *Open die forgings for general engineering purposes – Part 4: Stainless steels.*

PD 5500, *Specification for unfired fusion welded pressure vessels.*

SANS 14/ISO 49, *Malleable cast iron fittings threaded to ISO 7-1.*

SANS 32/ EN 10240, *Internal and/or external protective coatings for steel tubes – Specification for hot dip galvanized coatings applied in automatic plants.*

SANS 62-1, *Steel pipes – Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm.*

SANS 62-2, *Steel pipes – Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.*

SANS 151, *Fixed electric storage water heaters.*

SANS 181, *Thermostats for electric storage water heaters.*

SANS 198, *Functional-control valves and safety valves for domestic hot and cold water supply systems.*

SANS 204, *Energy efficiency in buildings.*

SANS 226, *Water taps (metallic bodies).*

SANS 241-1, *Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinands.*

SANS 241-2, *Drinking water – Part 2: Application of SANS 241-1.*

SANS 242, *Stainless steel sinks with draining boards (for domestic use).*

SANS 347, *Categorization and conformity assessment criteria for all pressure equipment.*

SANS 460, *Plain-ended solid drawn copper tubes for potable water.*

SANS 497, *Glazed ceramic sanitaryware.*

SANS 514, *Immersion heaters for electric storage water heaters.*

SANS 543, *Fire hose reels (with semi-rigid hose).*

SANS 664-1, *Wedge gate and resilient seal valves for waterworks – Part 1: General.*

SANS 664-2, *Wedge gate and resilient seal valves for waterworks – Part 2: Wedge gate valves.*

SANS 664-3, *Wedge gate and resilient seal valves for waterworks – Part 3: Resilient seal valves.*

SANS 665-1, *Wedge gate and resilient seal valves for general purposes – Part 1: General.*

SANS 665-2, *Wedge gate and resilient seal valves for general purposes – Part 2: Wedge gate valves.*

SANS 665-3, *Wedge gate and resilient seal valves for general purposes – Part 3: Resilient seal valves.*

SANS 719, *Electric welded low carbon steel pipes for aqueous fluids (large bore).*

SANS 752, *Float valves.*

SANS 776, *Copper alloy gate valves – Heavy duty.*

SANS 815-1, *Shoulder-ended and groove-ended piping systems – Part 1: Shoulder-ended steel pipes, fittings and couplings.*

SANS 815-2, *Shoulder-ended and groove-ended pipe systems – Part 2: Groove-ended steel pipes, fittings and couplings.*

SANS 821, *WC flushing cisterns.*

SANS 827, *The installation of pipes and applicances for use with natural gas.*

SANS 906, *Stainless steel wash-hand basins and wash troughs.*

SANS 924, *Stainless steel stall urinals.*

SANS 965, *Welded austenitic stainless steel tubes.*

SANS 966-1, *Components of pressure pipe systems – Part 1: Unplasticized poly(vinyl chloride) (PVC-U) pressure pipe systems.*

SANS 966-2, *Components of pressure pipe systems – Part 2: Modified poly(vinyl chloride)(PVC-M) pressure pipe systems.*

SANS 1006, *Plastic floats for ballvalves.*

SANS 1021, *Water taps (plastic bodies).*

SANS 1056-3, *Ball valves – Part 3: Light duty valves (not fire-safe).*

SANS 1062, *Pressure and vacuum gauges.*

SANS 1067-1, *Copper-based fittings for copper tubes – Part 1: Compression fittings.*

SANS 1067-2, *Copper-based fittings for copper tubes – Part 2: Capillary solder fittings.*

SANS 1109-1/ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads – Part 1: Dimensions, tolerances and designation.*

SANS 1123, *Pipe flanges.*

SANS 1156-1, *Hose for liquefied petroleum gas (LPG) – Part 1: Hose used in road and rail transport.*

SANS 1186-1, *Symbolic safety signs – Part 1: Standard signs and general requirements.*

SANS 1200 G (SABS 1200 G), *Standardized specification for civil engineering construction – Part G: Concrete (structural).*

SANS 1200 L (SABS 1200 L), *Standardized specification for civil engineering construction – Part L: Medium-pressure pipelines.*

SANS 1200 LB (SABS 1200 LB), *Standardized specification for civil engineering construction – Part LB: Bedding (pipes).*

SANS 1200 LF (SABS 1200 LF), *Standardized specification for civil engineering construction – Part LF: Erf connections (water).*

SANS 1223, *Fibre-cement pressure pipes and couplings.*

SANS 1237, *Single-state regulators for liquefied petroleum gas (LPG)*.

SANS 1240, *Automatic shut-off flush valves for water closets and urinals.*

SANS 1307, *Domestic solar water heaters.*

SANS 1356, *Fixed electric instantaneous water heaters.*

SANS 1480, *Single control mixer taps.*

SANS 1529-1, *Water meters for cold potable water – Part 1: Metrological characteristics of mechanical water meters of nominal bore not exceeding 100 mm.*

SANS 1529-3, *Water meters for cold potable water – Part 3: Physical dimensions.*

SANS 1529-4, *Water meters for cold potable water – Part 4: Mechanical meters of nominal bore exceeding 100 mm but not exceeding 800 mm.*

SANS 1529-9, *Water meters for cold potable water – Part 9: Requirements for electronic indicators used with mechanical water meters, electronic water meters and electronic prepayment water measuring systems.*

SANS 1539, *Appliances operating on liquefied petroleum gas – Safety aspects.*

SANS 1733, *WC flushing systems (low-flushing capacity) that operate with flushing cisterns.*

SANS 1808-5, *Water supply and distribution system components – Part 5: Flexible connectors.*

SANS 1808-9, *Water supply and distribution system components – Part 9: Metering taps and valves (metallic bodies).*

SANS 1808-10, *Water supply and distribution system components – Part 10: Copper alloy check valves (spring-loaded).*

SANS 1808-15, *Water supply and distribution system components – Part 15: Mechanical backflow-prevention devices.*

SANS 1808-16, *Water supply and distribution system components – Part 16: Drinking fountain taps.*

SANS 1808-24, *Water supply and distribution system components – Part 24: Gas-operated water heaters.*

SANS 1808-30, *Water supply and distribution system components – Part 30: Laboratory water taps.*

SANS 1808-35, *Water supply and distribution system components – Part 35: Electronically operated taps and valves.*

SANS 1808-37, *Water supply and distribution system components – Part 37: Single-control mixer taps (plastics).*

SANS 1808-44, *Water supply and distribution system components – Part 44: Pipe saddles.*

SANS 1808-58, *Water supply and distribution system components – Part 58: In-line strainers.*

SANS 1808-66, *Water supply and distribution system components – Part 66: Demand type water taps.*

SANS 1835, *Ductile iron pipes, fittings, accessories and their joints, for use in high and low pressure systems for potable and foul water.*

SANS 1848, *Geyser drip trays.*

SANS 1849, *Butterfly valves for general purposes.*

SANS 1857, *Copper alloy gate valves – Light duty.*

SANS 4427-1/ISO 4427-1, *Plastics piping systems – Polyethylene (PE) pipes and fittings for water supply – Part 1: General.*

SANS 4427–2/ISO 4427-2, *Plastics piping systems – Polyethylene (PE) pipes and fittings for water supply – Part 2: Pipes.*

SANS 4427–3/ISO 4427-3, *Plastics piping systems – Polyethylene (PE) pipes and fittings for water supply – Part 3: Fittings.*

SANS 4427–5/ISO 4427-5, *Plastics piping systems – Polyethylene (PE) pipes and fittings for water supply – Part 5: Fitness for purpose of the system.*

SANS 4633/ISO 4633, *Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials.*

SANS 6509/ISO 6509, *Corrosion of metals and alloys – Determination of dezincification of resistance of brass.*

SANS 10087-1, *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations – Part 1: Liquefied petroleum gas installations involving gas storage containers of individual water capacity not exceeding 500 L and a combined water capacity not exceeding 3 000 L per installation.*

SANS 10100-1 (SABS 0100-1), *The structural use of concrete – Part 1: Design.*

SANS 10105-2, *The use and control of fire fighting-equipment – Part 2: Fire hose reels and above-ground hydrants.*

SANS 10106, *The installation, maintenance, repair and replacement of domestic solar water heating systems.*

SANS 10140-3, *Identification colour markings – Part 3: Contents of pipelines.*

SANS 10140-4, *Identification colour marking – Part 4: Contents of taps and valves in laboratories.*

SANS 10142-1, *The wiring of premises – Part 1: Low-voltage installations.*

SANS 10177-2, *Fire testing of materials, components and elements used in buildings – Part 2: Fire resistance test for building elements.*

SANS 10254, *The installation, maintenance, replacement and repair of fixed electric storage water heating systems.*

SANS 10400-A, *The application of the National Building Regulations – Part A: General principles and requirements.*

SANS 10400-L, *The application of the National Building Regulations – Part L: Roofs.*

SANS 10400-S, *The application of the National Building Regulations – Part S: Facilities for persons with disabilities.*

SANS 10400-XA, *The application of the National Building Regulations – Part X: Environmental sustainability – Part XA: Energy usage in buildings.*

SANS 15874-1/ISO 15874-1, *Plastics piping systems for hot and cold water installations – Polypropylene (PP) – Part 1: General.*

SANS 15874-2/ISO 15874-2, *Plastics piping systems for hot and cold water installations – Polypropylene (PP) – Part 2: Pipes.*

SANS 15874-3/ISO 15874-3, *Plastics piping systems for hot and cold water installations - Polypropylene (PP) – Part 3: Fittings.*

SANS 15874-5/ISO 15874-5, *Plastics piping systems for hot and cold water installations – Polypropylene (PP) – Part 5: Fitness for purpose of the system.*

SANS 15875-1/ISO 15875-1, *Plastics piping systems for hot and cold water installations – Crosslinked polyethylene (PE-X) – Part 1: General.*

SANS 15875-2/ISO 15875-2, *Plastics piping systems for hot and cold water installations – Crosslinked polyethylene (PE-X) – Part 2: Pipes.*

SANS 15875-3/ISO 15875-3, *Plastics piping systems for hot and cold water installations – Crosslinked polyethylene (PE-X) – Part 3: Fittings.*

SANS 15875-5/ISO 15875-5, *Plastics piping systems for hot and cold water installations – Crosslinked polyethylene (PE-X) – Part 5: Fitness for purpose of the system.*

SANS 15876-1/ISO 15876-1, *Plastics piping systems for hot and cold water installations – Polybutylene (PB) – Part 1: General.*

SANS 15876-2/ISO 15876-2, *Plastics piping systems for hot and cold water installations – Polybutylene (PB) – Part 2: Pipes.*

SANS 15876-3/ISO 15876-3, *Plastics piping systems for hot and cold water installations – Polybutylene (PB) – Part 3: Fittings.*

SANS 15876-5/ISO 15876-5, *Plastics piping systems for hot and cold water installations – Polybutylene (PB) – Part 5: Fitness for purpose of the system.*

SANS 15877-1/ISO 15877-1, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 1: General.*

SANS 15877-2/ISO 15877-2, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 2: Pipes.*

SANS 15877-3/ISO 15877-3, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 3: Fittings.*

SANS 15877-5/ISO 15877-5, *Plastics piping systems for hot and cold water installations – Chlorinated poly(vinyl chloride) (PVC-C) – Part 5: Fitness for purpose of the system.*

SANS 16422/ISO 16422, *Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure – Specifications.*

SANS 21003-1/ISO 21003-1, *Multilayer piping systems for hot and cold water installations inside buildings – Part 1: General.*

SANS 21003-2/ISO 21003-2, *Multilayer piping systems for hot and cold water installations inside buildings – Part 2: Pipes.*

SANS 21003-3/ISO 21003-3, *Multilayer piping systems for hot and cold water installations inside buildings – Part 3: Fittings.*

SANS 21003-5/ISO 21003-5, *Multilayer piping systems for hot and cold water installations inside buildings – Part 5: Fitness for purpose of the system.*

SANS 22391-1/ISO 22391-1, *Plastics piping systems for hot and cold water installations – Polyethylene of raised temperature resistance (PE-RT) – Part 1: General.*

SANS 22391-2/ISO 22391-2, *Plastics piping systems for hot and cold water installations – Polyethylene of raised temperature resistance (PE-RT) – Part 2: Pipes.*

SANS 22391-3/ISO 22391-3, *Plastics piping systems for hot and cold water installations – Polyethylene of raised temperature resistance (PE-RT) – Part 3: Fittings.*

SANS 22391-5/ISO 22391-5, *Plastics piping systems for hot and cold water installations – Polyethylene of raised temperature resistance (PE-RT) – Part 5: Fitness for purpose of the system.*

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of this document, the definitions given in the relevant national legislation (see foreword), and the following apply.

3.1.1
acceptable
adequate
appropriate
satisfactory
suitable
acceptable to the authority administering this standard, or to the parties concluding this purchase contract, as relevant, or in the opinion of the water supply authority

3.1.2
aerator
device fitted to the outlet of a tap or mixing valve, to entrain air in the discharge

3.1.3
air vessel
air chamber
hydrosphere
expansion tank
closed chamber (with or without diaphragm) that utilizes the compressibility of contained air or gas, to

a) promote a more uniform flow of water when the chamber is connected to the delivery pipe or suction pipe of a reciprocating pump,

b) minimize shock due to water hammer when the chamber is connected to a high-pressure water system,

c) augment the transient supply pressure in an installation, or

d) to absorb volumetric thermal expansion of the fluid in the system

3.1.4
appliance
any receptacle, apparatus or device that is permanently connected to the water supply, such as storage tanks, cisterns and sanitary fixtures

3.1.5
automatic shut-off valve
flush valve
water fitting that is connected to a fixture and that when operated, supplies a pre-set quantity of water for flushing that cannot be held open and flush continuously

3.1.6
backflow
flow of water in a pipe in a direction opposite to the normal direction of flow

3.1.7
backflow prevention device

3.1.7.1
double check valve backflow preventer
water fitting that incorporates at least two independently acting non-return valves, complete with facilities for testing the water tightness of each non-return valve independently

3.1.7.2
reduced-pressure backflow preventer
water fitting incorporating two or more return valves and an automatically operating pressure-differential relief valve located between two non-return valves, and including facilities for testing the water tightness of the control stages within the valve

3.1.8
back-siphonage
backflow of water resulting from negative pressure in a water installation or in the water supply system

3.1.9
balanced pressure
hot and cold water delivery pressure to mixing components that is balanced in such a manner that the residual dynamic pressure does not vary by more than 20 %

3.1.10
balancing device
device fitted in a reticulation pipe system and used to permanently balance the hot water reticulation system dynamically, or a pressure compensating flow control device which can control the maximum flow in hot and cold supply lines

3.1.11
ball valve
ball cock
valve that can regulate flow by means of a ball with a hole through it that can be sealed by rotating the ball through 90°

3.1.12
blanket
insulation of a flexible type, which may be fibrous glass, mineral wool, polyester fibres or polyamic fibre

3.1.13
branch pipe
pipe that branches off from a service pipe, or a distribution pipe that serves only one terminal water fitting

3.1.14
calorifier
device for heating water by conductive heat transfer using an internal heat exchanger

3.1.15
capacity
capability of a storage tank or water heater to contain

a) in a storage tank: the volume of the tank between the operating level of the water contained in such a tank and the invert of the outlet from the tank, in litres,

b) in an instantaneous water heater: the rated hot water delivery rate of the water heater, in litres per minute, at stipulated temperature,

c) in a storage water heater: the nominal storage capacity of the heater, in litres, and

d) in an heat exchange water heater: the storage volume of the heater, in litres

3.1.16
cistern
small capacity storage tank to serve a toilet pan, urinal or a cistern type storage water heater

3.1.17
cold insulation
where the insulation is used to prevent heat gain to the process the term cold insulation will be used

3.1.18
combined installation
water installation used for fire-fighting, domestic, commercial or industrial purposes, or any combination thereof

3.1.19
communication pipe
pipe that is vested in the water supply authority and is installed by it for conveying water from a main to a water installation (see 3.1.38)

3.1.20
control valve
water fitting that is used to control the flow of water in a part of a water installation

3.1.21
cross-connection
link between two pipes

3.1.22
dead leg
that length of a hot water pipe between the terminal water fitting and the water heater or branch pipe forming part of a hot water circulation system

3.1.23
disinfection
sterilization of water or pipes and fittings, using chemicals such as chlorine or ozone

3.1.24
distribution pipe
pipe that branches off from a branch pipe that serves more than one terminal fitting

3.1.25
expansion control devices

3.1.25.1
expansion control valve
water fitting that is used to control the expansion pressure in a water heater consistently during normal operation of the water heater

3.1.25.2
expansion relief valve
water fitting that is used to relieve the expansion pressure in a water heater consistently during normal operation of the water heater and that includes a vacuum relief function

3.1.25.3
expansion control vessel
chamber
vessel that is designed to absorb and store the water that has expanded as a result of the heating of a mass of water in a water heater

3.1.26
fire hydrant
terminal water fitting that is connected to a pipeline and to which a fire hose may be attached

3.1.27
fire installation
water installation that conveys water solely for fire-fighting

3.1.28
float valve
terminal water fitting that is actuated by a lever attached to a float and that is used to control the water level in a cistern or storage tank

3.1.29
flood level rim
lowest part of the top edge of any open receptacle over which water may overflow

3.1.30
gate valve
full-bore isolating using a sluice or gate to slide on the valve across the stream, fully opening or shutting off the water flow

NOTE It is not suitable for flow regulation in-between the setting of fully open or fully closed.

3.1.31
hazard

3.1.31.1
high hazard
any condition, device or practice which in connection with the potable water supply system has the potential to cause death

3.1.31.2
medium hazard
any condition, device or practice which in connection with the potable water supply system has the potential to endanger health

3.1.31.3
low hazard
any condition, device or practice which in connection with the potable water supply system would constitute a nuisance but not endanger health or cause injury

3.1.32
heat pump
electrical device using the refrigeration principle to heat water by extracting heat from ambient air

3.1.33
high temperature cut-out
temperature cut-out device
electrical control device that is used to permanently disconnect the input of electrical energy used for heating water when the temperature of the water reaches the maximum permissible limit at the monitoring point

3.1.34
installation work
work carried out in respect of the construction and connection of any part of a water installation

3.1.35
ion exchange
water softener
process in which water is passed through a suitably treated material that replaces "hard" ions (calcium and magnesium) with "soft" ions (sodium)

3.1.36
isolating valve
water fitting that is used to shut off and isolate a part of a water installation from the main installation (mains); the term includes ball valves, gate valves, sluice valves, stop cocks or any other type of shut-off valve arrangement

3.1.37
local authority
authority empowered by statute to exercise jurisdiction over the installation of water, plumbing, sewerage or stormwater works

3.1.38
main(s)
any pipe, other than a communication pipe, vested in the local authority and used by it to convey water to consumers

3.1.39
mixer
mixing valve
water fitting that is furnished with both a hot water and a cold water connection and in which hot and cold water are then mixed before the water is discharged through a common outlet with the flow of water being controlled by one or more control valves

3.1.40
nominal diameter
nominal size
nominal internal diameter of a pipe thread or fitting

NOTE The nominal size reference to inside diameter is from the practice of designing systems with steel pipes whereas in both copper and plastic pipes their nominal sizes refer to the outside diameters, from which the wall thickness (within prescribed tolerances) is deducted to determine their inside diameter.

3.1.41
non-return valve
reflux valve
check valve
water fitting that automatically permits flow to occur in one direction only

3.1.42
operating temperature
temperature at which a system functions under normal operating conditions

3.1.43
operating water level
level of water reached in a storage tank when the valve controlling the inlet of water to such a tank closes under normal operating conditions

3.1.44
orifice-plate control device
fitting incorporating an orifice plate, which is installed in a pipeline and is intended to create a pressure drop, thereby reducing the flow rate

3.1.45
pipe fitting
any device incorporated in a water installation, including any tee, reducer, elbow, bend, valve, fire hydrant or fire-hose reel, but excluding any sanitary fixture or straight piping

3.1.46
pollution
introduction into any water supply system or installation, of any substance or thing that could cause the water conveyed in such system or installation to become harmful to health, or that could render such water unfit for its intended purpose

3.1.47
population
as defined in the relevant national legislation (see foreword)

3.1.48
potable water
water that does not contain any matter, pollution, contamination or minerals of an objectionable nature or in excessive quantity, or any infectious material, and that is considered by the water supply authority to be satisfactory for drinking, culinary and other domestic purposes (see SANS 241-1 and SANS 241-2)

3.1.49
pressure rating
nominal working pressure for which a water fitting is designed, before allowance is made for operational tolerances

3.1.50
pressure reducing valves
PRV

3.1.50.1
pressure reducing valve (adjustable)
water fitting that automatically reduces the pressure on its downstream side to a specific value that is adjustable by the installer, and does not vary due to any fluctuations on the inlet side

3.1.50.2
pre-set pressure reducing valve
water fitting that automatically reduces the pressure on its downstream side to a pre-set upper limit, irrespective of any fluctuation in the inlet pressure

3.1.50.3
pressure control valve
pre-set pressure reducing valve (PRV) that incorporates an expansion control function in one body

3.1.50.4
pressure control valve (adjustable)
water fitting that automatically controls the pressure on its outlet side to a specific value irrespective of any variation on the inlet side

NOTE The value can be adjusted by the installer.

3.1.51
pressure relief valve
water fitting that is pressure-actuated to automatically discharge water when a set pressure limit is exceeded

3.1.52
probable flow demand
design flow demand
estimated flow rate through a pipe as a result of the simultaneous use of the maximum probable number of terminal water fittings connected to the pipe

3.1.53
purpose of installation

3.1.53.1
commercial purposes
drinking, ablution and culinary purposes on premises used for business or trade (for other than factories; see 3.1.48)

3.1.53.2
domestic purposes
drinking, ablution and culinary purposes on private or industrial premises

3.1.54
required
by the local conditions (type of building), or local water supply system

3.1.55
residual pressure (head)
pressure that remains after all hydraulic energy losses have been deducted

3.1.56
return pipe
pipe that conveys hot water in a hot water circulation system, between the last terminal water fitting and the water heater

3.1.57
riser
pipe used for fire-fighting and that is only charged with water when a fire occurs

3.1.58
sanitary fixture
any receptacle, apparatus or device to which water can be permanently supplied, and from which waste water or soil water is discharged

3.1.59
service pipe
pipe that is part of a water installation and that connects with the communication pipe

3.1.60
static pressure
pressure in an installation at zero flow

3.1.61
stop cock
valve that can regulate or prevent flow by means of either incorporating an orifice that can be sealed with a washer and plate, as in a tap

3.1.62
storage tank
any tank, other than any tank used for storage of hot water or any cistern serving a toilet pan or a urinal, which forms part of a water installation and is used for the storage of water

3.1.63
storage water heater
water heater intended for the heating and storage of a fixed quantity of water

3.1.64
temperature and pressure safety valve
safety valve
water fitting that combines the functions of over temperature and over pressure protection

3.1.65
tempering valve
thermostatically-controlled blending valve to be used near the hot water tank to temper the hot water with cold water to reduce the hot water to a lower temperature, for example 50 °C, in the upstream water system from the terminal fittings

3.1.66
thermal conductivity
k
thermal transmission through a unit area of a material

NOTE It is measured per unit temperature difference between the hot and cold faces, and the unit is W/(m·K).

3.1.67
thermal resistance
R-value
resistance to heat transfer across a material, and is the mean temperature difference between two defined surfaces of a material or construction system under steady state conditions

NOTE Thermal resistance is measured as an *R*-value. The higher the *R*-value the better the ability of the material to resist heat flow; it is measured in (m^2·K/W).

3.1.68
thermostatic mixer
thermostatically-controlled mixing valve for blending two supplies of water of differing temperature, to achieve the desired temperature of the mixed flow to terminal fittings that is suitable for direct contact with the skin, including an anti-scalding feature

3.1.69
type of installation

3.1.69.1
domestic installation
water installation that conveys water solely for domestic purposes

3.1.69.2
general installation
water installation on a site, which conveys water for domestic, commercial or industrial purposes

3.1.70
vacuum relief valve
vacuum breaker
water fitting that is used to prevent a condition of negative pressure in a pipe or appliance

3.1.71
valve
water fitting for controlling the flow of water

3.1.72
water container
vessel
tank
vessel that contains water and that is subjected to any pressure that could develop in, or be transmitted by the water

3.1.73
water fitting
any component of a water installation, other than a pipe or pipe connection, through which water passes or in which water is stored

3.1.74
water heater
appliance, usually self-contained, for heating water that is either stored in the appliance or passes through it

3.1.75
water heating appliances

3.1.75.1
electric storage water heater
storage water heater in which water is heated by electrical energy

3.1.75.2
fixed water heater
water heater that is installed in the operating position and is permanently connected to the electrical wiring of a building

3.1.75.3
heat exchange water heater
water heater in which potable water is heated by a heat transfer system that maintains a physical separation between a primary heat transfer fluid and the potable water

3.1.75.4
gas water heater
water heater which is heated by either natural or liquid petroleum gas and can be of the instantaneous and storage water heater types

3.1.75.5
instantaneous water heater
water heater in which the water is heated either by gas or electricity during the time of demand

3.1.75.6
solar water heater
water heater that is designed to be integrally connected to solar water heating panels and receives its heating energy from such a panel

3.1.75.7
standard water heater
fixed thermostatically controlled electric storage water heater that complies with the requirements of SANS 151

3.1.75.7.1
cistern type
standard water heater that has an integral cold water cistern

3.1.75.7.2
closed type (unvented)
standard water heater that is not naturally vented to atmosphere but allows the expanded water to escape through an expansion control valve set to open and discharge at the rated working pressure of the water heater

3.1.75.7.3
closed type (vented)
standard water heater that is vented to the atmosphere through a vent pipe on the outlet that discharges to the atmosphere

NOTE The height of the vent pipe results in an increased static pressure in the hot water system.

3.1.75.7.4
open outlet type
standard water heater that is provided with a permanently open outlet from which hot water is discharged by displacement, the flow of water being controlled by means of a control valve in the supply pipe to the water heater

3.1.76
water installation
installation that is used or is intended to be used for the conveyance or storage of water in any building or on any site on which such building is situated, and that includes any pipe or water fitting but excludes any water meter vested in the water supply authority

3.1.77
water level control valve
water fitting, other than a float valve, that is used to regulate the inflow of water to a storage tank and to maintain the level of the water at a predetermined level

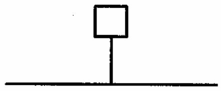
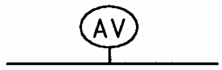
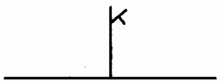
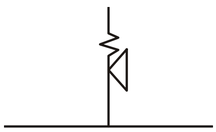
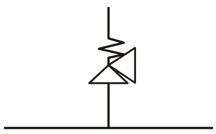
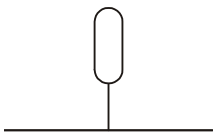
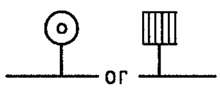
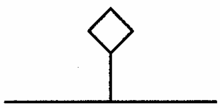
3.1.78
working pressure
<of a fitting or appliance> maximum water pressure at which a fitting or an appliance is designed to operate

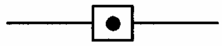
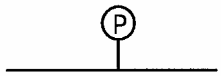
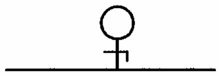
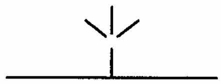
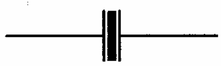
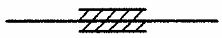
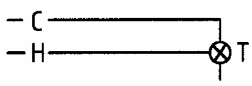
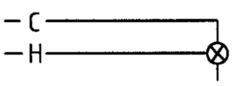
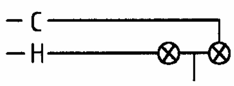
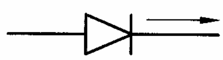
3.1.79
working pressure
<of an installation> water pressure that occurs in an installation during normal operating conditions

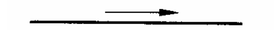
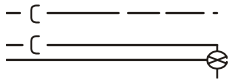
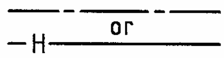
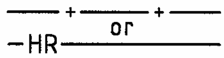
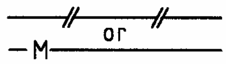
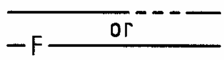
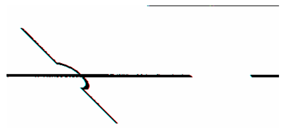
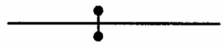
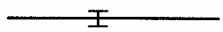
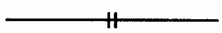
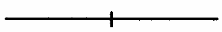
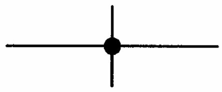
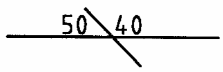
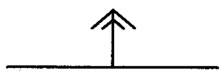
3.1.80
water supply system
any system of structures, aqueducts, pipes, valves, pumps, meters or other associated equipment that is vested in the water supply authority and that is used or intended to be used by the authority in connection with the supply of water

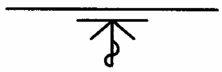
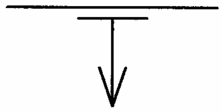
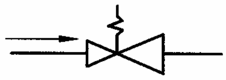
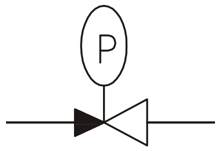
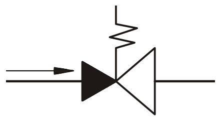
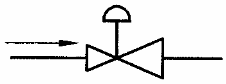
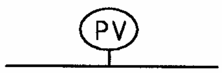
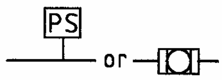
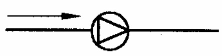
3.2 Symbols

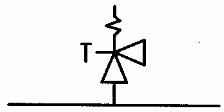
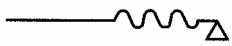
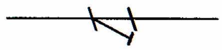
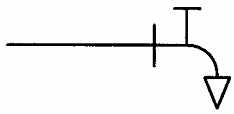
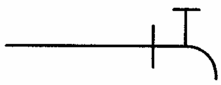
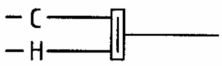
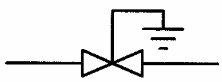
For the purposes of identification and explanation of details in the figures, the following symbols apply.

Air release valve	
Air vessel (air chamber)	
Automatic shut-off valve	
Balancing device (hot water control)	
Double check valve backflow preventer	
Draining tap	
Drinking fountain	
Dropper pipe (plan view, pipe cross-section)	
Expansion control valve	
Expansion control valve (incorporating vacuum relief)	
Expansion control vessel	
Fire brigade inlet/booster pump connection	
Fire-hose reel	
Fire hydrant	

Fire sprinkler	
Float valve	
Flow restrictor (controller)	
Flow switch	
Gauge (Pressure: P; Temperature: T; Level: L)	
Gauge with isolating valve	
Irrigation sprinkler	
Isolating coupling for dissimilar metals	
Isolating valve (flanged ends) (electrical control)	
Isolating valve (flanged ends) (manual control)	
Isolating valve (screwed ends) (electrical control)	
Isolating valve (screwed ends) (manual control)	
Lagged pipe	
Mixer (thermostatically controlled)	
Mixer (single manual control, single lever)	
Mixer (two manual controls)	
Non-return valve	

Normal direction of flow	
Orifice-plate control device	
Pipe carrying cold water	
Pipe carrying hot water	
Pipe carrying hot water (return)	
Pipe carrying mixed (temperature) water	
Pipe carrying water for fire-fighting	
Pipe crossing (not connected)	
Pipe joint (butt welded)	
Pipe joint (compression)	
Pipe joint (flanged and bolted)	
Pipe joint (screwed)	
Pipe joint (soldered or solvent welded)	
Pipe junction	
Pipe: nominal diameter (mm)	
Pipe support (adjustable)	
Pipe support (adjustable hanger)	

Pipe support (flexible)	
Pipe support (flexible hanger)	
Pipe support (guide)	
Pipe support (simple)	
Pipe support (simple hanger)	
Pressure control valve (PRV)	
Pressure control valve (adjustable)	
Pressure control valve combined with expansion control valve	
Pressure reducing valve (adjustable)	
Pressure reducing valve (preset)	
Pressure relief valve	
Pressure switch	
Pump	
Reduced pressure backflow prevention device	
Riser pipe (plan view)	

Temperature and pressure safety valve (safety valve)	
Shower (fixed)	
Shower (movable)	
Stopcock	
Storage water heater (domestic type)	
Strainer	
Tap (external)	
Tap (internal)	
Thermostatic controller	
Vacuum relief valve	
Vacuum relief valve combined with air release valve	
Water level control valve	
Water meter	

3.3 Abbreviations

For the purposes of identification and explanation of details on drawings and tables, the following abbreviations apply.

3.3.1 Abbreviations for materials

PVC-U unplasticized poly(vinyl chloride)

PE-X cross- linked poly-ethylene

PE-RT poly- ethylene raised temperature

PVC-M modified polyvinyl chloride

PB polybutylene

PVC-C chlorinated poly(vinyl chloride)

PVC-O oriented poly(vinyl chloride)

3.3.2 Abbreviations for fittings and fixtures

BA bath

BT tap (bath)

BTT bidet (taps and spouts)

ET external tap

FE fire extinguisher
FH fire hydrant

FM fire main

FPC fire pump connection

FS flow switch

FV float valve

HR hose reel

HSTO hot water storage tank

LCV level control valve

NRV non-return valve

PCV pressure control valve

PRV pressure reducing valve

PS pressure switch

PU	pump
RBT	registered break tank
RM	rising main
RV	reflux valve
ST	tap (sink)
STO	cold water storage tank
SH	shower (taps and showerhead)
UA	urinals (automatically controlled flushing device)
UM	urinals (manually operated flushing device)
US	urinals (sensor-operated flushing device)
V	valve
WB	wash-hand basin
WBT	tap (wash-hand basin)
WC	toilet pan (water closet)
WH	tater heater
WT	tap (wash trough)
WM	water meter

4 Initial design considerations

4.1 Information

4.1.1 Preliminary information required by the designer

The following information, as necessary, shall be obtained from the owner of the premises or from the water supply authority:

a) a plan of the site, showing contours, proposed and existing floor or terrace levels (all related to geodetic datum) and the location and description of any existing services on the site;

b) the intended function of the premises and the types of activities to be carried out on the premises;

c) drawings of buildings, showing

   1) points that require water supply, and

   2) the proposed type of sanitary fixtures and apparatus;

d) a schedule of sanitary fixtures and apparatus that require a water supply;

e) the design population of the premises and the times that the premises will be occupied;

f) the quantity of water and the water pressures required;

g) the nature of the subsoil on the site;

h) the quality of the water obtainable from the supply mains;

i) the static and, where possible, residual pressures in the water supply mains;

j) water quantities and flow rates obtainable from the water supply main for the various types of water demand;

k) if applicable,

   1) a schedule of acceptable pipes and water fittings, and the size of the water meter,

   2) requirements for drawings, and other information that has to be submitted in order to obtain approval for the water installation,

   3) any special precautions to be taken for the crossing of any other services on the premises, and

   4) details of any existing connections and services;

l) the location of the point of connection to the water supply main, or of the communication pipe;

m) details on the metering of the water installation; and

n) if the owner has to connect the water installation to the water supply, the following details:

   1) if the installation is to be connected either to the mains or to the communication pipe, details about the size and the type (material) of piping; and

   2) if the installation is to be connected to a water meter, details about the size and type of outlet from the meter.

NOTE 1 Items 4.1.1(a) to (e) and (g) can usually be obtained from the owner. Item 4.1.1(f) should be determined by the design process given in 4.2. Items 4.1.1(h) to (n) should be obtained from the water supply authority.

NOTE 2 The information required for the approval of water installations may include the following:

a) the title deed description of the premises;

b) the name of every street on which the premises abuts;

c) the scales of the drawings, and the north point;

d) the position and size of the communication pipe(s) serving the premises;

e) the location of every water fitting and its description;

f) the location and capacity of every storage tank and water heater;

g) details of the proposed accommodation for the water meter if it is to be installed within the premises;

h) the pressure for which the installation has been designed; and

i) the position of overflows.

NOTE 3 The potential aggressiveness of the water obtainable from the mains can provide guidance with regard to the types of pipes and materials to be used.

NOTE 4 The type or nature (or both) of the subsoil may restrict the choice of pipes and jointing methods to be used.

NOTE 5 SANS 10400-A classifies solar water heaters up to a limit of 6 m^2 on a roof and 12 m^2 not installed on a roof, as minor building works which may allow them not to require joints or approvals by some local authorities.

Note 6 This preliminary information is for the overall planning and approval of the design. For more detail on design requirements, see clause 7.

4.1.2 General information

4.1.2.1 If there is any indication that contamination of the ground has occurred, an investigation shall be undertaken to determine whether there is any residual contamination that could adversely affect buried pipes or fittings.

4.1.2.2 Where a water supply installation is to be extended, the existing system shall be examined to ensure that it is suitable for extension, after which the entire design shall be re-assessed and modified, by the designer, as appropriate.

4.2 Assessment of water demand

4.2.1 General

4.2.1.1 The design population of a building shall be determined in accordance with of the relevant national legislation (see foreword). For the energy efficiency of buildings, SANS 204 and SANS 10400-XA shall be considered.

NOTE 1 The population calculated in terms of the relevant national legislation (see foreword) is the total population for a building of a particular class of occupancy and includes personnel, the public and visitors.

NOTE 2 The total number of personnel will, in some cases, be the total population obtained from SANS 10400-A; the public and visitors being very few in number. In other cases, the proportion of personnel to the public and visitors will have to be established. The total number of personnel in a shopping complex, or in any particular shop, can be taken as 10 % of the total population for such complex or shop, calculated in terms of the relevant national legislation (see foreword).

NOTE 3 The scale of provision of facilities for different buildings, the selection of particular appliances most suited to their use, and the arrangement of such facilities within spaces in order to obtain optimum use of both space and appliances, are all matters requiring careful consideration if a high quality installation is to be obtained. It should be left to the owner of a building to decide what provision he wishes to make to satisfy the public and to safeguard his business interests.

4.2.1.2 An estimate shall be made

a) of the total daily water demand, using table 1 and table 2, or using any other approved data,

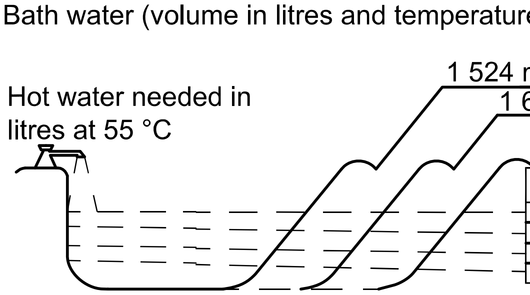
b) of the probable (or design) flow demand, in accordance with 4.2.2, and

c) of the total hot water demand, in accordance with 4.2.3, and of the time of peak hot water demand in terms of 4.2.3.2.

NOTE 1 The probable flow demand will depend upon the type of appliance or fixture or fitting, the type of building in which it is installed, and the frequency and duration of usage. In most installations it rarely happens that the total number of appliances installed are ever in use simultaneously. In order to minimize costs, it is therefore usual to design a system that provides for a design usage that is less than the possible maximum.

NOTE 2 Using gross floor area as the parameter for determining water demands can result in excessive water demand figures, especially for superstores such as hypermarkets and warehouses.

NOTE 3 The size and shape of the bath should be considered (see figure 1).



Depth mm	Warm 55 °C	Cold 15 °C	Tot. vol 39 °C
250	93	62	155
200	71	47	118
150	50	30	83
100	31	20	51

Depth mm	Warm 55 °C	Cold 15 °C	Tot. vol 39 °C
250	81	54	135
200	61	41	102
150	43	29	72
100	26	17	43

Depth mm	Warm 55 °C	Cold 15 °C	Tot. vol 39 °C
250	68	45	113
200	51	34	85
150	36	24	60
100	22	14	36

Drg.907f

Figure 1 — Bath detail

Table 1 — Daily water demand for different premises (excluding garden use)

1	2
Premises	**Water demand (including hot water)**
Boarding schools[a], children's homes and residential nurseries	135 L to 200 L per capita
Educational institutions	40 L to 50 L per capita
Kitchens (full meal preparation)	8 L to 12 L per meal prepared
Multiple dwelling units, such as flats	300 L to 400 L per dwelling
Hotels, boarding houses, motels and nurses' homes:	
with resident staff	200 L to 300 L per bed
without resident staff	200 L to 250 L per bed
Commercial premises:	
shops (staff only)	14 L to 18 L per 10 m^2 gross floor area
superstores, such as hypermarkets and warehouses	125 L per WC pan, or per 600 mm width of slab urinal
offices with canteens	10 L to 15 L per 10 m^2 gross floor area
offices without canteens	7 L to 10 L per 10 m^2 gross floor area
Clinics, hospitals, nursing homes and old-age homes	450 L to 550 L per bed
Factory ablutions	100 L to 200 L per capita
[a] Excluding kitchen but including laundry.	

Table 2 — Average water consumption (hot and cold) of appliances

1	2
Domestic and commercial appliances	L/operation
Bath	80 – 90
Bidet	6 – 8
Clothes washing machine	60 – 180
Dishwashing machine	3 – 70
Domestic waste disposal unit	10 – 15[a]
Shower	3 – 6[a]
Wash-hand basin	4 – 8
WC flushing valve (normal flush)	8 – 10
Domestic appliances	L/day/person served
Car washing and garden use	3 – 6
Drinking, food preparation and cooking	18 – 22
Laundry	10 – 15
Personal washing and bathing	20 – 30
Washing dishes	8 – 12
WC flushing	32 – 40
Office installation appliances	L/day/person served
Hand washing: normal taps	8 – 15
Hand washing: spray taps	3 – 7
Urinal flushing: 24 h day	10 – 18
Urinal flushing: 8 h day	4 – 6
WC flushing: no urinals provided	12 – 18
WC flushing: urinals provided	4 – 6
[a] Per minute.	

4.2.2 Probable (or design) flow demand

4.2.2.1 The probable water flow demand for pipes in installations without automatic shut-off flush valves shall be calculated using the following equation:

$$Q_p = (\Sigma Q)^n \quad (1)$$

where

Q_p is the probable flow demand, in litres per minute (L/min);

ΣQ is the arithmetic sum of the design flow rates of all the individual fittings supplied by the pipe (see table 3 for design flow rates), in litres per minute (L/min);

n is a factor related to the probable simultaneous use of the fittings.

NOTE Values of *n* are given in table 4.

4.2.2.2 The probable water flow demand for pipes in installations with low-pressure automatic shut-off flush valves shall be calculated using the following equation:

$$Q_p = (\Sigma Q)^n + 80 \quad (2)$$

Table 3 — Flow rates from terminal water fittings

1	2	3	4	5
Sanitary fixture or fitting	**Likely maximum flow rate per tap or fitting**[a] L/min	**Likely minimum flow rate per tap or fitting** L/min	**Design flow rate per tap or fitting** L/min	**Design flow pressure at tap or fitting for design flow rate**[b] kPa
Wash-hand basin				
15 mm taps (plain outlet)	25	5	10	10
15 mm taps (aerated outlet)	12	5	8	50
Mixer (plain outlet) (hot and cold separately)	25	5	10	15
Mixing valve (aerated outlet) (hot and cold separately)	12	5	9	50
15 mm taps (public facility) (flow controlled)	6	3	4	20
Bath				
15 mm taps (plain outlet)	30	12	15	15
20 mm taps (plain outlet)	40	20	25	15
20 mm taps (aerated outlet)	20	12	12	50
Mixer (plain outlet) (hot and cold separately)	40	12	25	15
Mixing valve (aerated outlet) (hot and cold separately)	25	15	20	50
Shower (wall mounted)				
Showerhead (standard) (hot and cold combined)	30	8	15	20 – 50
Showerhead (water saving) (hot and cold combined)	12	6	10	50 – 100
Water closet[c]				
Cistern float valve		3	5	100[d]
Automatic shut-off flush valve (low-pressure pattern)	–	–	110[e]	30 – 50[g]
Automatic shut-off flush valve (high-pressure pattern)	–	–	65[f]	150 – 200[g]
Urinal				
Siphonic type (automatic shut-off flush valve)	–	–	60	30
Wash-down type (automatic shut-off flush valve)	–	–	10	50
Bidet				
Mixer or mixing valve (hot and cold separately or combined)	12	5	9	50
Sink				
15 mm taps (plain outlet)	25	6	12	15
20 mm taps (plain outlet	35	15	20	15
Mixer (plain outlet) (hot and cold separately)	25	10	15	15
Mixing valve (aerated outlet) (hot and cold separately)	12	6	10	50

Table 3 (*concluded*)

1	2	3	4	5
Sanitary fixture or fitting	**Likely maximum flow rate per tap or fitting**[a] L/min	**Likely minimum flow rate per tap or fitting** L/min	**Design flow rate per tap or fitting** L/min	**Design flow pressure at tap or fitting for design flow rate**[b] kPa
Wash trough				
15 mm taps (plain outlet)	25	6	2	15
15 mm taps (aerated outlet)	12	5	8	50
20 mm taps (plain outlet)	35	10	15	15
20 mm taps (aerated outlet)	20	10	12	50
Mixer (plain outlet) (hot and cold separately)	25	10	15	15
Mixing valve (aerated outlet) (hot and cold separately)	12	6	10	50
Storage tank				
15 mm float valve (3 mm seat bore)	8	3	5	100
15 mm float valve (5 mm seat bore)	18	6	12	100
20 mm float valve (6 mm seat bore)	30	10	20	100
25 mm float valve (10 mm seat bore)	70	23	50	100
38 mm float valve (19 mm seat bore)	200	90	200	100
50 mm float valve (25 mm seat bore)	500	160	330	100
Taps				
15 mm (plain outlet)	25	6	15	15
20 mm (plain outlet)	35	10	25	15

[a] The likely maximum flow that the user of the fixture or fitting would normally allow the tap or fitting to discharge, and not necessarily the maximum flow rate attainable from the tap or fitting.

[b] Values to be used where the flow-pressure curve for the tap or fitting are not available from the manufacturer.

[c] Design flow rates for WC pans should preferably be approximately 120 L/min for maximum flushing efficiency.

[d] The cistern float valve can operate at lower pressures.

[e] Where a pipe supplies several low-pressure automatic shut-off flush valves, calculate the cumulative flow, *Q*, using the following flow rates:

first valve: 110 L/min, second valve: 85 L/min, third valve: 65 L/min, fourth valve: 45 L/min,
fifth valve: 20 L/min, all valves thereafter: 5 L/min each.

[f] Where a pipe supplies several high-pressure automatic shut-off flush valves, calculate the cumulative flow, *Q*, using the following flow rates:

first valve: 65 L/min, second valve: 55 L/min, third valve: 45 L/min, fourth valve: 35 L/min,
fifth valve: 25 L/min, all valves thereafter: 5 L/min each.

[g] Minimum flow pressure.

Table 4 — Values of *n*[a]

1	2
Nature of use of building	**Value of *n*[a]**
Dwellings (economic) Dwellings (low-cost) Offices	0,5 – 0,70 0,5 – 0,75 0,5 – 0,70
Shops Hostels Public facilities	0,5 – 0,70 0,75 – 0,80 0,75 – 0,80
Kitchens Hotels Factory ablutions Day school ablutions	0,70 – 0,80 0,5 – 0,75 0,75 – 0,80 0,5 – 0,80
[a] In large installations, the value of *n* adopted for the main supply pipes shall, in general, be less than that adopted for branch pipes. Where the flow exceeds 60 000 L/min, the value of *n* shall not exceed 0,7.	

4.2.2.3 The probable water flow demand for pipes in installations with high-pressure automatic shut-off flush valves shall be calculated using the following equation:

$$Q_p = (\Sigma Q)^n + 45 \quad (3)$$

4.2.2.4 The probable water flow demand for pipes in installations where all the fittings supplied by a pipe would probably operate simultaneously (automatic shut-off flush valves excluded) shall be calculated using the following equation:

$$Q_p = \Sigma Q \quad (4)$$

4.2.2.5 Equation (4) can be used in all cases for the final two fittings (automatic shut-off flush valves excluded) supplied by a branch pipe. Working upstream from this branch, the calculated value of Q_p shall be retained until it is replaced by a new value obtained from using equation (1), (2) or (3).

4.2.3 Hot water demand

4.2.3.1 For the assessment of the hot water demand, the following factors shall be considered:

a) the influence that the type of activity performed in the building might have on the demand pattern; and

b) the influence that external environmental factors (for example, climate) might have on the demand pattern.

Differentiation between the peak and the design hot water demand is advised so that the implications of an installation not meeting the peak demand can be recognized.

NOTE Often the pattern of hot water usage is largely a function of the population and of the type of activity that takes place in a building.

4.2.3.2 Tables 2 and 5 are a guide to be used to determine the hot water demand for the building. The usage shall be tabulated on an hourly basis over the operating period of the building, in order to establish a pattern of hot water usage for the building. In the absence of more detailed data for the premises listed in column 1 of table 6, the operating periods given in column 2 of table 6 shall be used.

Table 5 — Hot water demand, storage and heater power requirements

1	2	3	4
Premises	**Total hot water demand**	**Storage volume at 60 °C**	**Heater power**[a]
Clinics	(120 to150) L/bed/d	(30 to 35) L/bed/d	1,5 kW/bed/d
Colleges and schools:			
Day school	(10 to 12) L/capita/d	(5 to 6) L/capita	0,1 kW/capita
Boarding school[b]	(50 to 115) L/capita/d	(25 to 50) L/capita	(0,5 to 0,8) kW/capita
Dwelling houses:[c]			
Low rental	(80 to 115) L/capita/d	(100 to 150) L/unit	(2 to 3) kW/unit
Medium to high rental	(115 to 140) L/capita/d	(40 to 50) L/capita	(2 to 5) kW/unit
Factories:			
Staff	(10 to 20) L/capita/d	(5 to 7) L/capita/d	0,1 kW/capita
Ablutions	(30 to 60) L/capita/d	(30 to 60) L/capita/d	(1,5 to 2) kW/capita
Flats (blocks):			
Low rental	(65 to 75) L/capita/d	(20 to 25) L/capita	(2 to 3) kW/unit
Medium to high rental	(115 to 140) L/capita/d	(25 to 35) L/capita	(2 to 5) kW/unit
Hospitals:			
General	(130 to 140) L/bed/d	(25 to 30) L/bed/d	(1 to 1,5) kW/bed
Infectious	(220 to 230) L/bed/d	(40 to 50) L/bed/d	(1,5 to 2) kW/capita
Infirmaries	(65 to 75) L/capita/d	(20 to 25) L/capita/d	(0,9 to 1,2) kW/capita/d
Infirmaries with laundry	(85 to 95) L/capita/d	(25 to 30) L/capita/d	(1 to 1,4) kW/capita/d
Maternity	(220 to 230) L/bed/d	(30 to 35) L/bed/d	(1,5 to 2) kW/bed
Mental	(85 to 95) L/capita/d	(20 to 25) L/capita/d	(1 to 1,4) kW/capita/d
Nurses' homes	(120 to 130) L/capita/d	(40 to 50) L/capita/d	(1 to 1,5) kW/bed
Hostels	(80 to 120) L/capita/d	(30 to 35) L/capita/d	(0,8 to 1,1) kW/capita/d
Hotels:			
with resident staff	(120 to 140) L/bed/d	(50 to 70) L/bed/d	(0,9 to 1,2) kW/bed
without resident staff	(100 to 120) L/bed/d	(40 to 60) L/bed/d	(0,8 to 1,1) kW/bed
Kitchens:			
Full meal preparation	(5 to 7) L/meal	(5 to 6)L/meal	0,1 kW/meal
Offices:			
with canteens	(25 to 28) L/capita/d	(20 to 25) L/capita/d	0,5 kW/capita
without canteens	(10 to 12) L/capita/d	(5 to 7) L/capita/d	0,1 kW/capita
Shops (staff only)	(10 to 12) L/capita/d	(5 to 6) L/capita	0,1 kW/capita
Sports pavilions (participants only)	(30 to 40) L/capita/d	(30 to 40) L/capita/d	(1,5 to 2) kW/capita

[a] Refers to direct electrical heating elements only.
[b] Excluding the kitchen but including the laundry.
[c] Storage normally a minimum of 115 L with a 4 h heat-up period.

Table 6 — Operating periods for certain premises

1	2
Premises	Operating period h
Schools, kitchens, hostels, flats, offices, shops	12
Hotels, clinics	15
Factory ablutions	24

5 Materials, pipes, fittings, components and fixtures

5.1 General

5.1.1 Materials, components, fittings and fixtures shall be so selected that they are suitable for the expected conditions of use.

5.1.2 If required, approval shall be obtained from the local authority regarding the use of specific materials or workmanship in the area concerned. Most local authority water bylaws require that all components for use in their areas of jurisdiction shall be listed on a schedule of approved products.

NOTE The schedule of approved products is normally the Joint Acceptance Scheme for Water Installation Components (JASWIC) acceptance list.

5.1.3 If it is desired or deemed necessary to use materials, components, fittings or fixtures not covered by this part of SANS 10252, or by another appropriate standard, proof of quality and performance of the material or workmanship shall be established by tests or by reference to other appropriate standards. A single test report shall not sufficiently prove ongoing compliance.

5.1.4 The following factors shall be considered when materials, components, fittings and fixtures are being selected:

a) life cycle costs;

b) effect on water quality;

c) internal and external corrosion;

d) compatibility of different materials;

e) aging, fatigue and temperature effects;

f) mechanical properties;

g) durability;

h) availability;

i) water quality;

j) dezincification resistance; and

k) serviceability.

5.1.5 All materials, components, fittings and fixtures in every part of a water installation shall

a) operate effectively under all normal conditions likely to be experienced when the water installation is in service, and

b) withstand, without damage or deterioration, sustained temperatures of

1) up to 40 °C in the case of cold water installations, and

2) up to 60 °C and occasionally up to 100 °C in the case of hot water installations (in order to allow for malfunctions of heated water fittings or components) or to allow for periodic high temperature flushing as part of *Legionella* control regimes.

5.1.6 Selected fittings or components or any other apparatus shall not induce pressure surges that can cause damage to any part of the water installation.

NOTE Quick-closing valves and pressure booster pumps can (for example) induce undesirable pressure surges in a water installation unless special measures are taken to absorb such surges (see 6.7.3).

5.1.7 Materials selected for the manufacture of purpose-made water heaters and storage containers shall be compatible with the quality of the water to be heated or to be stored, and shall comply with the relevant requirements given in the appropriate of 5.2 and 5.4. Galvanized storage containers shall not be used where the temperature of the hot water exceeds 60 °C.

NOTE 1 Non-standard or purpose-made water heaters can be constructed of, but not limited to galvanized steel, epoxy-coated steel, copper or stainless steel.

NOTE 2 Hot water storage containers can be constructed of protected steel, stainless steel, copper or aluminium or of non-ferrous alloys.

NOTE 3 The risk of corrosion in water heaters can be reduced by cathodic protection. This can be accomplished by the immersion of a sacrificial anode consisting of magnesium or any other anodic metal, in the tank. High temperatures promote rapid anode consumption and routine replacement of the anode is important to prolong the life of the heater. The anode should be appropriately earthed to the tank and system.

NOTE 4 Steel storage tanks can be protected, to varying degrees, by galvanizing, by a layer of aluminium zinc (sprayed on), or by lining them with copper, glass or other appropriate materials.

NOTE 5 Heating water above 60 °C substantially increases its corrosiveness, and this adversely affects the life of certain types of piping. A water temperature of between 60 °C and 70 °C can cause reversals in galvanized piping, or it can lead to pinhole pitting in copper tubing in closed circulating systems. High variable temperatures also result in increased expansion and contraction strains that can contribute to leaks at joints. The temperature of hot water should be controlled in the range of 55 °C to 60 °C.

NOTE 6 The circulation rate of hot water affects the risk of corrosion of piping. Extreme temperature fluctuations in the piping can be avoided if a suitable hot water circulation rate is selected. Resistance caused by

a) air pockets at high points in the system,

b) sediment accumulation at low points,

c) long horizontal pipe runs,

d) defective balancing valves, and

e) rust or lime deposits in pipes,

can result in inadequate circulation.

5.1.8 All rubber components that are in contact with potable water, such as joint rings, tap washers and flange packings, shall, in order to control the multiplication of *Legionaella pneumophila* bacteria in water installations, be of a composition that will not promote microbiological growth.

Rubber joint rings that comply with the relevant requirements of SANS 4633 and that have the dimensions, composition and hardness that are suitable for the particular application, shall be deemed to be acceptable.

5.1.9 The type and thickness of insulation material shall be suitable for the expected conditions of use.

NOTE 1 The most commonly used insulation materials are the flocculent or fibrous types, which depend on the existence of innumerable small air pockets within the material for their insulating properties. The thermal conductivity of these types of material increases with an increase in temperature.

NOTE 2 Materials for use on a cold or lukewarm surface are not always suitable for use on a hot surface.

NOTE 3 The surface temperature of insulation is greatly dependent on factors such as the water temperature, the location of the insulated component, sunlight and air movement.

Thermal insulation of hot water supply and circulating pipes shall be a minimum of *R*-1 (see 6.7.5) in accordance with the relevant national legislation (see foreword) and SANS 204.

5.1.10 The use of dissimilar metals in the same below-ground installation should be avoided wherever practicable, or otherwise special measures shall be taken to prevent corrosion where pipes, pipe joints or connected fittings are of dissimilar metals.

5.1.11 Zinc (or alloys which are predominantly zinc) is not a suitable material for body castings, pressings or machined bodies and operating mechanisms on plumbing fittings, and therefore shall not be used in water installations.

5.2 Pipes and pipe fittings

NOTE 1 Piping materials used for water installations in buildings include, but are not limited to galvanized mild steel, copper, stainless steel, polypropylene, polyethylene, cross-linked polyethylene, PVC-U, chlorinated PVC, Poly butylene, PVC-M and PVC-O.

NOTE 2 Metals and metal alloys (such as copper and stainless steel) that rely on the presence of protective surface films for their corrosion resistance are particularly prone to pitting corrosion under unfavourable conditions.

NOTE 3 Where galvanized mild steel pipes and copper pipes are used in the same system, the corrosion rate of galvanized steel is usually substantially increased by the traces of copper present in the water. Dissolved copper ions can stimulate the corrosion of zinc coatings and bare steel surfaces, either by direct electrochemical exchange reactions or by galvanic attack. Dissolved copper is, however, usually only found in cases where galvanized mild steel hot water outlet pipes are used together with copper domestic water heaters that operate at excessively high temperatures.

NOTE 4 Where galvanized mild steel pipes and copper pipes are to be used in the same system especially at temperatures in excess of 60 °C, the copper pipe should be downstream of the galvanized steel pipe.

5.2.1 Copper and copper alloys

5.2.1.1 All copper alloy components in contact with potable water shall comply with the minimum standard when tested in accordance with SANS 6509. The maximum penetration shall not exceed 250 µm.

5.2.1.2 Notwithstanding the requirements in 5.2.1.3, the following shall be deemed to be acceptable:

a) copper tubes recommended in SANS 460 for the design conditions;

b) solders, fluxes and the method of soldering described in SANS 460 and the manufacturer’s instructions; and

c) copper-based fittings for copper tubes that comply with the requirements of SANS 1067-1,or SANS 1067-2, as relevant.

5.2.1.3 Unless the water is suitably treated, copper piping shall not be used where

a) the water can so dissolve an undue amount of copper that an unacceptable green staining is produced, or

b) copper deposits onto aluminium or zinc surfaces will promote galvanic attack.

5.2.1.4 Copper or copper alloy pipes and fittings shall not be used, unless suitably protected against external corrosion, where they might be in contact with materials such as

a) ash,

b) sodium chloride (salt),

c) ammonia, or

d) any compound that consistes of of magnesium oxychloride (magnesite).

5.2.1.5 Class O and class 1 copper tubing shall not be bent or formed in any manner during installation or installed underground.

NOTE Copper tubing should be free from carbon residues in the bore where the supply water can support localized pitting corrosion.

5.2.2 Fibre-cement

5.2.2.1 Fibre-cement pressure pipes that comply with the requirements in SANS 1223 shall be deemed to be acceptable.

5.2.2.2 Fibre-cement products shall:

a) be coated externally with bitumen where high acidity or sulfate-bearing soils are present, and

b) preferably only be used in locations that are readily accessible for maintenance purposes.

NOTE Fibre-cement pressure pipes are suitable where freedom from tuberculation and a higher corrosion resistance (except in sulfate-bearing soils) are required.

5.2.3 Plastics

5.2.3.1 Plastics materials, plastics pipes or plastics fittings shall be selected and used in accordance with the relevant standards (see 5.2.3.5, 5.2.3.6, 5.2.3.7 and 5.2.3.10), and the manufacturer's recommendations.

Plastics pipes and materials shall not be used in fire or combined installations above ground nor on the primary circulation loops between solar collectors and storage tanks. Special attention shall be paid to high temperatures and pressures, especially stagnation temperatures of solar water heating systems. Local authorities in some areas restrict the use of plastics pipes for direct connection into hot water heaters.

All SANS standards for plastic polymer piping system for hot and cold water supplies are approved for use inside buildings only. All plastics pipes used in hot and cold water installations near external doorways and windows, shall be protected from sunlight. Unlike metal pipes (steel and copper) that have generic pipe and fitting standards, thermoplastic pipe systems are required to be installed using the fittings and tools that are tested and approved as a complete system, The use of pipes, fittings and tools from other manufacturers or suppliers, that are not the same as the approved system, shall not be acceptable.

5.2.3.2 Attention shall be given to the burning characteristics of plastics materials used in high fire risk areas or close to sources of heat that can impair their performance.

NOTE Characteristics that should be considered include whether the material supports combustion in air and whether, and to what degree, it is a flame retardant.

5.2.3.3 Unless plastics pipes or fittings are suitably protected, they shall not be used in a position where permeation of gas or any other substance can cause (or is likely to cause) contamination of the water in them.

NOTE 1 For example, plastics pipes or fittings should not be laid beneath areas where spillage of oils, fuels, creosote or other hydrocarbons is likely to take place, unless such pipes or fittings are laid inside an impermeable sleeve or duct.

NOTE 2 Coefficients of expansion for plastics pipes exceed those for metal pipes, but this is normally not a problem where pipes are buried.

5.2.3.4 Fittings manufactured from polyacetal shall not be used in closed-loop hot water or heating systems.

NOTE Closed-loop hot water or heating systems will cause degradation of the acetal, due to zinc chloride build-up in water.

5.2.3.5 Piping systems manufactured from polyethylene shall comply with the requirements of SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5, and piping systems manufactured from polypropylene shall comply with the requirements in SANS 15874-1, SANS 15874-2, SANS 15874-3 and SANS 15874-5. The working pressure (for cold water temperatures exceeding 20 °C) of polyethylene and polypropylene pipes shall be rated in accordance with the requirements in SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5, and SANS 15874-1, SANS 15874-2, SANS 15874-3 and SANS 15874-5, respectively.

5.2.3.6 PVC-U pipes and fittings that comply with the requirements of SANS 966-1; PVC-M pipes and fittings shall comply with the requirements in SANS 966-2 and PVC-O pipes shall comply with the requirements in SANS 16422.

5.2.3.7 Plastics pipes and fittings for hot and cold water supply systems shall comply with one of the following standards:

a) for PE-X (cross- linked polyethylene): SANS 15875-1, SANS 15875-2, SANS 15875-3 and SANS 15875-5;

b) for PB (polybutylene): SANS 15876-1, SANS 15876-2, SANS 15876-3 and SANS 15876-5;

c) for PVC-C (chlorinated polyvinyl chloride): SANS 15877-1, SANS 15877-2, SANS 15877-3 and SANS 15877-5;

c) for PE-RT (raised temperature cross linked polyethyelene): SANS 22391-1, SANS 22391-2, SANS 22391-3 and SANS 22391-5; and

d) for PE-X Multi-layer piping systems: SANS 21003-1, SANS 21003-2, SANS 21003-3 and SANS 21003-5.

5.2.3.8 The minimum rating of a polymer pipe used in hot and cold water systems in buildings is class 2, PN16 at 20 °C, 8 bar at 70 °C, and shall be marked as such on the pipe.

5.2.3.9 Algae growth can occur in plastics pipes if there is any translucence. Plastic pipes on hot and cold systems shall only be used inside buildings.

5.2.3.10 For pipes and fittings, guidance on the application of the system shall be found in SANS 4427-5, SANS 15874-5, SANS 15875-5, SANS 15876-5, SANS 15877-5, SANS 22391-5 and SANS 21003-5. Any plastic piping systems for hot water use shall be class 2 (70 °C operating temperature), and shall have a minimum operating pressure (M.O.P) of 600 kPa (6 bar) at 70 °C.

5.2.4 Stainless steel

5.2.4.1 The following provisions shall be deemed to be acceptable:

a) welded steel tubes manufactured from austenitic stainless steel and that comply with the requirements in SANS 965;

b) pipes manufactured from stainless steel and that comply with the requirements in ASTM A 312, or EN 10250-4;

c) fittings manufactured from stainless steel and that comply with the requirements in ASTM A 403;

d) electric water heaters, or storage containers or pipes that are purpose-made from AISI type 316 L or SAF 2205 stainless steel for high pressure applications, and type 304 for low pressure applications; and

e) stainless steel sinks that comply with SANS 242, stainless steel wash-hand basins and wash troughs that comply with SANS 906, and stainless steel stall urinals that comply with SANS 924.

5.2.4.2 Stainless steel supports in contact with

a) stainless steel pipes or fittings shall be of the same grade as that of the pipes or fittings, and

b) stainless steel water heaters or storage containers shall be manufactured from material at least equivalent to AISI type 304 L stainless steel in accordance with ASTM A 240.

NOTE Pitting corrosion in stainless steels is invariably related to the presence of halides (particularly chlorides) in the environment. As chlorides can be encountered in most environments, the likelihood of pitting of the stainless steel should always be considered.

5.2.4.3 Stainless steel material shall not be used

a) below ground, unless approved, or

b) where it might be in contact with materials such as ash, sodium chloride (salt), or any compound containing magnesium oxychloride (magnesite), unless the stainless steel material is suitably protected against external corrosion.

5.2.4.4 Soldering fluxes that can cause pitting corrosion of stainless steel, for example, fluxes containing chlorides or borites, shall not be used for soldering stainless steel.

5.2.5 Iron and steel

5.2.5.1 The following shall be deemed to be acceptable:

a) malleable cast-iron pipe fittings that comply with the requirements in SANS 14;

b) ductile iron pipes that comply with SANS 1835;

c) steel pipes and pipe fittings with a nominal bore up to 150 mm that are suitable for screwing, in accordance with SANS 1109-1 pipe threads, and that comply with the requirements in SANS 62-2;

d) galvanized steel tubes, tubulars and fittings that have been galvanized in accordance with the requirements of SANS 32; and

e) steel pipes and fittings that comply with the requirements of SANS 62-1, SANS 719, SANS 815-1 and SANS 815-2, as applicable.

5.2.5.2 Where buried galvanized steel tubes and fittings can suffer rapid corrosion in acidic soils, special precautions shall be taken to protect such pipes and fittings against external corrosion. Several coastal local authorities do not allow the use of galvanized steel pipes in water supply installations.

NOTE Galvanized pipes can be protected against corrosion either by wrapping them with special tape in accordance with the manufacturer's instructions, or by covering them with suitable protective coatings.

5.2.5.3 Because of the risk of corrosion, galvanized steel pipes shall not be used in the circulation legs of hot water installations unless such pipes have an adequate rate of circulation.

5.2.5.4 In multiple-loop hot water systems regular circulation of the water in all loops shall be ensured in order to prevent oxygen depletion of the hot water.

NOTE Galvanized steel piping carrying stagnant water could be attacked internally by anaerobic bacteria.

5.2.5.5 Pipe saddles that are used for tapping off mains supply pipes of different materials shall comply with SANS 1808-44.

5.3 Terminal water fittings

5.3.1 General

5.3.1.1 Terminal water fittings installed outside any building other than a residential dwelling shall

a) incorporate a self-closing device,

b) have a removable handle for operating purposes,

c) be capable of being locked to prevent unauthorized use, or

d) be of a demand type that limits the quantity of water discharged in each operation.

5.3.1.2 Terminal fittings for hot water installations shall be compatible with the associated type of water heater.

5.3.2 Flushing devices and WC flushing cisterns

5.3.2.1 Any single flush or dual flush WC flushing cistern shall comply with the requirements in SANS 821, and automatic shut-off flush valves for water closets and urinals shall comply with the requirements in SANS 1240.

NOTE For water conservation, it is recommended that the dual flush WC units be considered.

5.3.2.2 Any flushing device that serves a water closet pan or urinal shall be activated

a) manually, by the person using the pan or urinal, or

b) automatically, by means of an approved apparatus that causes the flushing device to operate after each use of the pan or urinal, and

c) shall be designed so that the valve cannot be held open to exceed the prescribed flushing volume.

5.3.2.3 The design of any automatically operated flushing device shall be such that no flush will take place when the device malfunctions.

5.3.2.4 Any flushing device that serves a water closet pan shall comply with the requirements in SANS 821 and SANS 1240, as relevant, and shall be compatible with the water closet pan. During one flush action (full or part, as relevant) under normal operating conditions, the device shall

a) clear the trap of the water closet, but

b) not discharge more water than allowed by the local authority.

5.3.2.5 Any flushing device that serves a urinal shall not be capable of discharging more than 2 L of water during one complete flush per stall or per wall-hung urinal or per 600 mm width of slab urinal. An automatic cistern or a tipping tank shall not be provided as a flushing device for a urinal. In the interest of water conservation, wall-hung urinals should be used in preference to stall urinals, wherever possible.

5.3.2.6 WC toilet pans and wall-hung urinals shall comply with the performance requirements in SANS 497. Low flushing capacity (4,5 L) WC flushing systems (including WC pan and cistern) shall comply with SANS 1733.

5.3.2.7 Overflows of flushing systems shall be either method 1, external warning primary overflow, or method 2 of SANS 821, internal overflow without external as required by the local authority.

5.3.3 Taps, mixers and showers

5.3.3.1 Taps and mixers

5.3.3.1.1 Metallic water taps and mixers shall comply with the requirements in SANS 226, SANS 1480, SANS 1808-9, SANS 1808-16, SANS 1808-30, SANS 1808-35, SANS 1808-37, or SANS 1808-66, as relevant.

5.3.3.1.2 Draw-off taps shall operate effectively at the internal water pressure recommended by the manufacturer.

5.3.3.1.3 Plastics taps shall comply with SANS 1021.

5.3.3.2 Showers

Showers shall be of a type that can operate effectively at the internal water pressure recommended by the manufacturer.

5.3.4 Float valves

The following provisions shall be deemed to be acceptable:

a) float valves that comply with the relevant requirements in SANS 752; and

b) plastics ball-floats (for float valves), that comply with the relevant requirements in SANS 1006.

5.4 Non-terminal fittings and components

5.4.1 Backflow preventers

5.4.1.1 Vacuum breakers

The capacity and performance of any vacuum breaker shall be such that no water previously discharged from any associated draw-off fitting can return through such vacuum breaker.

NOTE There are two basic types of in-line vacuum breaker, the atmospheric type and the pressure type. The pressure type has a spring loaded air inlet valve and a check element biased to the closed position. Both types are only effective against back siphonage.

5.4.1.2 Combined check (non-return) valve and vacuum breaker

Only the type that admits air downstream of the check valve element for backflow prevention shall be used.

NOTE There are two types of combined check valve and vacuum breaker: one type operates to admit air to the pipework upstream of the check valve, and another type admits air downstream of the check valve.

5.4.1.3 Double check valve backflow preventer

Any double check valve assembly that complies with the appropriate requirements in SANS 1808-15 shall be acceptable.

5.4.1.4 Reduced pressure zone backflow preventer

Any reduced pressure zone backflow preventer that complies with the appropriate requirements of SANS 1808-15 is acceptable.

5.4.2 Circulation pumps for hot water systems

5.4.2.1 Circulation pumps for boosting or secondary circulation shall be installed with the shaft in the horizontal plane and shall be adequately resistant to corrosion.

5.4.2.2 Pumps shall not be audible above the background noise and the inlet and outlet connections to such pumps shall be fitted with full way valves and have union or flange type couplings to facilitate easy removal for maintenance or replacement.

5.4.3 Purpose-made stainless steel water heaters and storage containers

5.4.3.1 Purpose-made fixed electric water heaters and storage containers shall, subject to the requirements in 5.4.3.2,

a) be designed and manufactured (including all welding) in accordance with the requirements of PD 5500; and

b) comply with all the appropriate requirements in SANS 151.

5.4.3.2 Deviations from the requirements in 5.4.3.1 shall only be those in respect of limits to the capacity of the container, and those with regard to the external container and supports. Containers shall be conformity assessed in terms of SANS 347.

NOTE Several of the design aspects referred to can apply to other materials.

5.4.3.3 The same type of stainless steel shall be used to manufacture all the parts of the water heater or storage container. The design of the water heater or storage container shall be such as to ensure that no water can reach the insulation material or the external container (or cladding) of the water heater or storage container. The surface of the underside of the external cladding of the water heater or storage container shall be ventilated to prevent condensation within the insulation.

5.4.4 Safety trays

Safety trays shall comply with the requirements in SANS 1848.

NOTE See 8.4.4 for particulars regarding the installation of safety trays.

5.4.5 Strainers

Strainers shall comply with the requirements in SANS 1808-58.

NOTE The purpose of strainers is to prevent the passing through of solid material that could damage or block-up appropriate functional valves or terminal fittings.

5.4.6 Storage tanks

5.4.6.1 General

5.4.6.1.1 Storage tanks shall be

a) watertight and vermin proof,

b) properly covered and ventilated,

c) sized to comply with the requirements of the local authority, and

d) sized to make provision for the usable capacity of a storage tank, which is the volume of water between the upper and lower operating water levels in the tank under normal operating conditions.

NOTE 1 Water for drinking purposes in buildings that exceed three storeys is usually supplied from a storage tank.

NOTE 2 The storage tank fulfils the purpose of attenuation of peaks in the water supply system and also provides an emergency supply during mains failure.

5.4.6.1.2 Storage tanks shall be provided with an adequate drainage system to ensure that the premises are not flooded in the event of leakage or accidental overflow. The capacity of such a drainage system shall be such that it is capable of discharging water at a rate at least equal to the rate of flow of the incoming water supply. The outlet of the drainage pipe shall be so situated that the discharge of water can be readily detected.

5.4.6.1.3 The inlet pipe to any storage tank shall be provided with a float valve or any other approved level control device.

5.4.6.1.4 Pressurized storage tanks (metallic and non-metallic) shall be assessed for conformity in accordance with SANS 347, and the pressure equipment regulations in terms of the relevant national legislation (see foreword).

5.4.6.2 Tanks of capacity exceeding 2 kL

5.4.6.2.1 To access the interior of the tank, the following shall apply:

a) access shall be provided by an access opening that is of a size and shape into which a circle of diameter of at least 450 mm can be inscribed;

b) the access opening shall be located either on the side, or on the top of the storage tank;

c) the lid of the access opening shall be so designed that it cannot be left in the open position unattended;

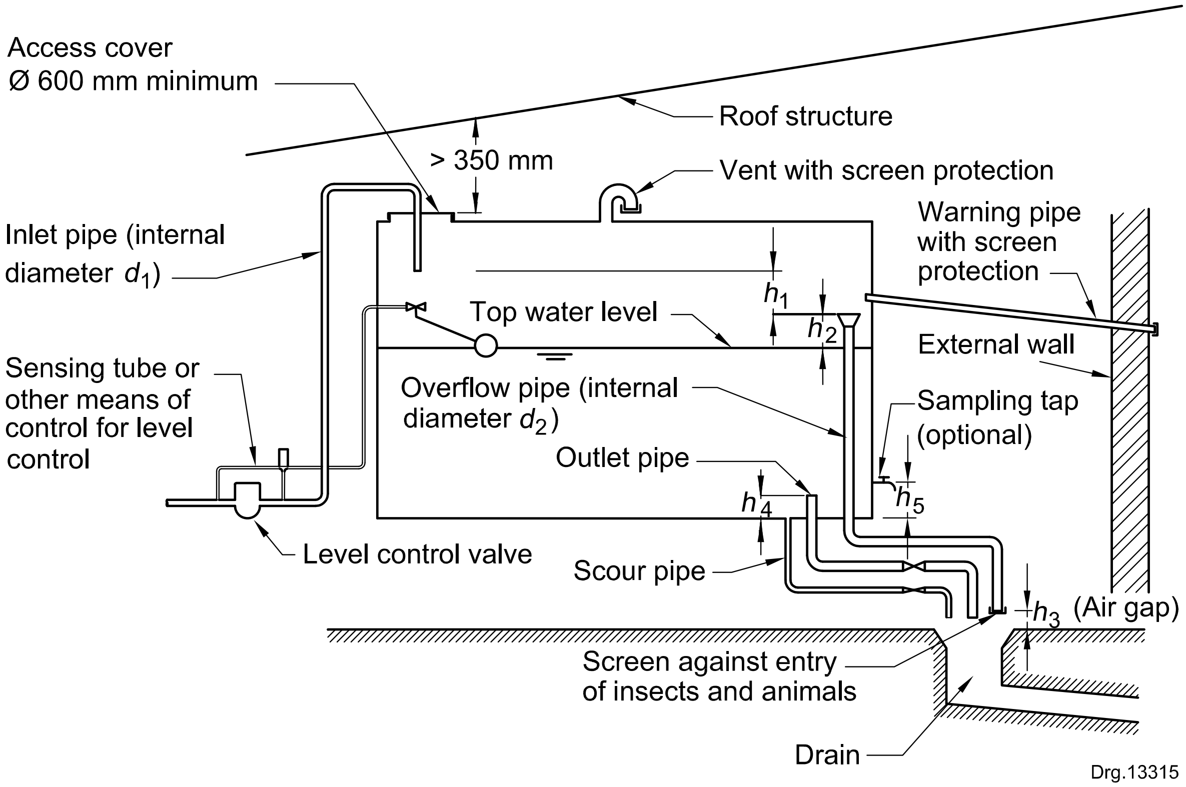
d) the access opening shall be covered by either a screwed-on cover or a tightly fitting lid that is hinged and has an overlapping rim of depth at least 40 mm; and

e) the access opening shall be designed for easy access to the inside of the tank for inspection and maintenance purposes.

NOTE Disconnecting of the inlet pipe will ensure that the access opening is kept closed to avert water pollution.

5.4.6.2.2 Where water shall be stored for drinking purposes and when so required, provision shall be made in the storage tank for the installation of a sampling tap situated at a point not less than 50 mm and not more than 150 mm above the internal floor of the tank.

5.4.6.2.3 If the storage tank serves both a general installation and a fire installation, the design of the tank shall be such that the portion of its contents that is reserved for the fire installation cannot become stagnant. A storage tank of capacity exceeding 2 kL is shown in figure 2, and a typical arrangement of outlet pipes from a storage tank is shown in figure 3.



NOTE 1 Minimum diameter for an access opening is 600 mm diameter.

NOTE 2 Discharge capacity of overflow pipe at the head ≤ (h_1 + h_2) ≥ discharge capacity of inlet pipe.

NOTE 3 h_1 ≥ 50 mm or h_1 ≥ 2d_1, whichever is the greater, subject to h_1 ≤ 150 mm (the actual value of h_1 is based on hydraulic considerations).

NOTE 4 h_2 ≥ 50 mm.

NOTE 5 h_3 ≥ 2d_2.

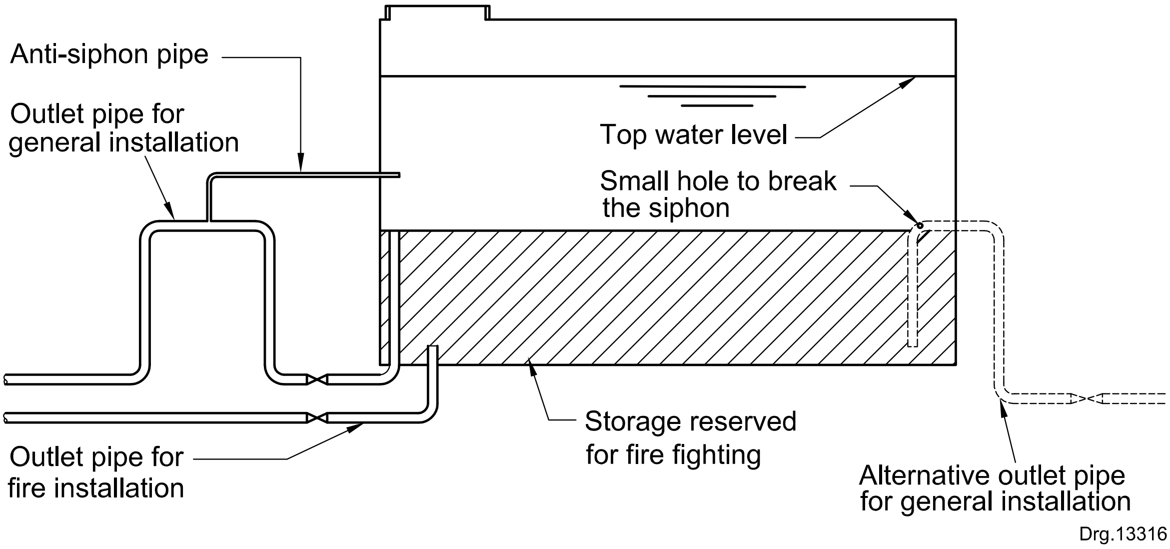
NOTE 6 h_4 ≥ 50 mm.

NOTE 7 50 mm ≤ h_5 ≤ 150 mm.

NOTE 8 Large tanks may have two access openings.

NOTE 9 Warning pipe is to have a minimum internal diameter of 19 mm and is to be of a rigid material. The invert of pipe is to be at least 25 mm above overflow level.

Figure 2 — Typical cold water storage tank of capacity exceeding 2 kL



NOTE Only outlet pipes are shown.

Figure 3 — Typical arrangement of outlet pipes from a cold water storage tank

5.4.6.3 Tanks of capacity 2 kL and less

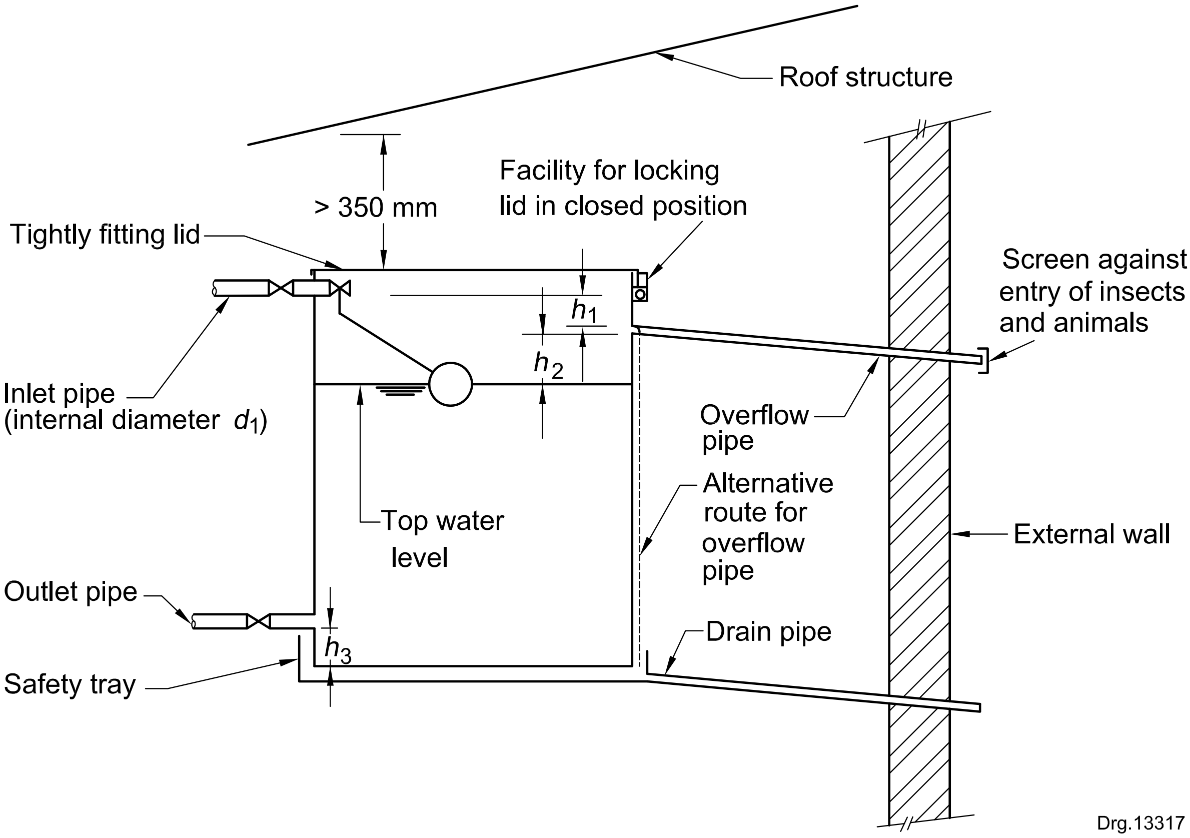
Access to the interior of the storage tank shall be provided by an access opening (through the top of the tank) that

a) has a tightly fitting lid that

   1) has an overlapping rim of depth at least 40 mm, and

   2) has a means of locking it in the closed position, and

b) if it does not extend over the full area of the top of the tank, is provided with a raised rim of depth at least 40 mm around its circumference. A storage tank of capacity 2 kL and less is shown in figure 4.



NOTE 1 The discharge capacity of the overflow pipe ≥ the discharge capacity of the inlet pipe capacity at the head ≤ h_1.

NOTE 2 $h_1 \geq 50$ mm or $h_1 \geq 2d_1$, whichever is the greater, subject to $h_1 \leq 150$ mm.

NOTE 3 $h_2 \geq 50$ mm.

NOTE 4 $h_3 \geq 50$ mm.

NOTE 5 Overflow pipe to be of a rigid material.

Figure 4 — Typical cold water storage tank of capacity 2 kL and less

5.4.7 Fixed type water heaters

5.4.7.1 Standard water heaters and solar water heaters shall comply with the requirements in SANS 151, and any electric instantaneous water heater shall comply with the requirements in SANS 1356.

5.4.7.2 Drain valves for water heaters shall comply with SANS 1808-35. All drain valves shall be furnished with removable keys.

5.4.7.3 Gas-operated water heaters shall comply with SANS 1808-24 and SANS 1539. For information on the mandatory requirements of gas water heaters see annex A.

5.4.7.4 Hot water storage tanks with external heating shall comply with all the relevant dimensional, mechanical strength, thermal and safety requirements in SANS 151.

5.4.8 Water heaters that use indirect electrical heating

Fluid for heat transfer shall be so selected as to convey the maximum amount of heat with a minimum amount of fluid and at the least possible cost.

NOTE 1 An indirect heating system uses a fluid in a separate circuit as a heating medium. The heated fluid transmits its heat through a heat exchanger to the water intended for distribution.

NOTE 2 The heat-carrying ability of a fluid is expressed as the "specific heat". The heat transfer efficiency is expressed in terms of the "volumetric specific heat". See I.1.2 for specific heat and volumetric specific heat values for fluids that can be used as heat transfer media.

NOTE 3 Water is a very efficient medium in terms of specific heat and is also one of the cheapest and most widely used.

5.4.9 Water heaters that use direct electrical heating

5.4.9.1 Elements of water heaters of capacity exceeding 500 L shall be removable without loss of water from the heater.

5.4.9.2 The main heating elements of any water heater shall be positioned close to the bottom of the container.

5.4.9.3 If they are to be installed, the auxiliary elements of any water heater shall be positioned near the top of the container.

NOTE 1 In order to improve the efficiency of larger hot water supply systems, an auxiliary immersion or dry element can be installed in the storage container, to augment the main elements. With the main elements at the bottom of the container connected to a time control, set to heat the water mainly during a time of off-peak electricity use, the auxiliary elements will ensure that hot water in the top third of the container is available over a period of 24 h.

NOTE 2 The auxiliary element is usually rated at one-third to two-thirds of the rating of the main elements.

5.4.9.4 The type of heater elements used shall be compatible with the associated type of water heater.

5.4.9.5 Immersion heating units for electric storage water heaters shall comply with the requirements in SANS 514.

NOTE Direct electrical water heating elements heat the water directly and can be one of the following types:

a) Immersion elements (submerged or wet elements): in this type of system, electrical rod elements are installed in the hot water storage container, in direct contact with the water. This is a very common method of heating water by means of electricity. Scale formation on the elements is restricted as a result of their expansion and contraction. However, the storage container needs to be drained before the elements can be replaced; and

b) Dry elements: Dry elements are so installed in a housing inside the storage container that they are not in direct contact with the water. Unfortunately, the outer surface of the housing, which is in contact with the water, is susceptible to the formation of scale, resulting in a decrease in heating efficiency over a period of time. The main advantage of this system is that the elements can be replaced without drainage of the storage container.

5.4.10 Storage type water heaters

5.4.10.1 Fixed electric storage water heaters for domestic use shall comply with the requirements in SANS 151.

NOTE 1 Mixing of hot and cold water occurs more readily within a horizontal cylinder than within a vertical cylinder.

NOTE 2 In urban areas, the most common method of heating water is by an immersion type electrical resistance element mounted in an insulated storage cylinder, commonly called a geyser. Geysers require little maintenance.

NOTE 3 Although it is common practice to increase the temperature setting of a geyser that is inadequate in size to supply the required volume of hot water, this practice has the effect of increasing energy loss and can shorten the life span of the geyser. The recommended temperature for storage of hot water is 60 °C.

5.4.10.2 Open outlet type storage water heaters as defined in SANS 151 shall incorporate a thermostat, shall not be pressurized or subjected to vacuum, and the flow of hot water shall be controlled on the inlet side.

5.4.10.3 Cistern type storage (combination) water heaters as defined in SANS 151 shall not be pressurized or subjected to vacuum, and the flow of hot water shall be controlled on the outlet side.

5.4.10.4 Closed type storage (unvented and vented) water heaters as defined in SANS 151 shall be fitted with temperature and pressure safety valves apart from a thermostat, and the flow of hot water shall be controlled on the outlet side.

5.4.11 Safety devices

5.4.11.1 Thermostats for electric storage water heaters shall comply with the requirements of SANS 181 and shall include a high temperature cut-out device. Reliance for the protection of water heaters shall not be placed solely on thermostats. Further protection measures include the provision of temperature and pressure safety valves.

5.4.11.2 Functional control and safety valves for pressurized hot and cold water systems shall comply with the requirements of SANS 198.

NOTE 1 The thermostat is usually an adjustable device controlling the electrical energy input for heating the water to a selected operating temperature.

NOTE 2 A high temperature cut-out device that permanently disconnects the electrical energy supply at a preset high temperature limit often forms part of a thermostat.

NOTE 3 A temperature and pressure safety valve controls the temperature and pressure, as relevant in a water heater. It does not disconnect the electricity supply to the heater.

NOTE 4 The function of an expansion control valve is to prevent the hydraulic pressure within a water heater from exceeding the working pressure rating of the heater. The excess pressure can be due either to the expansion of the water under normal operating conditions or to failure of the pressure control valve upstream of the expansion control valve.

5.4.11.3 Functional control and safety valves for use in pressurized hot and cold water systems at static inlet water pressures of up to 2 000 kPa, and for working pressures of up to 600 kPa, shall be constructed and marked in accordance with SANS 198 and matched to the pressure rating of the system. The requirements for colour coding of functional control and safety valves are summarized in table 8.

Table 8 — Colour coding for working pressure ratings of functional control and safety valves

1	2
Rated working pressure *p* KPa	**Colour**
$p \leq 50$ $50 < p \leq 75$ $75 < p \leq 100$	Yellow Orange Blue
$100 < p \leq 200$ $200 < p \leq 300$ $300 < p \leq 400$ $p \leq 600$	Black Brown Red Green

5.4.12 Gate valves, ball valves and butterfly valves

5.4.12.1 The following valves shall be deemed to be acceptable:

a) copper alloy gate valves that comply with the requirements in SANS 776 and SANS 1857, as relevant for isolating purposes only, not for dispensing or flow control;

b) ball valves that comply with the requirements in SANS 1056-3;

c) butterfly valves that comply with the requirements in SANS 1849; and

d) cast iron valves shall comply with SANS 664-1 SANS 664-2, SANS 664-3, and SANS 665-1, SANS 665-2 and SANS 665-3.

5.4.12.2 These valves shall not be used to control the flow-rate of water as this could cause damage to the seats of the valves, which, in high pressure systems, could be of a serious nature.

5.4.12.3 These valves shall not be used in installations that are prone to water hammer. In such cases, slow-acting valves (for example, stopcocks and diaphragm valves) are recommended.

5.4.13 Pressure gauges

Pressure gauges that comply with the requirements in SANS 1062 shall be deemed to be acceptable.

5.4.14 Flexible connectors

Flexible connectors shall comply with SANS 1808-5 and shall only be used for connecting to terminal fittings that have sufficient access for maintenance. They shall not be used in-line or for connecting to fixed water heating units.

5.4.15 Check non-return valves

Check valves shall comply with SANS 1808-10. Swing type check valves with metal-to-metal seats shall not be used on hot and cold water systems in buildings.

5.4.16 Fire hose reels

Fire hose reels shall comply with SANS 543.

5.4.17 Domestic solar water heaters

Domestic solar heaters shall comply with SANS 1307.

6 Layout

6.1 General

6.1.1 Metering of water supplies

6.1.1.1 All water supplied from a main to an installation shall pass through an approved water meter that complies with the relevant national legislation (see foreword).

6.1.1.2 When so required, the following shall apply:

a) The water meter shall be installed in a suitable location where it is easily accessible and maintainable. The installation condition shall be in accordance with the manufacturer's specifications. Meter installations size DN 15 to DN 40 shall include an upstream isolating valve. If not included in the water meter, an upstream strainer and downstream non-return valve shall be fitted. An isolating valve accessible to the consumer shall be fitted downstream of the water meter. Where meters are exposed to the elements in boundary or yard installation, the meter shall be installed in a protective meter box or manifold assembly. An additional isolating valve shall be fitted down stream of the water meter, either incorporated in the meter box or in the service connection to the consumer.

b) Plastic water meters shall not be exposed to direct sunlight and shall be fitted in a meter box or enclosure.

c) Water meters from size DN 50 and larger shall be fitted with a straight length of pipe of the same diameter as the meter directly up- and downstream of the meter in accordance with the manufacturer's specification, in order to prevent flow disturbances affecting meter accuracy.

   NOTE On mechanical water meter installation it is recommended that a strainer be installed upstream of the meter to prevent possible damage to the meter as a result of suspended solids.

d) Strainers shall have isolating valves fitted upstream and downstream of the strainer to allow for servicing of the meter and the strainer. Isolating valves shall not be used as flow restrictors. Pressure reducing valves shall only be fitted downstream of the meter after the prescribed length of straight pipe.

e) Installations where the water flow has a very high differential between low and high flow, combination meters shall be used.

f) Water meters shall not be installed in traffic areas. Water meters from DN 15 to DN 100, nominal size, shall comply with SANS 1529-1. Electronic water meters and prepaid meters shall comply with SANS 1529-9. The physical dimensions for water meters DN 15 to DN 100 are recommended in SANS 1529-3. The requirements for water meters exceeding DN 100, but not exceeding DN 800, are detailed in SANS 1529-4.

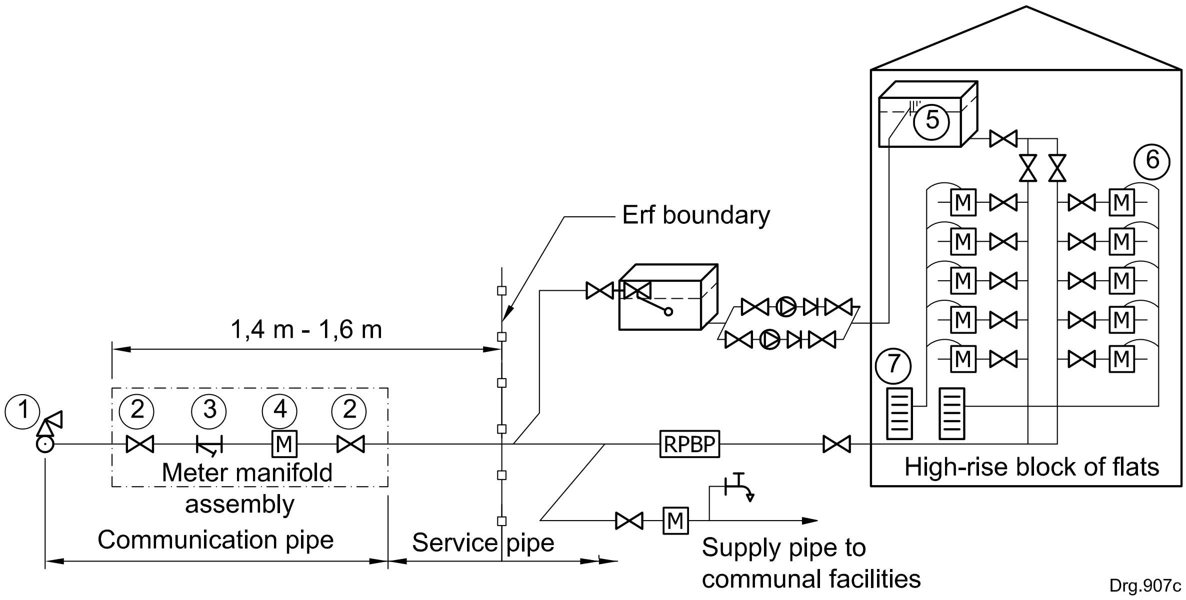
g) Provision shall be made for the drainage of water that might discharge from the pipe on which the water meter is to be installed.

6.1.1.3 General installations serving premises of separate occupancy shall facilitate individual metering.

NOTE 1 Individual metering promotes the economical use of water. This is best achieved via a single water connection. For high-rise buildings, meter reading can be facilitated by the use of meters fitted with remote reading systems using for example, radio, GSM, GPRS networks or wired counters. An installation serving individually metered flats in a high-rise block is shown in figure 5. The bulk meter shown can be used to check for example, un-metered leakage from the buried service pipes.

NOTE 2 The relation of boundary to meter should be in accordance with the local authorities.

NOTE 3 For more information on water meters, see annex B.



Key

1 Mains connection
2 Isolation valve
3 Strainer
4 Bulk meter
5 Automatic level control for pumps
6 Cable to connect meter with remote counter
7 Cabinet for remote counters/transmitters

Figure 5 — An installation serving a high-rise block of flats using remote counters

6.1.2 Booster pumps

6.1.2.1 Where it is necessary to pump water to maintain a water supply, such booster pump installations on premises shall, unless otherwise approved, be so designed that the pumps do not draw water direct from the water mains, but from a storage tank that

a) is fed by gravity from the mains,

b) is fitted with an inlet control valve of the correct size, so set as to admit water to the tank from the mains at a rate at least equal to the average hourly peak water requirement of the premises, and

c) has a minimum capacity of the greater of at least 25 % of the average daily water demand or one hour's capacity of the pumping system.

NOTE 1 Booster pumps may be required where premises or buildings or parts thereof are situated above a level that cannot be served by the normal pressure in the water main or if the owner requires to have a secure water supply.

NOTE 2 For information on pumps, see annex C.

6.1.2.2 Any booster pump shall be self-priming and float controlled or electrode controlled and shall be fitted with all electrical controls and safety devices for the protection of the pump or pump motors (or both), in the event of stoppage of the supply of water from the mains.

6.1.3 Isolating valves

6.1.3.1 Unless otherwise required, or provided that 6.1.3.2 does not apply, a specific isolating valve shall be provided

a) in the case of any water meter installed outside the boundary of the premises, in the service pipe at a point not exceeding 1,5 m inside the boundary of site,

b) in the case of any water meter installed inside the boundary of the site, at a suitable point on the consumer's side of the water meter,

c) where a pipe enters any building or any portion of a building in separate occupation,

d) on any branch pipe that serves a flushing cistern, and next to the cistern,

e) on any branch pipe that serves an automatic flush valve, or a flushing valve, unless such flush valves incorporate their own isolating valves,

f) on each side of, and next to, any backflow preventer or any combination of the backflow preventer and pressure reducing valve,

g) on each side of, and next to, any pressure reducing valve of nominal inlet diameter exceeding 25 mm,

h) on the upstream side of any pressure reducing valve of nominal inlet diameter not exceeding 25 mm,

i) in such positions that, should it become necessary to drain any pipe, the total length of the pipe that has to be drained between isolating valves does not exceed 30 m, and

j) in the case of any storage tank,

   1) on the inlet pipe next to, and upstream of, the valve controlling the supply to the tank, and

   2) on the outlet pipe from the storage tank and next to the tank that supplies water to the water installation.

NOTE Any isolating valve used to shut off the supply to the storage tank should be of a type that cannot be suddenly closed (for example, a gate valve and not a butterfly valve).

6.1.3.2 Notwithstanding the provisions of 6.1.3.1, an isolating valve shall not be provided between any pressure reducing valve and a water heater if such a pressure reducing valve incorporates an expansion relief device or vacuum relief device intended to protect such water heater.

6.1.3.3 Any isolating valve in hot water installations shall be of the full-bore type in order to limit the effects of scale formation within the valve.

6.1.4 Flow controllers

6.1.4.1 General

6.1.4.1.1 If necessary or if so required, flow controllers shall be incorporated in the water installation, to control the flow of water.

6.1.4.1.2 Manually operated valves shall not be used as flow controllers because of the damage that can be caused to the seats.

NOTE 1 A flow controller or an automatic flow-control orifice, which is a simple self-cleaning device installed in-line, is sometimes useful for controlling the flow of water. The automatic controlling mechanism has a flexible orifice that varies inversely with the pressure in its cross-sectional area so that a constant flow rate is maintained. The flexible insert acts as a fixed orifice until the inlet pressure reaches the threshold pressure (80 kPa to 100 kPa). When the threshold pressure is exceeded, the orifice deforms, causing the pressure to drop to whatever pressure is necessary to overcome the system friction and sustain the rated flow. These are also called pressure compensating flow controllers.

NOTE 2 Flow controllers are obtainable for a wide range of rated flows, and are usually designed for connection to pipes or fittings of nominal internal diameter up to 50 mm.

NOTE 3 Some fittings have flow controllers installed integrally within the fitting itself.

6.1.4.2 Balancing device

Where appropriate, an acceptable balancing device should be introduced in the reticulation pipework to dynamically balance the system.

6.1.4.3 In-line flow controller

Where the flow in a reticulation system needs to be controlled, an appropriate flow controller should be installed in the reticulation pipework or in the case of water reticulation systems with multiple loops the flow should be balanced to ensure equal distribution of flow throughout the reticulation.

NOTE This controller and its installation is normally of a permanent (non-replaceable) nature.

6.1.4.4 Terminal fitting flow controller

This controller shall be replaceable and should be fitted to the terminal fitting for the purpose of water conservation. The flow rates for taps on wash-hand basins shall be a maximum of 6 L/min and on showers 10 L/min.

6.1.5 Strainers

6.1.5.1 A suitable strainer shall be provided to prevent the entry of solid particles of size exceeding 710 µm into any fittings controlling water pressure or controlling the flow direction of water, unless such fittings incorporate their own strainers. Strainers for sizes 15 mm to 25 mm shall comply with SANS 1808-58.

6.1.5.2 A strainer shall be located in such a position that it is readily accessible for inspection and maintenance, without having to be disconnected from the supply pipe.

6.1.6 Safety trays

6.1.6.1 A safety tray shall be provided under every storage water heater and every storage tank located in any roof space above a ceiling, and such a safety tray shall be used only for the purposes of collecting and draining away water that results from an accidental discharge from a specific component of a water installation.

6.1.6.2 Cognizance shall be taken of the requirements of SANS 10254.

NOTE See 5.4.6.1.2 concerning the sizing and positioning of drain pipes.

6.1.7 Hot water fittings and components

6.1.7.1 If so required, the following shall be provided:

a) sediment traps in the form of clean-out tees with drain valves at the heels of all vertical lines;

b) convenient flush-out points on horizontal lines; and

c) the necessary connections for the backwashing of instantaneous non-storage water heaters, in order to remove sediment that might have accumulated.

6.1.7.2 The use of in-line fittings that could cause bottlenecks by providing a shoulder for deposit build-ups shall be minimized.

6.1.7.3 Acceptable measures shall be taken to prevent the back-siphonage of hot water into the cold water supply.

6.2 Terminal water fittings and overflow pipes

6.2.1 General

6.2.1.1 To prevent water in unused pipework from becoming stagnant, a water supply pipe shall

a) not be connected to any water fitting unless a terminal water fitting is also connected, or

b) be disconnected from the installation when a terminal water fitting is disconnected, unless such a terminal fitting is disconnected for repair or replacement, and provided that the supply pipe is put into use within an acceptable time period to prevent stagnation of the water under local climatic conditions.

6.2.1.2 Any terminal water fitting (other than a float valve) that serves a cistern or a storage tank shall be installed in such a position and in such a manner that the discharge of water from it is readily visible.

6.2.1.3 No terminal water fitting shall be attached to the outlet of an open-outlet type fixed storage water heater unless such a fitting has been designed to discharge hot and cold water while keeping the hot water outlet open to the atmosphere.

6.2.1.4 If required by the local authority, the overflow pipe from any water closet cistern shall be carried either through an outside wall of the building concerned, or to another point where the discharge of water from it is readily visible.

6.2.1.5 Unless otherwise required, the hot tap shall always be situated on the left hand side and the handle of a single control mixer shall be positioned to the left for hot water discharge.

6.2.2 Flushing of urinals

Each wall-mounted urinal, stall urinal or each 1,8 m width of slab urinal shall be provided with a separate user activated flushing device. Waterless urinals shall be situated so that the drain is located on a branch line downstream of a wash-hand basin or a flushing urinal.

6.2.3 Metering taps and showers

Unless otherwise required, ablution areas that have a battery of more than three wash-hand basins or showers shall be provided with metering or demand type taps or metering type showers.

6.3 Backflow prevention (see annex D)

6.3.1 General

Any backflow prevention device shall be arranged at, or as near as practicable to, the point of delivery, draw-off or use of water.

6.3.2 Non-return (check) valves

Where a non-return valve is connected in association with, and adjacent to, a vacuum breaker, the non-return valve shall be located upstream of the vacuum breaker.

NOTE In such cases, no minimum vertical distance between the non-return valve and the overflow level of the receiver or outlet of a draw-off fitting is required.

6.3.3 Vacuum breakers

6.3.3.1 A vacuum breaker shall be positioned at a height of at least 150 mm above the overflow level of any receiving appliance such as a cistern or vessel when the latter is fixed, or 300 mm above the outlet of the fitting in all other cases.

6.3.3.2 Control valves such as taps shall not be installed downstream of an atmospheric in-line type vacuum breaker.

6.3.3.3 Any vacuum breaker shall be suitably sized.

NOTE In general, a vacuum breaker should be of at least the same nominal size as the pipe on which it is installed.

6.4 Pumps in hot water systems

6.4.1 Circulation pumps

6.4.1.1 Unless otherwise required, a circulation pump shall be provided in all cases where the natural circulation in a hot water circulation system is insufficient.

6.4.1.2 Immersed rotor (glandless) type circulation pumps shall be provided on primary circuits only.

NOTE 1 The function of the pump is only to induce circulation in order to maintain acceptable temperatures in the system, and not to supply hot water to any fitting.

NOTE 2 Continuous pump operation (controlled by a time switch) is more advantageous than stop-start operation (energy controlled).

6.4.1.3 Any circulation pump shall be located in the return main where the temperature of the water is low and the pumps are more accessible.

6.4.2 Heat pumps

6.4.2.1 Heat pumps shall be so selected as to provide the total hot water demand.

NOTE 1 The heat pump extracts heat from one medium and transfers it to another. All refrigeration equipment, air conditioners and chillers with refrigeration cycles are in essence heat pumps, although the term "heat pump" is reserved for equipment that provides heat rather than that which removes heat for cooling purposes.

NOTE 2 Heat pumps are capable of heating water to more than 60 °C. They utilize ambient or waste heat, and can therefore be operated with greater energy efficiency than can conventional heating systems. In larger hot water installations, energy savings offset the higher capital costs of such pumps and therefore their use to supply or to augment existing systems is growing as an energy conservation method.

NOTE 3 A typical hot water installation that incorporates a heat pump is shown in figure 6.

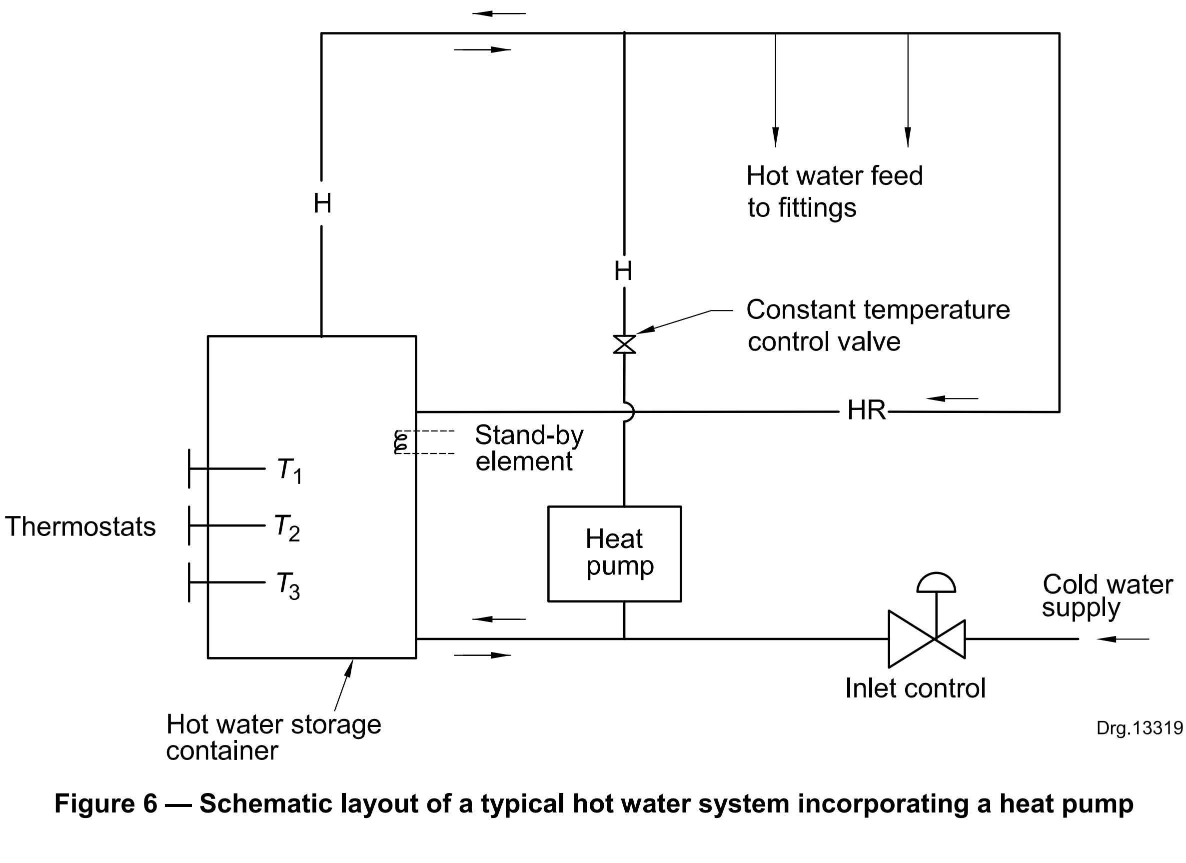


Figure 6 — Schematic layout of a typical hot water system incorporating a heat pump

6.4.2.2 If a heat pump is provided, and unless otherwise required, a stand-by heating system shall be provided as a backup in the event of failure of the heat pump.

6.5 Storage tanks

6.5.1 General

Any storage tank shall be so placed or special measures so taken that the tank can be readily drained, and then inspected and cleaned on the inside.

6.5.2 Cold water storage tanks

6.5.2.1 Where storage tanks are buried, or are partly sunk into the ground, special measures shall be taken to detect leakage from the tank.

NOTE 1 The measures necessary can include an underfloor drainage system, or an impervious membrane, draining to a readily visible outlet point.

NOTE 2 Where separate outlet pipes from any storage tank are provided for supplying hot water apparatus and for feeding cold water outlets, the former type of outlet should be set at a level at least 25 mm above the level of the latter type of outlet; this measure will minimize the risk of scalding should the water supply fail.

NOTE 3 Where possible, water for drinking purposes should not be supplied from a cistern or tank. Taps supplying water for drinking purposes (other than those discharging from a hot water system that supplies water for domestic purposes in dwelling houses or residential buildings) should preferably be connected to the water installation pipe at a point before such pipe supplies any cistern or tank.

6.5.2.2 A storage tank, under operating conditions, shall not have any opening to the atmosphere other than the overflow pipe and a suitably protected vent.

6.5.2.3 A storage tank shall be so situated that entry of surface water or ground water into the tank is prevented. This requirement shall be deemed to be satisfied if a storage tank is

a) located entirely above ground level on a well-drained site not liable to flooding, or when its base is at least 600 mm above the highest known flood level, or

b) a concrete reservoir that is buried or partly sunk into the ground and has been designed in accordance with SANS 10100-1, and constructed and tested in accordance with SANS 1200 G, or

c) situated in a watertight basement below ground level.

6.5.2.4 Unless inlet pipes to, and outlet pipes from, storage tanks are positioned as far apart as possible to limit the short-circuiting of flow, suitable measures shall be adopted to limit such possibility.

6.5.2.5 Where it is anticipated that, because of initial under-utilization of the installation, water entering any storage tank will remain there for longer than two weeks, temporary provision shall be made for disinfecting the water.

NOTE 1 One method of disinfecting water is to fit a chlorinator (using calcium hypochlorite tablets in a special holder) in a bypass on the supply pipe to the tank (see SANS 460).

NOTE 2 Dosing of the water in the tank by adding granules or tablets containing chlorine direct to the water in the tank without first dissolving them, and taking steps to disperse the chlorine solution in the tank can result in a localized concentration of chlorine and resultant corrosion.

6.5.3 Hot water storage tanks (see annex E)

6.5.3.1 Hot water storage tanks shall be thermally insulated in an acceptable manner to prevent heat loss.

6.5.3.2 When, because of its design, it is necessary for a non-mechanical safety device, such as a fusible plug to be fitted to a hot water storage tank, such tank shall also be fitted with a temperature and pressure safety valve designed to open at a temperature of at least 5 °C below that at which the non-mechanical safety device operates, or is designed to operate.

6.5.3.3 Where a hot water storage tank is to stand on a floor, it shall be of a type provided with internal supports.

6.6 Water heaters and associated fittings or components

6.6.1 Safety devices

6.6.1.1 The type of safety devices installed shall be compatible with the associated type of water heater, and such devices shall have corresponding pressure ratings that are not higher than the working pressure rating of the water heater, or of the fixed storage water heater.

NOTE 1 Problems and dangers can arise from defective fittings, faulty designs and incorrect installation. Examples of "incorrect" installation are

a) the placing of a non-return valve or isolating valve between the water heater and the expansion control valve,

b) restricting the outlet of a safety valve,

c) the location of a vacuum relief valve at a level below the top of the water heater, and

d) a system that permits water to be heated to a temperature exceeding boiling point.

NOTE 2 If water confined in a container is subjected to an increase in temperature above that at which it would normally boil, a potentially dangerous situation arises. If the pressure is suddenly reduced either by yielding of the walls of the container or by a sudden large draw-off of hot water, the water in the container could flash into steam, resulting in an explosion. If both the energy input control device and safety valve fail, then an explosion will occur.

NOTE 3 Bursting of the water container takes place when the container is subjected to a higher internal hydraulic pressure than it was designed for. This condition can develop due to an excessive inlet pressure, unrelieved expansion pressure (due to heating of the water) or an occurrence of both simultaneously.

NOTE 4 The water container can collapse when a condition of negative pressure which it is not capable of resisting is created within the container. This condition can be induced when

a) water is drawn off without the admission of air or water,

b) when the rate of water outflow from the container exceeds the combined rates of inflow of water and air, or

c) the water within the container cools without the admission of water or air.

NOTE 5 The heating element can burn out if it is not continuously immersed in water while electrical energy is supplied to the element. Such a condition is brought about by such conditions as the unintentional drainage of the water container by back-siphonage.

NOTE 6 Hot water systems require particular attention in terms of safety. The continuing safe operation of a hot water system depends on having the right equipment correctly installed in a well designed system, which is properly maintained and not exposed to misguided interference. The use of appliances that have all the necessary safety devices factory-fitted is recommended in order to prevent the omission of certain items during installation.

NOTE 7 Several devices are available to protect hot water systems against damage. These devices can either prevent the build-up of unsafe water temperatures in the storage tank, or relieve pressure within the system when an unsafe condition occurs, or both.

NOTE 8 A temperature and pressure safety valve is intended to protect a water heater against excessively high pressures and a water temperature above boiling point. It consists of a combination of

a) a pressure relief valve that opens when the pressure in the water heater reaches a pre-set maximum pressure which is related to the pressure rating of the water heater, and

b) a thermal probe that also opens the pressure relief valve when the temperature of the water in the heater reaches a pre-set value usually not exceeding 95 °C.

NOTE 9 A pressure reducing valve is intended to reduce the incoming water supply pressure either to the working pressure rating of a water heater incorporated in the installation, or to the maximum permissible pressure allowable in an installation. The pressure control valve is usually situated at a convenient position in the incoming cold water supply pipeline.

NOTE 10 An expansion control valve is intended to prevent the hydraulic pressure within a water heater from exceeding the working pressure rating of the heater. The excess pressure could be caused either by the expansion of the water under normal operating conditions or by failure of the pressure control valve upstream of the expansion relief valve.

NOTE 11 A vacuum relief valve is intended to prevent a state of negative pressure from occurring in a hot and cold water system. It therefore acts as a safeguard against the collapse or unintentional draining of the container.

NOTE 12 Figure 7 shows the relationship between the various protective devices associated with water heaters (arrows signify direction of water flow), and examples of installations for dwelling houses showing the location of protective valves are given in SANS 10254 (see annex F for a general guide).

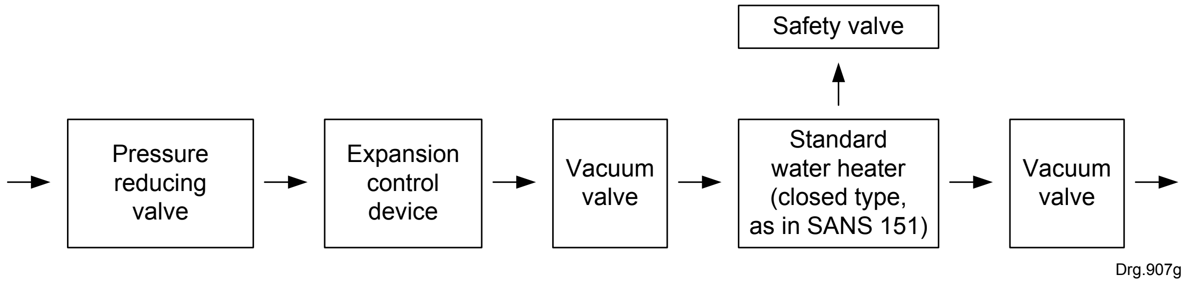


Figure 7 — Relationship between the various protective devices associated with water heaters

6.6.1.2 If necessary, a pressure control valve shall be installed to reduce the incoming water pressure either to the working pressure of a water heater incorporated in the installation or to the maximum permissible pressure allowed in the installation. The pressure control valve shall be situated at a convenient position in the incoming cold water supply pipeline.

6.6.1.3 Wherever water is heated,

a) the energy supply to each heater shall be under effective thermostatic control,

b) the energy supply to each heater shall be fitted with a temperature-operated manually reset energy cut-out that is independent of the thermostatic control, and

c) a means of dissipating the heat input shall be provided in the form of either adequate venting or a temperature and pressure safety valve, except where water is only heated indirectly by a primary circuit which itself is protected in accordance with the requirements given in 6.6.1.3(a) or (b), or when it is heated from a source of heat that is incapable of raising the temperature above 90 °C.

6.6.1.4 If the water contained in any water heater or cylinder is not at all times open to the atmosphere, or if the water heater is not vented, the following shall apply:

a) an expansion control valve shall be installed in the cold water supply pipe to the water heater in a position such that there is no valve between the water heater and the expansion control valve;

b) vacuum relief valves shall be installed on the inlet and outlet side (see SANS 10254) in the following positions, so as to prevent drainage of the water heater and in the case of copper water heaters, also to prevent collapse of the heater:

   1) as close as practicable to the water heater that is to be protected; and

   2) on upstands that are provided in both the cold water feed pipe to, and the hot water feed pipe from, the water heater, and such upstands shall extend at least 300 mm above the top of the water heater, if required by the local authorities and manufacturer's installation instructions, otherwise the height shall comply with the requirements in SANS 10254;

c) the discharge pipe connected to a safety valve shall be of metal and shall be at least the same size as the valve and able to withstand any continuous discharge of hot water or steam at a temperature of up to 125 °C without becoming deformed in any manner; and

d) if any temperature and pressure or temperature-pressure safety valves are installed, they shall be

   1) installed at, or as near to, the top of the water heater as is practicable,

   2) so fitted as to permit ready replacement, and

   3) protected from freezing.

6.6.1.5 The discharge pipes from the safety valve and the expansion relief valve shall not be interconnected.

6.6.1.6 Any temperature and pressure safety valve shall be installed within the top 20 % of water in the container, and preferably not lower than 150 mm from the top of the container. The thermal probe shall be situated in the zone of highest temperature.

6.6.1.7 The heating medium cannot safely control the maximum temperature in a water heater to 60 °C, a tempering valve shall be installed near the water heater in accordance with the manufacturer’s instructions and should the maximum temperature be thermostatically controlled at terminal fittings (i.e. for frail care, people with disabilities and infants) thermostatic mixers shall be installed.

6.6.2 Fixed water heaters

6.6.2.1 Unless a fixed water heater is so designed and installed that the water contained in it is at all times open to the atmosphere, provision shall be made

a) for the safe discharge of water arising from the expansion of the water under normal operation, and

b) for the dissipation of pressure resulting from abnormal operation of the heater.

6.6.2.2 No flow control fitting of any sort other than a draining tap shall be installed direct in the pipeline between any fixed water heater and its associated expansion control valve.

6.6.2.3 Drain pipes shall remain unobstructed and always be open to the atmosphere.

6.6.2.4 In the case of indirect water heating systems,

a) special additives shall, if necessary, be added to the heat transfer medium, to control corrosion, and

b) where pipes are subject to freezing temperatures, an anti-freeze substance shall be added to the heat transfer medium.

6.6.3 Water heaters that use electricity

6.6.3.1 Water heaters that use direct electrical heating shall lbe so controlled as to endeavour to limit the maximum simultaneous electricity demand for large consumers.

NOTE The electricity consumption of the water heater can be scheduled in such a way that the maximum electricity demand assessment before the water heater's contribution is not increased by the heater's demand. The water heater will thus consume electricity only during the individual consumer's off-peak electricity demand periods.

6.6.3.2 An electric water heater shall be provided, as needed, with

a) safety devices in accordance with SANS 151,

b) thermostats in accordance with SANS 181, including a temperature cut-out device.

6.6.4 Water heaters that do not use electricity

6.6.4.1 Gas-fired instantaneous water heaters of the tube type that have an output rating not exceeding 28 kW shall be provided with

a) an automatic gas flow valve controlled by the flow of water to the heater, and

b) a thermostatic water temperature control device, or a temperature-operated energy cut-out device.

NOTE For more information concerning gas water heaters, see annex A.

6.6.4.2 An unvented instantaneous water heater that has an output rating exceeding 8 kW shall be provided with a pressure relief safety valve.

6.6.4.3 Pressurized hot and cold water installations shall be provided with functional control and safety valves in accordance with SANS 198, as appropriate.

6.6.5 Relief valve drain pipes

6.6.5.1 Any relief valve drain pipe

a) shall be of a size not less than the size of the connection to which it is fitted with due consideration to the fact that in runs exceeding 4 m, the size shall be increased,

b) that has three or fewer bends, shall not exceed 9 m in length for each additional bend, and the maximum drain pipe length shall be reduced by 600 mm; all bends shall be formed with a centre-line radius at least five times the diameter of the drain pipe,

c) shall be so installed that

   1) it inclines downwards continuously to its outlet,

   2) drainage of both valve and piping is ensured,

   3) blockage due to freezing or foreign objects is prevented, and

   4) when flow occurs from it, the flow can be readily observed with the minimum risk of injury or damage due to steam or hot water, and

d) that is used for conveyance of water resulting from the normal expansion of heated water shall discharge to the atmosphere in a position where the discharge is readily discernable but shall not inconvenience the building's occupants or cause damage to the building.

6.6.5.2 Drain pipes from individual pressure, temperature or combined pressure-temperature safety valves shall not be combined.

6.6.5.3 Any vent or exhaust pipe from a fixed water heater shall

a) extend on a rising grade from the highest point of the container, without restriction or sharp change in direction between the heater and the outlet, and shall be as short as is practicable,

b) where a cold water feed tank is installed, extend on a rising main to a height of the greater of 300 mm and at least 80 mm above the water level in the cold water feed tank for every 1 m between the overflow water level in the cold water feed tank and the base of the heater. The pipe shall be

   1) turned downwards to pass through the cover of the cold water storage tank, terminating above the level of the water supply inlet and discharge, clear of the level control valve, or

   2) taken outside the building and suitably bent and properly supported or stayed where it projects more than 1 m above the roof,

c) where a pressure reducing valve is installed with a vent pipe relief, extend to a height above the valve equal to the pressure rating of the valve in metres of water plus a minimum of 1 m and a maximum of 2 m; the pipe shall extend on a rising grade to a height above the bottom of the water heater that does not exceed the maximum head of the water heater, and

d) be of sufficient size to relieve the energy input, but in no case be less than the size recommended by the water heater manufacturer, and shall not be less than the size given in column 2 of table 9 for the nominal thread size of the valve outlet connection given in column 1 of table 9, with the provision that, on secondary circuits, the vent pipe required at the highest point of the hot water piping shall also be accepted as providing the pressure relief for the container if it meets the condition set out in 6.6.5.3(a), (b) and (c).

Table 9 — Minimum size of relief drain pipes

Dimensions in millimetres

1	2
Nominal (thread) size of valve outlet connection	**Nominal size of drain pipes**
12	15
20	20
25	25
32	32
40	40

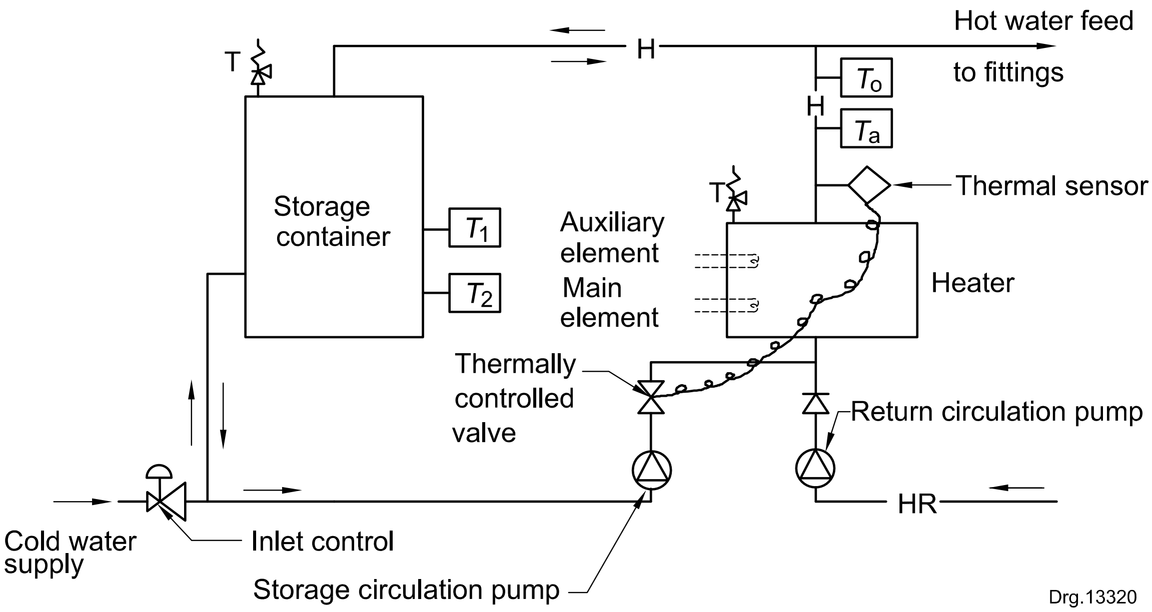
6.6.6 Heater elements

6.6.6.1 The type of heater elements used shall be compatible with the associated type of water heater, and immersion heaters for electric storage water heaters shall comply with the requirements in SANS 514. (See also 5.4.9.)

6.6.6.2 If so required, a system where the heater elements are housed in a separate vessel and not in the hot water storage container shall be provided. A hot water system with a separate heater is shown in figure 8.

NOTE 1 The installation allows hot water to be delivered either direct into the storage container or direct into the hot water supply pipework.

NOTE 2 The separate element system has the advantages of both the wet element and the dry element systems since scale formation on the elements is restricted (their being wet elements), while replacement of the elements is possible without drainage of the storage container.



Key

H	Hot water
HR	Circulated hot water return
T	Temperature and pressure safety relief valve
T_1 and T_2	Thermal sensors that control the operation of the storage circulation pump
T_o and T_a	Thermal sensors that control the operation of the heater elements

NOTE Thermal sensors T_1 and T_2 control the operation of the storage circulation pump. T_o and T_a control the operation of the heater elements.

Figure 8 — Schematic layout of a hot water system with a separate heater

6.7 Pipes

6.7.1 General

6.7.1.1 The pipe network layout for both hot and cold water systems shall be such that length and directional changes are minimized.

6.7.1.2 If necessary, thermosiphonic action that can take place within the pipes shall be controlled by means of a "thermal lock" formed by an in-line U-configuration of the feed pipes.

NOTE 1 It is not economically viable in terms of energy saving to insulate hot water piping that feeds terminal fittings that are used infrequently. Both the pipe and the insulating material have to be reheated each time hot water is run through the cooled pipe.

NOTE 2 In the case of larger size horizontal cold water feed pipes connected to water heaters, thermosiphonic action can take place within the pipe, resulting in hot water moving in an upstream direction on top of the cold water flow. This normally occurs during periods of no hot water or very little hot water demand and this reverse movement cannot be stopped by means of a non-return valve because of the extremely slow flow rates involved. However, it can be controlled by means of a "thermal lock", because cold water, owing to its higher density, fills the bottom of the "U" and cuts off the backflow of hot water.

6.7.2 Prevention of airlocks

6.7.2.1 Unless other suitable measures have been taken to prevent the formation of airlocks in pipes, the following shall apply:

a) pipes of length not exceeding 1 m shall be installed horizontally, or with an upward slope in the direction of flow;

b) pipes of length exceeding 1 m shall be installed with an upward slope of at least 1:100 in the direction of flow; and

c) where pipework cannot be installed in accordance with the requirements of (a) and (b) above, pipes shall be suitably vented at their highest positions.

6.7.2.2 When necessary, appropriate steps shall be taken

a) to avoid the trapping of air during filling,

b) against the formation of airlocks during operation, and

c) to ensure that the pipework layout facilitates the removal of air during filling.

NOTE Trapping of air can be avoided if vent valves are suitably installed in the pipeline These valves may discharge some water and adequate drainage should be provided.

6.7.3 Prevention of noise and water hammer

The layout of any pipework shall be such that noise and water hammer that occur in such pipework are limited to an acceptable minimum.

NOTE 1 Apart from poor design, poor pipe layout and poor installation can also cause unacceptable noise and water hammer.

NOTE 2 Sound is transmitted along metal pipes with very little loss of energy, so noise caused by outlet fittings is often mistakenly diagnosed as pipe flow noise. Plastics pipes appreciably attenuate noise, while rubber-hose-type vibration isolators attenuate noise transmission in metal pipelines.

NOTE 3 Bellows-type vibration isolators or rubber-hose-type vibration isolators can be used to reduce the sound pressure peaks as they travel along pipes. Air vessels should be used to absorb sound pressure peaks at a point close to their formation. (See also 8.6.4.1.)

NOTE 4 Noise caused by thermal movement of pipes consists of creaks, squeaks or one or more impulsive sounds and can be very disturbing. Such sounds can occur a considerable time after the water that causes the movement has been used. Significant thermal movement can occur in hot water pipes as a result of temperature changes. If movements take place smoothly, they do not create noise and the use of resilient pipe clips or brackets, or resilient pads between pipes and fittings, will often introduce sufficient flexibility to take up such movements. Where very long straight runs of pipe are involved, expansion loops or joints might be required.

NOTE 5 Taps can generate noise by the impact of the emergent water stream on the surfaces of an appliance or of a fixture, or on the water already in it. Most disturbance from this type of noise is likely to occur with metal sinks and similar appliances. The use of flow aerators helps to reduce such noise. The undersides of appliances can be treated to minimize vibration and noise transmission and it is good practice to isolate lightweight appliances from lightweight structural elements that could transmit and amplify noise of this kind.

NOTE 6 Cavitation at the seat of terminal fittings is also a major cause of noise, and a reduction in the water pressure and in the flow velocity is necessary to control such cavitation (for example. a float-operated valve will operate less noisily at a reduced flow pressure, while its rate of delivery can be maintained if a seat of larger diameter is fitted).

NOTE 7 Prevention and alleviation of water hammer can be achieved by preventing the sudden closure of valves and by absorbing pressure peaks and increasing the attenuation of sound pressure waves when transmitted through the pipework. A pipe layout that avoids long straight pipe runs to taps and valves should be selected. Solenoid-operated valves that usually incorporate a servo-action to ensure tight closure, and self-closing taps are frequently the cause of noise and water hammer. When fittings of this kind are specified, non-concussive types should be used and they should be properly maintained to ensure continuance of their non-concussive qualities.

NOTE 8 Oscillation of float-operated valves can also cause noise in water installations. Prevention of oscillation is usually simple if the float valve is suitable for the supply pressure and is properly installed and maintained. Oscillation can be prevented by means of a damping plate so fitted to the float or arm that it is immersed in the water in the tank and is oriented to present the greatest resistance to oscillary motion. An alternative procedure is to fit baffle vanes in the tank, to prevent any surface waves from affecting the float.

NOTE 9 A well-designed pump used under the correct conditions should not generate excessive noise. If the static pressure at the pump inlet is insufficient, there is a risk of cavitation and turbulence, which can cause noise and vibration. Noise transmission from pumps and also vibration of the pipes themselves can be reduced by means of rubber-hose-type vibration isolators fitted between the pump and such pipework.

NOTE 10 Lightweight structures are relatively easily set into vibration and readily transmit structure-borne sound. Where pipes have to be fixed to lightweight elements, flexible, vibration-isolating clips or brackets should be used. Where a choice of pipe material exists, the use of relatively flexible pipes of small diameter helps to reduce the transfer of sound energy from the pipework to the structure. Pipework can also be isolated from the building structure by means of resilient inserts in the pipe brackets. In severe cases of transmission of specific tones, a hydraulic-acoustic filter tuned to the unwanted frequency can be used, but specialist advice should be obtained in such circumstances.

NOTE 11 Airborne transmission of flow noise originating in outlet fittings should be reduced by means of sealing off the direct air path wherever possible. Whenever sound radiation from the pipework is a potential problem, pipes should be installed in closed ducts.

6.7.4 Use of different materials

Unless galvanic action is unlikely to occur, or unless effective measures are taken to prevent such deterioration, metal pipes of different materials shall as far as possible not be connected to one another.

NOTE 1 Galvanic action will be reduced when the sequence of metals in relation to the normal direction of flow is galvanized steel (zinc) to uncoated iron to copper.

NOTE 2 A copper supply pipe connected to a galvanized steel storage tank or coated steel storage water heater will result in galvanic action occurring in the tank or heater. The installation of a sacrificial anode in the tank or heater is commonly used to protect it against such galvanic action.

6.7.5 Thermal insulation

6.7.5.1 Pipes, fittings and components shall, when necessary, be protected against freezing. The insulation provided shall be appropriate to the minimum temperatures that can be expected in that geographical area.

NOTE For more information on thermal pipe insulation, see annex G.

6.7.5.2 All exposed pipes to and from the hot water cylinders and central heating systems shall be insulated with pipe insulation material with a thermal resistance (*R*-value) measuring unit ($m^2 \cdot K/W$) in accordance with table 10.

6.7.5.3 Insulation shall

a) be protected against the effects of weather and sunlight,

b) be able to withstand the temperatures within the piping, and

c) achieve the minimum total *R*-value given in table 10.

Table 10 — Minimum *R*-value of pipe insulation

1	2
Internal diameter of pipe mm	**Minimum *R*-value**[a] $m^2 \cdot K/W$
≤ 80 > 80	1,00 1,50
[a] Determined with a hot surface temperature of 60 ºC and an ambient temperature of 15 °C.	

6.7.5.4 Hot water vessels and tanks shall be insulated with a material that achieves a minimum *R*-value of 2.

NOTE To achieve this value, insulation in addition to the manufacturers' installed insulation might be required.

6.7.5.5 Insulation on vessels, tanks and piping containing cooling water shall be protected by a vapour barrier on the outside of the insulation.

6.7.5.6 The piping insulation requirements do not apply to space heating water piping

a) located within the space being heated where the piping is to provide the heating to that space, or

b) encased within a concrete floor slab or in masonry.

Such piping shall comply with this part of SANS 10252.

6.7.5.7 Piping to be insulated includes all flow and return piping, cold water supply piping within 1 m of the connection to the heating or cooling system and pressure relief piping within 1 m of the connection to the heating or cooling system. Where possible lengths of pipe runs shall be minimized.

6.7.5.8 After thermal insulation material has been installed, the outer surface of any insulation material shall be made as smooth as possible, to minimize the exposed surface area. The ingress of moisture into such material shall be prevented.

NOTE Roughness increases the effective surface area of insulation material and consequently, heat losses and moisture increase the thermal conductivity of the material.

6.8 Fire installations and combined installations

6.8.1 General

6.8.1.1 Water pipework shall not be enclosed in the same duct as a pipe containing fuel or gas.

NOTE 1 A fire installation can be either a dedicated fire installation, or combined with a general installation (i.e. combined installation).

NOTE 2 A fire installation in a building is essentially an extension of the reticulation in the street reserve, and is normally necessary to augment the fire brigade's special equipment.

NOTE 3 Water should be used only to extinguish class A fires, i.e. fire loads of wood, textiles and paper and all goods manufactured there from.

NOTE 4 Hose reels in a building are mainly intended for use by the occupants of a building, as a "first-aid" measure at the time of the outbreak of a fire and until such time as the fire brigade arrives.

NOTE 5 Water meters and other fittings in the service pipe can cause considerable pressure loss. Where there is a wide divergence between normal consumption flow rates and the required minimum fire flow rates, combination meters should be fitted.

NOTE 6 Combined installations should only be provided in buildings without booster pumps, unless the domestic draw-off connections are protected with pressure reducing valves since the automatic starting of such pumps is initiated by flow or pressure fluctuations in the fire installation.

6.8.1.2 A fire installation shall be connected to a communication pipe provided by the local authority and located at a position and depth to be determined by such local authority. Such fire installation shall either connect

a) direct to such communication pipe where the local authority's water supply is capable of providing the pressure and rate of flow as given in 7.2.2, or

b) where so required by the local authority or where the local authority's water supply is not capable of providing sufficient pressure and rate of flow, to a storage tank as given in 7.3.2.

NOTE The municipal water is supplied without guarantee of flow pressure, quality or continuance of supply. This needs to be taken into account when deciding on storage capacity.

6.8.1.3 A communication pipe and the water from that pipe are intended only for use in the case of fire and shall be used only for fire-fighting purposes; no connection of any kind shall be made from such communication pipe other than to hydrants, hose reels, or associated storage or pressure tanks.

6.8.1.4 When so required by the local fire service, a fire installation or combined installation shall at all times be kept charged with water.

6.8.1.5 No reflux valve in any installation shall be so positioned as to prevent or hinder the flow of water from any fire-pumping connection to any hose reel or hydrant connected to such installation.

6.8.1.6 Unless written consent is given by the local authority, no extension shall be made to any existing installation after such installation has been connected to the mains.

6.8.1.7 Where so required by the local authority, a pump system, including a tank, shall be installed in a ventilated compartment constructed in such a manner that it has a fire-resistance rating of at least 120 min when tested in accordance with SANS 10177-2. Where such a compartment is so located that access to it does not abut on a street or on a public place or on an open area on the premises,

a) the means of access shall be enclosed by walls that have a fire-resistance rating of at least 120 min, and

b) the access contemplated in (a) above shall not be used as a means of access to any other part of the building.

6.8.2 Hose reels

6.8.2.1 Hose reels shall comply with the requirements in SANS 543.

6.8.2.2 The number and distribution of hose reels and hoses shall be such that the whole of each floor is protected. Allowance shall be made for obstructions due to the design and layout of the building and due to goods being stored on the floor (see also SANS 10105-2).

6.8.2.3 Each hose reel shall be furnished, in close proximity to the inlet of the hose reel, with a shut-off control valve being a stop tap in accordance with SANS 226.

7 Design

7.1 Primary considerations

7.1.1 General

7.1.1.1 An approved competent person shall accept the responsibility for the design of

a) a structure that supports a water heater or storage tank of which the nominal capacity exceeds 300 L, or

b) a slab or a roof structure where a water heater or storage tank of any capacity is suspended from the underside of such slab or roof structure.

NOTE The local council water supply conditions may determine the design of the water system

7.1.1.2 A comprehensive operation and maintenance manual shall be readily available for any installation that incorporates storage tanks and reticulation systems. As-built drawings reflecting the pipe work and equipment installation shall be required. A schematic of the pipe work shall be displayed in the plant room.

For plant room design, cognizance shall be taken of the following requirements;

a) maintenance requirements;

b) repairs to the equipment;

c) installation of the equipment;

d) removal of the equipment;

e) general access to the equipment; and

f) ventilation requirements.

7.1.1.3 If the supply pressure could exceed 600 kPa in any general or combined installation, a pressure reducing or control valve shall be incorporated in the service pipe upstream of the first terminal water fitting, to limit such pressure to a static pressure of a maximum of 600 kPa.

7.1.2 Water supply quality — Human consumption

Conditions unfavourable for the development of the bacterium *Legionaella pneumophila* shall be maintained as far as possible in installations where cold water is stored for drinking purposes, or where hot water could be used for drinking purposes. For this reason,

a) the presence of organic matter in the water as well as the final products of metal corrosion, mainly iron, shall be kept to a minimum,

b) compositions of rubber used shall not form a source of nutrient for the bacterium,

c) storage tanks shall be regularly cleaned and kept free of contamination,

d) stored cold water shall be maintained at a temperature not exceeding 20 °C,

e) in a hot water installation, there shall be no zones where water is stored at temperatures of between 25 °C and 45 °C,

f) the stored hot water shall be maintained at a temperature of at least 55 °C, and

g) the quality of the water shall be such as to comply with SANS 241-1 and SANS 241-2.

NOTE 1 The bacterium *Legionaella pneumophila*, which is now known to cause Legionnaires' disease (legionellosis), has been found in hot water supply and air-conditioning cooling water systems in public buildings and hospitals. When present in a water system, the bacterium causes infection through human inhalation of fine droplets (aerosols) of water containing the bacterium. Aerosols can be generated at showers, sprays and whirlpool baths and spas.

NOTE 2 The possibility of the presence of the bacterium in a supply of water that has been heated to a temperature exceeding 55 °C is greatly reduced.

7.1.3 Water supply quality — Plumbing considerations

7.1.3.1 Treatment of the water shall be considered if the quality of the water supplied is such that it could adversely affect the water installation. Protection against scale formation and against corrosion shall be provided for hot water systems if considered essential.

7.1.3.2 In cases of doubt, a complete water quality analysis shall be undertaken. The more common problems in hot water systems are scale formation, corrosion, biological growth, suspended solid matter or any combination of these. These problems can seriously reduce the heating efficiency of the system or can lead to premature failure of equipment or create a health hazard to the user. While soft water can cause corrosion, hard water (which is less aggressive) can cause scale formation. Corrosion problems increase with an increase in temperature because corrosive gases such as oxygen and carbon dioxide are released while the electron conductivity of the water is increased. The tendency of hard water to deposit scale usually also increases with an increase in temperature. The scale can act as a protective shield against corrosion, but reduces the rate of heat transfer. The hardness and alkalinity of the water will therefore give a rough indication of the scaling or corroding properties of the water.

7.1.3.3 The use of water treatment chemicals for correcting naturally hard water shall be properly used according to the manufacturer’s instructions, as the improper use can cause more serious problems than might have occurred without treatment.

NOTE 1 Fungi, algae, slime or bacterial growth are not usually encountered in a hot water system if the water is heated to above 55 °C.

NOTE 2 Treatment methods to control scale formation are aimed at minimizing calcium carbonate precipitation, this mineral being the least soluble common constituent of water.

NOTE 3 A common method of preventing scale formation is to soften the water by means of an ion exchange process. In the process, calcium and magnesium ions are absorbed from the water in exchange for a chemically equivalent amount of sodium ions that are not scale forming.

NOTE 4 In cases where removal of the hardness from water is particularly difficult, the alkalinity can be removed in an ion exchange process that yields equivalent amounts of chloride.

7.2 Design pressures and flows

7.2.1 General

7.2.1.1 Unless otherwise required,

a) the design static pressure at any terminal fitting other than a fire hose reel or fire hydrant shall not exceed 600 kPa, and

b) the design static pressure at any fire hose reel valve or fire hydrant valve shall not exceed 600kPa.

7.2.1.2 Unless otherwise required (for example fire services), the velocity of the flow of water in any pipe shall not exceed

a) 3,0 m/s for buried pipelines and for pipelines installed above ground where noise is not a critical factor, or

b) 1,5 m/s to 2,5 m/s depending on the nature of the installation and the noise levels allowed.

NOTE Noise that occurs in pipework is caused when pipes vibrate due to the action of water flowing through them. Noise does not usually become significant at a flow velocity of less than 2 m/s and both noise and water hammer can be prevented and alleviated by the restriction of water velocities. A design flow velocity that does not exceed 2 m/s should be used for domestic and institutional installations (see 7.2.1.2(b)).

7.2.2 Fire installations and combined installations

7.2.2.1 A water gauge pressure of at least 300 kPa at the level of the highest protected point shall be maintained when one hose reel is in full operation in any combined installation.

7.2.2.2 A fire installation or combined installation shall

a) be so constructed as to provide

   1) a supply of water sufficient for the effective operation of the number of hose reels and hydrants that can be operated or come into operation simultaneously in any division, and

   2) a flow pressure, at any hose reel or hydrant, of at least 300 kPa and a flow rate of at least

      i) 30 L/min per hose reel, and

      ii) 1 200 L/min per hydrant, and

b) incorporate devices that limit the gauge pressure at any hydrant valve to 600 kPa under full flow conditions.

7.2.2.3 In a combined installation where a fire boosting system is installed (see 7.3.4), all branches to non-fire-related pipework (installations) shall be protected by a pressure control valve.

7.3 Emergency supplies

7.3.1 Capacity of water storage tanks for purposes other than fire-fighting

For the category of premises given in column 1 of table 11, provision shall be made for the storage of water for purposes other than fire-fighting and the volume of water to be stored shall be at least that given in column 2 of table 11.

NOTE 1 In the determination of the storage capacity, account should be taken of the pattern of water usage on the premises, and the likely frequency and duration of breakdown in water supply from the supplying authority.

NOTE 2 The design storage capacity can be derived from the values given in table 1.

Table 11 — Minimum water storage capacity required for premises

1	2
Category of premises	**Minimum storage required**
Boarding schools, children's homes or residential nurseries	4 h to 8 h demand[a]
Commercial premises, including offices and shops	4 h to 8 h demand based on gross floor area [a]
Educational institutions	4 h to 8 h demand for the design population of the building[a]
Hotels, boarding houses, motels and nurses' homes	4 h to 8 h demand per bed space[a]
Hospitals, clinics, nursing homes	24 h demand for every bed the building is designed to accommodate
All other buildings where continuous water supply is required, i.e. hairdressers	4 h demand per day
Multiple storeys that exceed 25 m in height above the lowest ground level abutting on such building	8 h demand per dwelling unit
Old-age homes	8 h demand per capita
[a] Recommended amounts are shown.	

7.3.2 Capacity of water storage tanks for fire-fighting purposes

7.3.2.1 A volume of at least 25 m^3 of water with a pumping system shall be immediately available at all times from a public supply or private reservoir where the building is more than 25 m in height.

7.3.2.2 For a combined installation where provision is made for the storage of water as given in column 1 of table 11, the following shall apply:

a) the storage tank serving the building shall be divided into two self-contained compartments or into two separate tanks;

b) both such compartments shall comply with the requirements of 5.4.6 and 6.5; and

c) the compartments shall be so arranged that each compartment can be shut down for maintenance and cleaning purposes, without causing an interruption in the supply of water to terminal fittings or appliances.

7.3.2.3 Unless otherwise required, a storage tank shall be provided for any building (see figure 9 to figure 13)

a) where a hose reel is installed at a height (or at a height exceeding that) at which the local authority is incapable of maintaining a water supply, from its water supply system, adequate for the effective operation of the hose reel, or

b) incorporating a dedicated fire installation.

7.3.2.4 The storage tank referred to in 7.3.2.3 shall be situated at a level above the highest hose reel or hydrant connected to the installation and shall contain a usable volume of water of

a) at least 4,5 m^3 but not exceeding 9 m^3, reserved for fire-fighting purposes (see figure 13), and

b) in addition to that required in (a), at least 1 m^3 to supply at least one and not more than five water closets in the building (to keep the water from becoming stagnant).

7.3.2.5 Unless otherwise required, a building where a hose reel or hydrant is installed at a height exceeding 25 m above the lowest ground level abutting on the building, or at a height exceeding that at which the local authority is capable of maintaining an adequate water supply from its water supply system and through the equipment of its fire brigade, shall be provided with

a) a high level storage tank in accordance with 7.3.2.3, and

b) a low level storage tank at or below ground level, that shall

   1) have a capacity of at least 25 m^3 that is reserved for fire-fighting purposes,

   2) be supplied by a service pipe that is

      i) of internal diameter at least 20 mm,

      ii) connected to a communication pipe,

      iii) provided with a pressure gauge reading of up to 2 500 kPa,

      iv) controlled at its outlet by a high pressure automatic shut-off valve, and

      v) fitted with a manually operated isolating valve,

   3) be connected to a supplementary service pipe that

      i) is of internal diameter at least 100 mm,

      ii) has a twin fire-pumping connection fitted at its inlet, and

      iii) has an outlet so positioned as to discharge into the top of the tank, and

   4) be provided with an approved gauge, of a type that does not become unreadable with time, to indicate the level of water contained in the tank.

NOTE 1 A sight glass should not be used to indicate the level of water in a tank is not recommended, since it is likely to become obscured by algae.

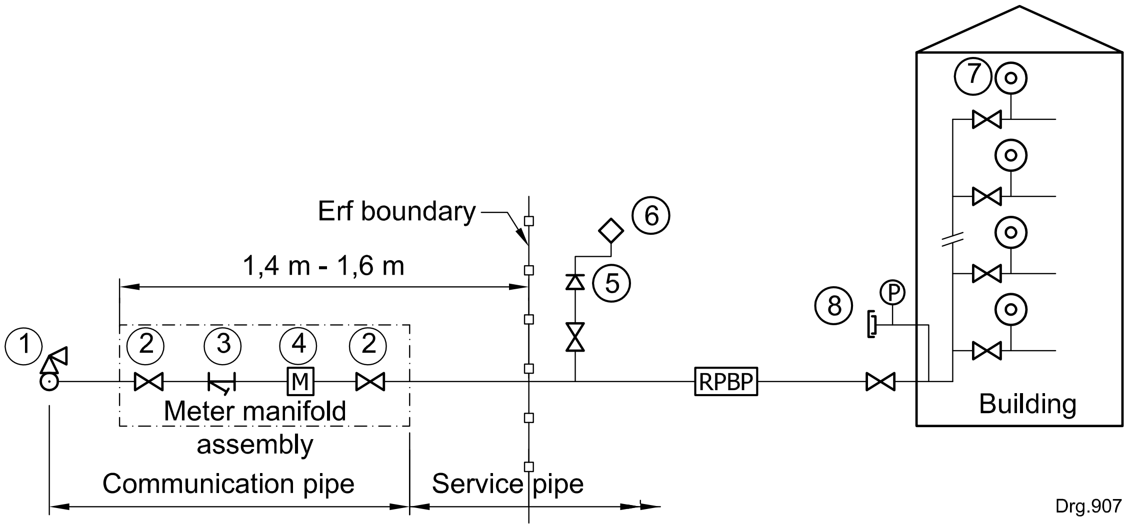
NOTE 2 A combined installation in a building, that incorporates only hose reels installed at a height not exceeding that at which the local authority is capable of maintaining an adequate water supply from its water supply system (booster pump not required) is shown in figure 9.

NOTE 3 A combined installation in a building, that incorporates both hose reels and hydrants installed at a height not exceeding that at which the local authority is capable of maintaining an adequate water supply from its water supply system (booster pump not required) is shown in figure 10.

NOTE 4 A fire installation in a building, that incorporates both hose reels and hydrants installed at a height not exceeding that at which the local authority is capable of maintaining an adequate water supply from its water supply system (booster pump not required) is shown in figure 11.

NOTE 5 A combined installation in a building, that incorporates both hose reels and hydrants installed at a height not exceeding that at which the local authority is capable of maintaining an adequate water supply from its water supply system (booster pump and storage for hose reels required) is shown in figure 12.

NOTE 6 A typical combined installation that incorporates both hose reels and hydrants in a building that exceeds 25 m in height is shown in figure 13.

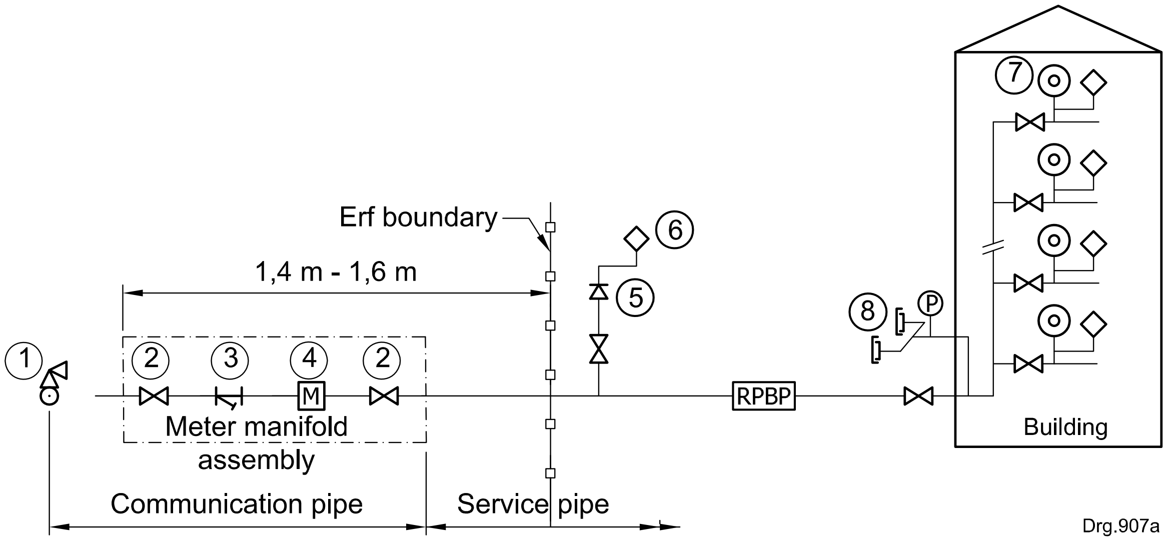


NOTE The relation of the boundary to the meter is in accordance with the local authority.

Key

1 Mains connection
2 Isolation valve
3 Strainer
4 Meter
5 Non-return valve
6 Fire hydrant
7 Fire hose reel
8 Booster connection
P Pressure gauge
RPBP Reduced pressure backflow preventer

Figure 9 — A typical combined installation that incorporates only hose reels in a building less than 25 m high where a booster pump is not required

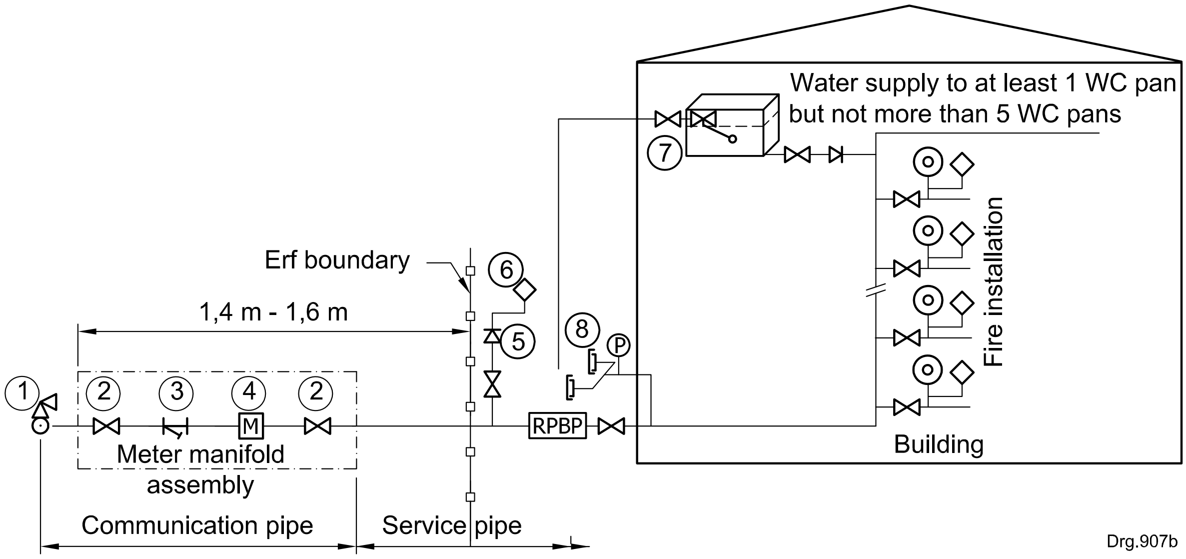


NOTE The relation of the boundary to the meter is in accordance with the local authority.

Key

1 Mains connection
2 Isolation valve
3 Strainer
4 Meter
5 Non-return valve
6 Fire hydrant
7 Fire hose reel
8 Booster connection
P Pressure gauge
RPBP Reduced pressure backflow preventer

Figure 10 — A typical combined installation that incorporates both hose reels and hydrants in a building less than 25 m high where a booster pump is not required

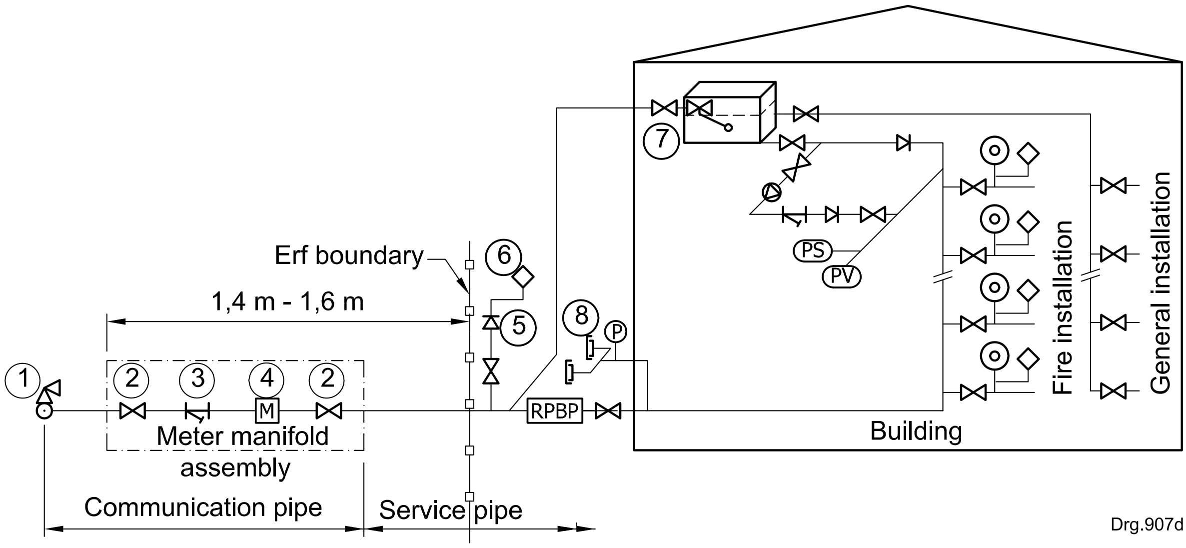


NOTE The relation of the boundary to the meter is in accordance with the local authority.

Key

1 Mains connection
2 Isolation valve
3 Strainer
4 Meter
5 Non-return valve
6 Fire hydrant
7 4,5 m^3 min. storage to be reserved for fire-fighting purposes, plus 1 m^3 min. for general purposes
8 Booster connection
P Pressure gauge
RPBP Reduced pressure backflow preventer

Figure 11 — A typical fire installation that incorporates both hose reels and hydrants in a building less than 25 m high where a booster pump is not required



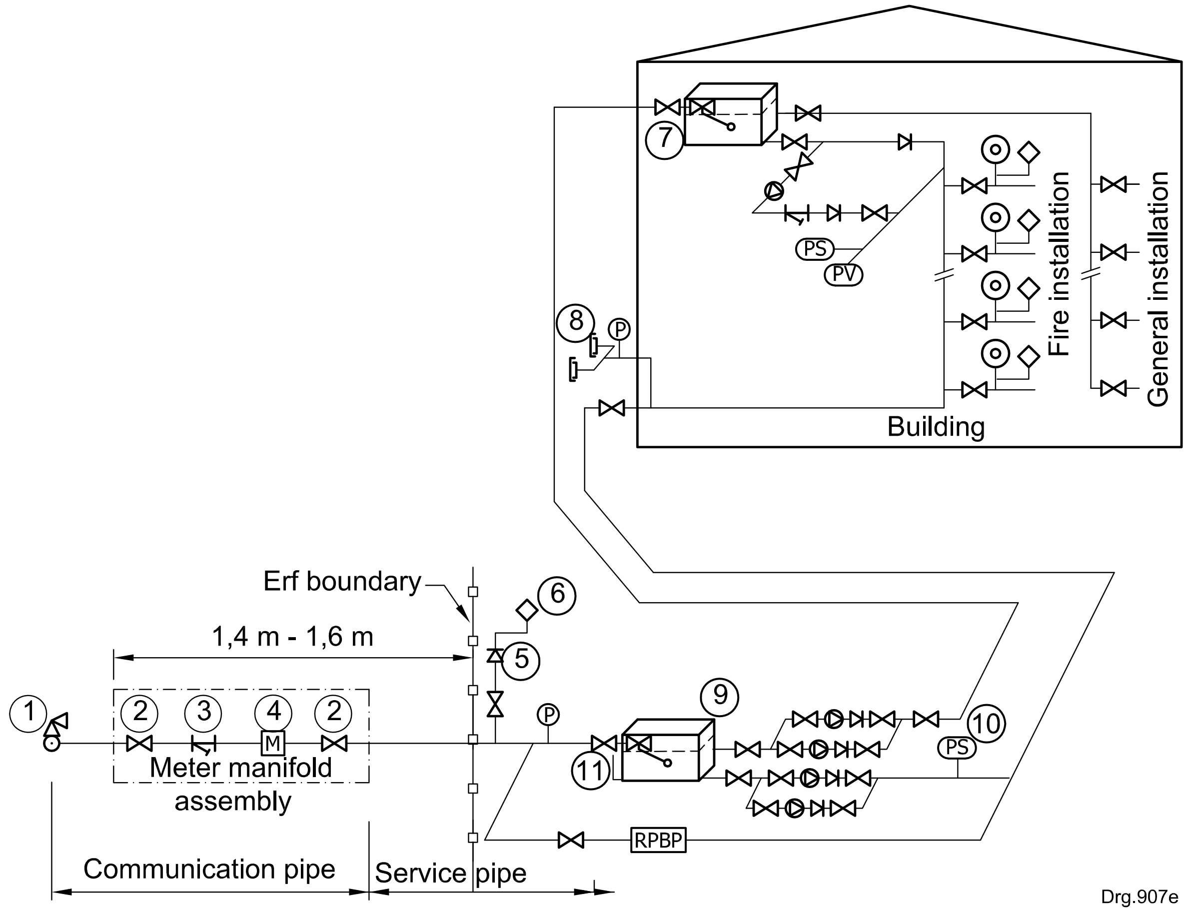
NOTE 1 A booster pump is required to provide a flow of 90 L/min at a flow pressure of 300 kPa at any hose reel when not more than 3 hose reels operate together (and no hydrants are operating).

NOTE 2 The relation of the boundary to the meter is in accordance with the local authority.

Key

1	Mains connection
2	Isolation valve
3	Strainer
4	Meter
5	Non-return valve
6	Fire hydrant
7	4,5 m^3 min. storage to be used reserved for fire-fighting purposes, plus 1 m^3 min. for general purposes
8	Booster connection
P	Pressure gauge
RPBP	Reduced pressure backflow preventor
PS	Pressure switch
PV	Pressure relief valve
M	Meter

Figure 12 — A typical combined installation that incorporates both hose reels and hydrants in a building less than 25 m high where a single booster pump and storage for hose reels are required



NOTE 1 A high level booster pump is required to provide a flow of 90 L/min at a flow pressure of 300 kPa at any hose reel when not more than 3 hose reels operate together (and no hydrants are operating).

NOTE 2 Each of the two interconnected power-driven booster pumps should be capable of providing a flow of at least 1 200 L/min at a pressure of 300 kPa at any hydrant valve operating alone.

NOTE 3 The relation of the boundary to the meter is in accordance with the local authority.

Key

1 Mains connection
2 Isolation valve
3 Strainer
4 Meter
5 Non-return valve
6 Fire hydrant
7 4,5 m^3 min. storage to be reserved for fire-fighting purposes, plus 1 m^3 min. for general purposes
8 Booster connection
9 25 m^3 storage to be reserved for fire-fighting purposes
10 Automatic pressure sensor control for fire pumps and alarm systems
11 Water level indicator

Figure 13 — A typical combined installation that incorporates both hose reels and hydrants in a building that exceeds 25 m in height

7.3.3 Pumping connections

7.3.3.1 Any pumping connection shall be situated in a readily accessible position outside the building at ground level, and shall be mounted on the face of the building in an accessible position.

The position and purpose of any pumping connection shall be suitably indicated.

NOTE The position and purpose of the pumping connection can be indicated by a notice reading as follows:

FIRE BRIGADE INLET
PRESSURE LIMIT 1 015 kPa

7.3.3.2 A water supply pumping connection fitted with a coupling of an approved size and type shall be provided in the pipe serving any storage tank of any hospital, clinic, nursing home, old-age home, or any other building from which the occupants cannot readily be removed in the event of an interruption in the water supply. An approved, non-return valve shall be installed immediately upstream of such pumping connection.

7.3.3.3 Unless otherwise required, the requirements in 7.3.3.4 shall apply to a fire installation or a combined installation in a building of height that exceeds 6 m above the lowest ground level abutting on such building.

7.3.3.4 Any pipe that serves both hose reels and hydrants shall be provided with a twin fire-pumping connection as follows:

a) one pumping connection shall connect direct to the water installation; and

b) the other pumping connection shall connect direct to either

   1) the only storage tank, if there is only one, or

   2) the storage tank situated at ground level, if there is more than one storage tank.

NOTE 1 These pumping connections are intended for the use of the fire brigade, either for the filling of the storage tanks or for fire-fighting purposes, when necessary.

NOTE 2 Any fire installation or combined installation that is provided with a storage tank and booster pump should incorporate a drain-cock between the pump and the reflux valve.

NOTE 3 Because non-return valves cannot be checked for positive water seals once they have been commissioned, they frequently cause low level storage tanks to overfill, and this overfilling is then incorrectly diagnosed as being the result of leaking float valves.

7.3.3.5 Unless a pumping connection discharges direct into a storage tank, any pipe fitted with one or more pumping connections shall be fitted with

a) a pressure gauge reading up to 2 500 kPa installed in the connecting pipe immediately upstream of, and next to, the pumping connection,

b) a reflux valve so located as to shut off the direct supply of water from the local authority's system to such installation automatically, whenever and for so long as any such pumping connection is in use, and

c) a test valve installed immediately upstream of, and next to, the pressure gauge as given in (a) above.

7.3.3.6 Unless otherwise required, an above-ground hydrant shall be provided at a point not more than 60 m from a pumping connection, where the distance between any pumping connection and any fire hydrant connected to the mains exceeds 60 m. In such cases, the following shall apply:

a) the hydrant shall be installed at a point upstream of any backflow prevention device installed in accordance with 6.3; and

b) a non-return valve shall be installed in the branch pipe that serves the fire hydrant, immediately downstream of its point of connection to the mains.

7.3.4 Booster pumps for fire-fighting purposes

7.3.4.1 Any booster pump installation shall be

a) so designed that where stand-by pumps are provided, any pump can be selected for duty at any time,

b) fitted with a suitable pressure gauge on the delivery side of the pump, and

c) at the entrance to the non-fire pipework (installation), fitted with an appropriate pressure reducing valve (see also 7.2.2.3).

NOTE 1 A mimic board or other suitable means of indication should be provided to show the status of pumps, water levels and alarms.

NOTE 2 It might not be necessary to provide booster pumps or storage tanks in buildings that incorporate hose reels at a height not exceeding 25 m above the lowest ground level abutting on the building if the water supply system is of such a standard that adequate flow rate and pressure that complies with 7.2.2 can be obtained at all times.

NOTE 3 For information on pumps, see annex C.

7.3.4.2 Where any installation is provided with a storage tank in accordance with 7.3.2.3, the installation shall be provided with a single power-driven booster pump capable of maintaining a flow rate of at least 90 L/min at a flow pressure of at least 300 kPa at any hose reel, where not more than three hose reels operate together (and no hydrant valves are operating).

7.3.4.3 Where any installation is provided with a storage tank in accordance with 7.3.2.5, such installation shall be provided with at least two interconnected power-driven booster pumps (see 7.3.4.4(c)), individually capable of producing and maintaining the flow rate and pressure as given in 7.2.2, and drawing water from the low level storage tank as given in 7.3.2.5. Each pump shall be connected to a delivery pipe of nominal internal diameter of at least 100 mm, or at least 150 mm in the case of any delivery pipe the height of which exceeds 50 m above such pump.

7.3.4.4 Booster pumps shall be fitted with either an automatic or a manual control starting mechanism that shall comply with the following:

a) an automatic starting mechanism shall be fitted with an automatic override control;

b) an automatic starting mechanism shall start a booster pump automatically as soon as any single fire hydrant or any two hose reels are brought into operation, causing a lowering of the static pressure in the fire installation; and

c) the two interconnected power-driven booster pumps as given in 7.3.4.3 shall be fitted with automatic starting mechanisms. One of the two booster pumps shall be powered by an electric motor and the other by a compression-ignition engine that starts automatically and immediately in the event of failure of the normal electricity supply.

7.3.4.5 If so required, a booster pump unit that is powered by an electric motor shall be connected to a stand-by motor-driven generator that starts automatically in the event of failure of the normal electricity supply to the motor.

7.3.4.6 Any building provided with automatic pump starting mechanisms shall comply with the requirements of the local authority.

7.4 Preservation of water and water quality

7.4.1 General

7.4.1.1 Adequate measures shall be taken to prevent deterioration of the quality of the water in any water installation. Water from an installation shall not be used in any manner that could affect its potability unless adequate measures are taken to prevent deterioration of the quality of the water, such as preventing the enrty of an substance into such an installation that could affect the potablilty of the water or is likely to endanger health, or both.

7.4.1.2 Water shall be stored under conditions that will not adversely affect the quality of the water (for example, storage tanks should be manufactured from material that is fully opaque to light transmission if located where light falls upon it).

7.4.2 Connections

7.4.2.1 No connection shall be made between

a) a general installation conveying water from the supply main and an installation conveying water from any other source of supply,

b) any water installation conveying potable water and any drain or sewer,

c) any water installation pipe and any service pipe upstream from any backflow preventer installed in terms of 7.4.3, and

d) a general installation and any fire installation when they are supplied through separate communication pipes.

7.4.2.2 No connection shall be made to a communication pipe upstream of any water meter.

7.4.2.3 Where a pumping connection is provided,

a) a reduced pressure backflow preventer shall be installed between any such pumping connection and the communication pipe serving the installation, and

b) a non-return valve shall be installed in the outlet pipe between a storage tank and the pumping connection where such pumping connection connects direct to the outlet pipe from such tank.

7.4.3 Prevention of backflow

7.4.3.1 Adequate measures shall be taken to prevent the back-siphonage of water into the following:

a) a communication pipe from any of the following water installations:

1) a fire installation or combined installation;

2) a general installation serving any of the following activities:

   i) medical treatment of people or animals;

   ii) medical, pharmaceutical or chemical research and manufacturing;

   iii) agriculture, including dairies and nurseries;

   iv) laundering and dry-cleaning;

   v) photographic processing;

   vi) metal plating; or

   vii) treatment of hides and skins;

3) a general installation serving any of the following locations:

   i) mortuaries;

   ii) abattoirs;

   iii) sewage purification plants;

   iv) refuse pulverizing works;

   v) harbours;

   vi) oil processing and storage facilities;

   vii) wineries, distilleries, breweries, yeast and soft drink factories;

   viii) sports fields; or

   ix) any other premises on which an activity is carried out that can affect the potability of water; and

b) an installation, in all cases where

1) the design of terminal fittings installed (including any hose bibcocks, laboratory taps or movable shower units) is such that a hose or any other flexible pipe can be attached to the fittings,

2) fire hose reels are installed in a combined installation,

3) an underground irrigation system can provide contact between polluted water and water within the installation, or

4) any other fittings can provide contact between polluted water and water within the installation.

NOTE Backflow can be caused by the following:

a) the development of negative pressure or the lack of pressure in a water supply system (i.e. when a main is drained for maintenance operations, or when fire-fighting is in progress nearby, or because of a burst water main); or

b) the downstream pressure exceeding that of the supply. (This is for example possible in an installation such as a heating system, an elevated tank, and a pressure producing system such as a boiler. In the case of a fire installation, non-potable water carried in a fire tender can be introduced into the installation via a pumping connection.)

7.4.3.2 To prevent the possibility of backflow of water in any of the water installations as given in 7.4.3.1, or in any other case where such a possibility exists, and unless other approved measures have been taken,

a) a storage tank shall be installed such that

1) the entry of water into the storage tank is solely from a pipe that discharges at a height, above the flood level rim of the tank, of the greater of at least 75 mm and twice the nominal diameter of such pipe, and

2) water required for any activity that can pollute the water supply is withdrawn only from the outlet of such storage tank, or

b) appropriate backflow prevention measures shall be selected from those listed in column 1 of table 12, for the degree of the potential hazard contemplated in column 2 of table 12.

Table 12 — Backflow prevention measures

1	2
Type of measure	**Application**
Reduced pressure backflow preventer	Where the possibility exists of contamination of the water supply by a substance that is hazardous to health.
Double check backflow preventer	Where potential pollutants are not toxic but could affect the taste or appearance of the potable water.

7.4.3.3 Unless other approved measures are taken to prevent the backflow of water from terminal water fittings that discharge water into a sink, wash-hand basin, bath or other similar appliance,

a) such terminal water fittings shall be so installed that the vertical distance between the point of discharge of the fitting and the spill-over level of the receiving appliance is at least equal to the distance given in table 13 for the size of the fitting concerned,

b) a double check valve shall be incorporated as close as is practicable to the point of discharge, or

c) a combined check valve and vacuum breaker shall be so installed that the vacuum breaker is at least 300 mm above the spill-over level of the receiving appliance.

Table 13 — Air gap at taps or similar terminal fittings

Dimensions in millimetres

1	2
Nominal size of tap or terminal water fitting	**Vertical distance between tap outlet and spill-over level of receiving appliance**
< 12	20
> 12 and < 20	25
> 20	The greater of 70 or twice the nominal size of the tap or fitting

7.4.3.4 Unless other approved measures are taken to prevent the backflow of water from any terminal water fitting (other than those given in 6.3.3.1) that can provide contact between polluted water and water within the installation,

a) a vacuum breaker shall be installed at the highest point of an upstand, at least 300 mm above the point of discharge of the highest terminal water fitting concerned,

b) a terminal vacuum breaker shall be so installed that it is situated at least 300 mm above the highest point of connection of any pipe to a riser serving the terminal water fitting concerned, or

c) a single check valve or vacuum breaker shall be installed next to any terminal water fitting unless such a terminal fitting incorporates a single check valve or vacuum breaker.

7.5 Hot water generation and distribution

NOTE 1 An appropriate method for a cost-benefit analysis would be to consider the net present value determined from a discounted cash flow analysis. Benefits that occur over the estimated lifetime of the equipment are thus related back to the first capital investment.

NOTE 2 Apart from other considerations, a detailed cost-benefit analysis should be carried out, when appropriate, in order to select the most suitable hot water generating plant and distribution system. All relevant factors should be considered, including the following:

a) the hot water demand, usage patterns and usage requirements;

b) the layout of the hot water installation;

c) available heat sources, and energy operating costs; and

d) capital expenditure, maintenance and long-term running costs.

7.5.1 Hot water storage type systems

7.5.1.1 General

The total hot water storage capacity in storage type systems shall allow for the effective "loss" of hot water storage capacity within the container as a result of the mixing of hot water with the incoming cold water. In the absence of reliable data, an allowance of 10 % to 25 % shall be made for the mixing of hot and incoming cold water.

Figure 14 shows the piping that contains hot water that can be considered part of the bulk storage.

NOTE In pumped hot water circulation installations, or those in which the water is kept hot by means of trace heating, a portion of the hot water in the piping can be considered to be in storage, thereby reducing the required bulk storage capacity and the recovery rate of the water heater.

7.5.1.2 Hot water storage capacity

The required hot water storage capacity shall be determined from the relationship that exists between hot water demand and the rate of heat recovery of the stored water.

7.5.1.3 Net heater power

In the absence of other suitable information, the net heater power required to heat a volume of water shall be determined using the following equation:

$$P = R \cdot C \cdot \Delta T \qquad (5)$$

where

P is the net heater power rating, in kilowatts (kW);

R is the replenishment rate at which water has to be heated, in litres per second (L/s);

C is the specific heat of the water (4,2 kJ/L·°C);

ΔT is the difference between the temperatures of the incoming cold water and the hot water to be delivered, in degrees Celsius (°C).

NOTE The efficiency of a properly insulated electric water heater usually exceeds 90 %.

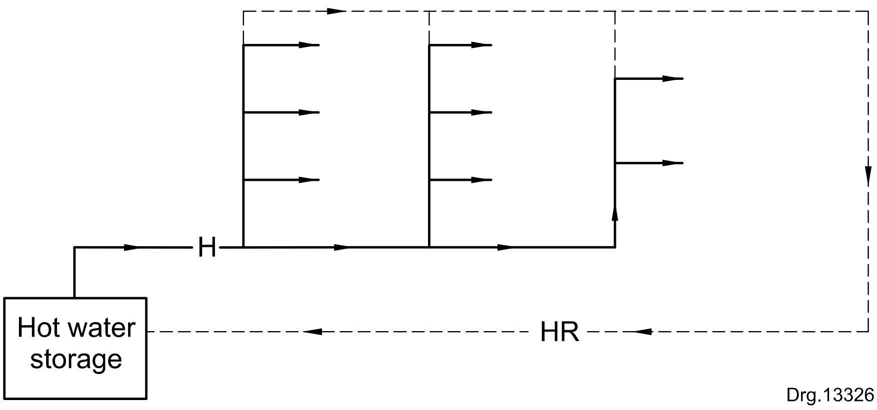


Figure 14 — Hot water piping (shown solid) that contains hot water considered to be part of the hot water bulk storage

7.5.1.4 Hot water temperatures

7.5.1.4.1 Minimum supply temperature

Unless otherwise required, the temperature of hot water available

a) at domestic fixtures such as baths, basins and showers shall be at least 38 °C, and

b) at sinks, shall be at least 45 °C (in order to melt fats).

7.5.1.4.2 Maximum supply temperature

Unless otherwise required, the temperature of water that discharges from any terminal water fitting supplied from a hot water installation shall not exceed 55 °C.

7.5.2 Instantaneous hot water generation plant

7.5.2.1 Unless otherwise approved, the net heater power rating for an instantaneous water heater shall be determined using the following equation:

$$P = \frac{F \times C \times \Delta T}{\eta} \qquad (6)$$

where

P is the net heater power rating, in kilowatts (kW);

F is the flow rate, in litres per second (L/s);

C is the specific heat of the water (4,2 kJ/L °C);

ΔT is the difference between the temperatures of the incoming cold water and the hot water to be delivered, in degrees Celsius (°C);

η is the percentage of heater efficiency.

NOTE 1 The net heater power rating is dependent on the flow rate through the heater.

NOTE 2 The value of the heater efficiency should be obtained from the manufacturer. It is generally 0,75 for gas-fired instantaneous water heaters.

7.5.2.2 In most cases, the instantaneous water heating process is triggered by a differential pressure switch and an orifice restrictor. This causes higher down stream hot water flow pressure drops than storage water heaters. Therefore pipe design, pipe sizing and simultaneous use of terminal fittings shall be carefully considered and calculated to ensure sufficient hot water and balanced hot and cold water pressure at terminal fittings.

7.5.3 Solar heated hot water storage type systems

7.5.3.1 Unless otherwise required, the energy input required for a solar water heater shall be calculated using the following equation:

$$H = \frac{V \times C \times \Delta T}{\eta} \qquad (7)$$

where

H is the solar energy required, in kilojoules per day (kJ/d);

V is the hot water demand, in litres per day (L/d);

C is the specific heat of the water (4,2 kJ/L °C);

ΔT is the required temperature rise of the water, in degrees Celsius (°C);

η is the percentage efficiency of the absorber (see table E.1).

7.5.3.2 In order to get the energy input as given in 7.5.3.1, the solar absorber shall, unless otherwise required, be of size at least equal to the area calculated using the following equation:

$$A = H/S \qquad (8)$$

where

A is the absorber area, in square metres (m^2);

H is the solar energy required, in kilojoules per day (kJ/d);

S is the mean available solar irradiance, in kilojoules per square metre per day ($kJ/m^2/d$).

7.5.3.3 The minimum storage capacity of a container in any solar hot water system shall, unless otherwise required, be as follows:

a) if no supplementary energy source is provided, a storage capacity of 20 % in excess of the daily hot water demand under winter conditions; and

b) if a supplementary energy source is provided,

1) for an integral solar heater system, a storage capacity of at least 100 % of the daily hot water demand under summer conditions, and

2) for an integral solar heater and supplementary storage container system, a storage capacity of

i) in the case of the solar container, at least 25 % of the daily hot water demand under summer conditions, and

ii) in the case of the supplementary container, at least 75 % of the daily hot water demand under summer conditions.

7.6 Pipe sizing

7.6.1 General

7.6.1.1 Pipework shall be so sized that the noise and water hammer that occur in such pipework are limited to a reasonable minimum. (See 6.7.3 and 7.2.1.2.)

NOTE There is more than one correct method for sizing pipework.

7.6.1.2 Unless pipe sizes are specified by reference to another similar installation, or unless otherwise approved, the general approach given in 7.6.1.3 to 7.6.1.12 shall be followed in order to size installation pipework.

7.6.1.3 Prepare the pipework diagram, and identify

a) the type of piping (pipe materials) to be used, and

b) the types and positions of terminal fittings.

NOTE 1 Since the internal diameter of pipes and fittings manufactured from different materials can differ from each other, the substitution of one pipe material of a particular nominal diameter for another pipe material of a similar nominal diameter can result in greatly differing flow rates in the installation.

NOTE 2 Using the term "nominal diameter" without stating the particular material can be misleading, since the nominal size of galvanized steel pipes refers to the inside diameter while that of plastics and copper pipes refers to the outside diameter. The bore sizes of copper, stainless steel and plastics pipes that have the same nominal diameter can also differ substantially because of greatly differing wall thicknesses. It is therefore essential not only to state the pipe diameters (nominal or actual), but also the pipe materials and pressure classes of pipes and fittings to be used.

7.6.1.4 Number each junction in the pipework diagram consecutively, starting from the main or cistern, in order to identify junctions and pipes.

7.6.1.5 Calculate the design static pressure available at each pipe junction and terminal water fitting by adding or deducting the drop or rise respectively, from a point where the available residual head is known.

7.6.1.6 Determine the minimum flow rate and residual head required at all terminal fittings or appliances, and for every pipe at the point of supply to any such fittings or appliances.

NOTE 1 Because of the widely divergent rates of flow obtainable with different types and makes of fittings, a particular fitting (which is to be flow-controlled) should be specified to ensure that all points will receive a sufficient flow of water without parts of the installation being starved of water.

NOTE 2 The choice of terminal water fittings can also have an influence on required storage volumes (for example, water economy taps and showerheads can produce a total saving in water consumption of up to one-third).

NOTE 3 See annex H for examples of calculations concerning pipe sizing.

7.6.1.7 Determine the loss of head through fittings and appliances in accordance with 7.6.2.4, or express such losses as an equivalent length of pipe by making reference to

a) the manufacturers' literature, or

b) tables 14 and 15, or

c) other suitable literature (such as design codes and plumbing reference material).

7.6.1.8 Add such equivalent lengths to the actual pipe length, keeping in mind that the losses given in table 14 through tees shall be assumed to occur at changes of direction only. Losses through fully open gate valves may be ignored. Where galvanized steel pipes are used for small installations such as those in dwelling houses, the calculations for pipe sizing shall be based on the data given in table 14. For larger installations, data relating specifically to galvanized steel shall be used.

7.6.1.9 Select the pipe sizes.

NOTE Final pipe sizes will be selected on the basis of an informed final rational estimation.

7.6.1.10 Take the loss of head through draw-off or delivery valves into account when the diameter of a pipe to supply such individual fittings is determined.

Table 14 — Loss of head through elbows, bends and tees, expressed as equivalent pipe length

1	2	3	4
Nominal bore of fitting mm	**Equivalent pipe length** m		
	Copper[a], stainless steel and plastics		
	Elbow	**Bend**	**Tee**
15	0,5	0,4	1,2
20	0,8	0,5	1,4
25	1,0	0,6	1,8
32	1,4	0,75	2,3
40	1,7	1,0	2,7
50	2,3	1,2	3,5
65	3,0	1,5	4,5
75	3,4	1,9	5,8
100	4,5	2,7	8,0
150	7,2	4,0	15,0

[a] Smooth bore.

Table 15 — Loss of head through draw-off taps[a], expressed as equivalent pipe length

1	2	3
Nominal size of bib tap or pillar tap mm	**Typical maximum discharge rate with tap fully open** L/s	**Equivalent pipe length[b]** m
15	0,20	4
20	0,30	12
25	0,60	22

[a] Head losses can vary with taps of different manufacture.
[b] For copper, plastics and stainless steel pipes.

7.6.1.11 The loss of head through draw-off taps is given in table 16.

NOTE 1 Some draw-off taps have a loss of head much higher than the losses given in the table (for example, a single tap hole mixer with a 2 mm × 8 mm connection).

NOTE 2 Where it is impracticable to forecast in detail the numbers and types of pipe fittings to be used, an approximation can be made by adding an equivalent length of pipe, as a percentage of the actual length, to cover all head losses in pipe fittings. The percentage added can vary between 10 % and 40 %, depending on the complexity of the pipe layout.

NOTE 3 In major hot water distribution systems, special fittings with significant head losses are often used. For information on these, reference should be made to the manufacturers' literature.

Table 16 — Loss of head through draw-off taps

1	2	3	4	5	6
Discharge rate L/s	**Loss of head** m				
	Size of bib tap			**Size of pillar tap**	
	15 mm	**20 mm**	**25 mm**	**15 mm**	**20 mm**
0,075	0,2			0,24	
0,12	0,4			0,4	
0,15	0,5	0,2		0,5	0,24
0,20	0,8	0,35		0,7	0,3
0,22	1,1	0,45		0,8	0,4
0,30	1,8	0,8	0,45		0,5
0,35		1,1	0,70		0,7
0,47		1,4	0,9		
0,55			1,2		
0,60			1,5		

7.6.1.12 Select the initial pipe sizes which would be finally established by rational estimation by making reference to 7.6.2, or any other suitable method, calculate the residual pressure at every terminal water fitting or appliance, starting with the point of supply or alternatively, the point where it is anticipated that the residual pressure will be critical.

7.6.1.13 Check the calculated residual pressures against those required to obtain the desired flow rate. If the calculated residual head is less than the head required for a particular fitting, or if the head is negative, select a larger pipe and recalculate the residual pressure.

NOTE 1 The rate of flow through a pipe depends upon the length and bore diameter of the pipe, the roughness of the internal surface of the pipe, and the pressure drop (loss of head) along the pipe.

NOTE 2 The use of in-line flow restrictors or flow controllers should be considered where the available residual pressure can result in an excessive draw-off at a fitting that could starve other areas where the available (residual) pressure is critical.

7.6.2 Friction loss formulae

7.6.2.1 An appropriate roughness factor, *K*, for pipes shall be determined by making reference to either

a) table 17, or

b) any other suitable literature (such as the manufacturer's literature, design codes and plumbing reference material).

NOTE Exponential formulae are often used in assessing the friction and transmission losses in a pipe network however, the best of them are only reasonably accurate, and then only in certain flow regimes. Of the various formulae, the D'Arcy-Weissbach and Colebrook-White formulae are fundamentally more accurate, since they are applicable over the whole range of conditions normally found within water distribution networks.

Table 17 — Roughness values for factor *K*

1	2	3
Material classification	**factor *K*** mm	
	New	**Deteriorated**
Drawn non-ferrous metallic and non-metallic smooth-walled pipes	0,003	0,060
Fibre cement	0,030	1,000
Galvanized mild steel	0,060	0,300

7.6.2.2 If appropriate, a growth factor shall be determined and the roughness factor *K*, adjusted, using the following equation:

$$K = K_o + \alpha \cdot t \quad (9)$$

where

K_o is the original roughness factor, in millimetres (mm);

α is the growth factor, in millimetres per year (mm/year);

t is the expected deterioration period of the component, in years.

Wherever possible, the growth rate shall be derived from the records of existing mains carrying the same type of water. In the absence of other suitable data, the following values shall be used for design purposes:

a) for fibre-cement pipes: α = 0,015 mm/year;

b) for plastics pipes: α = 0,001 mm/year; and

c) for galvanized steel: α = 0,002 mm/year.

NOTE 1 The carrying capacity of pipes usually diminishes with time because of the formation of tubercles, scale or slime on the inside walls. Furthermore, the interaction between the water and the pipe wall can result in corrosion of steel pipes and the development of tubercles that could partially block the pipe. Scale and slime formation are due to the precipitation (onto the wall of the pipe) of chemicals dissolved in the water where anaerobic bacteria can be active and help to promote corrosion. The type of phenomenon causing reduction in the carrying capacity of a pipe can thus be affected by the material of the pipe, its manufacturing process, the efficiency of protective coatings (for example, bitumen, epoxies, glass fibres and concrete), the chemical and biochemical characteristics of the water and the velocity of flow in the pipe.

NOTE 2 The precipitation potential of water can be derived from indices such as the Langelier Saturation Index and the Ryzner Stability Index. In the absence of other evidence, these indices could be used to estimate the growth rate α.

NOTE 3 Colebrook and White reported that the growth rate of scale formation or tuberculation under a given set of conditions is constant and although the growth rate formula suggests an unlimited increase in roughness, a practical upper limit occurs after 20 years to 30 years.

7.6.2.3 The head loss for steady-state turbulent flow along a rough pipe shall be calculated using the following equations:

$$h_f = \frac{\lambda \cdot L \cdot V^2}{2g \cdot \Delta} \tag{10}$$

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left[\frac{K}{3{,}75D} + \frac{2{,}51}{Re\sqrt{\lambda}} \right] \tag{11}$$

which at 25 °C becomes

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left[\frac{K}{3{,}75D} + \frac{2{,}247 \cdot 10^6 D}{Q\sqrt{\lambda}} \right] \tag{12}$$

where

h_f is the head loss, in metres (m);

λ is the D'Arcy-Weissbach friction factor;

L is the pipe length, in metres (m);

V is the mean flow velocity, in metres per second (m/s);

g is the acceleration due to gravity (taken as 9,8 m/s^2);

D is the diameter of the pipe, in metres (m);

K is the roughness, in metres (m);

Re is the Reynolds number which is = $\frac{VD}{\gamma}$;

Q is the volume flow, in cubic metres per second (m^3/s);

γ is the kinematic viscosity, in square metres per second (m^2/s).

NOTE 1 The friction factor, λ, varies with the viscosity of the fluid, the roughness of pipe walls, the diameter of the pipe and the velocity of flow.

NOTE 2 Equation (11), known as the Colebrook-White formula, is used to calculate the D'Arcy-Weissbach friction factor, λ, for the entire turbulent flow range (Reynolds number > 4 000).

NOTE 3 The kinematic viscosity, γ, for water depends on the temperature as follows: at 0 °C, γ = $1{,}79 \cdot 10^{-6}$ m^2/s; at 20 °C, γ = $1{,}01 \cdot 10^{-6}$ m^2/s; at 40 °C, γ = $0{,}66 \cdot 10^{-6}$ m^2/s.

NOTE 4 Friction loss and flow rate velocity curves for pipes of different materials are given in annex I. While the curves show the range of diameters listed in the standards, it should be ascertained which diameters are obtainable from manufacturers.

NOTE 5 Friction loss factors for Laminar flow are of no practical importance and have been omitted in the equations given in 7.6.2.3.

7.6.2.4 When necessary (see 7.6.2.5), the secondary energy losses shall be calculated using the following equation:

$$h_1 = k \cdot \frac{V^2}{2g}$$

where

h_1 is the secondary loss, in metres (m);

k is an empirical pressure loss coefficient;

V is the mean flow velocity, in metres per second (m/s);

g is the acceleration due to gravity (taken as 9,8 m/s^2).

Values of *k* shall be obtained by making reference to the manufacturers' literature, or to table 18, keeping in mind that since the values of *k*, for reflux valves, can vary considerably depending on the type of valve and whether the valve is installed horizontally or vertically, such values shall be obtained from the manufacturers.

NOTE 1 Secondary (or transition) losses occur with changes in direction, or with changes in the magnitude of the flow (when energy is expanded to maintain the resultant eddy flow), or both. While friction losses in long pipelines are usually far greater than secondary losses, the situation is often reversed in short, smaller diameter pipelines with several fittings. Secondary losses should therefore always be considered in water installations in buildings.

NOTE 2 Friction losses are usually expressed as a function of kinetic energy head.

7.6.2.5 If necessary, determine the total head loss for a pipe by adding the secondary losses and the friction losses.

Table 18 — Pressure loss coefficient *k*

1	2
Type of fitting	***k***
Entry losses (tanks):	
Sharp-edged entrance	0,50
Re-entrant entrance	0,80
Slightly rounded entrance	2,25
Bell-mouthed entrance	0,05
Foot valve and strainer	2,50
Exit losses (tanks):	
Sudden enlargement	1,00
Bell-mouthed outlet	0,20
Intermediate losses (pipe fittings):	
Elbows (R/D = 0,5 approx.)	
22,5°	0,20
44°	0,40
90°	1,00
Close radius bends (R/D = 1 approx.)	
22,5°	0,15
44°	0,30
90°	0,75
Long radius bends (R/D = 2 to 7)	
22,5°	0,10
44°	0,20
90°	0,40
Sweeps (R/D = 8 to 50)	
22,5°	0,05
44°	0,10
90°	0,20
Mitre elbows	
22,5° – 2 piece	0,15
30° – 2 piece	0,20
45° – 2 or 3 piece	0,30
60° – 2 piece	0,65
60° – 3 piece	0,25
90° – 2 piece	1,25
90° – 3 piece	0,50
90° – 4 piece	0,30
Tees:	
Flows in line	0,35
Line to branch or branch to line:	
Sharp-edged	1,20
Radiused	0,80
R/D = radius/diameter	

Table 18 (*concluded*)

1	2
Type of fitting	***k***
Angle branches:	
Flow in line	0,35
Line to branch or branch to line:	
30°	0,40
45°	0,60
90°	0,80
Sudden enlargements[a]:	
Ratio of inlet diameter to outlet diameter:	
4:5	0,15
3:4	0,20
2:3	0,35
1:2	0,60
1:3	0,80
1:5 and over	1,00
Sudden contractions[a]:	
Ratio of inlet diameter to outlet diameter:	
5:4	0,15
4:3	0,20
3:2	0,30
2:1	0,35
3:1	0,45
5:1 and over	0,50
Tapers[a]	
Flow to large end negligible	
Ratio of inlet diameter to outlet diameter:	
4:5	0,30
3:4	0,40
1:2	0,12
Valves	
Gate valves:	
Fully open	0,12
Quarter closed	1,00
Half closed	6,00
Three-quarters closed	24,00
Ball valve	10,00
Globe valve	10,00
Right angle valve	5,00
Reflux valve	1,00
Butterfly valve	0,30
Stopcock	10,00
R/D = radius/diameter	
[a] Values for enlargements, contractions and tapers apply to smaller diameter.	

7.7 Hot water piping

7.7.1 General

7.7.1.1 The hot water demand for the building shall be determined in accordance with 4.2.3.

7.7.1.2 With regard to the hot water supply pipe, the following shall be determined:

a) the lengths; and

b) the sizes in accordance with the demand from the fixtures to be served, and in accordance with 7.6.

7.7.1.3 Unless otherwise stated, the length of an unheated pipe (dead leg) conveying water direct from a fixed water heater to a terminal water fitting, or from the point of take-off from a hot water circulating system to a terminal water fitting, shall be such that the internal volume of that pipe does not exceed 4 L. The internal volume of pipes and permissible lengths in terms of the 4 L volume limit are given in table 19 and recommended limits are given in table 20.

NOTE The objective is to provide hot water at the locations, in the quantities and at the temperatures required by the user, in the most economical way.

Table 19 — Internal volume of pipes

1	2	3	4
Type of pipe	**Nominal diameter** mm	**Internal volume** L/m	**Length of pipe containing 4 L of water** m
Galvanized mild steel (medium)	15 20 25 32	0,196 0,356 0,581 1,012	20,4 11,2 6,9 4,0
Copper (class O)	15 22 28 35 42 54	0,150 0,330 0,547 0,835 1,232 2,091	26,7 12,1 7,3 4,8 3,2 1,9
NOTE Apart from the volume limit, more than just the internal volume of the pipe might have to be run to waste before water of sufficient temperature emerges from the tap, since the hot water has to heat up the pipe. For example, a tap in a wash basin supplied by a 15 mm diameter galvanized mild steel pipe 12 m in length and discharging at a rate of 6 L/min, would have to run for 1 min to 2 min before the temperature of the water entering the basin is adequately hot. Thus, the volume of water run to waste would be 6 L to 12 L, whereas the actual internal volume of the pipe is only 2,4 L. The designer should therefore attempt to ensure that where practicable, the lengths of such pipes are well below those given in column 4 of this table.			

Table 20 — Recommended maximum lengths of dead-leg piping from a storage heater, or from the point of take-off from a hot water circulation system to a terminal water fitting

1	2
Internal diameter of pipe mm	**Maximum length of pipe** m
≤ 19 > 19 and ≤ 24 > 24	12 8 3

7.7.1.4 Unless otherwise required, the temperature drop from the storage water heater or other heating equipment to the branch serving the furthest terminal fitting shall be restricted to not more than 8 °C.

7.7.1.5 Insulation material of an appropriate type and thickness shall be selected in accordance with 5.1.9 and the rate of heat loss in the system shall be determined in accordance with 7.7.2, or by reference to any other suitable method.

7.7.1.6 If the temperature of the hot water discharged at any terminal fitting is not adequate, one or any combination of the following steps shall be carried out:

a) adjust pipe sizes in accordance with 7.6;

b) re-select insulation materials; and

c) take other appropriate measures (for example, trace heating, recirculation flow and return systems).

NOTE When appropriate, such as in the case of larger hot water installations, undertake a cost/benefit analysis to identify the most appropriate steps to take.

7.7.1.7 For hot water circulation systems

a) the piping that begins at the heating equipment and ends at the branch serving the last fixture shall be regarded as the supply piping, and the piping from this branch back to the heating equipment shall be regarded as the return piping,

b) insulation material of an appropriate type and thickness shall be selected in accordance with 6.7.5, and the rate of heat loss on the supply and return side of the system shall be determined in accordance with 7.7.2, or by reference to any other suitable method,

c) the piping shall be sized in accordance with 7.7.3, or by reference to any other suitable method, and

d) the heating equipment shall be sized, taking into account all the heat losses in the supply piping, the heating equipment and the return piping.

NOTE 1 Water is only drawn from the supply piping and the only purpose of the return piping is to complete the loop to allow for circulation.

NOTE 2 The supply side of a hot water circulation system will be maintained at an acceptable temperature as long as a sufficient amount of hot water is circulated.

NOTE 3 Heating equipment can include elements such as, secondary elements, heat pumps and trace heating.

NOTE 4 Extensive heat losses can occur in a thermosiphonic circulation system and designs using this type of principle often require return piping of large diameter, resulting in high and costly thermal losses, especially with long pipe runs. A disadvantage of this system is that it cannot be shut off when circulation is not required.

NOTE 5 In the forced-flow hot water circulation system, a centrifugal pump is used to create circulation, using smaller diameter piping to avoid large thermal losses on the return piping. The pressure induced by the pump is comparatively high so that the pressure loss due to the decrease of water temperature can be ignored.

7.7.2 Calculation of heat losses

Heat lossed shall be calculated using the following equations:

a) For heat losses from flat, or nearly flat, surfaces:

$$q = \frac{T_1 - T_m}{h/k + 1/f} \qquad (14)$$

b) For heat losses from cylindrical surfaces (pipes):

$$q = \frac{T_1 - T_m}{\left[\frac{d_o}{2k}\right] Log_e \left[\frac{d_1}{d_o}\right] + \left[\frac{d_o}{fd_1}\right]} \qquad (15)$$

$$q_1 = \pi \cdot d_o \cdot q \qquad (16)$$

where

q is the rate of heat loss per unit area of hot surface, in watts per square metre (W/m^2);

T_1 is the temperature inside the container or pipe, in degrees Celsius (°C);

T_m is the ambient temperature, in degrees Celsius (°C);

h is the thickness of the insulation material, in metres (m);

k is the thermal conductivity of the insulation material, in watts per metre per degree Celsius (W/m/°C);

f is the heat transfer coefficient per unit area of external insulation surface, in watts per square metre per degree Celsius($W/m^2/°C$);

d_o is the external diameter of the pipe, in metres (m);

d_1 is the external diameter of the insulation, in metres (m);

q_1 is the rate of heat loss through the insulation per unit length of pipe, in watts per metre (W/m).

7.7.3 Circulation systems

7.7.3.1 The circulation head shall be determined using the following equation:

$$CH = F_1 + NSH \qquad (17)$$

where

CH is the circulation head, in metres (m);

F_1 is the friction loss in the circulation system, in metres (m);

NSH is the net static head (NSH = 9,81 ($\rho_{rp} - \rho_{sp}$) H_c), in metres (m);

ρ_{rp} is the density of water in return piping, in kilograms per cubic metre (kg/m^3);

ρ_{sp} is the density of water in supply piping, in kilograms per cubic metre (kg/m^3);

H_c is the circulation height, in metres (m).

NOTE The circulation pressure consists of the net static head plus the total friction loss in the circulation pipe system.

7.7.3.2 In a closed-loop pumped hot water circulation system, the required rating of the circulation pump shall be such as to provide the necessary circulation pressure and flow in the system.

7.7.3.3 Pipe sizes shall be such that a sufficient rate of flow is maintained in order to control the drop in the temperature of hot water conveyed through the pipes. The return piping shall be so designed that the temperature drop on a circuit is not less than 5 °C and not more than 22 °C. In the absence of other suitable data, the relation between water flow and temperature shall be derived using the following heat balance equations:

$$\Phi = \Delta\Phi \cdot L \qquad (18)$$

$$\Delta\Phi = (Q \cdot \rho \cdot C \cdot \Delta T)L \qquad (19)$$

where

Φ is the heat loss from the pipe, in kilowatts (kW);

$\Delta\Phi$ is the heat loss from the pipe per metre run, in kilowatts per metre (kW/m);

L is the total length of pipe, in metres (m);

Q is the water flow, in litres per second (L/s);

ρ is the density of water, in kilograms per litre (kg/L);

C is the specific heat of water, in kilojoules per kilogram degree Celsius (= 4,2 kJ/(kg·°C);

ΔT is the temperature drop, in degrees Celsius (°C).

7.8 Fire installations and combined installations

7.8.1 General

7.8.1.1 Any fire installation or combined installation shall be the subject of a rational design.

7.8.1.2 The design shall make provision for the number of hose reels and hydrants that can be operated or can come into operation simultaneously in any division.

7.8.1.3 Unless otherwise required, fire hydrants in any building that exceed 12 m in height, or when the total floor area of the building exceeds 1 000 m^2, shall be provided on the basis of one hydrant per 1 000 m^2 of floor area for each floor or part thereof.

7.8.1.4 Hydrants, although intended for use by the fire brigade, shall be situated in suitable positions subject to direction by the local authority.

7.8.2 Pipe sizes

7.8.2.1 Pipes in any fire installation or combined installation shall be sized according to a rational design and in accordance with 7.6, where appropriate.

7.8.2.2 In any fire installation,

a) the nominal diameter of

1) a communication pipe serving such installation shall be at least 75 mm,

2) a pipe supplying water to a fire hydrant shall be at least 75 mm, except that where the length of such pipe exceeds 50 m, the nominal diameter of such pipe shall be at least 100 mm, and

3) a service pipe supplying water to a hose reel on any one storey of a building shall be at least

i) 25 mm, if it serves one or two hose reels,

ii) 32 mm, if it serves three hose reels,

iii) 40 mm, if it serves four or five hose reels, and

iv) 50 mm, if it serves more than five hose reels.

7.9 Facilities for people with disabilities

Facilities for people with disabilities shall be designed to comply with SANS 10400-S.

8 Installation

8.1 General

The relevant national legislation (see foreword) and local authorities require that installation work shall be done by or under the adequate control of a plumber as defined in SANS 10400-A.

8.2 Handling and storage of materials, fittings and components

8.2.1 Pipes, fittings and components shall be handled carefully to obviate damage.

8.2.2 The manufacturers' instructions shall be followed as to how their products shall be loaded, transported, unloaded and stored.

8.2.3 All the manufacturer's documentation accompanying the product and components with regard to warranties, guarantees, operating instructions, safety instructions and required maintenance shall be passed on to the owner of the property.

NOTE For information on pumps, see annex C.

8.3 Identification

8.3.1 All pipes and fittings shall bear acceptable markings for the purpose of identification as required, except for pipes and fittings for domestic dwellings. In installations where services are grouped together (such as in access shafts or ducts), all pipes shall be suitably marked in accordance with SANS 10140-3.

8.3.2 All equipment on which the safety of a hot water system depends shall be clearly marked in order to prevent faulty adjustments being made on site, or to prevent such equipment from being replaced with incorrect items.

8.3.3 The contents of taps and valves in laboratories shall be marked in accordance with SANS 10140-4.

8.4 Installation of fittings and components

8.4.1 General

8.4.1.1 All circulation pumps, valves and water meters shall be installed in readily accessible positions.

NOTE For more information on water meters, see annex B.

8.4.1.2 Supply branches from horizontal hot water mains shall, as far as possible, be taken from the top half of the pipe, to avoid the formation of sediment traps and air pockets.

8.4.1.3 Ground joint unions shall not be used in galvanized piping that conveys hot water because the brass seat could result in abnormal localized corrosion within the union, giving rise to restrictions.

8.4.1.4 If the consumer is responsible for the construction of the connection between the water main and the installation, such connection shall be made in accordance with SANS 1200 LF.

8.4.2 Backflow prevention devices

8.4.2.1 Any backflow prevention device shall be installed in such a position that

a) it can be readily inspected,

b) a condition of backflow in the pipe in which the device is installed can be readily detected,

c) it is readily accessible for removal for the purposes of servicing, repair or replacement, without alteration to the water installation or to the structure within which the device is situated,

d) it cannot be flooded by water or any other liquid, and

e) in the case of a vacuum breaker, it is installed in an appropriate anti-syphon loop.

8.4.2.2 Any additional installation instructions issued by the manufacturer or supplier of non-return valves shall be complied with.

8.4.3 Circulation pumps

Circulation pumps shall be installed in accordance with the manufacturer's instructions and space shall be allowed for maintenance and removal without disturbing the piping.

NOTE See also annex C for more information.

8.4.4 Safety trays

8.4.4.1 Where a storage tank or water heater is installed and a galvanized steel safety tray is provided, hardwood spacers shall be used to separate the storage tank or water heater from the tray. The surface of the tray shall be painted with at least two coats of bitumen paint.

8.4.4.2 The drain from a safety tray shall

a) be adequately supported to maintain a continuous fall to its point of discharge,

b) discharge to the atmosphere in a position where the discharge is readily visible, but will not cause any damage to the building or its contents, and

c) not be used to drain away periodic overflows such as those due to the normal expansion of hot water.

NOTE Suitable alternatives to galvanized steel safety trays should be provided for areas that have highly corrosive atmospheres (see also 5.4.4).

8.4.5 Water heaters and storage tanks

8.4.5.1 The various pipe connections to any water storage container shall be carefully positioned to limit the degree of mixing of hot and cold water within the container. The cold water feed shall

a) if applicable, be connected at the bottom of a horizontal cylinder to a long perforated pipe within the cylinder, or to a bend or tee, with the tee's outlet or two branches (as the case might be) discharging horizontally into the bottom of the cylinder, and

b) not be allowed to discharge upwards in a storage container.

8.4.5.2 Any storage tank shall be installed in such a position that its exterior and interior can readily be inspected, cleaned and maintained.

8.4.5.3 A minimum clear working space of 600 mm shall be provided on all the sides of a storage tank constructed of bolted sections, in order to allow for access to the bolts.

NOTE For information on the installation of gas water heaters, see annex A.

8.4.5.4 All protective devices associated with water heaters shall be so installed that

a) they are protected from freezing, and

b) any discharges to the atmosphere are readily visible.

8.4.5.5 Where any storage tank or water heater is installed in a roof space above a ceiling, or in a confined space, an access opening shall be provided in the ceiling, or in the confined space, for the removal of the storage tank or water heater from such space. Any dimension of the access opening shall be

a) at least a diameter of 600 mm, and

b) large enough to allow for removal of the water heater or storage tank.

8.4.5.6 Where a water heater with an internal sacrificial anode is installed, sufficient space shall be provided for the removal and replacement of such anode.

8.4.6 Supports for storage tanks and water heaters

8.4.6.1 Where a water heater or storage tank is supported by any platform, such platform shall

a) be capable of safely sustaining any loads to which it is likely to be subjected,

b) support the water heater or storage tank in accordance with the instructions of the manufacturers of such water heaters or storage tanks, and

c) shall comply with the requirements in SANS 10400-L.

8.4.6.2 When a wooden platform is used to support a water heater or storage tank of capacity not exceeding 2 kL, such wooden platform shall, unless otherwise required, be constructed as follows:

a) the dimensions of the platform shall not be less than those of the water heater, storage tank or any associated safety tray, plus an additional working space of at least 500 mm in width that extends over the full length of one side of the platform;

b) the supports shall be constructed from structural timber that is

1) at least 114 mm × 38 mm in cross-section,

2) placed on edge, and

3) spaced not further apart than 350 mm; and

c) the platform decking shall be constructed of timber planks that are at least 75 mm wide and 25 mm deep, and such decking shall be placed at right angles to the supports,

1) with a space that does not exceed 25 mm between them if the decking is to support a lightweight metal tank, or

2) abutting on one another if the decking is to support a storage tank or water heater made from plastics material, fibre cement or fibreglass.

8.4.6.3 A platform that supports a water heater or storage tank shall, if applicable, be supported by at least two load-bearing walls or two suitably designed roof trusses.

8.4.6.4 A storage tank made of bolted steel panels shall be supported on rigid beams that are spaced not more than 350 mm apart and that are located under the jointed flanges of the bolted panels in one direction only.

8.4.6.5 Only water heaters or storage tanks of capacity below 200 L shall be attached by means of brackets or hangers to a load-bearing masonry or concrete wall or to any other vertical structural element. Tanks and water heaters 200 L and larger shall not be wall mounted.

8.4.6.6 The installation of gas operated water heaters shall comply with SANS 10087-1 for LP gas and with SANS 827 for natural gas. All gas installations shall be installed by a registered gas practitioner as required by the relevant national legislation (see foreword). After commissioning, a certificate of compliance shall be issued.

8.4.6.7 Solar water heater installations for domestic use shall comply with SANS 10106.

8.5 Joints

8.5.1 General

8.5.1.1 When joints are made,

a) all proprietary joints shall be made in accordance with the manufacturer's instructions,

b) such joints shall be made watertight and shall remain so during use,

c) all pipes, fittings and components to be jointed shall be internally clean,

d) care shall be taken to ensure that no jointing material projects inside the bore of the pipe,

e) all burrs shall be removed from the ends of pipes, and

f) care shall be taken to prevent jointing materials from entering the waterways.

8.5.1.2 Since some flexibility is desirable where there is a possibility of movement in the pipeline or between pipes and fittings, provision shall, where necessary, be made in the assembly of the pipework to accommodate and control thermal movement.

8.5.1.3 All pipework connected to, and all protective valves associated with, water heaters shall be connected by means of flush unions or similar connectors, to facilitate the replacement of such fittings.

8.5.1.4 Pipes shall be so joined to one another as to maintain the continuity of the bore.

8.5.1.5 Jointing materials shall comply with the following:

a) bronze welding filler rods shall contain at least 57 % copper;

b) silver brazing alloys shall contain at least 1,8 % silver;

c) soft solder shall contain no lead and be predominantly tin with a small percentage of copper; and

d) rubber rings used for jointing shall be of the dimensions, composition and hardness suitable for the particular application.

8.5.1.6 Threaded joints shall be formed on metal threads by the use of polytetrafluoroethylene (PTFE) tape, hemp, or an acceptable pipe jointing compound, and on PVC-U threads by the use of PTFE tape only.

8.5.2 Copper or copper alloy pipes

8.5.2.1 Light gauge copper pipes shall be jointed

a) with suitable compression fittings (manipulative or non-manipulative),

b) with suitable capillary-soldered fittings,

c) by forming the tube ends into capillary-type soldered joints,

d) by either bronze welding or silver brazing, or

e) as otherwise approved.

8.5.2.2 The manufacturer's instructions shall be strictly followed when copper pipes are being jointed, particularly with regard to the grade of solder and flux to be used for capillary-soldered fittings.

NOTE 1 Copper pipes can sometimes contain a carbonaceous film from the lubricant used in the drawing process, and this film can promote corrosion. The film develops when (during the manufacturing process) the tubing is heated to a high temperature for the drawing process.

NOTE 2 Soft solder of copper-tin or silver-tin has an adequate shear strength in all normal water temperature conditions.

8.5.2.3 Copper flanges shall be secured to the flanges of fittings and appliances by means of gunmetal or extruded-brass bolts and nuts, and the joint shall be made watertight with a gasket.

8.5.3 Fibre-cement pipes

8.5.3.1 Joints between fibre-cement pipes shall be of the spigot and socket type, with a rubber sealing ring or bolted gland, or as approved.

8.5.3.2 Joints between fibre-cement pipes and metal pipes shall be bolted gland or, when fibre-cement spigots are being jointed to metal sockets, lead caulked, or as approved.

8.5.3.3 Small bore connections shall be made by tees (branches) and crosses, tapping bands or ferrule main taps.

NOTE Fibre-cement products should be protected from impact when used in exposed positions, and care should be exercised when connections are made to fibre-cement storage tanks, since the joints tend to become brittle when cold.

8.5.4 Ductile iron pipes

8.5.4.1 Joints between ductile iron pipes and fittings shall be

a) spigot and socket pipes with push-fit joints with elastomer gaskets, or

b) flanged pipes (weld-on type and integrally casted flanges)

8.5.4.2 When ductile iron pipes are to be jointed with push fit joints, the following procedure shall be carried out:

a) Clean socket chamber and pipe spigot as well as gasket.

b) Check if the spigot is chamfered and in good condition. If it is a cup pipe, remake the chamfer.

c) Insert the gasket into the socket chamfer after the condition is inspected, looping it into a heart shape, with the lip seal nose directed towards the back of the socket. Check that the gasket fits snugly around the circumference.

d) Apply lubricating paste to the exposed surface of the gasket, the spigot end and the chamfer. Ensure that the lubricating paste is brushed-applied in reasonable amounts.

e) Centre the spigot in the socket and maintain it in this position by resting it in mounds of tamped soil, or preferably gravel.

f) Push the spigot into the socket, checking that everything is correctly aligned.

g) Deflect the joints, if necessary, within the permissible limits.

h) Allow 1 cm from the end of the spigot to the end of the socket chamber when inserted.

8.5.4.3 When ductile iron pipes are to be jointed with flanges, the following procedure shall be carried out:

a) Check the appearance and cleanliness of the flange faces and the gasket.

b) Align the parts being assembled.

c) Leave a small gap between the flanges being joined for the gasket to be inserted.

d) Centre the gasket between the raised faces on both flanges using the located lugs as indicated.

e) Fit the bolts and nuts.

f) Tighten the bolts and nuts in opposing sides first. Observe the torques for the bolts as prescribed.

8.5.5 Galvanized steel pipes

8.5.5.1 Joints between galvanized steel pipes and between galvanized steel pipes and fittings shall be

a) screwed joints that have pipe threads that comply with SANS 1109-1, where pressure-tight joints are to be made on the threads,

b) flanged joints using steel pipe flanges that comply with SANS 1123, or

c) as otherwise approved.

8.5.5.2 A suitable thread filler shall be used to obtain watertight joints where necessary, and exposed threads after jointing shall be suitably protected against corrosion.

NOTE Exposed threads can be painted, or where the pipes are to be installed underground, thickly coated with bituminous or other suitable paint to prevent corrosion.

8.5.5.3 When joints are made by either screwed or cast-on flanges, the nuts shall be tightened in opposite pairs.

8.5.5.4 Pipes shall not be welded or brazed unless galvanizing is done afterwards.

8.5.6 Plastics pipes

8.5.6.1 Polyethylene, cross-linked polyethylene and polypropylene pipes

8.5.6.1.1 Only mechanical jointing fittings or other approved methods shall be used for jointing polyethylene pipes, and any such mechanical jointing fitting shall be suitable for the class of pipes being used.

8.5.6.1.2 Couplings used to join high density polyethylene pipes shall be as given in 8.5.6.1.1, or shall be compression-type jointing fittings suitable for the class of pipes being used.

8.5.6.2 Unplasticized polyvinyl chloride (PVC-U) pipes

8.5.6.2.1 The manufacturer's instructions shall be scrupulously followed when PVC-U pipes are being jointed, particularly in the case of solvent welding.

8.5.6.2.2 Pipes of size 50 mm and greater shall be jointed by means of push-fit integral elastomeric sealing rings that are compressed when the plain-ended pipes are inserted into the adjoining sockets.

8.5.6.2.3 Plain pipe ends shall be chamfered, cleaned and lubricated before they are inserted into the adjoining socket.

8.5.6.2.4 Pipe ends shall, unless provision is made for expansion, be inserted either fully into the adjoining socket or as far as any locating mark put on the spigot end by the manufacturer.

8.5.6.2.5 Compression joints shall only be used on PVC-U piping of size up to and including 50 mm. Such joints shall be of the non-manipulative type and care shall be taken not to over-tighten them.

8.5.6.2.6 When solvent cement welded joints are made, pipes and fitting shall be cleaned at the joint and the type of solvent cement shall be appropriate for the composition of the plastics material.

8.5.6.2.7 Various designs of ring seal are available according to each manufacturer's system. Joint rings from different manufacturers are not generally interchangeable and the rings used shall be those designed for the system concerned.

NOTE 1 A solvent weld system is one in which most of the joints have been made by means of the solvent cement weld technique. A solvent weld system normally comprises socketed fittings in conjunction with double spigot lengths of pipe. Most ranges of fittings also include some components with spigot ends for close coupling to sockets on other items. In the case of a solvent weld system, it might, in some situations be necessary to introduce expansion joints into the pipework.

NOTE 2 It is difficult to make satisfactory solvent welded joints in the field, and such joints tend to be brittle. Some local authorities do not permit solvent weld joints, particularly in trench conditions.

8.5.7 Stainless steel pipes

8.5.7.1 Joints in stainless steel pipework of size up to 25 mm shall be

a) compression-type joints, using copper or copper alloy fittings,

b) capillary-soldered-type joints, using copper or copper alloy fittings,

c) capillary-soldered-type joints, using expanded sockets made in the stainless steel tube, or

d) cruxed-type joints, using approved fittings.

8.5.7.2 Joints in stainless steel pipework that exceed 25 mm in size shall be

a) butt welded, using a tungsten inert gas argon arc method, or

b) flanged joints with flanges drilled in accordance with SANS 1123.

8.6 Laying of pipes

8.6.1 Pipes laid underground

8.6.1.1 Unless otherwise approved, pipes shall have a soil cover over the outside, of at least

a) 450 mm for any pipe of nominal diameter less than 75 mm, or

b) 750 mm for any pipe of nominal diameter 75 mm and above, keeping in mind that, if the soil cover is less than that required, appropriate steps shall be taken to protect any such pipes against

   1) freezing, where necessary, and

   2) the transmission of excessive superimposed loads direct to the pipes.

8.6.1.2 Unless otherwise approved, pipes shall have a soil cover of not more than 1 m over the outside.

8.6.1.3 Where a sanitary drain pipe and a pipe that conveys potable water are laid underground horizontally next to each other, they shall be laid at least 500 mm apart.

8.6.1.4 When a sanitary drain pipe and a pipe that conveys potable water cross each other, the pipe that conveys the water shall be laid at least 100 mm above the line of the sockets of the drain pipe.

8.6.1.5 Trench excavations, bedding and backfilling shall be carried out in accordance with SANS 1200 LB and pipes, shall be so laid that

a) they are evenly supported throughout their lengths, and

b) no pipes rest on their sockets, or on bricks, tiles or other makeshift supports.

8.6.1.6 In the case of pipework with flexible joints, adequate measures shall be taken to prevent movement of the pipework due to water pressure effects. Thrust blocks shall be designed and installed in accordance with SANS 1200 L.

8.6.1.7 The following precautions shall be taken to minimize the effects of ground movement on pipes and fittings:

a) suitable types of pipework and fittings shall be used where the ground is liable to move; and

b) continuous longitudinal support shall be provided where the pipes or the joints are not sufficiently flexible to accommodate movement of the pipeline.

8.6.2 Pipes laid under walls or under surface slabs

Where any portion of a pipe passes under a building or under a surface slab, and unless otherwise approved, the following shall apply:

a) such portion shall be installed inside a sleeve of internal diameter of at least 15 mm plus the outside nominal diameter of such portion;

b) such portion shall be protected against the transmission of any load to it;

c) such portion shall be laid without any change of direction, and without any junctions; and

d) the trench in which such portion is laid shall in no way impair the stability of any building, or interfere with, or affect, any existing services.

8.6.3 Pipes laid in or through floors, concrete slabs or walls

8.6.3.1 Where any portion of a pipe is concealed in a floor, concrete slab or wall, the following shall apply:

a) adequate measures shall be taken to protect such portion from external pressure or from the transmission of any load to it;

b) should a leak develop in such portion, the installation shall be such that the portion of the pipe can be removed without danger to the building structure; and

c) plastics pipes shall not be rigidly encased in floors, concrete slabs or walls.

8.6.3.2 Where any portion of a pipe passes through a wall or under a floor, such portion should preferably be installed inside a sleeve of internal diameter of at least 15 mm plus the outside nominal diameter of such portion (see figure 15 and figure 16).

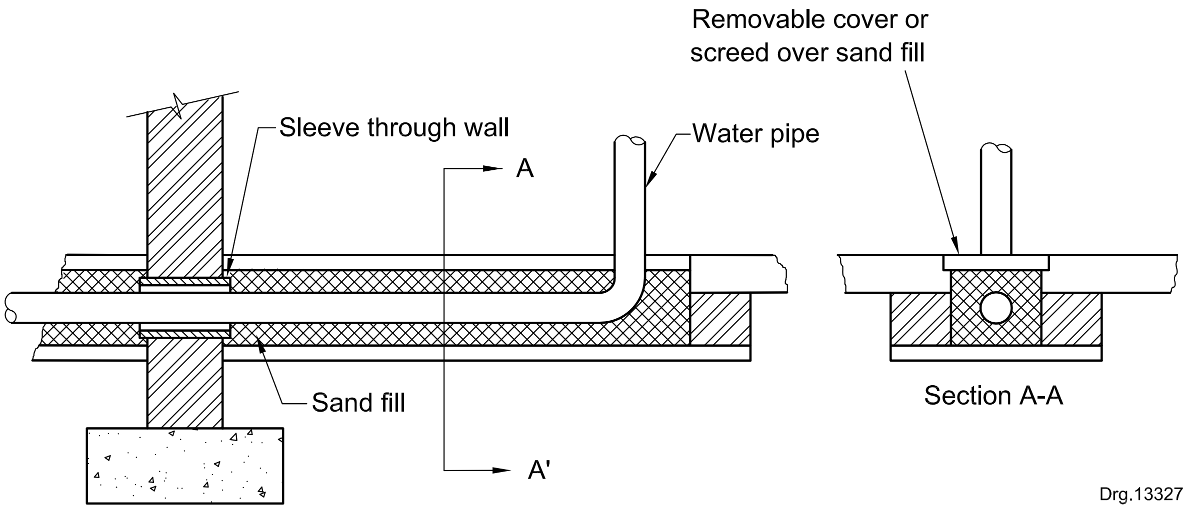


Figure 15 — Example of a duct for installing a water pipe within a surface slab or a floor

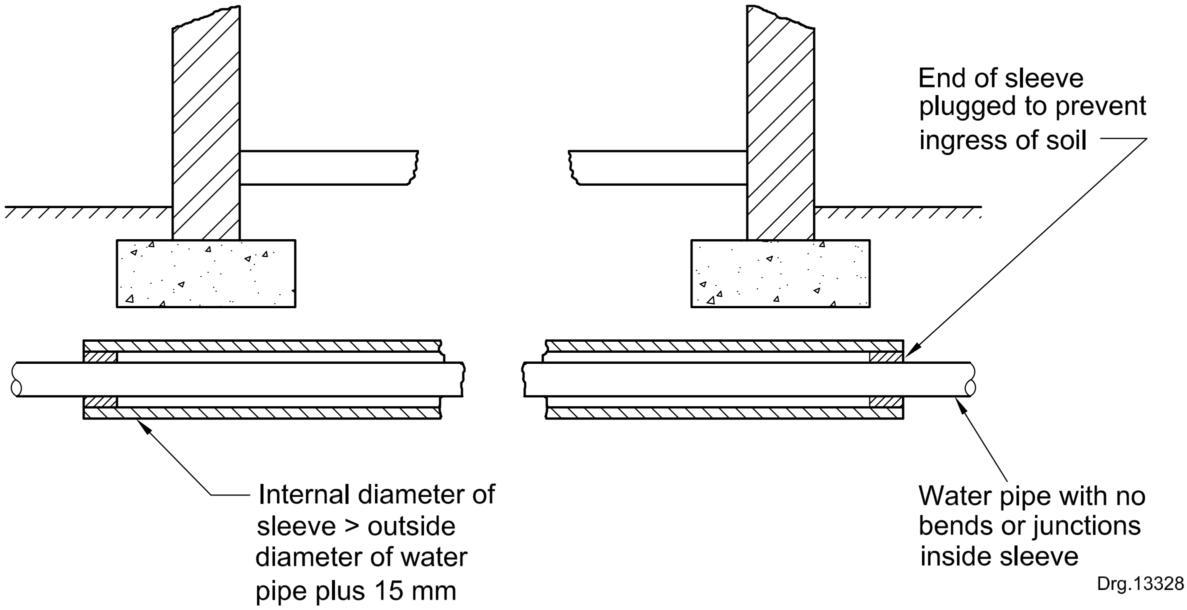


Figure 16 — Sleeve for installing a water pipe under a building or under a surface slab

8.6.3.3 Pipes installed within a cavity wall shall be securely fixed. No pipe shall pass through concrete expansion or concrete joints, unless acceptable provisions have been made to the pipework for movement.

8.6.3.4 Concealed piping in reinforced concrete structures shall be

a) housed in properly constructed builders' work ducts, or wall chases, and

b) laid in continuous lengths without joints or fittings except where such joints or fittings are located within access ports of sufficient size to permit maintenance and inspection (see figure 17).

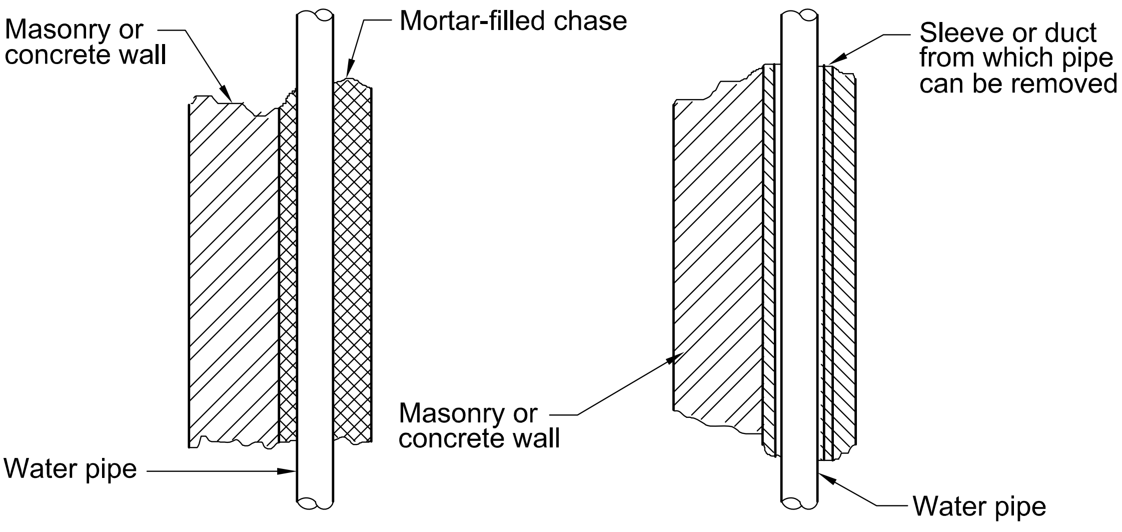


Figure 17— Installation of pipes in walls and structural elements

8.6.3.5 Where penetrated, compartment walls, floors and fire barriers shall be fire-stopped to prevent the passage of smoke and flame.

8.6.3.6 All hot water piping (including relief drain pipes), that is encased in concrete, plaster or similar material that can restrict the movement of such piping owing to expansion or contraction, shall be lagged throughout the whole encased length with hair felt or other approved flexible lagging material of thickness of at least 6 mm, or in accordance with the manufacturer's instructions.

8.6.4 Pipework above ground

8.6.4.1 Provision for expansion shall be made in pipe runs by allowing freedom of movement at bends or branches. Reference shall be made to the pipe manufacturer's instructions and such provision for expansion shall include

a) a clear space to permit movement,

b) sufficient free length of tubing around the bend or along the branch, to prevent overstressing of the tube, and

c) an offset or loop to allow the pipe to be sprung should it be required to allow for disconnecting unions, to remove, or replace in-line valves, or other functional components.

In the case of tubing of length exceeding 18 m and that conveys hot water, provision shall be made for expansion and contraction, preferably close to the midpoint of the tubing.

Expansion-absorbing devices are shown in figure 18.

NOTE Provision for expansion could include the forming of expansion loops and offsets, introducing changes in direction in order to avoid long straight pipe runs, and the fitting of proprietary expansion joints. Expansion loops and offsets are simple and effective but require space, which might not be available. (See 6.7.3.)

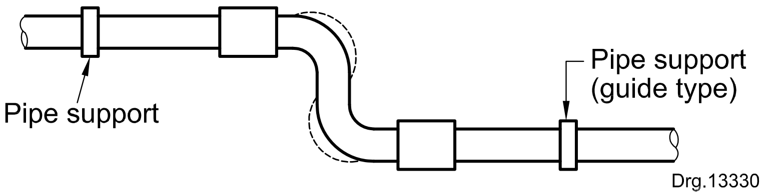
8.6.4.2 Pipes shall be so installed that noise and water hammer that occur in such pipework are limited to an acceptable minimum.

8.6.4.3 When pipes are installed in open spaces and are not otherwise held in place, they shall be securely fixed with pipe supports to any structural member of a building with which they come into contact.

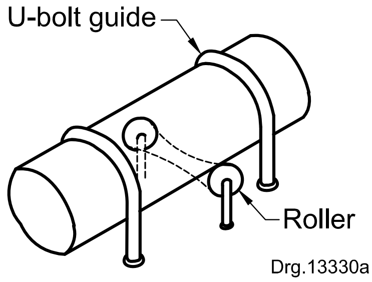
8.6.4.4 Pipe supports shall be of a type and material appropriate to the pipe, shall be capable of withstanding the applied loads and shall be corrosion resistant when pipes are installed in locations exposed to corrosive conditions.

8.6.4.5 Copper holderbats shall not be used for the fixing of steel piping.

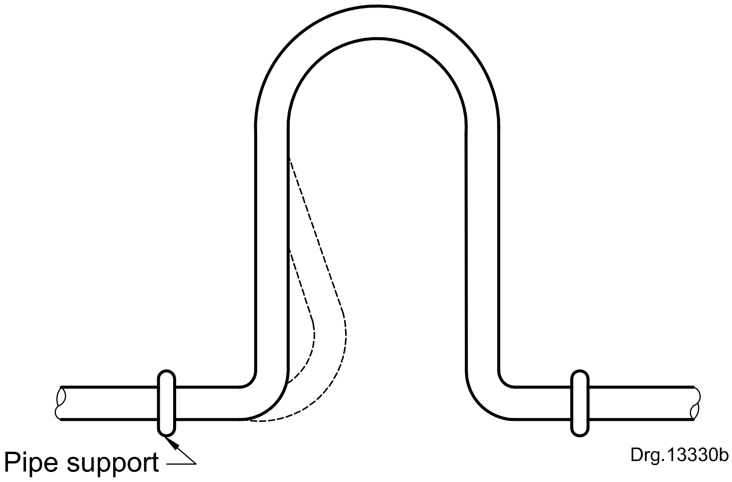
8.6.4.6 Holderbats shall be either built into, or bolted to, the structure of a building.



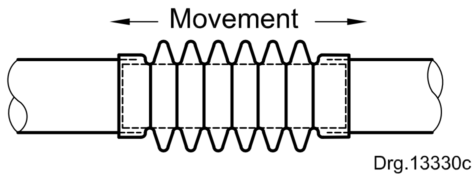
a) Expansion offset



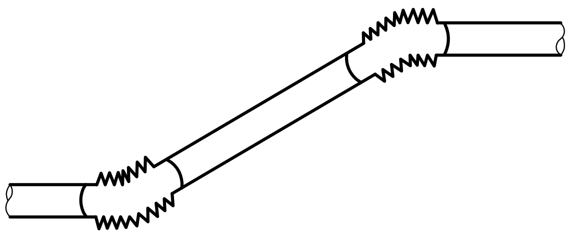
b) Pipe support (guide type)



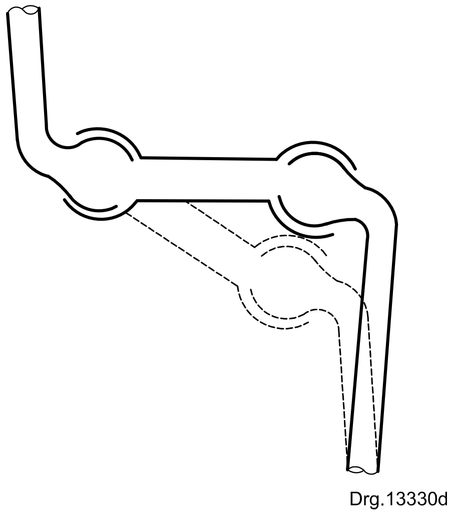
c) Expansion loop



d) Axial expansion bellows



e) Articulated expansion bellows



f) Ball joint connections

Figure 18 — Expansion-absorbing devices

8.6.4.7 Brackets and clips shall be securely fixed in one of the following ways:

a) by drilling and bolting through;

b) by drilling and caulking with lead (wooden plugs shall not be used);

c) by securing with a screwed or bolted masonry anchor;

d) by percussive fasteners used in accordance with the manufacturer's instructions; or

e) by other approved means.

8.6.4.8 The spacing of pipe supports shall be determined as follows:

a) the spacing is acceptable if, under normal operating conditions,

1) the permissible maximum stress for the material from which a pipe is manufactured is not exceeded, and

2) the maximum deflection of the pipe from a straight line between neighbouring supports does not exceed $\frac{1}{150}$ of the distance between the supports;

b) if the requirements in (a) are not complied with, then

1) in the case of metal pipes, the spacing of pipe supports shall not exceed the values given in columns 2 and 3 of table 21, for the size of pipe given in column 1 of table 21, and

2) in the case of PVC-U or polyethylene pipes, the spacing of pipe supports shall not exceed the values given in columns 2 and 3 or 4 and 5, respectively, of table 22, for the size of pipe given in column 1 of table 22, except that,

3) in the case of polyethylene pipes where the ambient temperatures or the temperature of the piped fluids are such that the temperature of the pipework exceeds 20 °C, the spacing of the pipe supports shall be so reduced that the requirements given in (a) are complied with for the design life of the pipe system, taking into account the creep behaviour of the pipe material and normal operating conditions and loads.

Table 21 — Maximum spacing of supports for metallic pipes installed horizontally, inclined or vertically, in open spaces

1	2	3
Nominal pipe diameter mm	**Distance between pipe supports when pipes are installed** m	
	Non-vertically	**Vertically**
15 to ≤ 25	1,6	3,0
> 25 to ≤ 40	2,7	3,0
> 40 to ≤ 50	3,0	3,6
> 50 to ≤ 65	3,6	4,5
> 65 to ≤ 150	4,0	4,5

Table 22 — Maximum spacing of supports for plastics pipes installed horizontally, inclined or vertically, in open spaces

1	2	3	4	5
Nominal pipe diameter mm	**PVC-U piping**		**Polyethylene piping**	
	Distance between pipe supports, when pipes are installed m			
	Non-vertically	**Vertically**	**Non-vertically**	**Vertically**
≤ 20	0,6	1,2	0,3	0,6
> 20 to ≤ 32	0,8	1,7	0,4	0,8
> 32 to ≤ 50	1,0	1,75	0,42	0,87
> 50 to ≤ 80	1,15	2,25	0,55	1,10
> 80 to ≤100	1,35	2,70	0,67	1,35
> 100 to ≤ 150	1,5	3,0	0,75	1,5

8.6.5 Standpipes

8.6.5.1 All standpipes connected to water installations shall be securely supported by fixing to walls of buildings or, when necessary, shall be suitably supported by other means.

8.6.5.2 Standpipe draw-off taps shall be at a height of at least 450 mm, measured above ground level or above the gully top, as applicable.

NOTE Standpipes leaking direct over gulleys discourage repairs and result in unnecessary water wastage.

8.6.5.3 Standpipes shall not be connected between the water mains and the lower outlet bend of the water meter assembly.

8.6.6 Fixtures and equipment with electrical power

Fixtures and equipment that use electrical power and their application in ablution facilities shall be installed to comply with the requirements in SANS 10142-1.

9 Cleaning, inspection, testing and disinfection

9.1 Cleaning

9.1.1 Before a general or combined water installation is disinfected, or is pressure-tested for acceptance, it shall be properly cleared of all foreign matter.

NOTE Flushing out a system with water often fails to remove matter, such as non-water-soluble cutting oils, corrosion products, mortar or foreign objects that might have wedged in a fitting. Problems experienced with installations that have not been properly cleaned out include poor hydraulic performance, or a bad taste to the water which could linger for several months (or both). The presence of dirt in a system could also, to some extent, negate the effectiveness of chlorination.

9.1.2 An effective method of cleaning out installations is to pass a specially designed "pig" through the system. A pig is usually a bullet-shaped polyurethane foam cylinder with or without strips of harder material such as urethane rubber on its surface. Figure 19 shows a pig in position, ready for launching. Figure 20 shows a typical arrangement for launching of pigs in a water installation.

NOTE 1 Suitably designed pigs can negotiate elbows and tees. A pig of appropriate diameter can be introduced into an empty pipeline through a tee or blanked-off pipe end and be propelled along the pipeline by water pressure.

NOTE 2 Water for propelling the pig could be introduced behind the pig either direct from a storage tank connected to the system, or via a hose connected to another part of the installation that is supplied with water. The pressure needed for propelling a pig is usually substantially less than the operating pressure for the system, but should generally be at least 100 kPa to 300 kPa, depending on the diameter of the pipeline and the type of pig used.

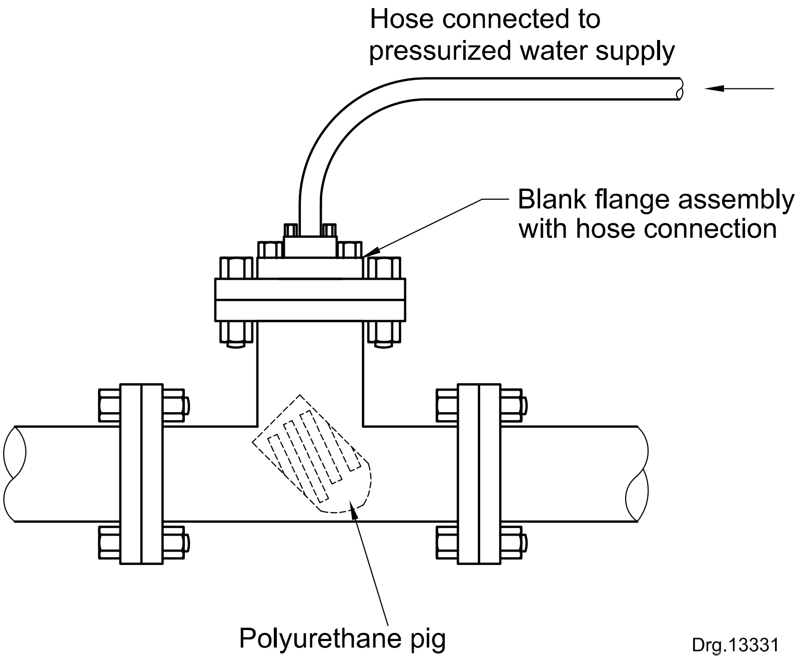


Figure 19 — Provision for launching a cleaning pig

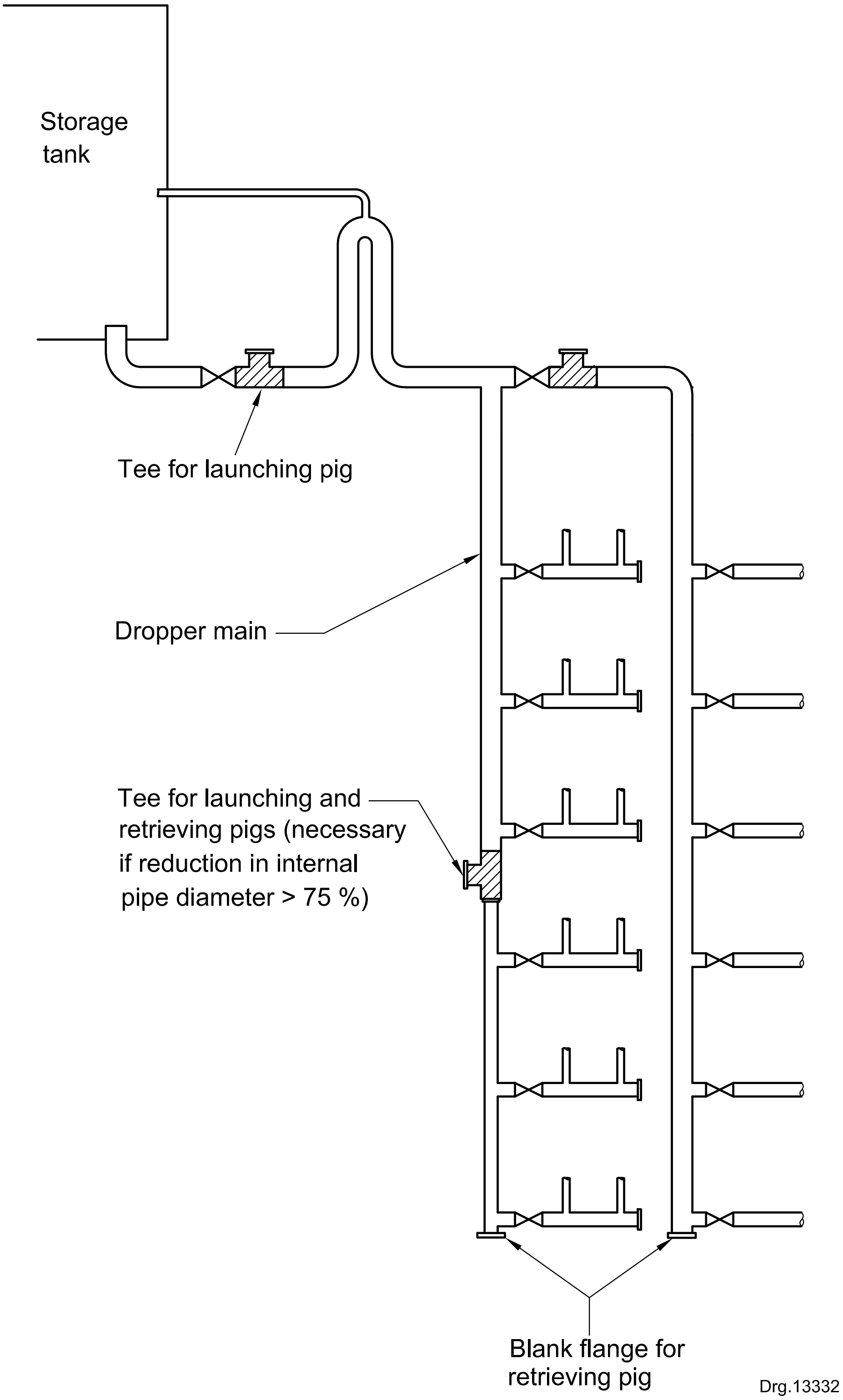


Figure 20 — Typical arrangement for launching and retrieving cleaning pigs in a general installation

9.2 Inspection and testing

9.2.1 Inspection

Before testing, the installation shall be inspected

a) visually, to detect faults in construction or materials, and

b) for compliance with drawings, specifications and requirements.

NOTE Particular attention should be paid to the pipe beds, levels of pipes, irregularities at joints, the installation of fittings and components (especially the correct fitting and installation of safety devices), protective coatings, and the supporting and fixing of pipes, fittings and components (especially for storage tanks and heaters), and to verifying that the appropriate backflow prevention devices have been selected and are installed correctly.

9.2.2 Testing

9.2.2.1 Slowly fill the installation with water, with the highest draw-off point open, to allow air to be expelled from the system.

9.2.2.2 Check each terminal fitting for rate of flow against the specified requirements.

9.2.2.3 Unless otherwise required,

a) subject any water installation other than a fire installation or a combined installation to a test pressure of at least 1 500 kPa, but not less than 1,5 times the maximum working pressure of the installation, and maintain such test pressure for at least 1 h, and

b) subject any fire installation or combined installation to a test pressure of at least 2 000 kPa, but not less than twice the maximum working pressure of the installation, and maintain such test pressure for at least 1 h.

9.2.2.4 Ensure that there is no loss of water and no visual evidence of leakage anywhere in the installation.

9.2.2.5 For buried pipelines, test the pipeline in accordance with SANS 1200 L.

9.3 Disinfection

9.3.1 Water installations

When any extension or modification has been made to a water installation on any premises separately occupied, or any private dwelling that has its own separate service pipe, then that water installation shall, immediately before being taken into use, be thoroughly flushed with fresh water drawn direct from the mains.

9.3.2 Storage tanks

9.3.2.1 Apply the following disinfection procedure to any storage tank:

a) remove all visible dirt and debris from the inside of the storage tank;

b) fill the storage tank with clean water and then drained until empty;

c) refill the storage tank with clean water and add a solution of sodium hypochlorite to the water until a free residual chlorine level of 50 mg/L in the water is measured;

d) leave the chlorinated water in the tank for not less than 1 h and not more than 3 h, after which (in turn) open each terminal fitting served by the storage tank, starting at the one closest to the tank and working progressively away from the tank, until the water discharged begins to smell of chlorine, then close each terminal again;

e) do not allow the storage tank to become empty during the discharging described in (d); refill and re-chlorinate the tank as in (c), as necessary;

f) when the discharging is carried out on the terminal fitting furthest from the tank and the smell of chlorine becomes evident, measure the level of free residual chlorine in the water discharged. If the concentration of free residual chlorine is less than 30 mg/L, repeat the disinfecting process, starting from (c); and

g) keep the tank and pipes charged with the chlorinated water for at least 16 h and then thoroughly flush them with clean water until the free residual chlorine level at any terminal fitting does not exceed that present in the clean water from the mains.

9.3.2.2 In the case of pipework under pressure, apply the following procedure:

a) carry out chlorination treatment through a properly installed injection point, using a chemical pump at the start of the installation until the measured free residual chlorine at the end of the installation is at least 20 mg/L; and

b) leave the chlorinated water in the system for at least 24 h, after which flush the installation with clean water until the free residual chlorine level in the water, measured at the furthest point from the injection point, does not exceed that present in the clean water of the mains.

NOTE 1 Disinfection should be compatible with the pipe system manufacturer’s specifications.

NOTE 2 Should the use of alternative disinfection systems be considered, the process should be performed under the supervision of and the results certified by a suitably qualified specialist personnel as specified by the manufacturer of the materials and equipment.

NOTE 3 Following the performance of the disinfection process, it is recommended that a water sample be obtained and submitted for quality analysis in terms of the requirements given in SANS 241-1 and SANS 241-2.

Annex A
(informative)

Gas appliance installation requirements

A.1 General

Where any gas appliance needs to be installed it shall be installed by an authorized person (i.e. a registered gas practitioner as defined in the relevant national legislation (see foreword) (see annex J for the regulation), and shall be installed according to the requirements of SANS 10087-1.

A.2 Installation of appliances

A.2.1 Fixed appliances shall be installed by a registered installer in accordance with the relevant national legislation (see foreword). When siting an appliance, due regard shall be paid to convenience in use, to protection from draughts and damage, and to the layout of the gas piping system. Pipe runs shall be as neat, tidy and as short as possible. Pressure regulators shall be of an approved type. Low-pressure regulators shall comply with SANS 1237.

A.2.2 Appliances shall be installed on a firm and level base (this is specially important in the case of refrigerators which require checking with a spirit level during installation). A table or shelf used as a support for an appliance shall be large enough to accommodate the appliance and, unless the support has edges that are flanged upwards, shall provide margins that are wide enough to prevent the appliance from slipping off the support. All appliance supports (including floors, walls and ceilings) shall be strong enough to carry the appliance(s) and all superimposed loads.

A.2.3 Appliances shall be connected to the pipework of an installation in a way that will eliminate undue strain on the pipework and fittings and, if rigid connections are used, the appliances shall also be so rigidly fixed that they are not capable of being moved after their installation. If an appliance is, for example, to be moved for cleaning, it shall be connected to the pipework by means of flexible tubing or hose. To prevent the hose or tubing from being ruptured or torn from its mountings, the appliance shall have a restraining mechanism of a length that is shorter than the hose or tube. Tubing and hoses shall comply with the appropriate requirements given in SANS 1539 and SANS 1156-1.

A.2.4 Appliances shall be installed in such a way as to avoid draughts that are strong enough to extinguish the burners when they are set on "low" flame.

A.2.5 Appliances shall not be installed in small, confined spaces that are poorly ventilated. Gas burners require an unrestricted supply of fresh air and when a cooking appliance is built in, the supply of fresh air for combustion shall not be impeded. Provision shall be made for any accumulations of un-burnt gas to disperse safely, and also for the free escape of products of combustion. Where gas appliances that require back ventilation are installed against a wall, there shall be a gap of at least 50 mm between the appliance and the wall.

A.2.6 In any bathroom in which a conventional gas water heater is installed, the heater shall be flued to the outside and provision shall be made to ensure permanent ventilation.

A.3 Instantaneous gas water heater — General requirements

A.3.1 Where any gas appliance is installed it shall be done by an authorized person (i.e. a registered gas practitioner) as defined in the relevant national legislation (see foreword).

A.3.2 All gas appliances (LP gas and natural gas) shall comply with the safety requirements of SANS 1539 and the installation requirements as given in SANS 10087-1 and SANS 827.

A.3.3 The water heaters are categorized into several types according to the method of evacuation of the combustion products and the admission of the combustion air (see A.4.1). The type of water heater installed shall be indicated on either the data plate or by additional labelling.

A.3.4 The temperature sensing device (overheat protection) fitted to an instantaneous water heater shall be subjected to the requirements given in SANS 1539. The sensor shall shut off the gas supply to the main burner within the nominal value as set by the manufacturer, not exceeding 10 % above the nominal.

A.3.5 Where a water heater is fitted with a combustion fan it shall be subjected to the requirements given in SANS 1539. The gas supply shall be shut off to the main burner within 1 min of the fan stopping.

A.3.6 Permanent air supply (which is a continuous supply of fresh air through an open vent (for example an open air brick)), shall be provided. Permanent ventilation (which is an opening to the outside atmosphere and which is fixed in the open position), shall be provided where instantaneous water heaters are installed in bathrooms

A.4 Type A instantaneous water heaters

A.4.1 General

Type A instantaneous water heaters are appliances with a maximum rated heat input of 42 MJ (11,7 kW·h) primarily for indoor use and are not intended to be connected to a flue or other device for evacuating the combustion products to the outside of the room. This type of appliance is intended for short delivery periods only.

A.4.2 Requirements for type A instantaneous water heaters

Type A instantaneous water heaters shall be fitted with

a) a flame-failure device,

b) an atmospheric sensing device which shall shut down the appliance in the event that the air quality in the room in which the appliance is installed reaches a preset level of oxygen depletion,

c) a deflector that is an integral part of the appliance, and which is intended to deflect the combustion products away from the wall against which it is installed, and

d) a temperature sensing device that shall shut down the appliance in the event that the water temperature in the heat exchanger reaches a preset limit.

NOTE This device is factory set by the manufacturer.

A.4.3 Additional requirements

In addition to the marking requirements given in SANS 1539, the following additional markings shall apply to type A instantaneous water heaters:

a) the following information shall be included in the user instructions:

   1) this appliance is fitted with an atmospheric sensing device; and

   2) this appliance may only be used for short delivery periods and may not be used for the purpose of supplying hot water to a shower, bath or washing machine; and

b) the following information shall be included in the installer instructions:

   1) this appliance may only be installed in a room if the room meets the appropriate ventilation requirements (see SANS 10087-1); and

   2) this appliance shall not be connected to a flue.

A.5 Type B instantaneous water heaters

A.5.1 General

Type B instantaneous water heaters are appliances primarily for indoor use and shall be connected to a flue for evacuating the combustion products to the outside of the building in which the appliance is installed and where the combustion air is drawn directly from the room in which the appliance is installed.

A.5.2 Requirements for type B instantaneous water heaters

Type B instantaneous water heaters shall be fitted with

a) a flame-failure device,

b) a draught diverter in the combustion products circuit,

c) a combustion products discharge safety device (flue sensor), which shall shut down the appliance in the event of a spillage of combustion products into the room in which the appliance is installed, and

d) a temperature sensing device that will shut down the appliance in the event that the water temperature in the heat exchanger reaches a preset limit.

   NOTE This device is factory set by the manufacturer.

A.5.3 Additional requirements

A.5.3.1 Where the appliance is fitted with a fan in the combustion circuit

a) apart from the provision of air from the air supply circuit, the remainder of the combustion products circuit shall be sealed from the room to prevent the combustion products discharge from entering the room, and

b) the appliance shall be fitted with a mechanism that will shut off the gas supply to the burner in the event of fan failure or a flue blockage or back draft that could cause an overheat situation and then A.5.2(c) shall not apply.

A.5.3.2 No additional markings are required for type B instantaneous water heaters.

A.6 Type C instantaneous water heaters

A.6.1 General

Type C instantaneous water heaters are appliances for indoor use where the complete combustion circuit is sealed with respect to the room in which it is installed and are intended to be connected to a flue or other device for evacuating the combustion products to the outside of the building. Combustion air is taken from outside of the building.

A.6.2 Requirements for type C instantaneous water heaters

A.2.6.1 Type C instantaneous water heaters shall be fitted with

a) a flame-failure device,

b) an inlet/outlet connection designed to accept the ducts to be fitted to the appliance, and

c) a temperature sensing device that will shut down the appliance in the event that the water temperature in the heat exchanger reaches a preset limit.

NOTE This device is factory set by the manufacturer.

A.2.6.2 Where a fan is fitted in the combustion circuit, a mechanism that will shut off the gas supply to the burner in the event of fan failure shall be fitted.

A.6.3 Additional requirements

In addition to the marking requirements given in SANS 1539, the following statement shall be included in the appliance installation instructions:

"This appliance is required to be connected to a dual duct flue system incorporating separate paths for provision of the combustion air and the exhaust of the combustion products to and from the exterior of the building. Note the manufacturer's specific instructions regarding installation of the appliance."

A.7 Type D instantaneous water heaters

A.7.1 General

Type D instantaneous water heaters are appliances for outdoor installation only.

A.7.2 Requirements for type D instantaneous water heaters

A.7.2.1 Type D instantaneous water heaters shall be fitted with

a) a flame-failure device,

b) a deflector that is an integral part of the appliance, where the appliance is of the type for use without a flue, and which is intended to deflect the combustion products away from the wall against which it is installed, and

c) a temperature sensing device that will shut down the appliance in the event that the water temperature in the heat exchanger reaches a preset limit.

NOTE This device is factory set by the manufacturer.

A.7.2.2 Where the appliance is fitted with a fan in the combustion circuit, the appliance shall be fitted with a mechanism that will shut off the gas supply to the burner in the event of fan failure.

A.7.3 Additional requirements

In addition to the marking requirements given in SANS 1539, the following additional markings shall be applied to type D instantaneous water heaters:

a) A label with the words

"For outdoor use only"

shall be permanently attached to the appliance. This label shall be in addition to and separate from other labelling information or markings. The wording shall be at least 10 mm in height.

b) The following information shall be included on a label on the packaging:

"For outdoor use only".

This label shall be in addition to and separate from other labelling information or markings. The wording shall be at least 10 mm in height.

c) A statement indicating the following shall be included in the appliance installation instructions:

"This appliance shall only be installed in an outside location".

Annex B
(informative)

Extract from Regulation R509 (8 June 2001) in terms of the Water Services Act, 1977 (Act No. 108 of 1997)

13. Measurement or control of water supplied

(1) A water services institution must -

(a) within two years after promulgation of these Regulations, fit a suitable water volume measuring device or volume controlling device to all user connections provided with water supply services that are existing at the time of commencement of these Regulations; and

(b) fit a suitable water volume measuring device or volume controlling device to every user connection made after the commencement of these Regulations.

(2) If constructed or installed after promulgation of these Regulations, a suitable water volume measuring device or volume controlling device must be fitted to separately measure or control the water supply to every -

(a) individual dwelling within a new sectional title development, group housing development or apartment building;

(b) individual building, having a maximum designed flow rate exceeding 60 litres per minute within any commercial or institutional complex; and

(c) irrigation system with a maximum designed flow rate exceeding 60 litres per minute that uses water supplied by a water services institution.

(3) Where the water supplied is measured by way of a meter, that meter must comply with the Trade Metrology Act, 1973 (Act No. 77 of 1973), if of a size regulated under that Act.

Annex C
(informative)

Pumping of water

C.1 Pumping of water

C.1.1 Types of pumps

Generally, two groups of pumps can be distinguished, namely positive displacement pumps and rotodynamic pumps. Rotodynamic pumps are the group most commonly in use and include pumps of the following types:

a) radial-flow (centrifugal) pumps;

b) mixed-flow pumps; and

c) axial-flow pumps.

The difference between the three types of pumps is the way in which water flows through the pump; this depends on the construction of the pump and determines the use of any particular pump.

C.1.2 Specific speed

The specific speed, N_s, of a homologous series of pumps can be defined as the rotating speed of any one unit of the series and of such a size that it delivers 1 m^3/s at a head of 1 m, at its point of peak efficiency.

The specific speed gives an indication of which of the three types of rotodynamic pumps given in C.1.1, should be used in a given situation.

From the theory of homologous pumps, the following equation for specific speed can be derived:

$$N_s = n \cdot Q^{0,5}/H^{0,75} \quad \text{(C.1)}$$

where

N_s is the specific speed, in revolutions per minute (r/min);

n is the drive speed, in revolutions per minute (r/min);

Q is the volume discharge rate of the pump, in cubic metres (m^3);

H is the total pressure head per stage, if a multistage pump is used, in metres (m).

By means of equation C.1 and table C.1, the type of rotodynamic pump to be used can be determined.

Table C.1 — The specific speed for different types of rotodynamic pumps

1	2
Type of rotodynamic pump	**Specific speed** N_s r/min
Radial flow (centrifugal) Mixed flow Axial flow	10 to 80 70 to 80 150 to 315

C.1.3 Pump characteristic curves

C.1.3.1 General

Pump characteristic curves consist of the three curves of pump head, *H*, power input, *P*, and pumping efficiency drawn to a common baseline of discharge rate, *Q*. In the usual case of a fixed-speed electric motor, only the set of curves for the given speed is required. In special cases, it is possible to plot all three variables against a fourth. As the power of a pump is dependent on the efficiency of the pump over its utilization range, the shape of the characteristic curve should be carefully studied.

C.1.3.2 Head-discharge characteristic curve

C.1.3.2.1 General

Among all the possible shapes that can occur with radial-flow pumps, the following two distinct shapes should be recognized, namely, a stable head-discharge characteristic and an unstable head-discharge characteristic.

C.1.3.2.2 Stable head-discharge characteristic

In a stable curve, there is only one rate of discharge corresponding to a specified head (except perhaps at very small percentage flows). Such curves usually have fairly steep falling head-discharge characteristics, as indicated by the solid line in figure C.1(a).

C.1.3.2.3 Unstable head-discharge characteristic

In an unstable head-discharge curve, the curve is reasonably flat and therefore there can be more than one rate of discharge corresponding to a specified head (see the dotted curve in figure C.1(a)). When one pump is connected in parallel with an identical pump, the rate of discharge will keep fluctuating between the two possibilities and will cause severely harmful pulses to occur in the pipelines.

C.1.3.3 Overloading versus non-overloading curve

C.1.3.3.1 General

Corresponding to the two classes of head-discharge curve, there are two types of power-discharge characteristics. They are shown in figure C.1(b) and are called non-overloading and overloading curves.

C.1.3.3.2 Non-overloading curve

This curve is related to the stable head-discharge curve, has a somewhat flat gradient and rises to a limited height. Therefore, a varying pressure head cannot jeopardize the motor.

C.1.3.3.3 Overloading curve

This curve is related to the unstable head-discharge curve and continues to rise indefinitely. This means that the pump should operate at a pressure head lower than the design point. With such a pump setup, should certain friction-loss elements be eliminated (i.e. the bursting of a pipe), the motor will be overloaded and will consequently burn out.

In the case of a water supply system with a varying pressure head, a pump that has non-overloading characteristics should be installed, or the motor itself should be overload-protected, or an overload pump that has a motor that considerably exceeds the design point power should be used, whichever would be most economical.

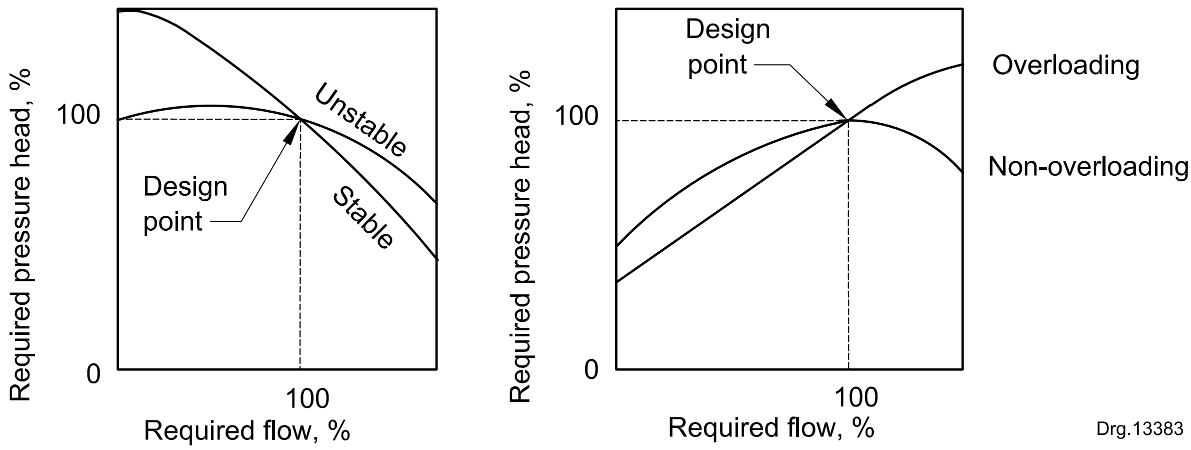


Figure C.1(a) — Stable and unstable head discharge curve

Figure C.1(b) — Overloading and non-overloading curve

Figure C.1 — Pump characteristic curves

C.2 Series connection of radial-flow pumps

When identical pumps are connected in a series, the installation will have a characteristic curve of pressure head versus discharge rate (*H/Q* curve) that is derived using the following equation (see figure C.2):

$$H_w = H \cdot n \qquad (C.2)$$

where

H_w is the pressure head for the series-connected pumps at delivery rate Q, in metres (m);

n is the number of pumps connected in a series.

When a number, n, of non-identical pumps is connected in a series, the installation will have an *H/Q* curve composed of the sum of the individual n and H values, of each discharge rate, Q.

When the total pressure head required exceeds, with acceptable efficiency, the limit that can be developed in commercially obtainable single-stage pumps, multistage pumps can be used.

However, multistage pumps are commercially obtainable only in the low and medium discharge classes. Almost the same results as those obtainable with a multistage pump can be obtained by connecting single-stage pumps in a series by means of external piping (instead of the internal flow channels normally used in multistage pumps). It is essential that identical pumps be used, but it is important that the delivery at maximum efficiency for the individual pumps does not differ too much. Where one pump does produce a considerable larger discharge, this pump should be used as the first stage.

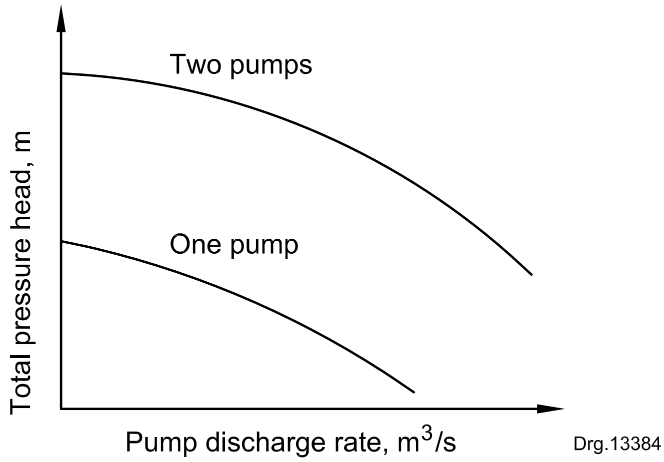


Figure C.2 — A series connection of pumps

C.3 Parallel connection of radial-flow pumps

C.3.1 Performance curves

When identical pumps are connected in parallel, the installation will have an *H/Q* curve composed of the sum of the individual *n* and *Q* values at each *H*, as shown in figure C.3.

C.3.2 Use of parallel connection

C.3.2.1 The demand in pump installations can fluctuate over a wide spectrum. If a pump has been selected for maximum delivery, it is almost certain that the pump will operate at low efficiency during times of lower demand. Furthermore, in cases where high reliability is required (for example, for urban water supply), a duplicate pump of the same capacity should be installed.

C.3.2.2 In cases where stand-by pumping capacity is required, it is best to connect two or more smaller units in parallel; this offers the advantage of one or more pumps remaining switched off at the lower demand and those pumps that do work, operating at the design point (i.e. maximum efficiency).

C.3.2.3 In high-reliability installations, one or more pumps will be used as stand-by substitutes. The advantage here is that the "idle" capital locked up in such a "dormant" pump will be much less than for a (large) single pump, because pumps connected in parallel are mostly much smaller. Even when constant delivery is required, two or more pumps connected in parallel are preferable, especially since some installations are so large that a single pump that can fully supply the demand is not readily available. Besides, two or more pumps in parallel can be used to utilize the most efficient speed of existing drive motors.

C.3.2.4 In many pump installations where a combination of pumps (each with a half, a third, a quarter or smaller fractional capacity of the demand) are used together with one or more stand-by pumps, the aggregate installation cost is lower than it would have been if two full-sized pumps had been installed.

C.3.2.5 It is not necessary that pumps connected in parallel be identical. However, as already stated, pumps that have unstable *H/Q* curves can cause problems when connected in parallel.

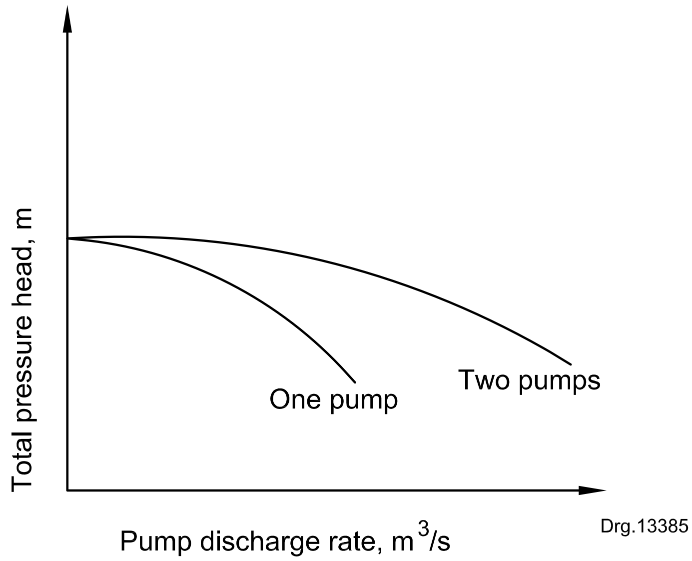


Figure C.3 — Parallel connection of pumps

C.4 System characteristic curves

C.4.1 Determination of operating point

C.4.1.1 The operating point of a pump is that point on the pump characteristic curve at which the pump can supply a given discharge rate to a given system, at a given drive speed, and at a given pressure head.

C.4.1.2 It is important to first determine the working point at which any pump will function when connected to any specific pipe system. The required pressure head for a discharge rate, Q, is given using the following equation:

$$H_{req} = H_{stat} + H_{loss} \quad \text{(C.3)}$$

$$= (H_s + H_d) + (h_{fs} + h_{fd}) \quad \text{(C.4)}$$

where

H_{req} is the required pressure head for a discharge, Q, in the relevant system, in metres (m);

H_{stat} is the static head, in metres (m);

H_{loss} is the energy head loss due to friction and secondary losses, in metres (m);

H_s is the static suction head, in metres (m);

H_d is the static discharge head, in metres (m);

h_{fs} is the energy head loss in the suction branch, in metres (m);

h_{fd} is the energy head loss in the discharge branch, in metres (m).

Applying Bernoulli's equation to the suction and delivery branches in turn,

$$h_{fs} \frac{P_s}{w} = H_s + \frac{(V_s)^2}{2g} + \frac{h}{s} \quad \text{(C.5)}$$

where

P_s is the pressure at the pump inlet, in pascals (Pa);

w is the density of water, in kilograms per litre (kg/L);

V_s is the characteristic velocity in the suction branch, in metres per second (m/s);

g is the gravitational acceleration, in metres per square second (m/s^2).

C.4.1.3 It is clear, therefore, that the total head pumped against comprises the static lift plus the system energy losses. The latter can all be expressed as a function of Q^2, which is a quadratic relationship.

This relationship can be graphically illustrated by a curve that has a parabolic shape and is called the pumping installation characteristic curve.

When the pumping installation characteristic curve is superimposed over the pump head versus the discharge characteristic curve, the point of intersection of the two curves will present the working point. As the working point is a point of dynamic equilibrium, it means that at the working point on the characteristic curve, a balance exists between the added total energy and the energy required by the system.

C.4.1.4 In an economic analysis, the piping system cannot be considered in isolation from the pump, since the pump performance and the external piping characteristics are interrelated. A pump should be so selected for a particular application that the pump is not only capable of delivering the stipulated discharge rate, but it also does so at, or near, its peak efficiency.

The piping layout is an important feature of any pumping installation, and considerable care should be taken to ensure that the design is efficient. On the suction side, the aim should be to reduce head losses to a minimum so as to keep the total suction lift within the prescribed limits (see C.4.2).

Economic considerations are involved in deciding the best diameter for the discharge pipework. The larger the diameter, the higher the capital cost, but also the lower the running cost because of reduced frictional losses. Usually the pipe sizes selected result in velocities of between 1,5 m/s and 3 m/s.

The pump can only deliver according to its *H/Q* characteristic curve. The total head pumped against, however, comprises the static lift plus the pipe system energy losses (see equation (C.3)).

A family of parabolic curves based on different pipe diameters can be drawn, and if these curves are super-imposed on the pump performance curves as in figure C.4, and the relevant working points are noted, the actual discharge and efficiency can be determined for delivery piping of any given diameter.

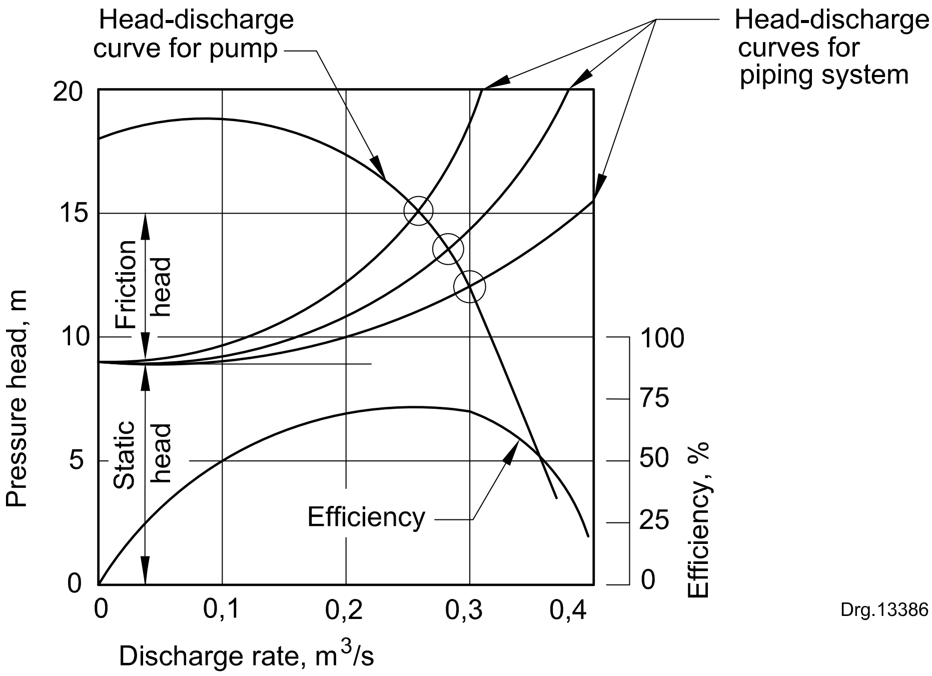


Figure C.4 — Pump and pump installation characteristic curves

C.4.2 Determination of the maximum permissible suction head

C.4.2.1 The term "suction head" denotes the total static pressure head difference between the surface of the water on the suction side of the pump impeller and the point in the pump where the absolute pressure, P_{sa}, is at its minimum (usually in the impeller eye). To avoid cavitation, the pressure at the inlet to the pump should not fall below a certain minimum, which is dictated by the further reduction in pressure that occurs within the pump passages.

C.4.2.2 From equation (C.5), the absolute pressure at the inlet is given, using the following equation:

$$\frac{P_{sa}}{w} = H_a - \left[H_s + \frac{V_s}{2g} + h_{fs} \right] \qquad \text{(C.6)}$$

where

P_{sa} is the absolute pressure at the inlet, in pascals (Pa);

H_a is the atmospheric pressure head, in metres (m).

C.4.2.3 From equation (C.6), it can be seen that the maximum static suction head, H_s, is limited by the atmospheric pressure head, H_a, the total energy loss on the suction side (function of V_s), and the absolute pressure, P_{sa}.

C.4.2.4 The head required to force the water from the suction inlet into the impeller is called the net positive suction head (*NPSH*). By definition, it is equal to the inlet head minus the vapour pressure head, or

$$NPSH = \left[\frac{P_{sa}}{w}\right] - \frac{P_V}{w} \qquad \text{(C.7)}$$

C.4.2.5 Using equation (C.7), the following is obtained:

$$NPSH = H_a - \frac{P_V}{w} - H_s - h_{fs} \qquad \text{(C.8)}$$

where

NPSH is the net positive suction head, in metres (m);

P_{sa} is the absolute pressure at the inlet, in pascals (Pa);

w is the density of water, in kilograms per litre (kg/L);

P_v is the vapour pressure of the liquid to be pumped at the temperature prevailing inside the pump, in pascals (Pa);

H_a is the height of a water barometer, in metres (m);

H_s is the static suction head, in metres (m);

h_{fs} is the energy head loss in the suction branch, in metres (m).

C.4.2.6 The *NPSH* is dependent on the pump design. The relationship between the *NPSH* and the pump discharge rate, *Q* that applies to any specific commercial pump, is normally determined by the manufacturer under laboratory conditions and is supplied with the pump (normally as a graph of *NPSH* versus *Q*).

C.4.2.7 In equation (C.8), the sum of H_s and h_{fs} is the effective suction lift, H_{es}, so that

$$NPSH = \frac{P_a}{w} - \frac{P_v}{w} - h_{es} \qquad \text{(C.9)}$$

C.4.2.8 Using equation (C.9), the maximum permissible suction head can then be calculated using the following equation:

$$H_{ms} = \left(\frac{P_V}{w}\right) - \left(\frac{P_a}{w}\right) + NPSH \qquad \text{(C.10)}$$

where

H_{ms} is the maximum permissible suction head, in metres (m);

P_v is the vapour pressure of the liquid to be pumped at the temperature prevailing inside the pump, in pascals (Pa);

w is the density of water, in kilograms per litre (kg/L);

P_a is the local atmospheric pressure, in pascals (Pa);

H_{es} is the effective suction lift, in metres (m);

NPSH is the net positive suction head, in metres (m).

C.4.2.9 The local atmospheric pressure can be determined physically with an atmospheric pressure gauge or barometer, or it can be established from table C.2. The relationship between vapour pressure and atmospheric pressure can be established from those given in figure C.5.

Table C.2 — Atmospheric pressure as a function of altitude

1	2
Altitude m	**Atmospheric pressure** kPa
0	101,3
500	95,3
1 000	89,9
1 500	84,4
2 000	79,5

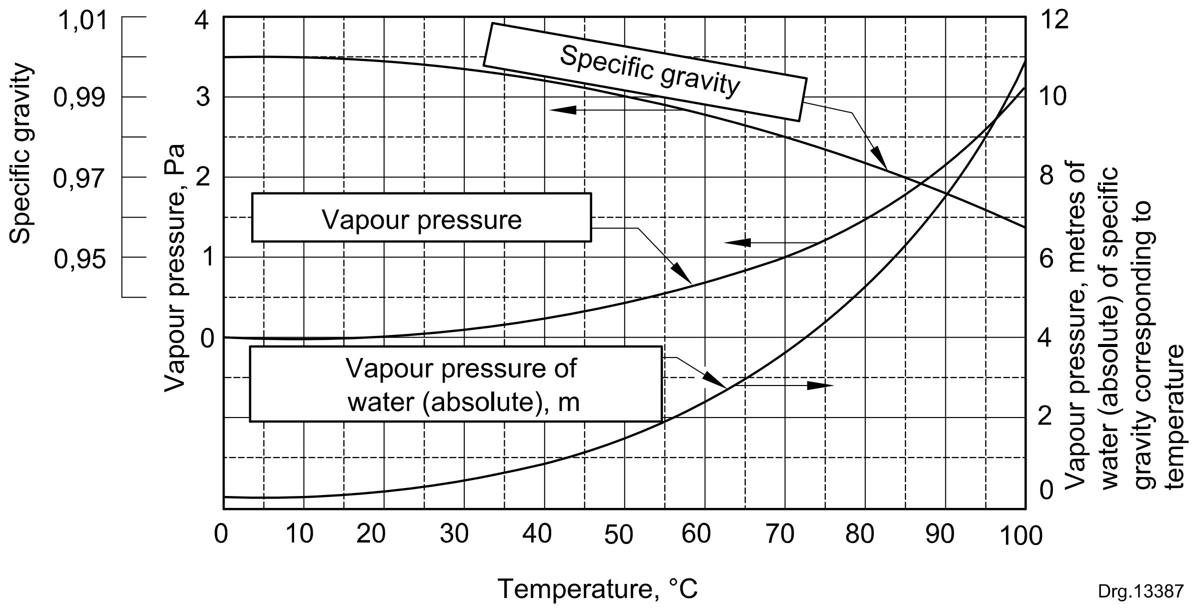


Figure C.5 — Relationship between vapour pressure and atmospheric pressure for water

C.4.2.10 If the suction head is fixed for a given pump arrangement, the required *NPSH* can be calculated using equation (C.10). With the aid of the pump characteristic curve supplied by the pump manufacturer, a check can then be carried out to determine whether a pump meets the required *NPSH.*

As for the required *NPSH*, a curve can also be drawn of the available *NPSH* against *Q*, where the available *NPSH* will decrease as *Q* decreases. The point of intersection of the available and required *NPSH* curves represents the maximum *Q* at which the pump will still function satisfactorily.

C.5 Pump installation layout

C.5.1 General

The layout of the pump station should be such that maintenance on any part of it can be carried out without difficulty, and that another motor or pump can be so installed during the servicing of the relevant motor or pump that the water supply system will remain operative.

The installation and specifically the discharge pipeline should also be protected against dynamic pressures that can develop after the pump has been switched on and off, or as a result of any other cause. Backflow should be avoided by the use of one-way control valves.

Attention should be given to the location of the plant, to minimize noise so as not to affect the user of the service.

C.5.2 Stand-by pumps

To ensure that the pump system remains at least partially operative during maintenance or repair work, it is sound practice to so select pump units that between 50 % and 100 % of additional pump capacity remains available. Another approach that can be adopted is to ensure that the total pump capacity is equal to at least four times the average demand.

C.5.3 Inlets to pumps

The pump inlets of water installations, especially larger water installations, should be protected by grids placed in front of the inlet openings. The grids should be of such design that unwanted objects are kept away from the pump without causing an unacceptable loss of energy.

Any pump should be protected against low water pressure in the suction pipe. The pump inlets should be so located that eddying does not occur, since this will cause air to enter the suction pipe, especially when water levels drop on the suction side. Prevention of eddying is particularly important in the suction pipes of booster pumps for fire protection. It is important to provide for the decrease in the flow rate of water that will still be available after the introduction of anti-eddying measures.

C.5.4 Ventilation and lighting

Adequate ventilation should be provided to prevent overheating of the pump motors. Likewise, lighting should be adequate to allow effective inspection and maintenance of the pump installation.

C.5.5 Instructions for operation and maintenance

A clear description of the operation of the pump installation together with a schematic indication of the positions of the shut-off valves should be available in a user friendly format at the pump installation.

A clear indication of the maintenance required should be given. Log books should be kept ready for signature as proof that the necessary maintenance has been carried out.

An electrical diagram of the installation should also be kept in a conspicuous place at the installation, in accordance with SANS 10142-1.

C.6 Electric motors for pumps

C.6.1 Applicable specifications

The following standards are generally applicable to electric motors (see C.1):

a) SANS 1804-1;

b) SANS 1804-2;

c) SANS 1804-3; and

d) SANS 1804-4.

C.6.2 General design approach

The following general aspects should considered:

a) single-phase motors can be used for ratings up to and including 3 kW;

b) motors larger than 3 kW are generally of the three-phase type;

c) wherever possible, the speed of motors should not exceed 5 000 r/min; and

d) motors should be rated to cope with continuous full-load working conditions.

C.6.3 Methods of starting pump motors

The following starting methods are in general use:

a) motors up to 5 kW – direct on-line;

b) motors from 5 kW up to 50 kW – reduced voltage, half-wound or slip-ring starting methods; and

c) motors larger than 50 kW – reduced voltage, half-wound or slip-ring starting methods (closed cross-over only).

Generally, pump motor control systems should be so designed that switching on and off of the motor does not occur more than 15 times/h. Note should also be taken of the manufacturer's recommendations in this regard and of the types of starters that should be used.

C.6.4 Protection of motors

C.6.4.1 The following equipment should be installed on the control panel as standard equipment for the pump installation:

a) a main isolating switch;

b) circuit-breaker protection for each motor;

c) contactors for each motor;

d) thermal overcurrent protection for each motor;

e) surge breakers when the installation is exposed to the weather;

f) undervoltage and overvoltage protection in accordance with the relevant standards;

g) phase-failure and rotation protection (three-phase motors);

h) low water level protection; and

i) short-circuit protection.

C.6.4.2 The size and characteristics of the equipment given in C.6.4.1 are determined by the following factors:

a) the electrical fault level of installation;

b) the starting current of pumps;

c) the running current of pumps; and

d) the supply voltage to the installation.

C.6.5 Control systems for pumps

C.6.5.1 Pumps that are controlled by float switches, or by surface sensors (surface switches), should be installed in reservoirs so that the oscillation of the water does not affect them. Surface switches should be operated only by low voltage, up to a maximum of 48 V.

C.6.5.2 Each pump should be fitted with a three-position selector switch that allows the pump to be switched to automatic, manual control and off.

C.6.5.3 The pump installation should at least be fitted with the pilot lights indicated in table C.3. The pilot lights can also be duplicated on a central control panel or on a mimic panel, if so required.

C.6.5.4 It is also good practice to connect the high water level alarm, low water level alarm and pump-faulty alarm to a siren for early warning.

Table C.3 — Pilot lights for pump installations

1	2
Description	**Colour of light**
Pump ON	Red
Pump FAULTY	Orange
Ground storage tank low-level alarm	Orange
High-level storage tank high-level alarm	Orange
Pump system on automatic control	Green
Pump system on manual control	Red
Undervoltage or overvoltage, phase failure or phase rotation fault	Orange

Annex D
(normative)

Cross connection control and backflow prevention

D.1 Protection of potable water supplies

D.1.1 Design, installation and maintenance

All water supply systems shall be designed, installed, and maintained so as to prevent contaminants from being introduced into the potable water supply system.

D.1.2 Protection of fixtures

Only potable water shall be supplied to plumbing fixtures or outlets.

D.1.3 Prevention of contaminants

No device or system that may permit the introduction of any foreign substance into the water service, shall be connected directly or indirectly to any part of the water supply system.

D.1.4 Combined tanks serving flush valves (other than directly connected)

D.1.4.1 Combined tanks storing potable water and water for other purposes shall be separated by a double partition wall installed internally.

D.1.4.2 The space between the partition walls shall be so arranged to ensure that any leakage shall not be able to enter the other compartment of the tank.

D.1.4.3 The tank shall be drained so that any discharge is externally and readily noticed.

D.1.5 Alternative water supplies

D.1.5.1 Where water supplied from one source is connected to another water source

a) a suitable backflow prevention device shall be fitted, and

b) the installation shall be approved.

D.1.5.2 Where the alternative supply is a non-potable water supply, it shall be clearly and permanently labelled "Drinking of this water is prohibited", at every outlet.

D.1.5.3 Such labels (see D.1.5.2) shall meet the requirements of SANS 10140-3 for the distribution pipes, and SANS 1186-1 for the outlets.

D.1.5.4 Where the non-potable water supply is installed below ground the service shall have a continuous marker tape, stating the pipe below contains non-potable water and is installed in the trench above the service.

D.1.5.5 Piping conveying water downstream of a high or medium hazard backflow prevention other than which is used for containment shall be clearly and permanently labelled "DRINKING OF THIS WATER IS PROHIBITED", at every outlet.

D.1.5.6 The caution sign shall comply with SANS 1186-1 and the distribution pipes shall be clearly marked in accordance with SANS 10140-3.

D.1.6 Fixtures, appliances or apparatus

D.1.6.1 Where backflow prevention devices are provided as an integral part of a fixture, appliance or apparatus, and are suitable to the cross-connection hazard generated by the fixture, appliance or apparatus, no additional backflow prevention shall be required upstream of the point of connection to the water supply system.

D.1.6.2 Where a cross-connection is found in the water service at any property or if the water service is installed in a manner that will enable backflow to occur, such cross-connection shall be reported to the water supply authority.

D.2 Cross-connection hazard rating

Cross-connection shall be rated as one of the following:

a) high hazard;

b) medium hazard; or

c) low hazard.

D.3 Provision of backflow prevention devices

D.3.1 General

D.3.1.1 The backflow protection required shall be determined by first identifying the individual hazard(s) within the premises.

D.3.1.2 Working upstream from each hazard, the water shall be regarded as non-potable until a backflow prevention device is provided suitable to the degree of hazard (see figure D.1).

D.3.1.3 Backflow prevention devices shall comply with AS/NZS 2845.1.

NOTE 1 In assessing a potential backflow condition, consideration should be given to the complexity of piping, the probability of piping change, and negligent or incorrect use of equipment resulting in a backflow condition.

NOTE 2 Typical potential cross-connection examples are given in AS/NZS 3500.1.

D.3.2 Type of backflow protection

Backflow prevention devices shall be provided in accordance with

a) the hazard rating given in D.2; and

b) the suitability of the device shown in table D.1.

NOTE See appendix E of AS/NZS 3500.1:2010 for examples of devices relative to levels of protection.

D.3.3 Hose taps

Hose taps within 18 m of a zone protected area within the same premises shall have a backflow protection device of the same hazard rating as the zone protection near which they are installed.

NOTE An example of backflow prevention is given in table C.2 of AS/NZS 3500.1:2010.

D.3.4 Additional backflow protection

In water supply installations where there is potential for unprotected cross-connections, additional backflow protection shall be provided if required by the local authority or by the installation of the supplementary containment zone or individual backflow prevention devices.

D.3.5 Water downstream of backflow prevention device

D.3.5.1 The water service downstream of the backflow prevention device shall not be reconnected to the water service upstream of the backflow prevention device without the installation of an additional backflow prevention device of the same hazard rating.

D.3.5.2 Water downstream of a containment device shall be considered to be potable unless there are unprotected hazards within the premises. Individual or zone protection against these hazards shall be provided to preserve the potability of the internal water supply.

D.3.5.3 Piping downstream of the zone protection shall be identified as not potable.

D.3.6 Inspection and maintenance

D.3.6.1 Testable backflow prevention devices shall be inspected and tested after installation and prior to service.

D.3.6.2 Testable backflow prevention devices shall be maintained in working order and inspected for operational functions at intervals not exceeding 12 months.

D.3.6.3 Where there is no such program, these devices shall not be fitted and the standard air gap requirements shall apply.

D.3.7 Hot water systems

D.3.7.1 Backflow prevention devices shall be installed in hot water supply systems in the same way as cold water supply systems.

D.3.7.2 The backflow prevention device used shall be suitable for the specific hot water installation.

D.4 Suitability of devices for hazards

The actual device selected for each hazard rating shall comply with table D.1, and be approved.

Table D.1 — Suitability of devices

1	2	3	4	5
	Device	**Cross-connection hazard rating**	**Protection against back pressure**	**Protection against back siphonage**
Testable backflow prevention device	Break tank (BT)	High/medium/low	Yes	Yes
	Air gap (AG)	High/medium/low	Yes	Yes
	Reduced pressure zone device (RPZD)[a]	High/medium/low	Yes	Yes
	Reduced pressure detector assembly (RPDA)[a]	High/medium/low	Yes	Yes
	Double-checkvalve assembly (DCV)[a]	Medium/low	Yes	Yes
	Double-check detector assembly (DCDA)[a]	Medium/low	Yes	Yes
	Anti-spill pressure type vacuum breakers (APVD)[a]	Medium/low[b]	No	Yes
	Pressure type vacuum breakers (PVD)[a]	High/medium/low	No	Yes
Non-testable backflow prevention device	Dual-check valve with atmospheric port (DCAP)[c]	Low	Yes	Yes
	Dual-check valve (DUAL CV)[c]	Low	Yes	Yes
	Dual-check valve with intermediate vent (DuCV)[c]	Low	Yes	Yes
	Air gap (AG)	Low	Yes	Yes
	Break tank (BT)	Low	No	Yes
	Atmospheric vacuum breaker (AVB)[c]	Low	No	Yes
	Hose connection vacuum breaker (HCVB)[c] (see note 3)	Low	No	Yes
	Beverage dispenser dual-check valve (BDDC)	Low	Yes	Yes

Table D.1 (*concluded*)

1	2	3	4	5
Non-testable backflow prevention device	**Device**	**Cross-connection hazard rating**	**Protection against back pressure**	**Protection against back siphonage**
	Vacuum break-check valve	Low	No	Yes
	Single-check valve	Fire services only in accordance with appendix C of AS/NZS 3500.1:2010.		

NOTE 1 Pressure type vacuum breakers are designed to vent at 7 KPa, or less. However, they may require a significantly higher pressure to reseat and should only be installed in systems which provide pressures sufficient to ensure full closing of the valve and should not be installed close to water outlets where low pressures could be encountered.

NOTE 2 In areas where water spillage may cause nuisance, tundishes or alternative drainage should be installed to receive the charges from

a) reduced pressure zone devices,
b) pressure type vacuum breakers,
c) dual check with atmospheric port, or
d) atmospheric vacuum breakers.

NOTE 3 Hose connection vacuum breakers are designed to withstand the small amount of back pressure that would occur if the end of hose is higher than the hose tap.

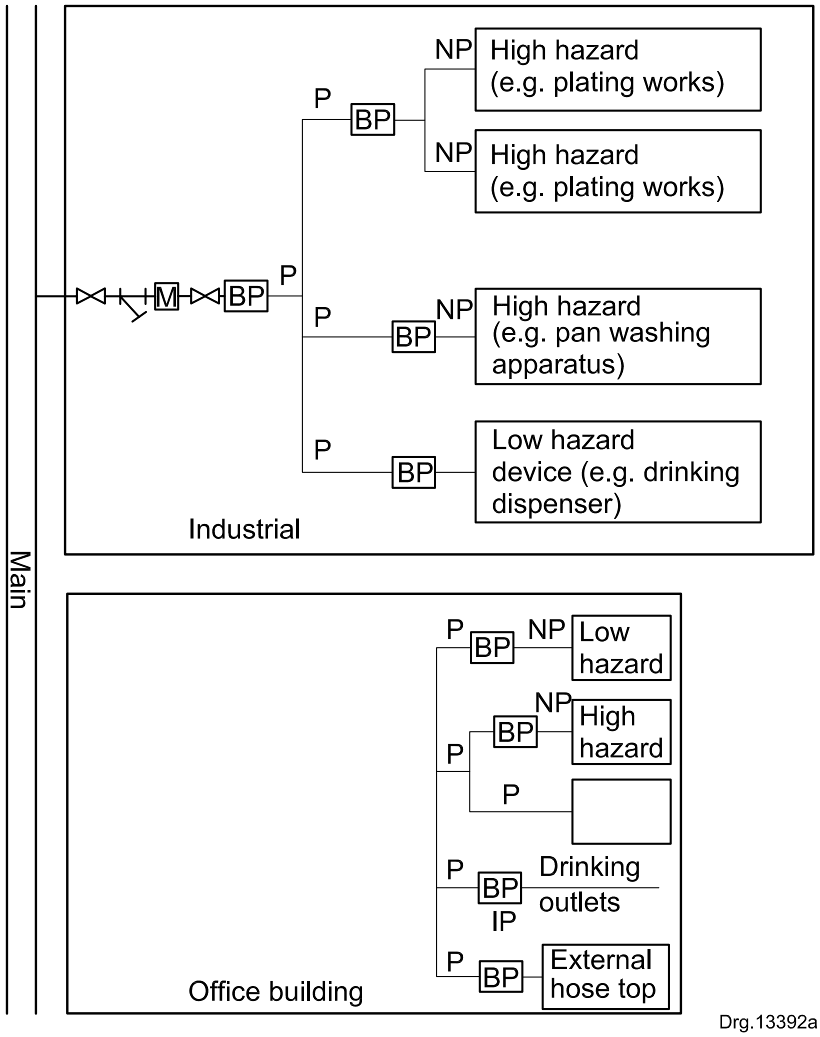
NOTE 4 Pressure type vacuum breakers, atmospheric vacuum breakers and hose connection vacuum breakers, should only be used to protect against back siphonage.

NOTE 5 A single-check valve is not considered a backflow prevention device in accordance with AS/NZS 2845.1.

[a] Backflow prevention devices that are provided with test taps for the purposes of testing the operation of the devices, and do not necessarily include isolating valves.

[b] Anti-spill vacuum breakers are suitable for high hazard installation for mains pressure flushing valves.

[c] Backflow prevention devices that are not provided with test taps for the purposes of testing the operation of the devices.



Key

BP backflow prevention device

NP non-potable water

P potable water

IP individual protection

Figure D.1 — Typical backflow prevention setup

D.5 Installation of backflow prevention devices

D.5.1 General

D.5.1.1 No heat shall be applied to any device during installation.

D.5.1.2 Installation for pressure type vacuum breakers (PVB), anti-spill pressure type vacuum breakers (APVB), double check valves (DCV), and double detector check valve (DDCV), as well as reduced pressure zone devices (RPZD) and dual reduced pressure zone devices (DRPZD), shall be fitted with line strainers in accordance with D.5.1.4.

D.5.1.3 Except where used in fire service installations, line strainer elements shall comply with the requirements given in table D.2.

Table D.2 — Maximum orifice diameters and maximum centre distance of line strainer element perforations

1	2	3
Size (nominal diameter) DN	**Max. orifice diameter** mm	**Max. centre diameter** mm
20	1,6	2,4
25	1,6	2,4
32-40-50	3,25	5,6
80-100-150	4,6	5,6
200-250-300	4,6	5,6

D.5.1.4 For all testable devices, resilient seated (drop tight when closed) isolating valves shall be installed in the following positions:

a) immediately upstream of the line strainer, or immediately upstream of the device in cases where no integral line strainer is fitted (see D.5.1.2); and

b) immediately downstream of the device.

D.5.1.5 Piping shall be flushed before devices are connected.

D.5.2 Installation of devices

D.5.2.1 Unprotected bypasses shall not be installed around backflow prevention devices.

D.5.2.2 The devices shall be installed in accordance with D.5.6 and the manufacturers written instructions.

D.5.2.3 The devices shall be protected from damage, including freezing.

D.5.2.4 Where continuous water supply is essential, devices shall be installed in parallel to permit the shut down of a device.

D.5.2.5 In-line devices should have a capability for easy removal and replacement.

NOTE For typical installations see AS/NZS 3500.1.

D.5.3 Location of devices

D.5.3.1 Backflow prevention devices shall not be located in a corrosive or polluted atmosphere, where the contaminated air can enter the piping system through the air gap or open vent port, or cause the device to malfunction.

D.5.3.2 Insulation or any other protection of a backflow prevention device shall not interfere with its operation, testing or maintenance.

D.5.3.3 Vented testable backflow prevention devices shall not be located in pits.

D.5.3.4 Backflow prevention devices shall not be buried in the ground.

D.5.3.5 Where water hammer occurs it should be rectified by the installation of a surge protector or water hammer arrestor.

D.5.3.6 All in-line devices shall be installed with connections that permit the removal and replacement of the device.

D.5.4 Accessibility

D.5.4.1 All devices shall be readily accessible for ease of maintenance or testing.

D.5.4.2 Where the device is fitted with test taps, their location shall ensure the accessibility necessary for the performance of the applicable test procedure and maintenance as given in AS 2845.3.

D.5.5 Drainage and leakage

Backflow prevention devices shall be positioned so that any leakage from the air ports of vacuum breakers, or drainage from reduced pressure zone devices and vented double check valves shall be readily visible, but not constitute a hazard or a nuisance.

D.5.6 Specific installation requirements for testable and non-testable devices

D.5.6.1 General

Backflow prevention devices shall be installed in accordance with D.5.1, D.5.2 and the requirements given in D.5.6.2.1 to D.5.6.2.6.

NOTE For examples of backflow prevention devices see AS/NZS 3500.1.

D.5.6.2 Testable devices

D.5.6.2.1 Break tanks shall comply with section 8 of AS/NZS 3500.1:2010, and the following air gap requirements:

a) The unobstructed vertical distance through the free atmosphere between the lowest opening for a water service pipe or fixed outlet supplying water to a break tank (BT), and the highest possible water level of such BT, shall be as given in table D.3.

b) Where any break tank receives water from two or more water services of different diameter, the air gap shall be not less than the air gap required for the largest effective opening of the water service outlets as given in table D.3.

D.5.6.2.2 Pressure type vacuum breakers shall

a) be located not less than 300 mm above the surrounding surface,

b) be ventilated to the atmosphere at all times, and

c) not be located in an area that may be subject to ponding or freezing.

Table D.3 — Minimum air gap

Dimensions in millimetres

1	2	3
Diameter of the effective opening of the water service outlet	**Minimum air gap**	
	When not affected by near wall	**When affected by near wall**
≤ 9	20	25
> 9 ≤ 12	25	40
> 12 ≤ 20	40	55
> 20 ≤ 25	50	75
> 25	2 × effective opening	3 × effective opening

D.5.6.2.3 Double check valves shall be located so as not to be subject to freezing.

D.5.6.2.4 Double check valves and reduced pressure detector assemblies shall

a) have free ventilation to the atmosphere for the relief valve outlet at all times,

b) not be located in an area that may be subject to ponding,

c) have the relief drain outlet located not less than 300 mm above the surrounding surface, and

d) be located so that they are not subject to freezing.

D.5.6.2.5 Double check detector assemblies (DCDA) shall be located so that they are not subject to freezing.

D.5.6.2.6 Anti-spill pressure vacuum breakers (APVB) shall

a) be located not less than 300 mm above the highest outlet,

b) be ventilated to the atmosphere at all times, and

c) not be located to an area subject to ponding.

D.5.6.3 Non-testable devices

D.5.6.3.1 General

Although non-testable devices are not subject to verification for on-going effective operation, they should be checked for effective operation (at least every two years).

D.5.6.3.2 Atmospheric vacuum breakers (AVB)

Atmospheric vacuum breakers shall

a) be located not less than 150 mm above the highest outlet,

b) have no isolating valves located downstream of the vacuum breaker,

c) not, under normal operation, remain continuously pressurized for 12 h (see AS/NZS 2845.1),

d) be ventilated to the atmosphere at all times,

e) not be located in an area that may be subject to ponding, and

f) be located in line and be at least the same size as the supply and discharge piping.

D.5.6.3.3 Hose connection vacuum breakers (HCVB)

Hose connection vacuum breakers shall

a) be located downstream of the isolating valve,

b) not, under normal operation, remain continuously pressurized with water for more than 12 h, and

c) be ventilated to the atmosphere at all times.

D.5.6.3.4 Dual-check valves with atmospheric port (DCAP)

Dual-check valves with atmospheric port shall

a) not be located in an area that is subject to ponding or freezing, and

b) have the vent port located not less than 300 mm above the surrounding surface so that the device is freely drained.

D.5.6.3.5 Dual-check valves (DUAL CV)

Dual-check valves shall be located in an area not subject to freezing.

D.5.6.3.6 Dual-check valves with intermediate vent (DuCV)

Dual-check valves with an intermediate vent shall

a) not be located in an area subject to ponding, and

b) have the vent port located in accordance with figure E.5 of AS/NZS 3500.1:2010.

NOTE See D.5.5 regarding leakage from devices.

D.5.6.3.7 Beverage dispenser dual check valves (BDDC)

Beverage dispenser dual check valves shall

a) be located in an area not subject to freezing, and

b) have the vent port located not less than 300 mm above the surrounding surface so that the device can drain freely.

D.5.6.3.8 Vacuum breaker check valves (VBCV)

Vacuum breaker check valves shall

a) be located in an area not subject to freezing, and

b) have the vent port located not less than 300 mm above the surrounding surface so that the device can drain freely.

D.5.6.3.9 Single check valves (spring loaded)

Single check valves shall

a) have an isolating valve installed upstream and adjacent to the device,

b) be fitted in an accessible position, and

c) only be used in fire services.

Annex E
(informative)

Hot water systems

E.1 Types of generating plants

E.1.1 Direct and indirect hot water generating plants

In a direct hot water generating plant, the potable water is heated through direct contact with the heater elements. In an indirect hot water generating plant, the potable water is heated indirectly by means of a heat exchanger in which heat is transferred from a circulating fluid inside a primary circuit to the potable water in a secondary system.

In direct systems, scale formation in pipes or corrosion of pipes is more prevalent than in indirect systems. While the indirect system is commonly used in large installations, it is expensive for small installations. Indirect systems are less efficient than direct systems owing to performance losses at the heat exchanger.

E.1.2 Storage and non-storage systems

Hot water systems can incorporate storage or can be of a non-storage type. A storage system is characterized by the storage of the bulk of the water which is heated at a more or less constant rate, and hot water is drawn from the storage on demand. A non-storage system or an "instantaneous water heater" that heats the water on demand is usually a localized type of system, with each fitting usually needing its own heater.

A storage system can supply hot water at a high discharge rate, but the total quantity of hot water that can be drawn is limited. On the other hand, a non-storage system usually delivers hot water at a rather slow rate, but can keep it up almost indefinitely.

The cold water that enters near the bottom of the heater should not mix appreciably with the hot water in the heater. The satisfactory delivery of the total hot water demand from a storage system is often dependent on the effects of temperature stratification within the storage vessel. Stratification can be defined as the floating of hot water on a layer of cold feed water, which occurs naturally owing to the different densities of hot and cold water. This phenomenon enables hot water to be drawn from the top of a storage vessel.

Figure E.1 shows a water heater that delivers into a storage tank or into a distribution network, and figure E.2 shows a water heater that delivers into storage only.

E.2 Energy sources and heat transfer equipment

Energy sources include fuel combustion, electrical energy conversion, solar energy collection, and the transfer of heat between sources and recipients. Sources that can release energy include ambient air, water, soil or recovered waste heat from flue gases, process waste water or ventilation and air-conditioning systems.

Heat transfer equipment can be solid-fuel fired, oil fired, gas fired, solar powered, or heated by electricity. Direct heating by electricity can be accomplished with immersion elements, dry elements or external heater elements and indirect heating by electricity with a heat pump or a steam heater (calorifier).

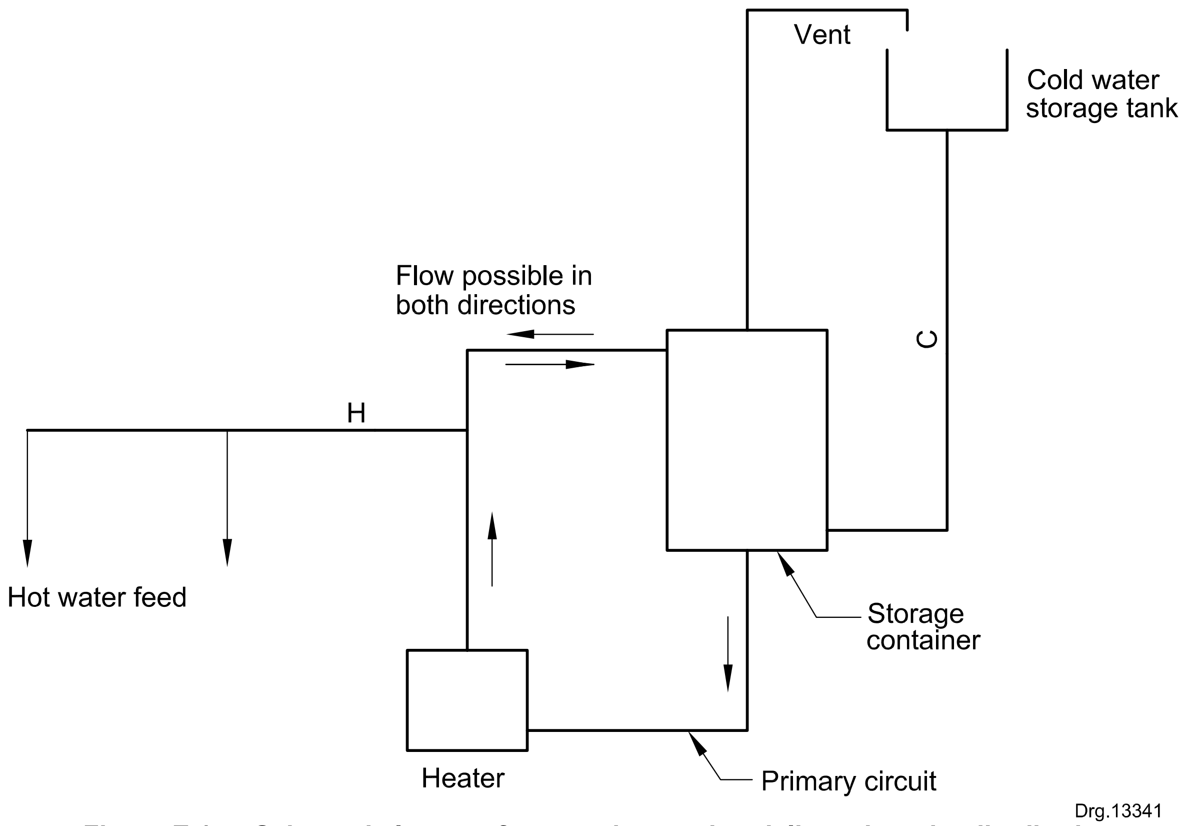


Figure E.1 — Schematic layout of a water heater that delivers into the distribution network or into the storage container

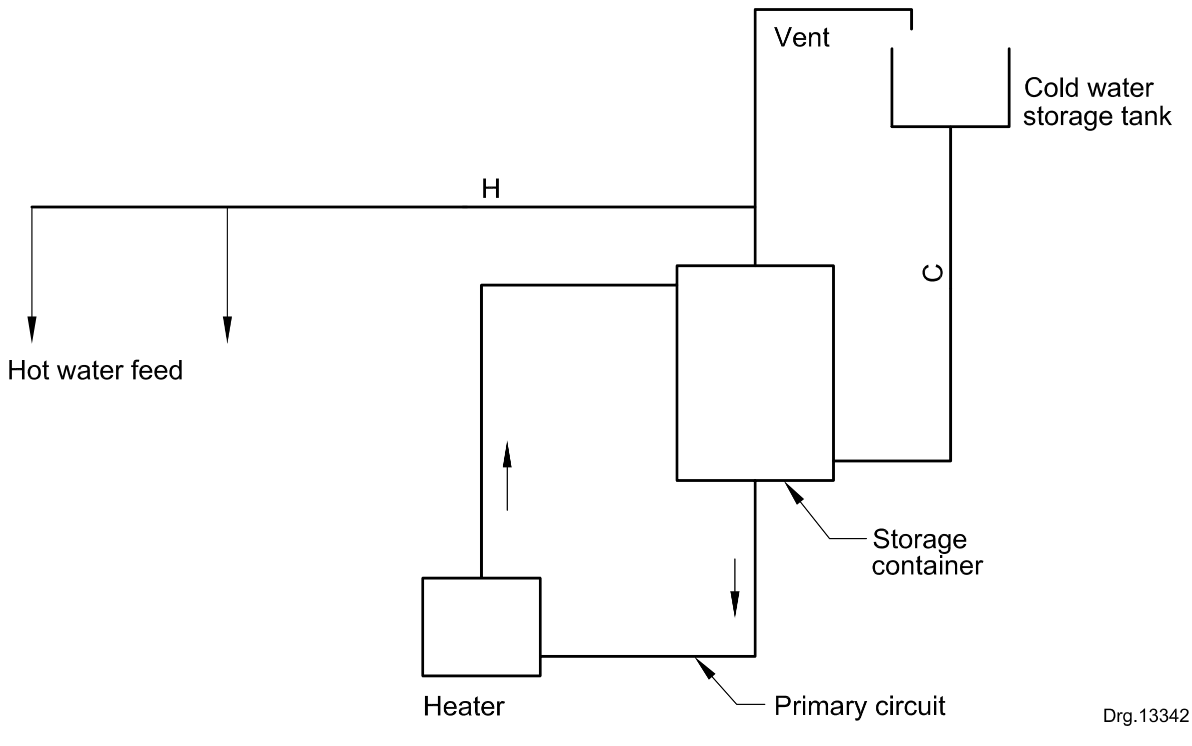


Figure E.2 — Schematic layout of a water heater that delivers into storage only

E.3 Types of water heaters

E.3.1 Fuel water heaters

E.3.1.1 Fossil-fuel type direct-fired heating

E.3.1.1.1 Fuel-type direct-fired water heaters utilize fossil fuel fired in a boiler, and the hot water can be used for space heating as well as for domestic purposes, without the need for a heat exchanger.

E.3.1.1.2 The high temperatures attained in boilers can result in disadvantages such as

a) where the water is soft and therefore corrosive, discoloration of the water due to corrosion can occur,

b) where the water is hard, discoloration will be less serious but the formation of scale and the accumulation of sludge could occur, and

c) the water temperature that is usually far from uniform.

E.3.1.1.3 Particular note should be taken of statutory requirements regarding these types of systems.

E.3.1.1.4 A typical fuel-type direct-fired hot water system is shown in figure E.3.

The two types of fossil fuels that can be fired in the boiler are described in E.3.1.2 and E.3.1.3.

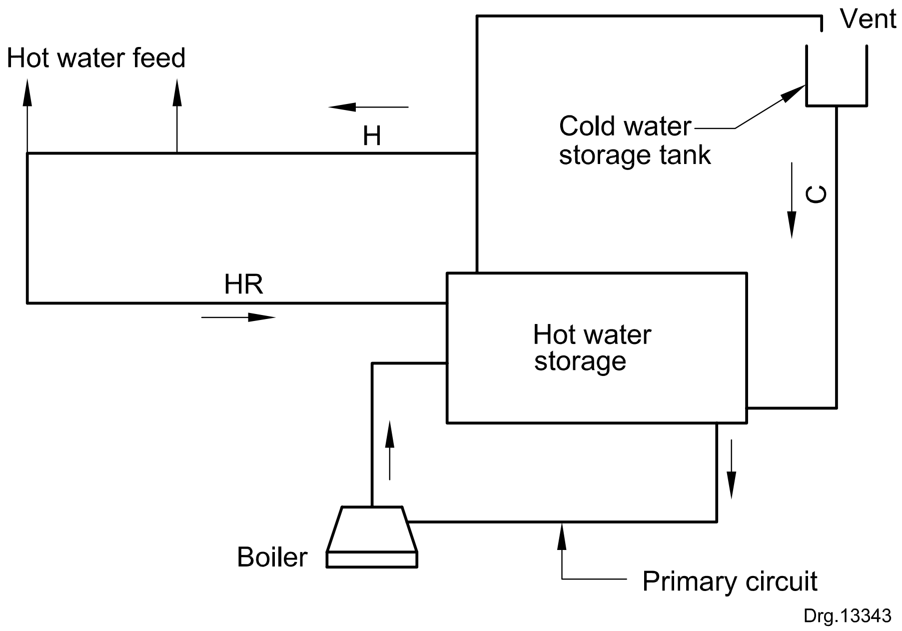


Figure E.3 — Fuel-type direct-fired hot water system

E.3.1.2 Solid-fuel-fired boilers

The solid fuel burned in solid-fuel-fired boilers is usually coke. Such boilers should be located close to ground level because of installation requirements such as fuel delivery and storage, and the removal of ash. Since the flue should be taken up to a level where the combustion products could be discharged harmlessly and without creating a nuisance, this often requires that the flue be taken above the highest part of the building and this further limits the location of the boiler and flue. Where the boiler room is remote from the flue, it is possible to run a portion of the flue horizontally, but induced draught fans would be needed to assist the flow of the gases. Ventilation of the boiler room is essential, not only for combustion, but also to control temperatures in the boiler room.

E.3.1.3 Oil-fired heaters

Oil-fired heaters are generally of the storage type, but could also be of the instantaneous type. A characteristic of an oil-fired heater is its high energy yield. This type of heater can utilize a system, of pressure-atomizing aspirating or vaporizing burners. The energy delivery rate can range from approximately 2,5 L/min, undergoing a temperature rise of approximately 55 °C with 75 L of storage, to 80 L/min undergoing the same temperature rise with 750 L of storage. As far as their location on the site is concerned, oil-fired heaters are less restricted than solid-fuel-fired boilers, since oil can be pumped up to a small boiler feeder tank if necessary. A flue is also required to carry the products of combustion to a place where they can be harmlessly discharged.

E.3.2 Instantaneous water heaters

E.3.2.1 General

Instantaneous water heaters heat and deliver water on demand. These heaters are often used where a supplementary hot water supply is required, for example, at a single outlet in a position remote from the main hot water system. The advantage of an instantaneous heater is the fact that it is compact and does not waste energy in keeping stored water hot. Two types of instantaneous heaters are described in E.3.2.2 and E.3.2.3.

E.3.2.2 Gas-fired instantaneous heaters

A gas-fired instantaneous heater is self-contained and can be either of the automatic instantaneous or of the continuous flow type. Water is heated as it flows through a copper coil or tube while the opening of the gas valve is controlled by a water flow switch or a pressure switch. Most instantaneous heaters have a modulating gas valve that varies the gas flow to cater for changing water flow rate demands. Usually a pilot burner ignites the main burners on demand.

In general, gas-fired instantaneous heaters are most suited for installations in which water flow rates are mainly steady and where accurate temperature control is not needed. Automatic gas-fired instantaneous heaters are more suitable for domestic purposes, and continuous flow storage/circulation tank types for industrial use. Circulation types in effect comprise a separate heater that is connected to a storage tank although the burner, storage tank, steel jacket, insulation and controls are housed in a single unit. These systems require forced circulation of the water and usually both the heater and the pump are controlled by a temperature sensor in the tank. Generally, a copper coil (or tube) heater is used as a heat exchanger. A typical gas-fired instantaneous water heater is shown in figure E.4.

E.3.2.3 Instantaneous electric heaters

The delivery rate of hot water is dependent on the flow rate, the temperatures of the incoming and outgoing water and the power rating of the element. For example, with an incoming water temperature of 15 °C, a required flow rate of 10 L/min and a required temperature rise of 20 °C, a 14 kW element would be necessary. Local authorities in South Africa do not permit elements for domestic single-phase equipment that exceed a rating of 3 kW to 4 Kw, to be connected to their electricity supply systems.

A thermostatic mixing valve can be used in conjunction with an instantaneous electric water heater, to maintain the hot water supply at a uniform temperature and to limit the danger of scalding.

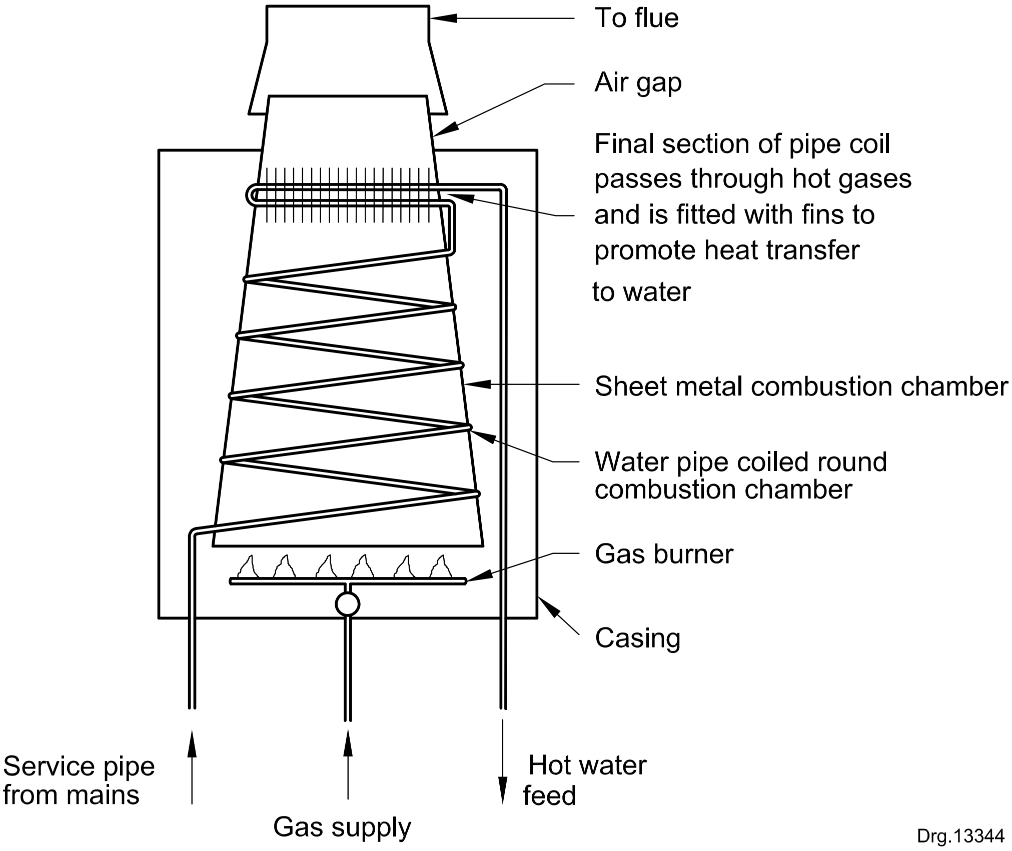


Figure E.4 — Gas-fired instantaneous water heater

E.3.3 Hot water generating plant that uses steam heating

Because of the large energy transfers obtained with steam, accurate temperature control is very difficult and this type of system is therefore usually not appropriate for producing hot water for domestic purposes.

Hot water can be generated by making use of steam from an external source, either by introducing it direct into the cold water by means of an injection process, as it is sometimes used in commercial laundry or industrial process equipment, or by circulating it through a coil immersed in an auxiliary storage vessel. The latter is an indirect system, known as a calorifier, in which heat is transmitted from the coil to the water in the storage cylinder, without direct contact between the steam and the water.

Calorifiers are designed for service conditions where hot water requirements are not constant and where large volumes of heated water have to be held in storage for periods of peak load. Calorifiers are often used where steam is already available, or where a building requires central heating and a central hot water supply in addition to a central steam supply, as is often the case in a hospital.

Corrosion and scale formation are usually not a problem in a calorifier because very little make-up water, and hence very little oxygen, is introduced into the primary (steam) circulating system. It is good practice to provide a condensate trap on the return side of the coil to prevent a condensate build-up that can promote corrosion. Space is to be provided to allow for the removal of steam coils or tubes.

A typical calorifier system is shown in figure E.5. A spiral coil calorifier is shown in figure E.6 and a U-tube battery calorifier is shown in figure E.7.

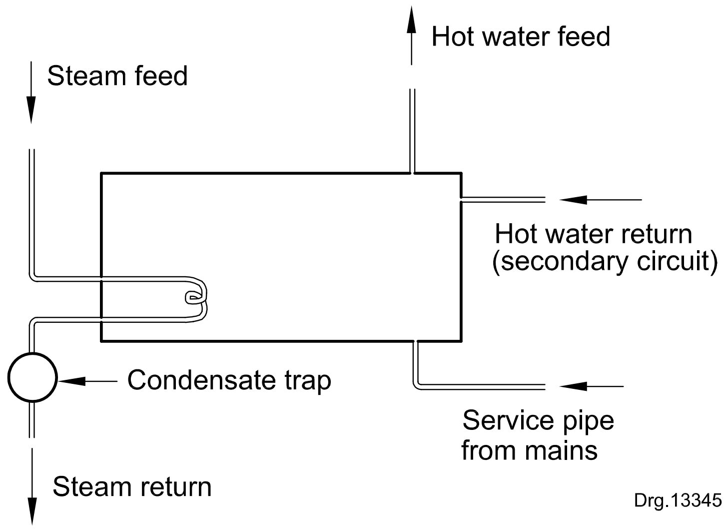


Figure E.5 — Calorifier system

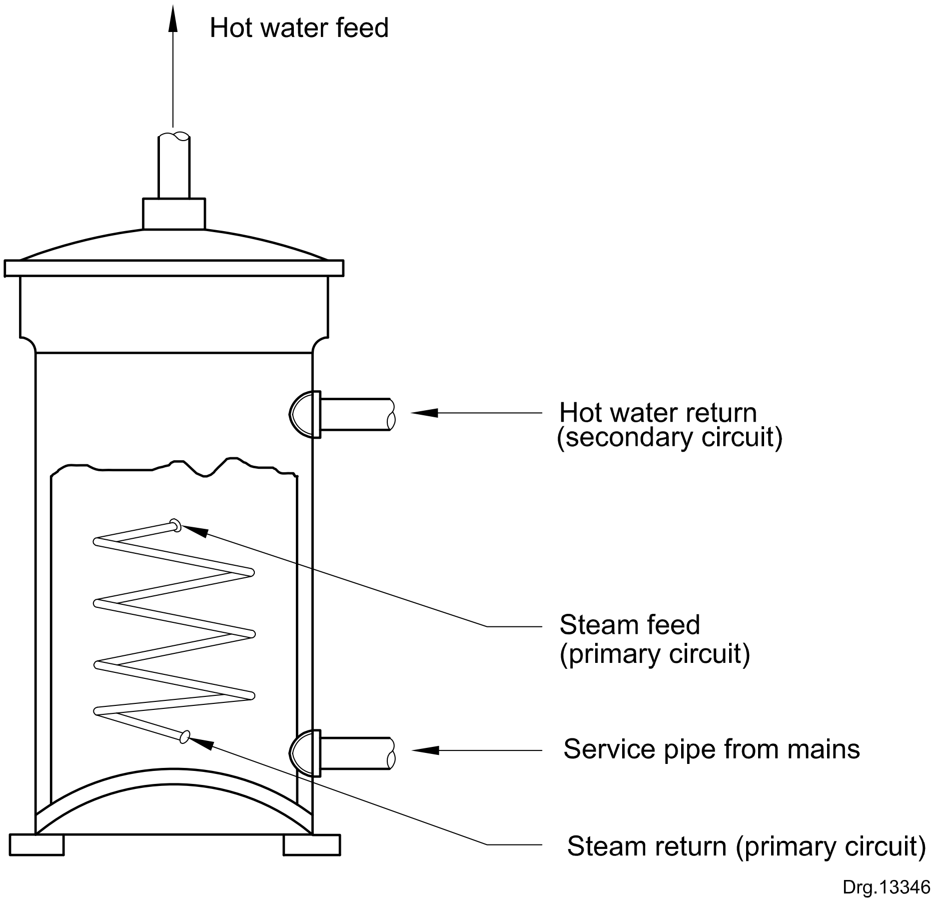


Figure E.6 — Spiral coil calorifier

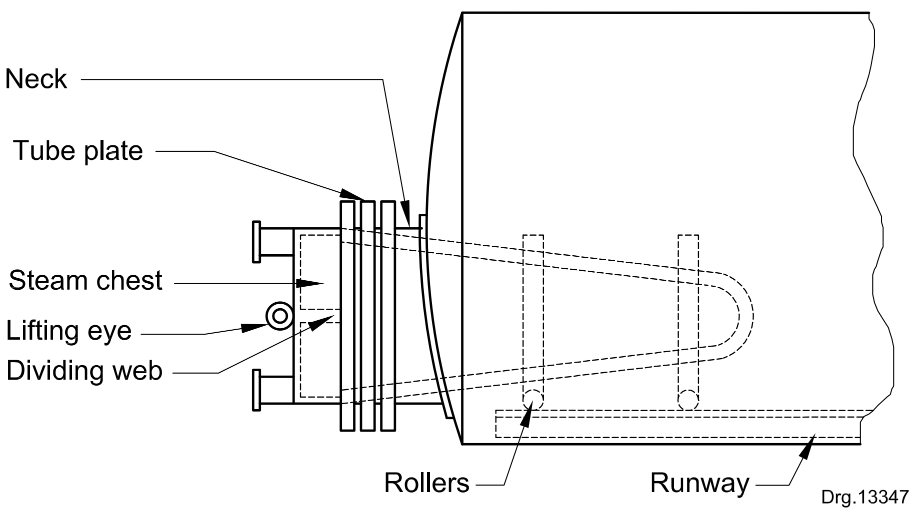


Figure E.7 — U-tube battery calorifier

E.3.4 Solar hot water generating plant

E.3.4.1 Solar heaters effectively absorb heat from the sun from approximately 10:00 until approximately 16:00. Solar irradiance is at its peak between approximately 12:00 and 14:00. However, sufficient quantities of hot water are stored for use after 16:00. Solar heaters currently available cannot meet the hot water demands of a modern household on their own. Savings in electricity consumption are obtained when a solar heater is used to pre-heat water for an electric storage water heater. On average, the electricity used for water heating in a domestic dwelling constitutes approximately 50 % of the total electricity consumption. A well designed solar heating system generally provides approximately 80 % of the hot water requirement, thereby reducing the electricity account by 40 %. The average efficiency of different types of solar absorbers is given in table E.1.

E.3.4.2 A critical factor in the installation of solar heating systems is the position of the collector relative to the movement of the sun. In the southern hemisphere, collectors should be pointed true north and tilted at an angle above the horizontal equal to the latitude of the site plus 10°. This angle is chosen mainly to favour the collection of solar heat during winter[1)] when the sun is fairly low in the sky, to obtain year round efficiency. A deviation of up to 45° east or west of north may, however, be acceptable in many cases.

E.3.4.3 The shadows of tall objects nearby can severely limit the satisfactory operation of a solar system.

E.3.4.4 All solar water heaters consist basically of an absorber unit that collects the incident solar radiation during the day and a storage tank to contain the heated water. These two main components are separate in most conventional systems, as shown in figures E.8 and E.9, but can also be combined to form a single absorber/storage unit.

E.3.4.5 The design of the absorber unit can vary from a simple flat plate to a more sophisticated reflector type absorber. The latter unit is usually costly. The absorber unit consists of a solar collector and insulation, housed in a weatherproof box with a transparent cover. The flat plate collector, which is useful for domestic water heating, basically consists of a sheet of more or less flat material constructed in such a way that channels are formed through which water can circulate.

E.3.4.6 Ideally, the exposed surface of the collector should absorb the maximum amount of incident solar radiation with a minimum of heat loss. The exposed absorber surface is usually coated with a non-reflective or matt black paint. Unfortunately, ordinary black painted surfaces also re-radiate heat rather well, causing undesirable heat losses that have to be minimized, especially when the ambient temperature is low.

E.3.4.7 Heat losses to the rear, on the unexposed side of the collector plate, are minimized with a layer of insulation. Heat losses will still take place owing to infra-red re-radiation from the plate, air convection around the plate and, to a lesser extent, conduction losses by direct contact between the plate and the atmosphere.

E.3.4.8 The transparent cover over the collector plate prevents ingress of rain, reduces the cooling effect of outside air movement over the collector plate and restricts re-radiation losses, the latter probably being the most important. This means that the incident solar radiation is transmitted through the transparent cover with a minimum loss of heat energy due to absorption, therefore, the cover should also be opaque to infra-red in order to reduce the re-radiation losses from the collector plate. Average achievable absorber efficiencies are given in table E.1.

---

1) A shallower angle may be chosen in winter rain regions.

E.3.4.9 Water circulates between the storage tank and the absorber unit in well insulated pipes. The primary flow pipe carries heated water from the absorber to the tank while the primary return pipe carries cooler water from the tank back to the absorber unit.

E.3.4.10 Thermosiphonic circulation can be created by placing the absorber at the lowest point of the system. The resulting circulation pressure is fairly small and any obstruction or an accumulation of air bubbles in the system can impede the natural flow of the water. The absorber and all pipes are therefore sloped in such a way that air can escape to the tank to be vented off. A typical solar thermosiphonic system is shown in figure E.10. In systems where the storage tank is below the absorber unit, reverse circulation will tend to occur at night; this can be prevented by the installation of a non-return valve in the primary return pipe.

E.3.4.11 While the thermosiphonic system, as shown in figure E.10, is the most popular one for domestic applications, pumped systems permit greater freedom in the placement of the absorber(s), which can then be situated either above or below the storage tank. A typical pumped system is shown in figure E.11. Pumped systems can be direct (where the potable water itself circulates through the solar collector) or indirect as shown in figure E.8, where the potable water is heated via a heat exchanger. In an indirect system, additives can be added to the solar panel water (or primary circulating water) to control corrosion. Figure E.9 shows a more complex arrangement in which a solar installation is used to pre-heat the feed tester for the main hot water storage tank.

E.3.4.12 Indirect systems are less efficient than direct systems, owing to losses from the heat exchanger. Indirect systems do, however, have the following advantages over both thermosiphonic and pumped direct systems:

a) frost damage can be prevented by the use of a suitable heat transfer fluid, usually water with an antifreeze additive;

b) damage due to boiling can be prevented if a suitable heat transfer fluid with a high boiling temperature is selected;

c) corrosion within the primary system can be minimized by the use of a corrosion-inhibited heat transfer fluid; and

d) scale formation within the primary system can be more effectively controlled.

Table E.1 — Average efficiencies of different types of solar absorbers

1	2
Type of absorber	**Average efficiency** %
Aluminium tube-in-strip	57
Commercial radiator	56
Low-cost unit: Galvanized steel	56
Low-cost unit: Fibreglass	56
Galvanized steel pipe framework on copper strips	55
Black polyethylene piping	54
Two corrugated galvanized steel sheets	51
Corrugated galvanized steel sheet on flat galvanized steel sheet	50
Copper tube-in-strip	59
Two flat steel plates	49
Fibre cement, insulated	44
Fibre cement, uninsulated	35

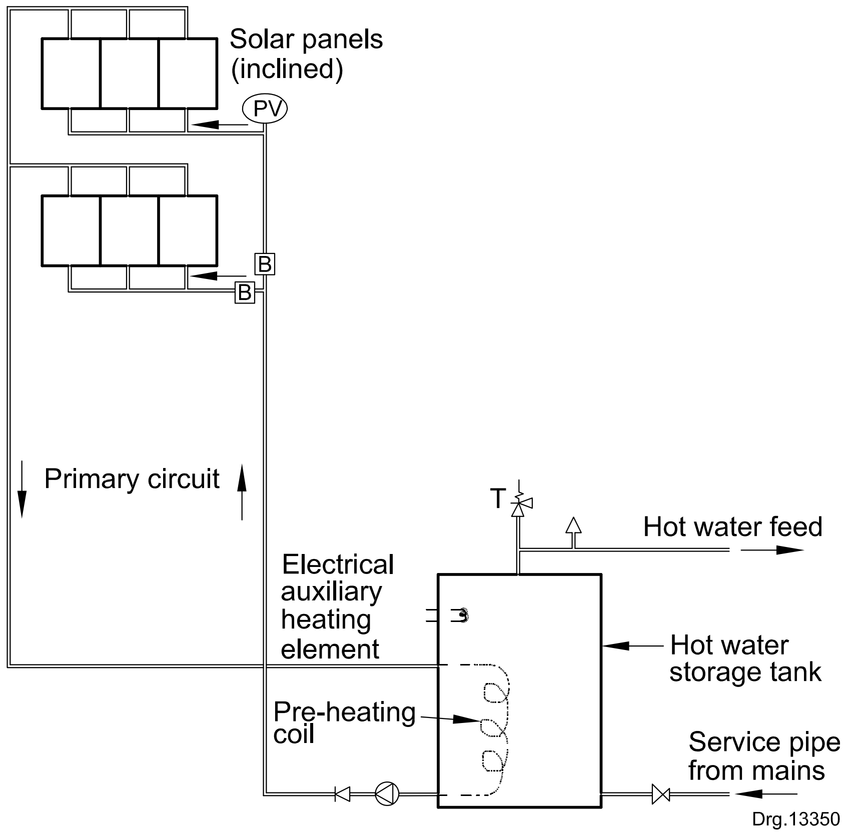


Figure E.8 — Pumped indirect solar water system

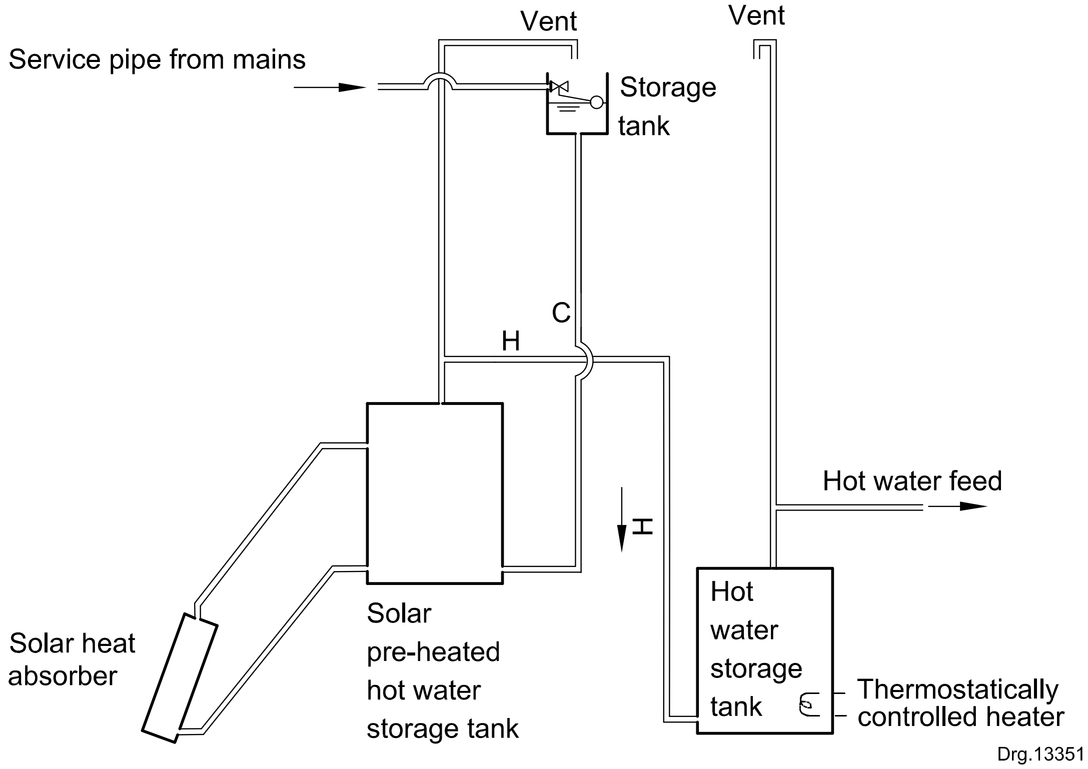


Figure E.9 — Solar water heater used for pre-heating in a hot water system

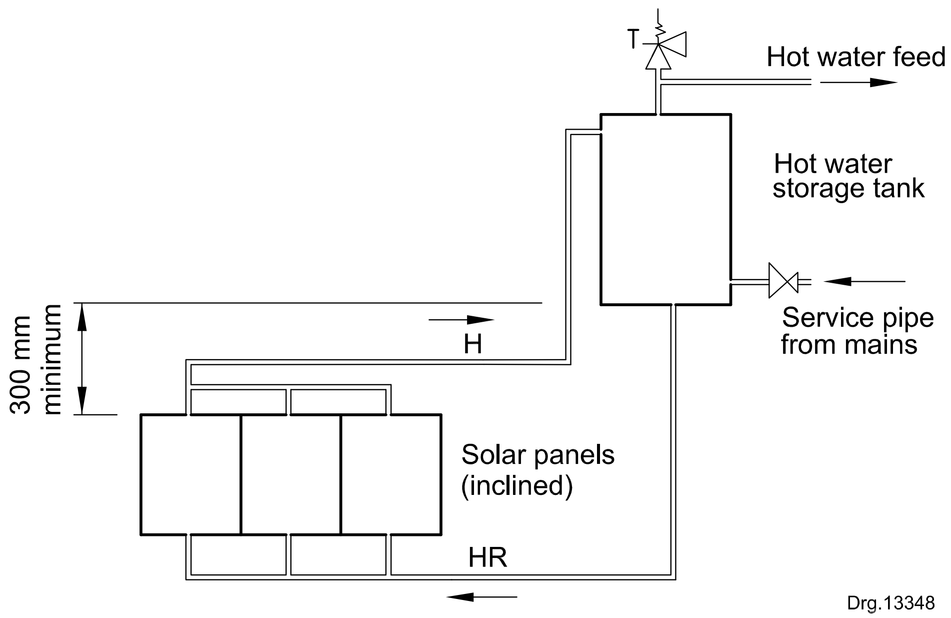


Figure E.10 — Thermosiphonic hot water system

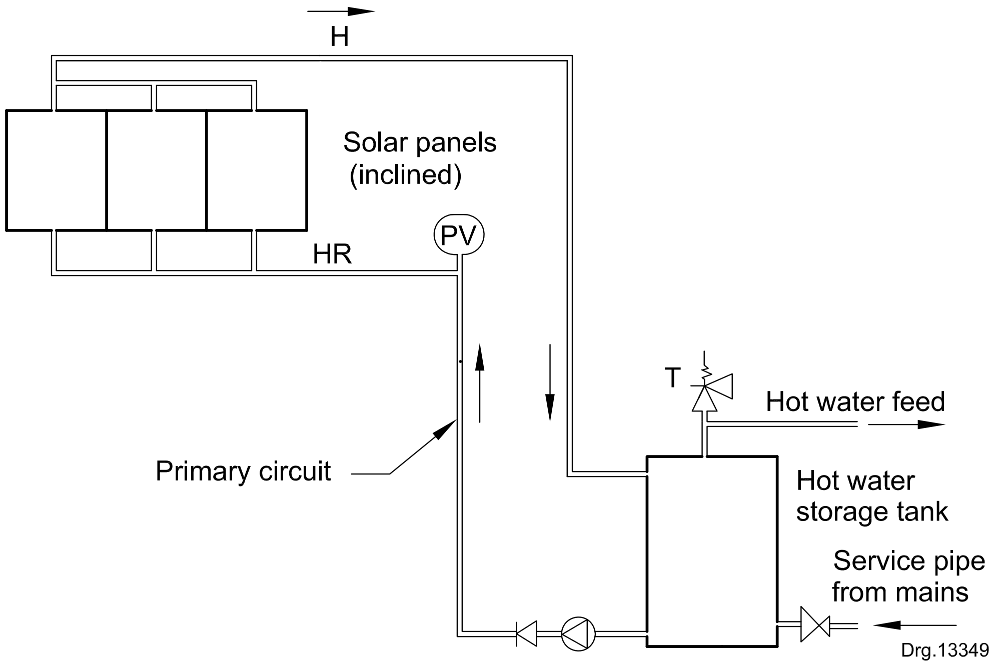


Figure E.11 — Pumped direct solar hot water system

E.4 Supply systems

E.4.1 Local and central hot water supply systems

In large buildings, both dead-leg pipes (in which hot water remains stationary between draw-offs (local system)) and central hot water supply systems can be used. In the former, water is heated locally (or is heated and stored locally) for local use, whereas in the latter, water is heated and stored centrally for general distribution.

Large and continuous hot water demands, particularly if they are close to the central plant, are best provided for by a central installation, while scattered hot water demand points, particularly if the demand is very intermittent, can often be served more economically by local water heaters where water is usually distributed on demand through dead legs.

E.4.2 Non-pressurized and pressurized hot water supply systems

A non-pressurized system is one in which the storage water heater is vented directly into the atmosphere; in a pressurized system, the heater is not vented directly into the atmosphere. The major advantage of the pressurized system is the fact that balanced pressures can be obtained at mixer fittings. However, air can be entrapped in pressurized systems and, should a circulating pump be in use, can cause cavitation in that pump. Air release valves located at all the high points of the system are therefore often necessary.

The pressure in a hot water system depends on the available head and is usually controlled by an in-line pressure reducing control valve, while expansion water is released via an expansion relief device. Pressurized systems also require the installation of pressure and temperature relief safety valves.

In the case of low-pressure rated water heaters (100 kPa or 200 kPa working pressure), vacuum relief protection should also be provided. In the case of high-pressure rated water heaters (300 kPa working pressure and higher), vacuum protection is not necessary because the inherent strength of the cylinder (required by the higher working pressure) renders it safe against vacuum collapse.

E.4.3 Unheated dead-leg hot water systems

The local (or dead-leg) type of hot water supply system conveys water direct from the heating equipment to terminal fittings, without secondary circulation. Such a system is generally only used where pipe runs are short, resulting in low pressure and heat losses, or where tenants in a building are responsible individually for the payment of separate water/electricity accounts.

E.4.4 Trace heating

A recent alternative development for maintaining elevated water temperatures within pipes for the immediate draw-off of hot water is the use of trace heating. In this system, the heat losses are replaced by an electric heating tape strapped to the pipework underneath the thermal insulation.

The trace incorporates a self-regulating electrical strip that automatically varies its power output in response to sensed temperatures at various points along its entire circuit. This heating action continues until a stage of thermal stability is reached, where the heat input matches the heat loss. Trace heating, compared with a circulation system, is both energy efficient and cost effective.

The use of trace heating would enable an existing hot water system to be upgraded without the need for enlarging, or installing return pipes and a circulation pump. Trace heating enables a single supply pipe reticulation to be installed, instead of a complete main circulating ring. However, for most domestic hot water installations, the use of trace heating cannot be economically justified because of relatively short pipe runs.

E.4.5 Hot water circulation systems

E.4.5.1 General

The objective of a circulation system is to reduce the length of dead legs and to maintain an acceptable hot water temperature even at the supply branch serving the last fixture. A hot water circulation system enables hot water to be available at a terminal fitting, with a minimum of initial cold water draw-off. The continuous circulation of hot water offsets heat losses in the supply piping. Energy losses can also be made up by means of a secondary heating element installed in the return piping of the circulating system. A central hot water system usually requires the circulation of hot water because of the lengths of piping involved (in order to reduce the quantity of cold water drawn off before hot water arrives at terminal fittings), unless trace heating is provided.

Circulation can be induced by means of thermosiphonic action, or forced by means of a pump. In the former case, heat losses are allowed to occur in the return piping in order to promote circulation by gravity owing to the higher density of the colder water in the return piping. In modern hot water systems, the forced-flow circulation principle is used almost exclusively. In large installations, circulation by booster pump is used almost exclusively, while in smaller installations, the thermosiphonic type of circulation is more popular. The circulating hot water supply can be a single-ring or a multiple-ring, up-feed or down-feed system. The down-feed system is often used in high-rise buildings that have a succession of floors with identical draw-off arrangements in adjacent bathroom or kitchen units. Generally, the down-feed system has less pipework than the up-feed system and is thus more economical.

E.4.5.2 The up-feed circulation system

Supply and return pipes from and to the hot water container run horizontally in the building, usually at soffit level in the basement. Riser pipes are taken from the supply and return pipes and run up through the building in convenient positions. Feed pipes to terminal fittings are taken from the supply riser pipes which continue to the top of the building to join the return pipes to the container. The appropriateness of an up-feed system is often governed by the layout of terminal draw-off points in the building. A typical up-feed system is shown in figure E.12.

E.4.5.3 The down-feed circulation system

In a down-feed system, the hot water feed main is taken from the hot water storage container to the top of the building from where it is distributed horizontally to serve a drop pipe or pipes. Feed pipes to terminal fittings are taken from the drop pipes which continue to the basement to join the return pipes that reconnect to the container. A typical down-feed system is shown in figure E.13.

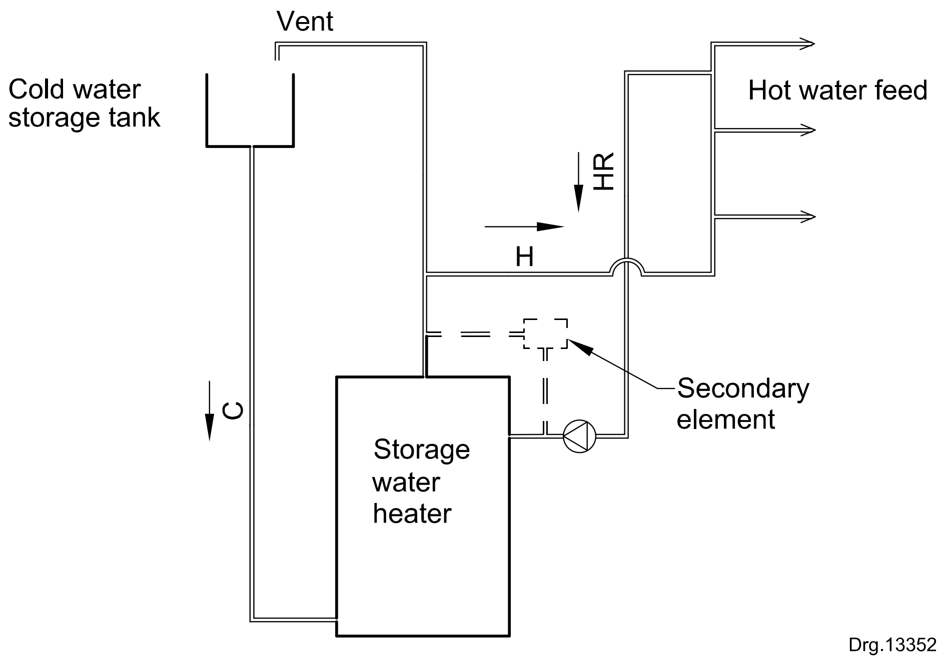


Figure E.12 — An up-feed circulation system

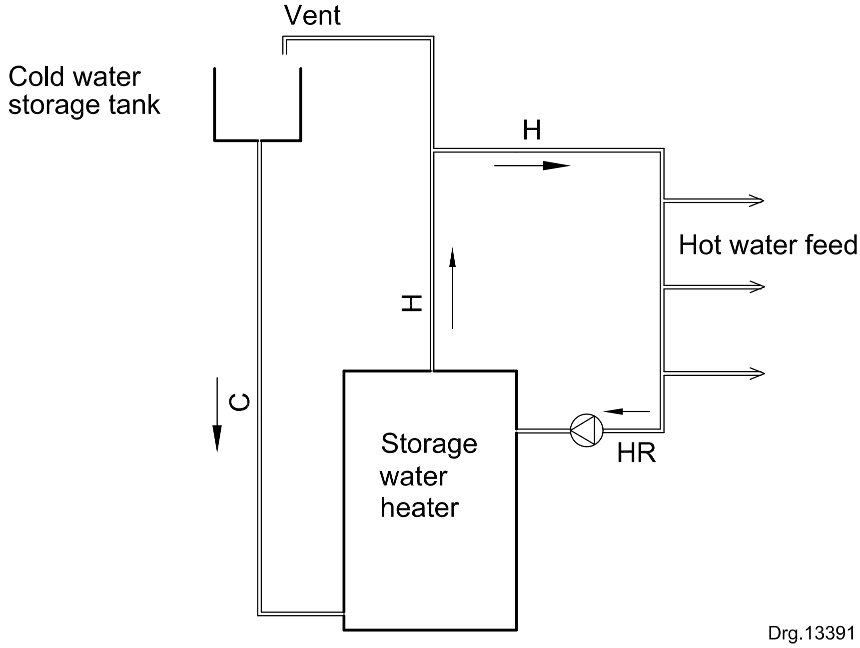


Figure E.13 — A down-feed circulation system

E.4.5.4 Multiple-ring and single-ring hot water systems

A multiple-ring hot water system is an extension of a single up-feed or down-feed (or both) circulation system, since circulation takes place in more than one circuit simultaneously. This layout is usually provided in large multistorey buildings. Either thermosiphonic or forced-flow principles can be used, but the latter is usually preferable.

Multiple-ring hot water systems normally function poorly if not properly balanced. In improperly balanced systems, long waiting periods often occur till hot water arrives at terminal fittings remote from the heating equipment. Each individual return pipe should be provided with a balancing valve (and temperature gauge) to control the flow of water and, in circuits situated close to the circulating pump, such valves should be adjusted to produce sufficient hydraulic resistance to prevent short-circuiting of the flow through other branches.

A balancing action can be obtained by using suitably pre-adjusted standard balancing valves or by making use of the so-called checker tee. The checker tee is basically a standard tee-piece with a plug screwed into one branch in order to throttle the flow passing through the branch. Another practical, and possibly easier, way of balancing the return reticulation is by making use of a ball valve (with a temperature gauge) and a sight glass in each circuit. The sight glass permits a visual evaluation of the water flow in each circuit while the ball valve is sensitive to small adjustments.

An example of a multiple-ring up-feed forced-flow system is shown in figure E.14.

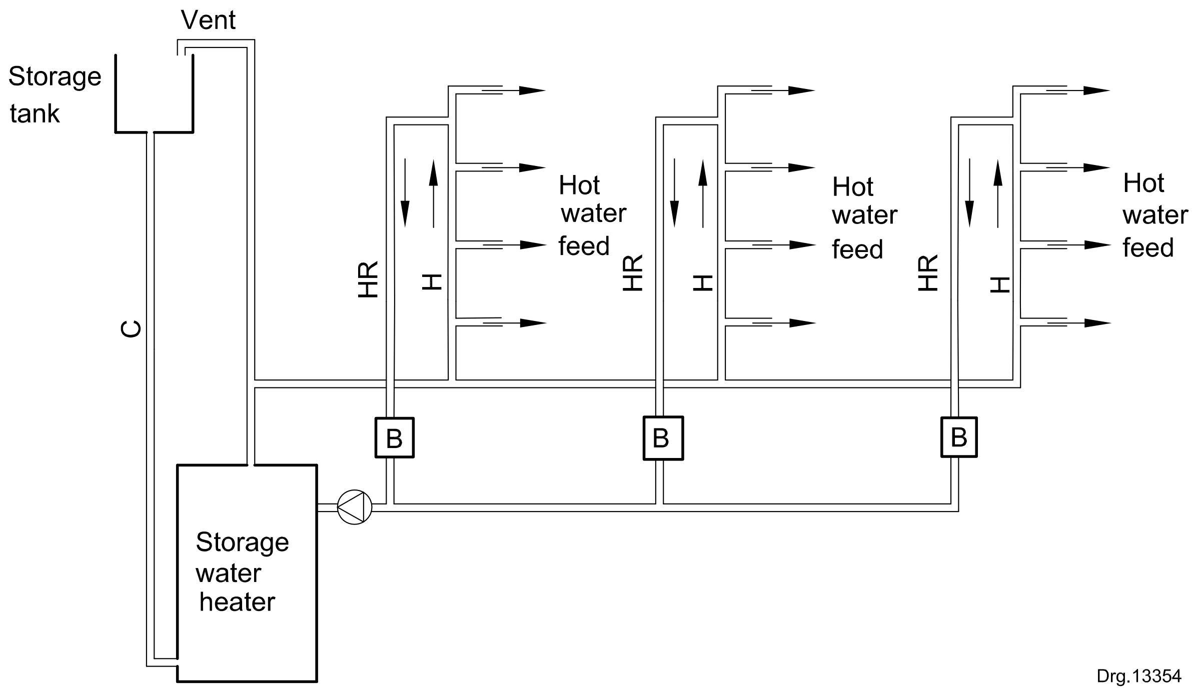


Figure E.14 — Multiple-ring up-feed forced-flow hot water system

E.5 Replenishment/storage capacity curves for various categories of premises

All categories of premises within which similar types of activity take place and which have the same operating period will have similarly shaped replenishment/storage curves. The only variable will be the quantitative values of storage and the recovery co-ordinates.

Figures E.15 to E.22 show the relationship between replenishment and storage capacities for various categories of premises. Any point on any given curve represents a combination of storage and replenishment capacities that will satisfy the net requirements of the occupants.

If the minimum replenishment rate and the maximum storage capacity on any curve are used, this will yield the smallest hot water capacity capable of satisfying the hot water requirements of that building. The higher the replenishment capacity, the greater the required heating capacity and the smaller the required storage capacity.

The replenishment capacities shown in figures E.15 to E.22 do not make allowance for heat losses in the system. The storage volumes represent net usable volumes to which an allowance should be added to compensate for the mixing of hot and cold water and for heat losses within the system.

NOTE 1 Figures E.15 to E.22 are derived from the ASHRAE Handbook (see bibliography).

NOTE 2 Additional replenishment capacity is added to offset the heat losses in the system.

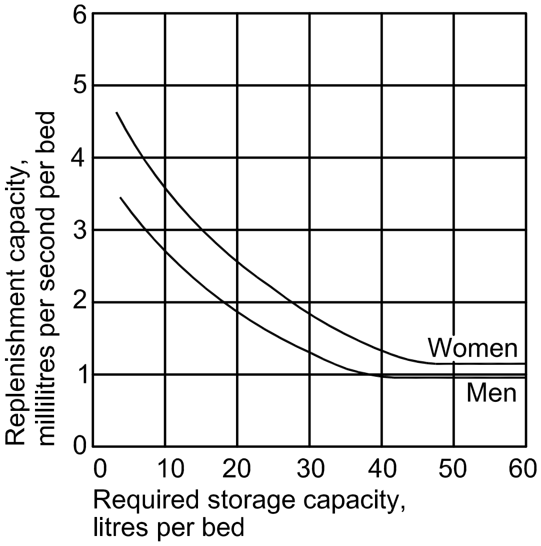


Figure E.15 — Dormitories

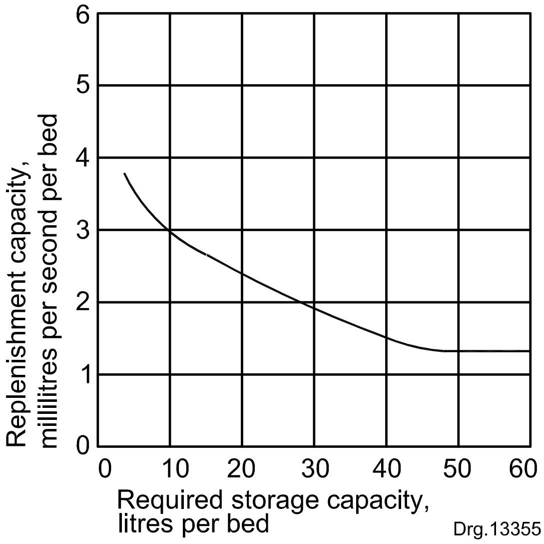


Figure E.16 — Nursing homes

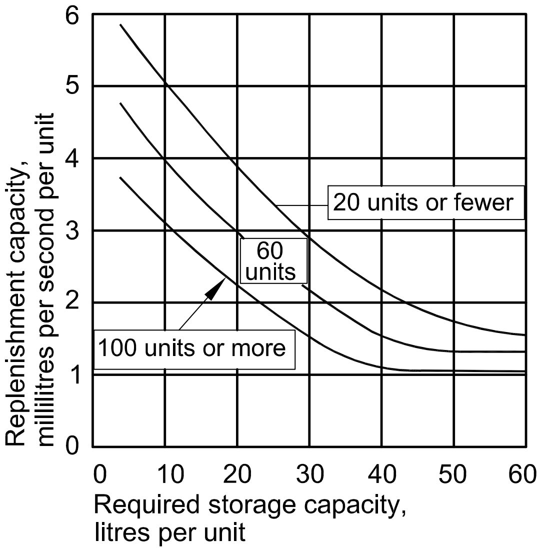


Figure E.17 — Hotels

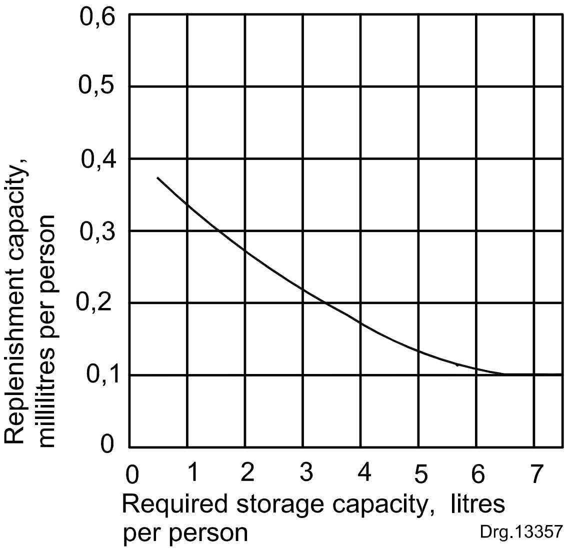


Figure E.18 — Office buildings

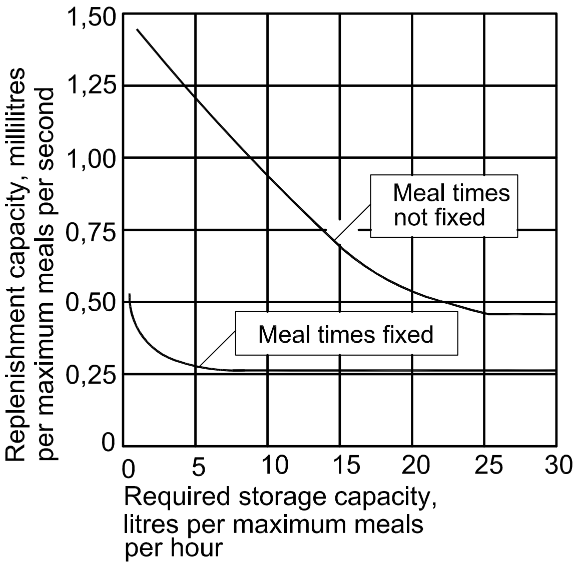


Figure E.19 — Food services

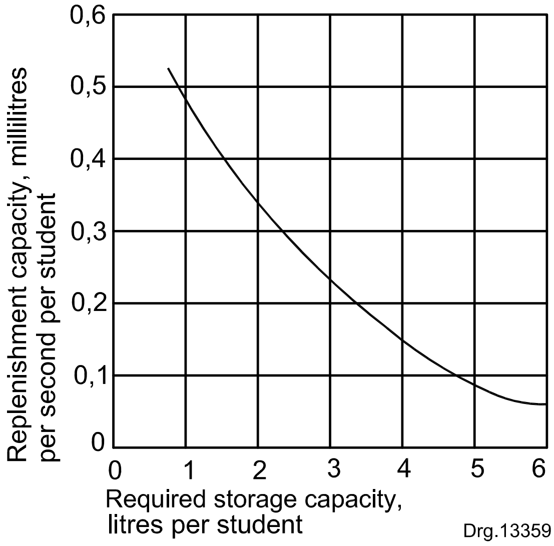


Figure E.20 — Primary schools

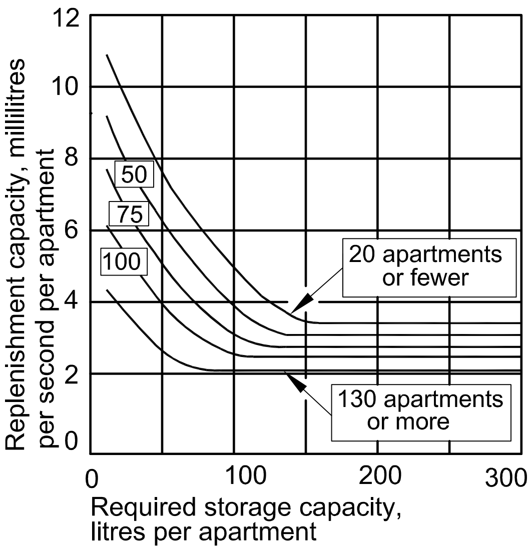


Figure E.21 — Apartments

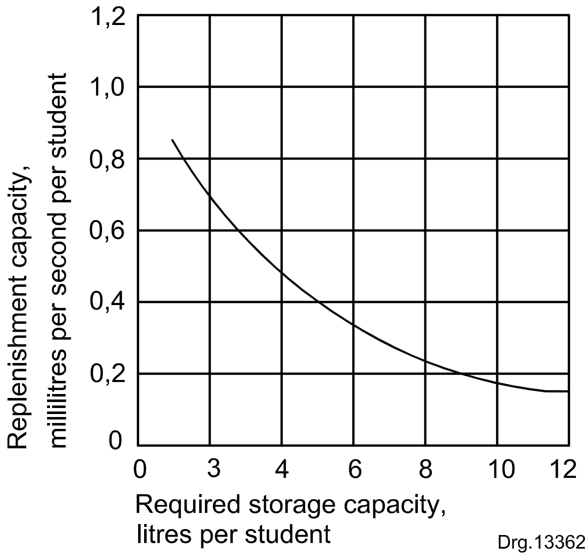


Figure E.22 — High schools

Annex F
(informative)

Installations of hot and cold supply systems for dwelling houses (domestic installations)

F.1 General

In the case of dwelling houses, it will usually not be necessary to carry out a detailed exercise to size the pipes for the installation. For the internal hot and cold water supply systems, certain basic pipe sizes will be generally applicable. The service pipe between the boundary and the house should be sized. Where automatic shut-off flush valves are used in lieu of cisterns for WCs, it will be necessary to size the pipes supplying such valves.

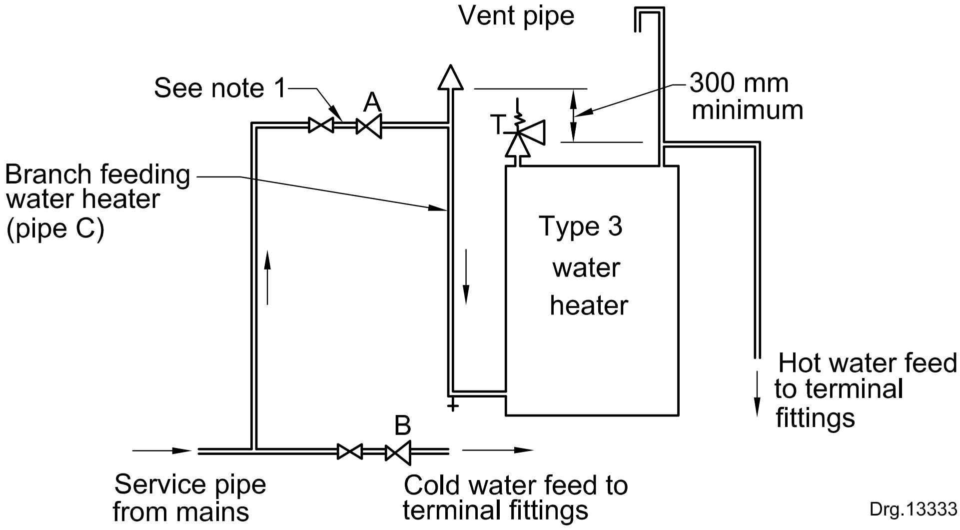
NOTE 1 Where the cold and hot water pressures at terminal water fittings are unbalanced, the use of mixing valves is not recommended.

NOTE 2 Where a pressure control or reducing valve is installed in the service pipe from the mains, the installation of additional pressure control valves (as shown in figures F.1 to F.5) in the cold water feed to terminal water fittings, or to the water heater might not be necessary.

NOTE 3 Depending on the size and slope of the site and the location of the house, the size of the pipe could drastically influence the available pressure at the house.

F.2 Installations that incorporate a mains-fed SANS 151 type 3 standard water heater

The recommended pipe sizes for in-house installations that incorporate a mains-fed type 3 standard water heater as given in SANS 151, are given in table F.1. Such installations are shown in figures F.1 to F.5.



NOTE 1 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 2 Where a pressure control valve or reducing valve is installed in the service pipe, pressure control valves (A) or (B) (or both) may not be necessary.

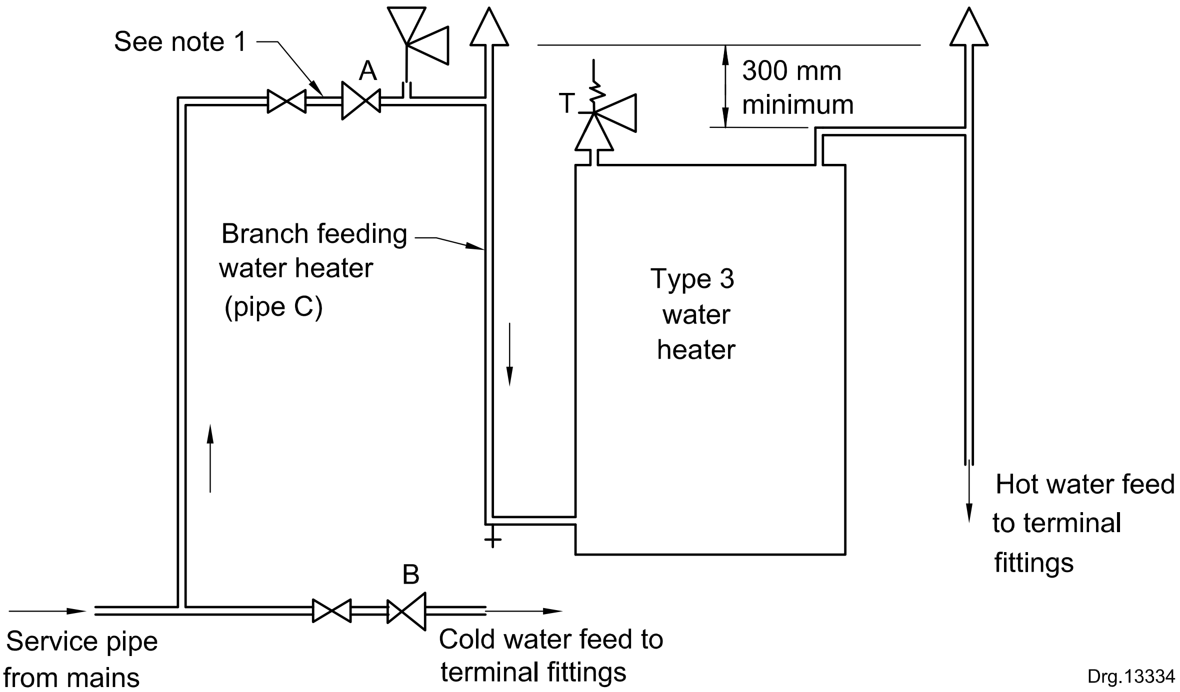
NOTE 3 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe C).

NOTE 4 The height of the vacuum breaker should comply with requirements of the local bylaws and SANS 10254.

Figure F.1 — System that incorporates a standard water heater, two pressure control valves and an atmospheric vent pipe

Table F.1 — Recommended pipe sizes for in-house installations that incorporate a mains-fed of a type 3 standard water heater (see SANS 151)

1	2	3
Pipe	**Pressure rating of water heater**	
	Not exceeding 200 kPa	**Exceeding 200 kPa**[a]
	Recommended pipe size (average internal diameter)	
Branch from service pipe to water heater	Larger of 19 mm and the service pipe	Smaller of 19 mm and the service pipe
Cold water feed to first branch		
Hot water feed from water heater to first branch		
All other pipes		
[a] Pressure rating of pressure control valve controlling supply to water heater exceeds 200 kPa.		



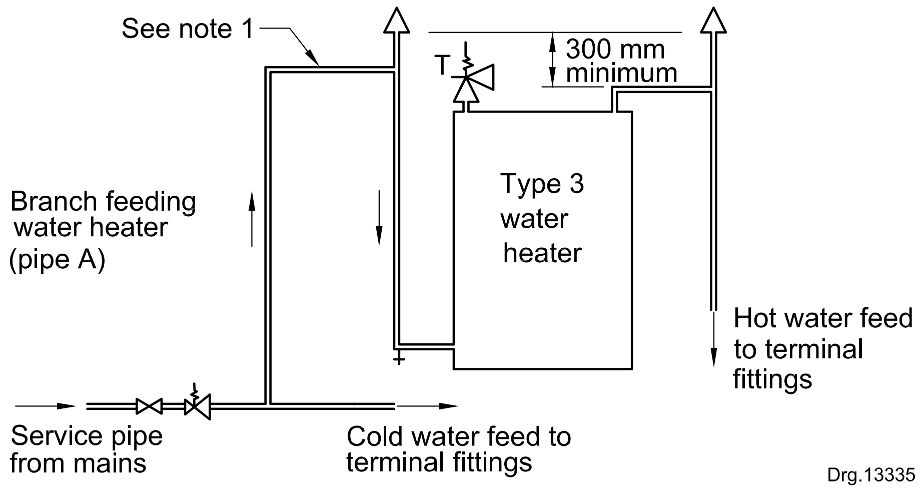
NOTE 1 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 2 Where a pressure control valve or reducing valve is installed in the service pipe, pressure control valves (A) or (B) (or both) may not be necessary.

NOTE 3 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe C).

NOTE 4 The height of the vacuum breaker should comply with requirements of the local bylaws and SANS 10254.

Figure F.2 — System that incorporates a standard water heater, two pressure control valves and a separate expansion relief valve

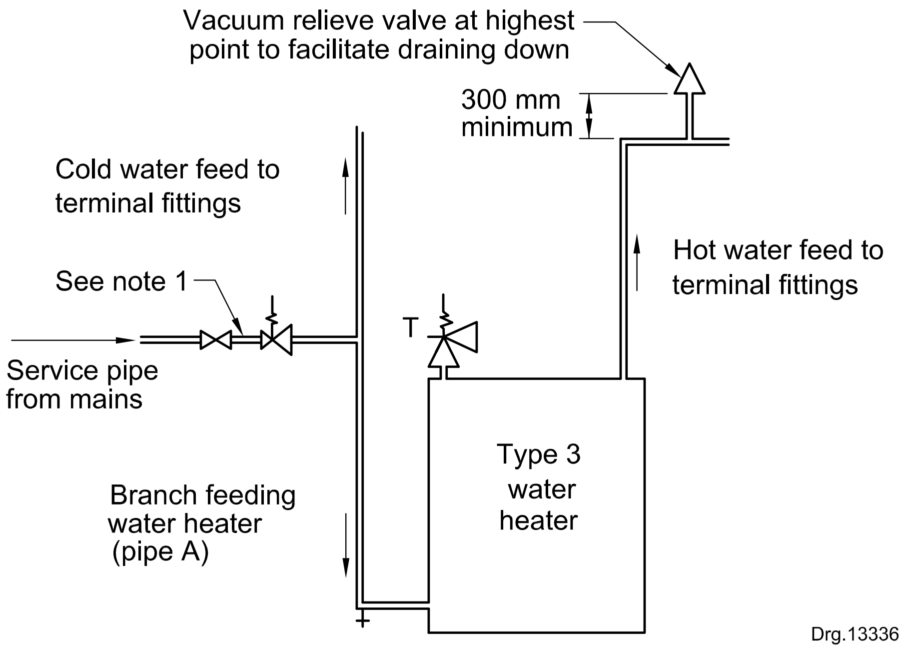


NOTE 1 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 2 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe A).

NOTE 3 The height of the vacuum breaker should comply with requirements of the local bylaws and SANS 10254.

Figure F.3 — System that incorporates a standard water heater and a pressure control valve with integral expansion relief valve

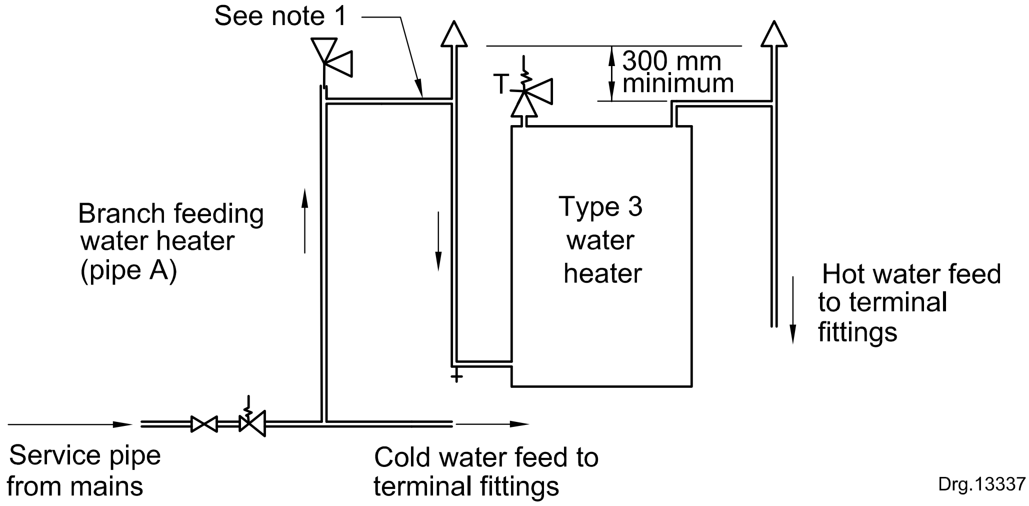


NOTE 1 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 2 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe A).

NOTE 3 The height of the vacuum breaker should comply with requirements of the local bylaws and SANS 10254.

Figure F.4 — System where the water heater is located below all outlet points and that incorporates a pressure control valve with integral expansion relief valve



NOTE 1 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 2 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe A).

NOTE 3 The height of the vacuum breaker should comply with requirements of the local bylaws and SANS 10254.

Figure F.5 — System that incorporates a standard water heater, pressure control valve and a separate expansion relief valve

F.3 Installations that incorporate a storage tank and a type 3 standard water heater given in SANS 151

The recommended pipe sizes for installations that incorporate a storage tank and a type 3 standard water heater as given in SANS 151, are given in table F.2. Such an installation is shown in figure F.6.

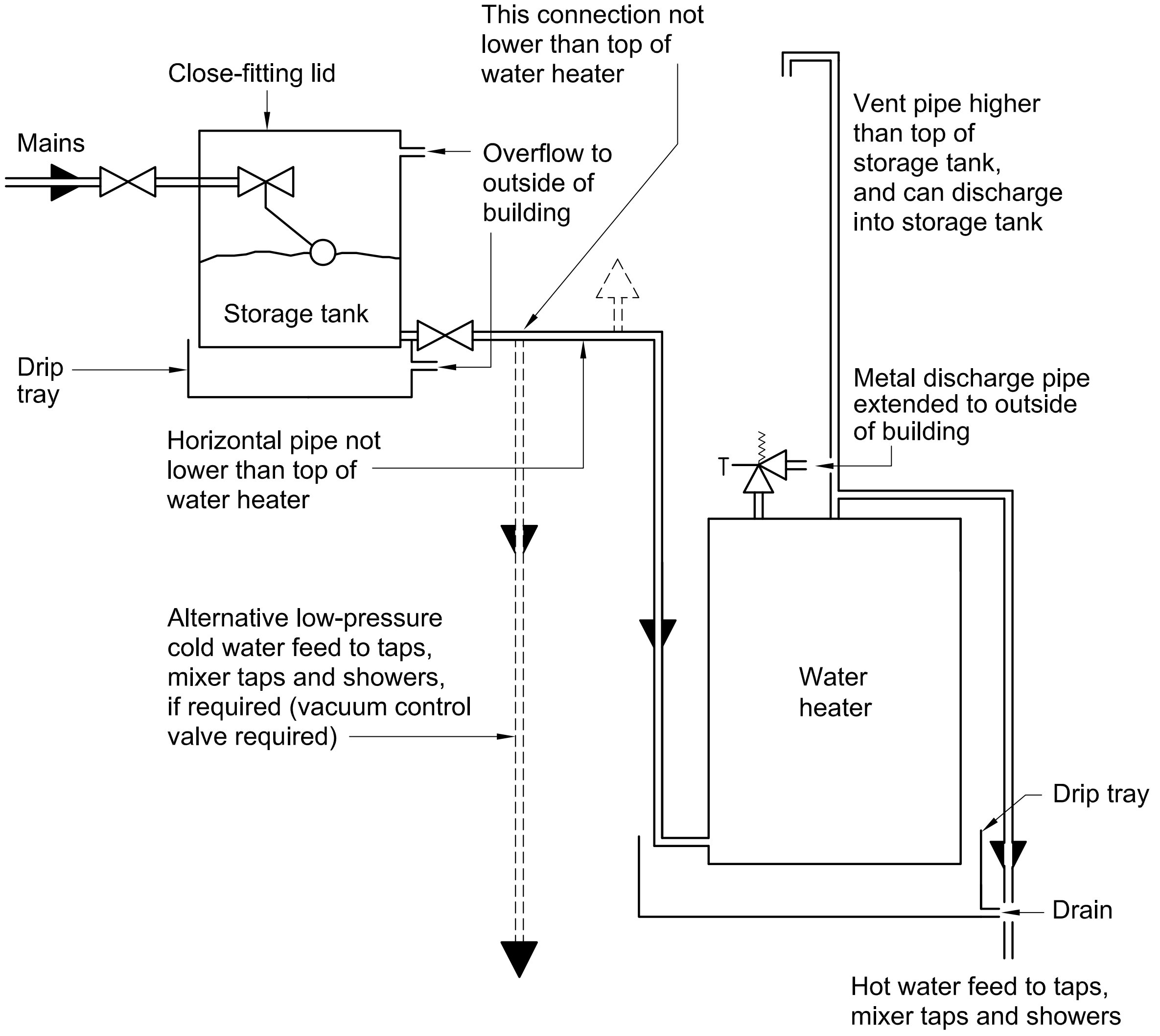
NOTE 1 Where the cold and hot water pressures at terminal water fittings are unbalanced, the use of mixing valves is not recommended.

NOTE 2 Where practicable, the vent/expansion pipe could terminate in the storage tank above the overflow level. This arrangement is preferable to having the vent/expansion pipe project above the roof.

NOTE 3 A safety tray with drain should be provided under the storage tank (2 kL capacity and smaller), to accept accidental leakage or overflow.

Table F.2 — Recommended pipe sizes for installations that incorporate a storage tank and vented water heater

1	2
Pipe	**Recommended pipe size** (nominal internal diameter) mm
Branch from service pipe to storage tank	13 to 19
Cold water feed from service pipe to first branch	Smaller of 19 and the service pipe size
Pipe from storage tank to water heater	19 to 21
Low-pressure cold water feed to first branch	13 to 19
Hot water feed from water heater to first branch and vent	19 to 21
All other pipes	13 to 19



NOTE 1 Where a pressure control valve or reducing valve is installed in the service pipe, the pressure reducing valve in the cold feed may not be necessary.

NOTE 2 The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

NOTE 3 A safety tray with drain should be provided under the storage tank (2 kL capacity and smaller), to accept accidental leakage or overflow.

NOTE 4 Where practicable, the vent/expansion pipe could terminate in the storage tank above the overflow level. This arrangement is preferable to having the vent/expansion pipe project above the roof.

NOTE 5 The use of high pressure mixing valves is not recommended with this system.

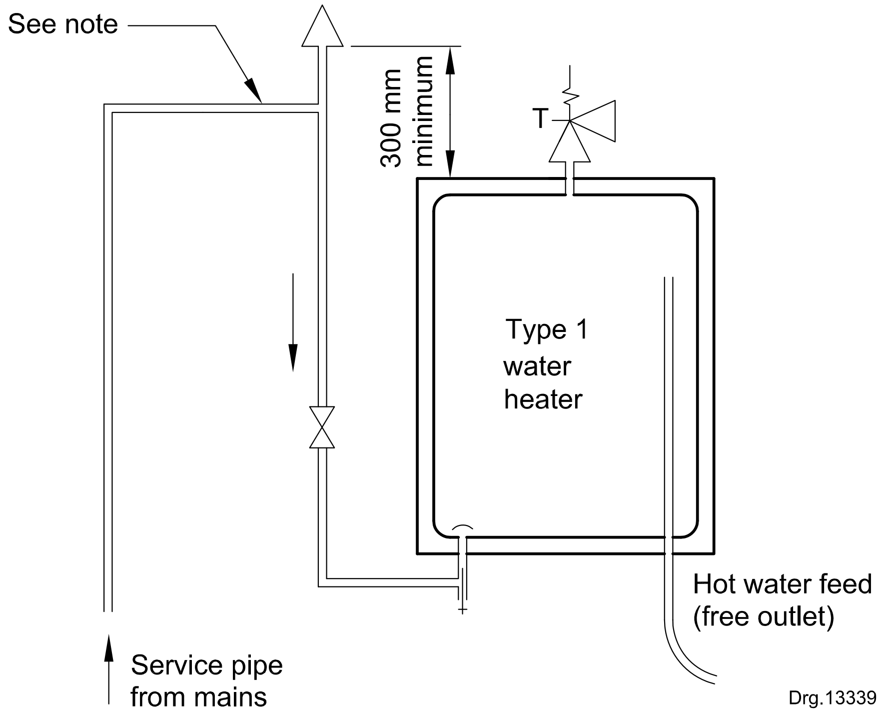
Figure F.6 — System that incorporates a standard water heater and a storage tank

F.4 Installations that incorporate a type 1 free-outlet water heater given in SANS 151

The recommended pipe sizes for in-house installations that incorporate a type 1 free-outlet water heater given in SANS 151, are given in table F.3. Such an installation is shown in figure F.7.

Table F.3 — Recommended pipe sizes for in-house installations that incorporate a free-outlet type water beater

1	2	3
Capacity of water heater L	**Pipe**	**Recommended pipe size** (nominal internal diameter) mm
< 25	Branch from cold water supply to water heater	13 to 16
> 25 and < 250	Branch from cold water supply to water heater	19 to 21



NOTE The horizontal branch that feeds the water heater should not be installed below the top of the water heater.

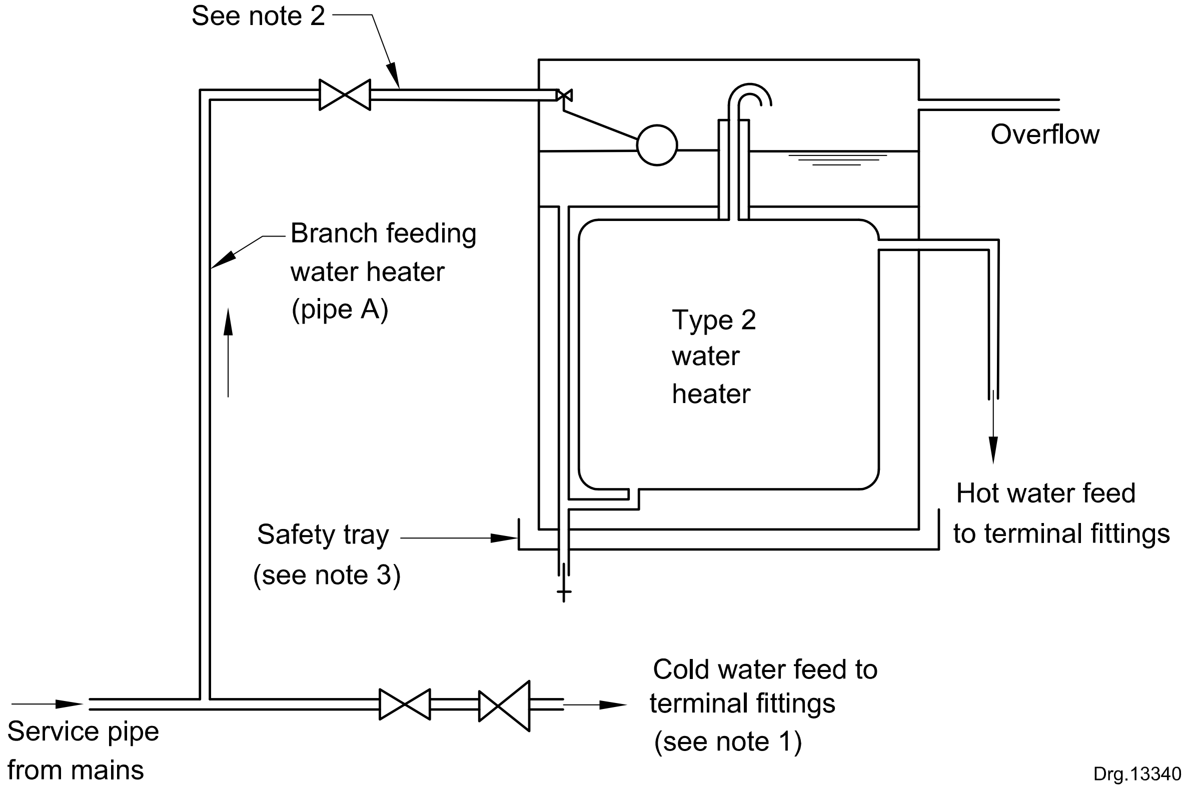
Figure F.7 — System that incorporates a free-outlet type water heater

F.5 Installations that incorporate a type 2 combination water heater given in SANS 151

The recommended pipe sizes for installations that incorporate a type 2 combination water heater given in SANS 151, are given in table F.4. Such an installation is shown in figure F.8.

Table F.4 — Recommended pipe sizes for installations that incorporate a type 2 combination water heater in SANS 151

1	2
Pipe	**Recommended pipe size** (average internal diameter) mm
Branch from service pipe to water heater cistern	13 to 19
Cold water feed to first branch	Smaller of 19 and the service pipe
Hot water feed from water heater to first branch	Larger of 19 and the service pipe
All other pipes	13 to 19



NOTE 1 Where a pressure control value or reducing valve is installed in the service pipe, the pressure reducing valve in the cold feed to the water heater may not be necessary.

NOTE 2 Any pipes that feed cold water terminal fittings should not be connected to the branch that feeds the water heater (pipe A).

NOTE 3 A safety tray with drain should be provided under a type 2 water heater, to accept accidental leakage or overflow.

NOTE 4 The use of high pressure mixing valves is not recommended with this system.

Figure F.8 — System that incorporates a type 2 combination water beater and pressure control valve given in SANS 151

Annex G
(informative)

Thermal insulation for pipework

G.1 General

This annex details the application of thermal insulation to pipework and equipment and does not cover structural insulation of buildings and cold stores, fire protection of structures, refractory linings of plant, airborne installations and all external underground mains. This annex explains the basic principles that should be followed in selecting insulating systems for specific requirements.

G.2 Purpose of pipe insulation

G.2.1 General

Proper insulation improves the thermal efficiency, limiting heat transfer and providing a vapor barrier against moisture. Proper pipe insulation materials also eliminate condensation formation, which accelerates pipe deterioration.

If there is a temperature differential between the heating or cooling process and ambient conditions, heat will flow from the higher to the lower temperature.

G.2.2 Corrosion protection

Where the operating temperature is less than 130 °C and the equipment or pipework is other than austenitic alloy, the surfaces should be coated with a suitable paint. It has been found that below this temperature corrosion conditions can occur.

Most thermal insulations will not, of themselves, cause stress corrosion cracking as may be shown by tests. When exposed to elevated temperature (with a boiling point range of between 80 °C and 200 °C), environments containing chlorides, moisture and oxygen, insulation systems may act as collecting media, transmigrating and concentrating chlorides on heating stainless steel surfaces. If moisture is not present, the chloride salt cannot migrate, and stress corrosion cracking because of chloride contaminated insulation cannot take place. (See ASTM C 692.)

If insulation is to be applied over certain austenitic alloy steel where the operating temperature is between 80 °C and 200 °C, it is recommended that a stress corrosion barrier is applied before the application of the insulation so as to prevent stress corrosion. At 500 °C and above none of the stress corrosion barrier materials can withstand the temperatures and therefore should not be used.

It should be noted that during start up and shutdown, operating temperatures might occur within 80 °C to 200 °C temperature band and under such circumstances stress corrosion could occur.

The barrier might be of aluminium foil not less than 0,06 mm thick or a specially formulated paint that is applied. The recommendations of the manufacturer should be followed particularly in respect of the limiting temperature of the dried film.

G.3 Designing insulation systems

G.3.1 General

Factors that influence the design of a pipe insulation system are given in G.3.2 to G.3.5.

G.3.2 Location

The following are possible locations for insulating systems:

a) indoors;

b) outdoors protected from the weather; and

c) outdoors exposed to the weather.

It is important to consider shape, size and elevation when designing insulation systems.

G.3.3 Temperature conditions

The following temperature conditions should be considered:

a) the normal operating temperature;

b) extreme temperature, if other than the normal operating temperature;

c) any fluctuating temperature; and

d) the duration of extreme or fluctuating temperature.

G.3.4 Surrounding atmospheric conditions

The following sourronding atmospheric conditions should be considered:

a) the ambient temperature;

b) the relative humidity, in order to establish the dew point for cold insulation;

c) flammable conditions;

d) potentially corrosive atmosphere;

e) acidic conditions in the atmosphere; and

f) the air flow over the insulated surface (wind velocity).

G.3.5 Service condition requirements

The following requirements for service conditions should be considered:

a) resistance to compression, for example, foot traffic;

b) resistance to fire;

c) resistance to vibration;

d) resistance to mechanical damage;

d) resistance to corrosive fluids or gases;

e) the anticipated wide fluctuations of temperature, for example, steam out;

f) resistance of insulation protection to ingress of oils and flammable liquids;

g) the application of insulation over special alloys;

h) resistance to moisture and other weather conditions; and

i) resistance to vermin.

G.4 Insulation materials

G.4.1 General

The types of materials used will depend upon whether the installation is underground, outside of buildings, underground within buildings, or aboveground within buildings. The availability of certain types of desired piping materials and fittings may also determine the type of pipe used.

G.4.2 Insulation types

The following are types of insulation materials:

a) Boards or batts: Rigid binder bound fibrous insulation for use on flat or large cylindrical surfaces.

b) Felt: Semi-flexible binder bound fibrous insulation for use on all surfaces where vibration is of a low order, for example boilers.

c) Loose granulated insulation with a low binder content for filling voids.

d) Mattress: Flexible low binder fibrous insulation for use on all surfaces. A wire mesh fixed to one or both sides by through stitching maintains the shape of the mattress. Because of the low binder content the material is able to withstand higher temperature without binder breakdown.

e) Pipe section: Insulation preformed to fit in two halves round cylindrical surfaces of various diameters.

f) Pipe section covered: As for pipe section except that the outer surface is fitted with a cover by the manufacturer, for example, canvas or foil.

g) Segments: Cylindrical insulation for fitting around large cylindrical surfaces with more than two parts. This type is confined to the closed cell insulants.

h) Slab: All the closed cell flat insulation and expanded/extruded insulants fall into this category and may be applied to all surfaces provided they are suitably shaped.

i) Rope: Usually of fibrous material, used for spirally wrapping around small pipes.

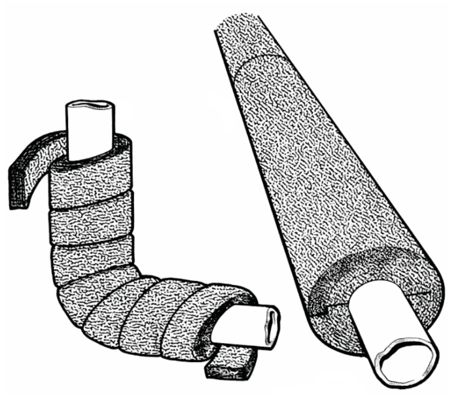
j) Spray fibre: Used for insulating irregular shapes such as turbines, and also used for fireproofing.

k) Spray foam: Usually of polyurethane or polyisocyanurate, the main applications of which are for large regular surfaces such as roofs or tanks and for cavity filling.

l) Foam rubber: Placed over the pipes, wrapped at the ends, and secured with duct tape.

m) Pipe sleeves: Made from polyethylene or neoprene foam and presented in a wide variety of sizes. Pipe sleeves are easy to install and very effective. Match the pipe sleeve with the pipe's outside diameter to get a snug fit. To secure the insulation to the pipe, use wire or tape, or clamp it with a cable. If more than one sleeve is needed, duct tape the seam where the pipes meet.

n) Tape: Usually of fibre and used for spiral wrapping on pipe work where conditions so demand.



a) Insulation wrapped round pipe **b) Preformed insulation**

Figure G.1 — Typical insulation of water pipes

G.4.3 Recommendations for use

G.4.3.1 The use of felt or mattress is not recommended over cylindrical shapes with an outside diameter of less than 200 mm. Under certain circumstances boards or slab may be used on cylindrical surfaces by cutting the insulation into bevelled staves.

G.4.3.2 Generally, with certain applications, when installing where the total insulation thickness exceeds 50 mm, a multi-layer system should be used with staggered joints to reduce the heat loss or gain through direct paths to the atmosphere.

G.4.3.3 When very high or very low temperatures are encountered, expansion or contraction joints should be provided. These are usually 40 mm wide and packed with a suitable insulant.

G.4.3.4 It is incumbent on the manufacturers to provide all the necessary values such as thermal conductivity *(k* factor) and water vapour permeance, based on the tests conducted by an approved testing authority. If required, the test number and date should be given together with the particular test method and the conditions.

G.5 Vapour barriers

All insulation designated as "cold" shall be provided with a vapour barrier (see table G.1).

Table G.1— Selection guide for vapour barriers

Type	Product name	Temp range °C	D.F.T[a] mm	Wet flam-mable	Exposure resistance	Non-suitable substrate	Water vapour permeance[b] g/s	Method of appli-cation
Bitu-minous	BE2 Bitumen emulsion	−5/55	1,5	No	Internal	None	0,0083	Brush
	BE Emulsion	−5/55	1,5	No	Internal	None	0,0022	Trowel
	570 Rubberized emulsion	−30/60	1,5	No	Internal	None	–	Brush
Epoxy	769 Epoxy paint	−10/8	0,3	Yes	External	EPS		Brush/ spray
	304 Epoxy coating	−10/120	0,3	No	External	None		Brush
	Abecote SF322	Dry 120	± 1,0	Flash 0° C			0,005	Brush
	Flintoat 390	−10/50	± 0,5	Flash 0° C			0,058	Brush
	Ivory 340	−10/90	0,8	No	Internal	None	0,003	Brush
	IC KL		Film	N/A	Internal	None	0,001	N/A
	IC KH		Film	N/A	Internal	None	<0,001	N/A
	IC RH		Film	N/A	Internal	None	Neg.	N/A
Electro-metric	Foster Monolar	−30/120	0,76	Yes	External	EPS	0,006	Brush/ spray/ trowel
	Foster 95-44	−73/121	Seal’t	Yes	External	EPS	–	Trowel/ glove
	Foster 30-45	−60/149	Seal’t	Yes	External	None	–	Trowel/ glove
	800 Hypalon	−40/120	0,3	Yes	External	EPS	0,000	Brush/ spray
	795 PU Coating	−20/180	0,3	Yes	External	EPS	0,000	Brush/ spray
	696 Elastothane	−30/120	1,0	No	External	None	–	Brush
	153 FR Mastic	−30/80	1,9	Yes	External	EPS	N/A	Trowel
	625 Non-slump mastic	−40/120	Bead	Yes	External	EPS	N/A	Gun
	151 Oleo mastic	−70/150	Bead	No	Internal	None	N/A	Gun/ trowel

[a] Recommended dry film thickness.
[b] Tested in accordance with ASTM E 96 (desicant method).

Table G.1 *(concluded)*

Type	Product name	Temp range °C	D.F.T[a] mm	Wet flam-mable	Exposure resistance	Non-suitable substrate	Water vapour permeance[b] g/s	Method of appli-cation
Synthetic emulsions	Foster 30-36	−18/82	0,9	No	Internal	None	0,083	Brush/ spray
	Foster 30-70 (lagtone)	−46/82	0,4	No	External	None	0,180	Brush/ spray
	Foster 35-00	−29/93	1,0	No	External	None	0,090	Trowel/ glove
	2415 Plustex	−20/120	0,45	No	External	None	0,057	Brush/ trowel
	2191 Plustex	−20/80	0,45	No	External	None	0,072	Brush/ trowel
	249 Plustex	−20/90	0,45	No	External	None	0,05	Brush/ trowel
	835 Acryl seal	−20/80	0,5	No	External	None	–	Brush
	147 Acryl coat	−20/80	0,2	No	External	None	–	Brush
	158 Vapour seal	−30/85	1,3	No	External	None	–	Brush/ trowel
Other	Foster 65-05	−29/93	2,0	Yes	External	EPS	0,007	Brush/ spray
	Foil-mylar	−70/100	Film	N/A	Internal	None	0,001	N/A

[a] Recommended dry film thickness.
[b] Tested in accordance with ASTM E 96 (desicant method).

G.6 Protection of insulation

G.6.1 General

The protection of the insulation required to protect the insulation from mechanical damage and the elements (weather barrier). may consist of metal cladding or a coating system.

Metal and non-metallic finishes should generally be as given in the insulation guideline for hot insulation (see G.8). However, care should be taken where piping and equipment is being clad; the cladding should be manufactured and installed so as to prevent the vapour barrier being punctured. Cushioning material applied between screws or rivets and the vapour barrier, or other suitable means, would be the general practice.

G.6.2 Metal Cladding

G.6.2.1 The following main metals are used:

a) galvanised steel;

b) pre-painted, or pre-coated steel;

c) aluminium;

d) stainless steel; or

e) other specialised formulations.

G.6.2.2 Depending on the requirements of the application, the metal can be either flat sheet or profiled. The thickness depends on the degree of mechanical damage the cladding is expected to withstand and may vary from 0,5 mm to 1,2 mm. For areas susceptible to heavy damage a thicker gauge may be required.

G.6.2.3 In the application of cladding it should be ensured that

a) good water shedding exists at all joints or the sealing of joints where a water shedding joint is not possible,

b) at point where dissimilar metals come into contact with one another, precautions shall be taken to prevent galvanic action,

c) all metal joints shall be straight and square to preserve a symmetrical appearance,

d) the cladding system shall be constructed so that due allowance is made for the expansion or contraction of the equipment, and

e) where the cladding is applied over a vapour barrier, great care shall be taken to avoid puncturing the vapour barrier either during or after erection, for example, a spacer or protective liner.

G.6.3 Plaster finishes

G.6.3.1 The term plaster includes both hard-setting plaster and mastics, which may be used separately or together. Plaster may be used on all surfaces but when exposed to the weather it should be over coated with a mastic or finishing paint.

G.6.3.2 If plaster is used over a fibrous insulation the insulation shall be of sufficient density to withstand the trowel application.

G.6.3.3 A mastic is not suitable for direct application to fibrous insulation. Generally, the purpose of the plaster is to provide a surface resistant to mechanical damage or a foundation (or both) for the mastic, which provides the waterproofing.

G.6.3.4 Both the plaster and the mastic should be applied in two layers with a reinforcing between the layers, i.e., galvanised wire mesh for the plaster and fibreglass mesh for the mastic. The first coat in each case should provide an anchor to ensure a key for the second.

G.6.3.5 Because of its high mass, the plaster coat is subject to slipping on large vertical surfaces. The wire mesh reinforcing shall therefore be tied back, with binding wire, to fixed supports on the equipment.

G.7 Application

G.7.1 General

Before insulation is applied, thoroughly clean all surfaces to be insulated in order to remove dirt, oil, moisture, loose rust or any other foreign matter. Use mild cleanser on an old rag, swiped a few times across the pipe. Do not use a harsh cleanser because it could cause corrosion. Allow the pipe to dry completely before installing insulation. Choose the type of insulation appropriate to the application.

In addition to the basic insulation material, a system may need the following:

a) supports for the insulation;

b) fastenings for the insulation;

c) a vapour seal in case of cold insulation;

d) mechanical or weather protection of the insulation, for example, metal cladding;

e) supports for the protection of the cladding;

f) fastenings for the protection of the cladding; or

g) finishing, for example, paint coatings, decorative finishes or identification bands.

G.7.2 Pre-installation supports

G.7.2.1 General

Install insulation supports before the application of the insulation.

G.7.2.2 Supports for insulation

The following can support insulation:

a) adhesive;

b) pins (plastic or nylon);

c) strapping bands for large cylindrical surfaces;

d) pressure-sensitive tape for small diameter surfaces; and

e) pre-installed insulation support rings, normally used on large vertical vessels.

G.7.3 Installation of pipe insulation

G.7.3.1 Standard foam insulation is installed by wrapping it around the water pipe and securing it with duct tape. Foam insulation can be wrapped with an overlap if required.

G.7.3.2 Tubular sleeve insulation is more convenient because the insulation already comes in tubes that will automatically wrap around the pipe. Cut the insulation to the length required and wrap it around the pipe, also securing it with duct tape.

G.7.3.3 Ensure that the whole pipe is covered as fully as possible, paying special attention to corners and T-joints. The need may arise to cut slits or make miter angles in tubular sleeve insulation to cover joints entirely. Make sure that duct tape is wrapped over the bends because this is where the insulation is most likely to come apart.

G.7.3.4 Use protective attire when installing fibre glass insulation. Before installation begins, switch off the hot water system to prevent burning on the pipes.

G.8 Hot insulation

G.8.1 General

G.8.1.1 Equipment or pipework with an operation temperature greater than 55 °C, in the case of metallic surfaces, and 65 °C in the case of non-metallic surfaces, should be insulated so that the surface temperature after insulation (cold surface temperature) does not exceed 55 °C.

G.8.1.2 It is accepted that temperatures of 60 °C or greater will result in extreme discomfort to personnel and therefore a maximum cold surface temperature of 55 °C should be considered as advisable.

G.8.1.3 If the fluid inside the pipe is likely to remain static for long periods when the ambient temperature is below the freezing point of the fluid, it is important that this shall be stated. Also, the fluid in small diameter pipes may be especially susceptible to freezing, particularly if the rate of flow is intermittent or slow, it may be necessary to consider the use of a supplementary means of heating, possibly only in local areas, for example, heat tracing.

G.8.2 Selection of hot insulation materials

G.8.2.1 Careful consideration should be given to insulation thickness. On pipework an over-specification of thickness creates a needless increase in the cost of the outer protection.

G.8.2.2 When a multi-layer system of insulation is envisaged, the selection of materials is interdependent on the type of protection. For example, an aluminium protection will result in a higher cold surface temperature and a lower heat. (Aluminium protection has a low emissivity and therefore radiates less heat.)

G.8.2.3 Where constant load supports are involved, the mass of the insulation system becomes critical and shall be kept within the tolerances of such constant load supports. Where used for internal linings of ventilation ductwork the thermal insulating material itself should be non-combustible as given in SANS 10177-5.

G.8.3 Hot insulation materials

G.8.3.1 It is recommended with all hot insulation materials that their use be limited to conditions of 90 % of the manufacturer's limiting temperatures in order to safeguard against a temperature surge at the start-up operations of a plant.

G.8.3.2 The following are examples of typical hot insulation materials:

a) calcium silicate;

b) ceramic fibre (blanket);

c) cellular glass;

d) glass mineral wool;

e) melamine foam (flexible);

f) perlite (expanded);

g) rock wool; and

h) vermiculite.

G.8.4 Application of hot insulation

G.8.4.1 Pipe section, mattress or any flexible insulation may be used for pipework. However, practical reasons preclude the use of mattress or flexible insulation where the outside diameter of the pipe or the outside diameter of any previous layer of insulation is 200 mm or less.

G.8.4.2 Where mattress or materials of low density are used and metal is the protection medium, supports should be provided for the metal at not more than 1 m intervals where the pipework is horizontal or inclined up to 45°. Between 45° and the vertical, the spacing of the supports is dependent on temperature and expansion requirements. (See BS 5970.)

G.8.4.3 As a guide, the expansion allowances on pipework are generally 1 mm/running meter/ 100 °C of temperature. In all applications of insulation the material shall be well butted together and in the case of multi-layer applications all joints of each subsequent layer shall be staggered from the previous layer. Weld pins or clips, binding wire and strapping are used for securing the insulation as a single or composite system dependent on the circumstances.

G.9 Cold insulation

G.9.1 General

G.9.1.1 Cold insulation should be considered where operating temperatures are below ambient and where protection is required against heat gain, condensation or freezing.

G.9.1.2 In designing an insulation system where formulae and surface coefficients are used they should be to an appropriate international standard, for example, BS 5422, is recommended. In selection of material density, it should be considered whether insulation requires being load bearing or not.

G.9.2 Design of cold insulation

G.9.2.1 Whatever the primary reasons for cold insulation, it should be designed to prevent condensation. Condensation occurs when water vapour in the atmosphere comes in contact with a surface at a temperature of less or equal to the dew point. Therefore, if the surface temperature is less than the dew point, condensation will occur.

G.9.2.2 The presence of condensation on the warm side of the vapour barrier has no detrimental effect on the insulation but, nevertheless, it is a condition that has to be avoided. To prevent condensation, the insulation thickness should be so designed that the temperature on the warm side of the vapour barrier is above the dew point.

G.9.2.3 In calculating the thickness of the insulation required to prevent condensation, it is prudent to know or assume conditions of high relative humidity. If the fluid inside the pipe is likely to remain static for long periods when the ambient temperature is below the freezing point of the fluid, it is important that this shall be stated. Also, the fluid in small diameter pipes may be especially susceptible to freezing, particularly if the rate of flow is intermittent or slow, it may be necessary to consider the use of supplementary means of heating, possibly only in local areas, like heat tracing.

G.9.3 Cold insulation materials

The following are examples of cold insulation materials:

a) cellular glass;

b) cork;

c) glass mineral wool;

d) nitrile rubber (expanded);

e) perlite (expanded);

f) phenolic foam;

g) polyethylene foam;

h) polyisocyanurate foam (PIC);

i) polypropylene;

j) polystyrene (expanded);

k) polystyrene foam (extruded);

l) rigid polyurethane foam (PUR);

m) rock wool; and

n) synthetic rubber (expanded).

G.9.4 Selection of cold insulation materials

G.9.4.1 General

G.9.4.1.1 Closed-cell insulation is the most commonly specified material used for coldwork because it possesses a degree of resistance to water vapour and because the thermal conductivity (*k* factor) of some of these materials is better than the fibrous alternative products.

G.9.4.1.2 Selection of insulation materials should be carefully considered where the possibility of steam purging of the equipment is required or for other reasons which may cause the temperature to be increased to a level which exceeds the maximum limiting temperature of the insulation materials, i.e., the material then deteriorates.

G.9.4.1.3 Special precautions to prevent the possibility of combustion shall be exercised when insulating piping, fittings or equipment containing oxygen, as the insulation system should then not contain any organics. It is therefore strongly recommended that the material suppliers are consulted before the selection of the insulation material.

G.9.4.1.4 Fibrous materials may be used for cold insulation where conditions such as fire resistance are present. However, because of their poor resistance to water vapour, extra care shall be taken in the selection and application of the vapour barrier.

G.9.4.1.5 In case of fire, certain insulation systems may generate appreciable quantities of smoke and noxious and toxic fumes. Consideration should be given to the choice of materials, bearing in mind their location (for example, in enclosed areas or adjacent to air ducts through which smoke or fumes may spread), and that they shall be in accordance with the local requirements and specifications.

G.9.4.1.6 If there is a potential hazard from contamination by oil or other flammable chemicals, a suitably resistant finish, for example, a metal sheet or an appropriate non-absorbent coating, shall be applied over the vulnerable areas. The lapped joints of sheet finishes shall be arranged to shed contaminating fluids away from the insulating material.

G.9.4.2 Joint sealers and adhesives

G.9.4.2.1 All materials intended for use for cryogenic insulation of pipes and vessels should be checked for their suitability at low temperatures and if, for example, no acceptable joint mastic is available for 196 °C (such as liquid oxygen or nitrogen) then only the joints on the outer layer on a multi-layer system should be sealed.

G.9.4.2.2 Joint sealers and adhesives should be completely compatible with the insulation barrier and the item being insulated (refer to the manufacturer’s instructions).

G.9.4.2.3 When insulating low temperature pipework, it is advisable to create circumferential vapour dams extending from the bare pipe to the vapour seal on the warm side of the insulation. The longitudinal spacing of the dams is arbitrary and as a guide, 2 m, for very low temperatures to 10 m, for example chilled water, should be considered. The purpose of the dams is to prevent the failure of long sections of pipe insulation should the warm side vapour seal be ruptured in any way.

G.9.4.3 Vapour barriers

G.9.4.3.1 General

G.9.4.3.1.1 For whatever purpose cold insulation is required, the insulation system is only as good as its vapour barrier and the care with which it is installed. A vapour barrier is a membrane of very low permeance placed on the warm side of insulation to limit the flow of water vapour into the insulation.

G.9.4.3.1.2 Where there is a differential in temperature or humidity between the cold surface of the equipment and the ambient temperature a differential water vapour pressure occurs. The greater the temperature differential, the greater the differential water vapour pressure. Water vapour should not be confused with moisture. Water vapour is a transparent, tasteless and odourless gas capable of permeating through most materials depending on the pressure differential on either side of the insulation.

G.9.4.3.1.3 Permeability of water through a vapour barrier is expressed in metric perms in the metric system. A metric perm is the passage of 1 g of water through a material with a surface area of 1 m^2 for 24 h and a pressure difference of 1 mm Hg. Many materials, which are moisture-resistant, are not necessarily vapour-resistant.

G.9.4.3.1.4 All insulation materials are susceptible to water vapour penetration to various degrees. If penetration is not prevented, the water vapour condenses to moisture or ice when its temperature reaches the dew point. This will, in time, saturate the insulation thereby rendering it useless. To prevent this from taking place, a vapour barrier is applied on the warm side of the insulation.

G.9.4.3.2 Selection of a vapour barier

G.9.4.3.2.1 In selecting a vapour barrier, material comparisons should be made between the various permeability ratings as supplied by manufacturers as there may be vast differences between materials (see BS 5970).

G.9.4.3.2.2 Care should be taken to ensure that the choice of vapour barriers does not affect the fire performance of the whole assembly of insulating and finishing materials. The design of the cold insulation system should assume that at sometime a breakdown of the vapour barrier might occur.

G.9.4.3.2.3 In the case of pipework, it is preferable that the water vapour has free passage to the cold surface where the resultant water or ice will be encased by the insulation.

G.9.4.3.2.4 A break in the vapour barrier of the insulation system will eventually cause the system to fail but its effective life will have been prolonged by a design which permits the through transmission of water vapour.

G.9.4.3.3 Types of vapour barriers

G.9.4.3.3.1 Membrane barriers such as

a) metal foils,

b) laminated foils,

c) treated papers,

d) plastic films,

e) plastic sheets,

f) coated felts, and

g) coated paper

are either part of the insulation as supplied, or can be supplied separately.

G.9.4.3.3.2 Coating barriers are available in fluid form as a paint or mastic (or semi-fluid of the hot-melt variety); the material can be asphaltic, resinous or polymeric. These provide a seamless coating but require time to dry and are normally reinforced with a membrane sandwiched between layers.

G.9.4.3.3.3 A pinhole through the vapour barrier can eventually render the insulation system useless, therefore, the selection of a vapour barrier needs careful consideration. Foil or sheets usually have the better permeability rating but foil has poor resistance to mechanical damage and needs a protective cover or protective laminate. Sheet metal has a good rating but requires great care in the sealing of joints and fastenings.

G.9.4.3.3.4 Water, solvent and mastic based vapour barriers tend to be resistant to mechanical damage. Their permeability rating varies from water based at the bottom of the scale to cured resins at the top. Most of these types, however, need to be suitably reinforced.

G.9.4.3.3.5 Water-based formulations tend to dry out, and in doing so leave minute pinholes. It is therefore essential that the manufacturer's recommended thickness shall be considered as a minimum to prevent pinholes extending continuously through the coating and, as a further precaution, the application shall consist of multiple coats.

G.9.4.3.3.6 In the case of solvent-based vapour barriers the manufacturer's application procedures shall be carefully followed, as the danger of solvent entrapment exists due to premature over coating resulting in surface "bubbles".

G.9.4.3.3.7 Resin-cured vapour barriers are excellent but again the manufacturer's recommended thickness shall be considered minimum. Adherence to the manufacturer's mixing proportions is mandatory. The application shall consist of multiple coats. Vapour barrier applications are only as good as the applicator. Where the insulation terminates, the vapour barrier shall be returned to the cold equipment so as to totally encapsulate the insulation.

G.9.5 Application of cold insulation materials

G.9.5.1 Generally on pipework, preformed pipe sections should be used, or alternatively, an in-situ or spray application could be considered. All insulation should fit snugly around piping and equipment.

G.9.5.2 On low temperature insulation work all attachments to the piping or equipment and projecting through the insulation should also be insulated for a distance of four times the thickness of the basic insulation from the point where the projection is exposed.

G.9.5.3 All the insulation and the vapour barrier should be continuous at pipe supports. Where metal cradles preformed to the outside diameter of the insulation are provided at the pipe supports, the cradle should be designed to prevent undue compression of the insulation due to the weight of the insulated pipe.

G.9.5.4 Higher density insulation preformed material often manufactured from PUR, PIC, phenolic foam or wood, can be used between the support and the pipe to accommodate the weight if it is considered necessary.

G.9.5.5 Insulation contraction joints should be provided for. Firebreaks should be provided at, for example, 20 m maximum, or where the insulated pipe passes from one building to another.

G.9.5.6 Where the total thickness of insulation exceeds 50 mm it should be applied to multiple layers and all joints should be staggered to prevent direct heat paths to the cold face. The creation of cavities should be avoided.

G.9.5.7 Adhesives or mastics for the application of insulation should be used with care as vapour dams may be created.

Annex H
(informative)

Examples of hot water storage and pipe sizing

H.1 Sizing hot water storage

H.1.1 Example 1

Example 1 shows how to calculate the amounts of hot, V_2 and cold, V_1,) water required to produce bath water at 40 °C.

Cold water at T_1 = 15 °C and hot water at T_2 = 60 °C, are to be mixed to give V_f = 120 L of water at T_f = 40 °C, for bathing.

Calculate the quatity of both hot and cold water required, using the following equations:

a) Volume of cold water required:

$$V_1 = V_f \frac{T_2 - T_f}{T_2 - T_1} = 120\,\text{L}\,\frac{60 - 40}{60 - 15} = 53{,}3\,\text{L}$$

b) Volume of hot water required:

$$V_2 = V_f - V_1 = 120\text{ L} - 53{,}3\text{ L} = 66{,}7\text{ L}$$

or

$$V_2 = V_f \frac{T_f - T_1}{T_2 - T_1} = 120\,\text{L}\,\frac{40 - 15}{60 - 15} = 66{,}7\,\text{L}$$

H.1.2 Example 2

NOTE Example 2 is based on the *Plumbing services design guide* (see bibliography).

H.1.2.1 Determine the replenishment/storage relationships for the hot water installation serving a hostel with a hot water demand given in table H.1, in which hourly readings of total water consumption are given starting with the hour of peak demand.

NOTE Typical replenishment/storage capacity curves for various categories of premises are given in H.5.

The demand data can be plotted in the form of a histogram as shown in figure H.1.

From the histogram in figure H.1, a series of sequential peak hourly loads can be calculated for groups of hours, from 1 h to the maximum number of hours in the observation period. The average hourly load for each group of hours under consideration can thus be determined.

To construct the graph in figure H.2, proceed as given in H.1.2.1 to H.1.2.4.

Table H.1 — Hot water demand starting with peak period

1	2	3	1	2	3
No. of hours passed	**Total volume of water drawn** L	**Average rate of draw-off** L/h	**No. of hours passed**	**Total volume of water drawn** L	**Average rate of draw-off** L/h
1	3 400	3 400	13	27 000	1 077
2	6 600	3 300	14	28 300	2 021
3	9 600	3 200	15	28 800	1 920
4	11 600	2 900	16	28 900	1 806
5	13 300	2 660	17	29 000	1 706
6	16 300	2 717	18	29 100	1 617
7	19 300	2 757	19	29 200	1 537
8	22 000	2 750	20	29 300	1 465
9	24 000	2 667	21	29 400	1 400
10	25 600	2 560	22	29 500	1 341
11	26 400	2 400	23	29 600	1 287
12	27 200	2 267	24	29 700	1 238

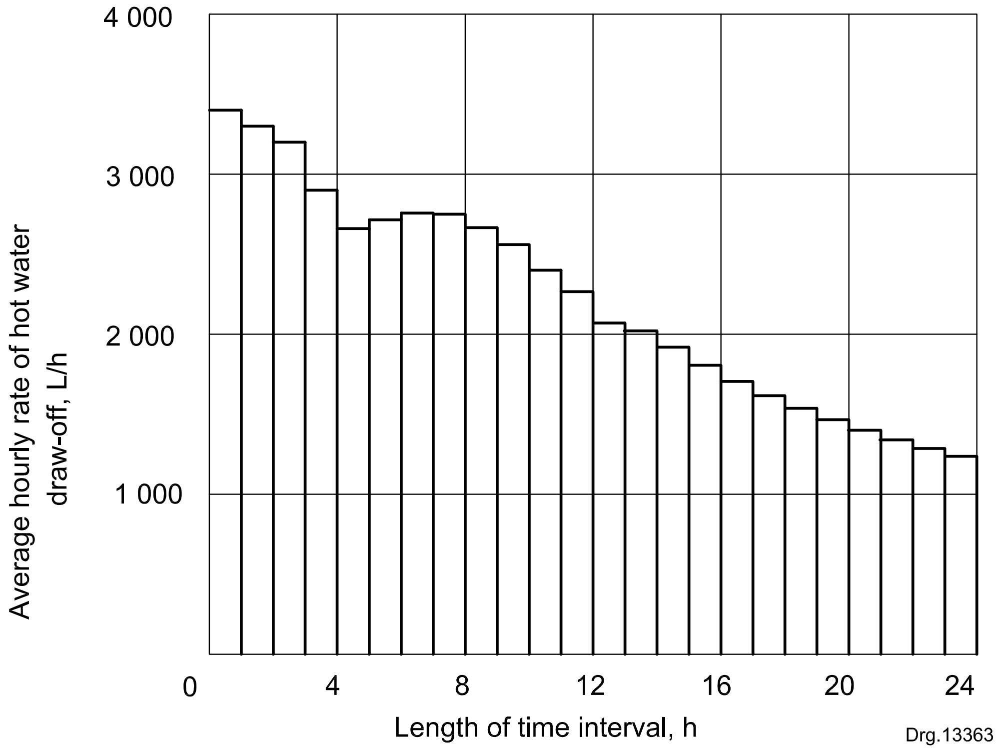


Figure H.1 — Typical demand pattern for hot water on premises

H.1.2.2 For each average value plotted in column 3 of table H.1, draw a straight line that represents the equivalent linear estimate of "volume left" versus "hours passed", for example, the line from the point (0 h, 1 806 L/h) to the point (16 h, 0 L/h).

H.1.2.3 Draw the horizontal line corresponding to the minimum value found in column 3 (in this case, 1 238 L/h corresponding to the 24 h interval).

H.1.2.4 The straight lines drawn in H.1.2.1 and H.1.2.3 should all be tangent to the required graph (the line from H.1.2.3 actually forms the rightmost part of the graph). Beginning at the leftmost top point (in this case, 0 h, 3 400 L/h), draw the best possible smooth curve that touches (but never intersects) as many of the straight lines from H.1.2.1 as possible and that finally goes over into the horizontal line from H.1.2.3.

H.1.2.5 Any point on the resultant graph indicates the maximum draw-off rate which is catered for if a testing period of the indicated length is chosen at random during any day.

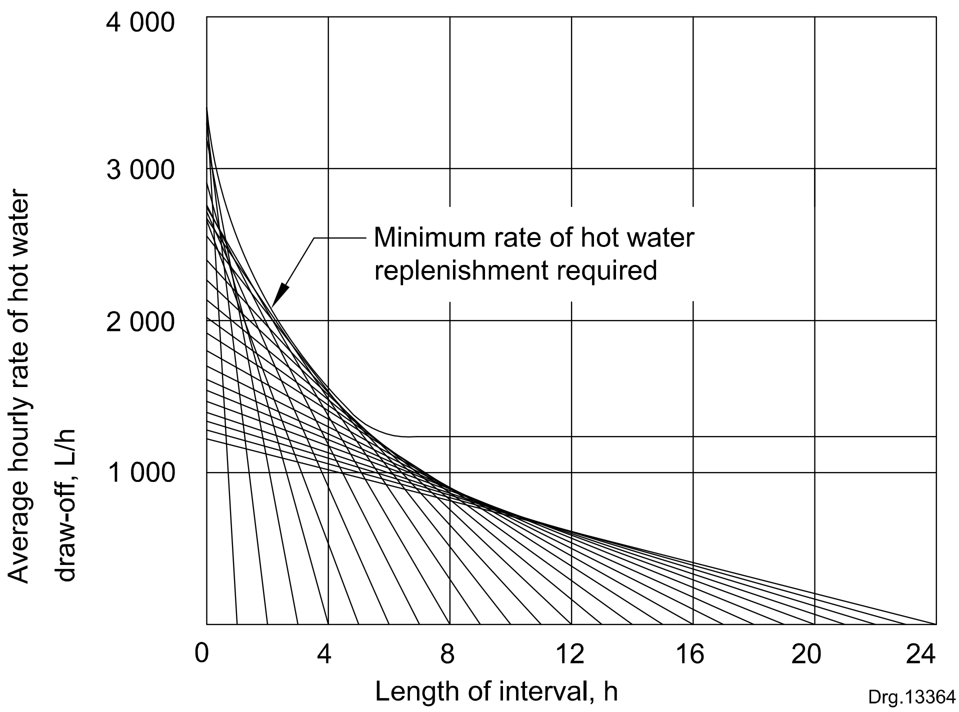


Figure H.2 — Typical minimum hot water recovery rate

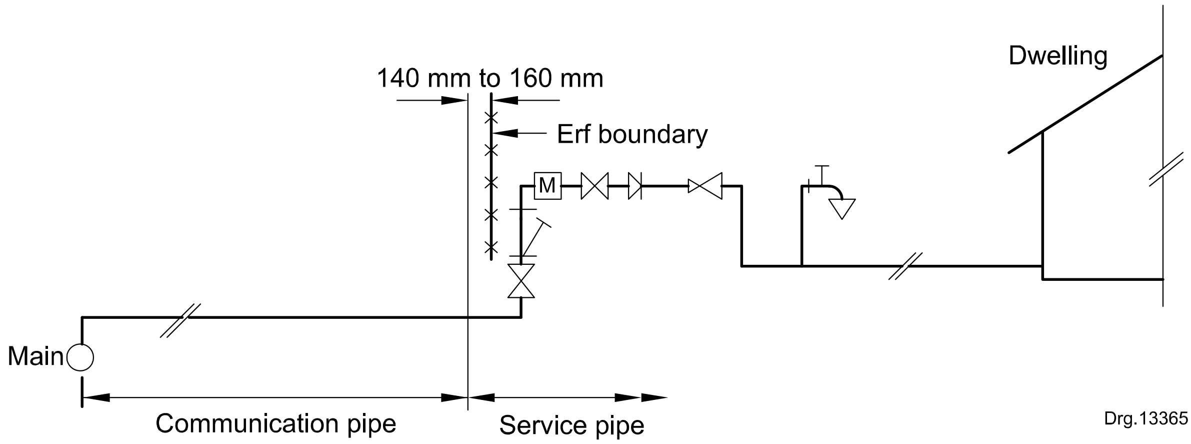
H.2 Sizing of a service pipe serving a dwelling house

H.2.1 Data given

Assume the maximum pressure in the local authority's main is 800 KPa and the minimum pressure (during peak demand) is 700 kPa (the schematic arrangement of the service pipe is shown in figure H.3).

H.2.2 Probable demand

Step one will be to determine the probable demand in the service pipe. Such a calculation is shown in table H.2.



NOTE 1 The pressure control valve may be at the building.

NOTE 2 The relation of boundary to meter in accordance with the local authority.

Figure H.3 — Schematic arrangement of a service pipe

Table H.2 — Probable demand in the service pipe

1	2	3	4
Fixture/Fitting	**Number**	**Design flow rate per tap or fitting** (see table 4) L/min	**Maximum demand** *Q* L/min
Garden (115 mm taps)[a]	3	15	45
Wash-hand basin (mixer)	2	9	18
Sink (mixer)	1	9	9
Wash trough (15 mm taps)	2	10	20
Bath (mixer)	2	25	50
Showerhead	1	15	15
Water-closet (float valve in cistern)	3	5	15
			Total max. demand: $\Sigma Q = 172$
NOTE 1 Probable maximum demand $Q_p = (\Sigma Q)^{0,7} = 37$ L/min.			
NOTE 2 If the designer prefers to allow for both bath mixers to operate simultaneously at the design flow of 25 L/min each, Q_p becomes 50 L/min.			
[a] Included in the total demand for a dwelling for simplicity.			

H.2.3 Alternative approaches to sizing the service pipe

Two alternative approaches to sizing the service pipe are given in table H.3 and table H.4. In table H.3, a 400 kPa rated pressure control valve is used, resulting in the need for a 32 mm diameter service pipe from the pressure control valve to the house in order to reduce the friction loss.

In table H.4, a 500 kPa rated pressure control valve is used, allowing the use of a 25 mm diameter service pipe from the pressure control valve to the house.

H.3 Sizing of a service pipe serving a four-storey hostel

H.3.1 Data

Use the following data to determine the pipe sizing of cold and hot water supply services in a four-storey hostel block:

The four-storey hostel block has four identical ablution facilities which are fed from a storage tank situated on the roof.

NOTE Figures H.4 to H.8 (inclusive), are schematic arrangements for sizing pipes only and do not show provision for venting and expansion.

H.3.2 Determine probable demand

Determine the probable demand in the branch pipe at each floor.

Using table H.5 determine the probable demand for cold water and from table H.6 determine the probable demand for hot water.

Table H.3 — Sizing of the service pipe for a dwelling house (approach 1)

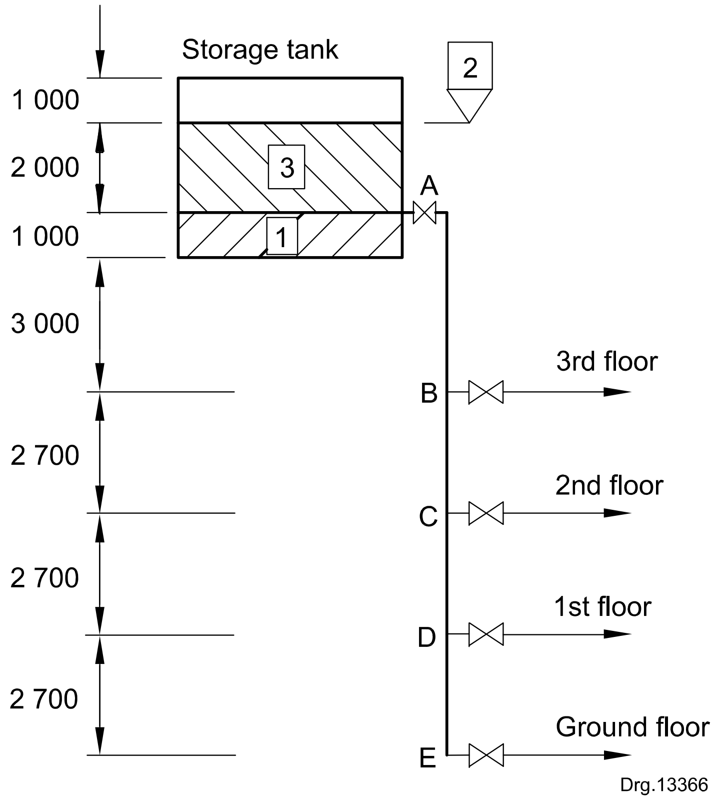
1	2	3	4	5	6	7	8	9	10	11	12	13	14
						Secondary energy loss							
Pipe	**ΣQ** L/min	**Qp** L/min	**Pipe material pressure class and nominal diameter**	**Pipe length** m	**Pipe friction loss h_1** m/m	**Fittings**	**K*** (see table 18)	V m/s	$\frac{k^{*}V^{2}}{2g}$ m	**Total head loss** (5) × (6) + 10 m	**Available head** m	**Difference in ground level** m	**Net residual head** m, min.
Communication	172	50[a]	HDPE (class 10) 25 mm	11,6	0,35	1 × Sudden contraction	0,5	2,5	0,16	4,2	70	Nil	65,8
Service from communication pipe to pressure control valve	172	50[a]	Below ground: HDPE (class 10) 25 mm	1,50	0,35	2 × 90° elbows 2 × Gate valve pipe to PCV	2,00 0,12	2,5 2,5	0,64 0,04				
			Above ground: Copper (class 3) 25 mm	b	b	1 × Strainerc 1 × Meter (size 3)[c]	5,00 18,8	2,5 2,5	1,59 6,00	8,8	57,0	Nil	57,0[d] 25[e]
Service from pressure control valve to house	172	50[a]	Above ground: Copper (class 3) 22 mm	b	b	2 × 90° elbows 2 × Gate valve 1 × Reducer	2,00 0,12 0,30	2,5 2,5 2,5	0,64 0,04 0,10				
			Below ground: HDPE (class 10) 32 mm	13,5	0,11	1 × Tee	0,35	1,5	0,04	2,3	22,7	1,7	21,0

[a] Although Q_p from table H.2 is 37 L/min, assume both bath mixers are operating together. (See note 2 in table H.2.)
[b] Length and friction loss is negligible.
[c] Obtain the value of *k** from the manufacturer.
[d] Residual head upstream of the pressure control valve.
[e] Residual head downstream of the pressure control valve, assuming a 400 kPa rated unit.

Table H.4 — Sizing of the service pipe for a dwelling house (approach 2)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pipe	**ΣQ** L/min	**Q_p** L/min	**Pipe material pressure class and nominal diameter**	**Pipe length** m	**Pipe friction loss h_1** m/m	**Secondary energy loss**				**Total head loss** (5) × (6) + 10 m	**Available head** m	**Difference in ground level** m	**Net residual head** m, min.
						Fittings	***k****(see table 18)	***V*** m/s	$\frac{k^*V^2}{2g}$ m				
Communication	172	50[a]	HDPE (class 10) 25 mm	11,6	0,35	1 × Sudden contraction	0,5	2,5	0,16	4,2	70	Nil	65,8
Service from communication pipe to pressure control valve	172	50[a]	Below ground: HDPE (class 10) 25 mm	1,50	0,35	2 × 90° elbows 2 × Gate valve pipe to PCV	2,00 0,12	2,5 2,5	0,64 0,04				
			Above ground: Copper (class 3) 25 mm	[b]	[b]	1 × strainer 1 × meter (size 3)[c]	5,00 18,8	2,5 2,5	1,59 6,00	8,8	57,0	Nil	57,0[d] 25[e]
Service from pressure control valve to house	172	50[a]	Above ground: Copper (class 3) 22 mm	[b]	[b]	2 × 90° elbows 2 × gate valve 1 × Tee	2,00 0,12 0,35	2,5 2,5 2,5	0,64 0,04 0,11	5,5	19,5	1,7	17,8
			Below ground: HDPE (class 10) 32 mm	13,5	0,35								

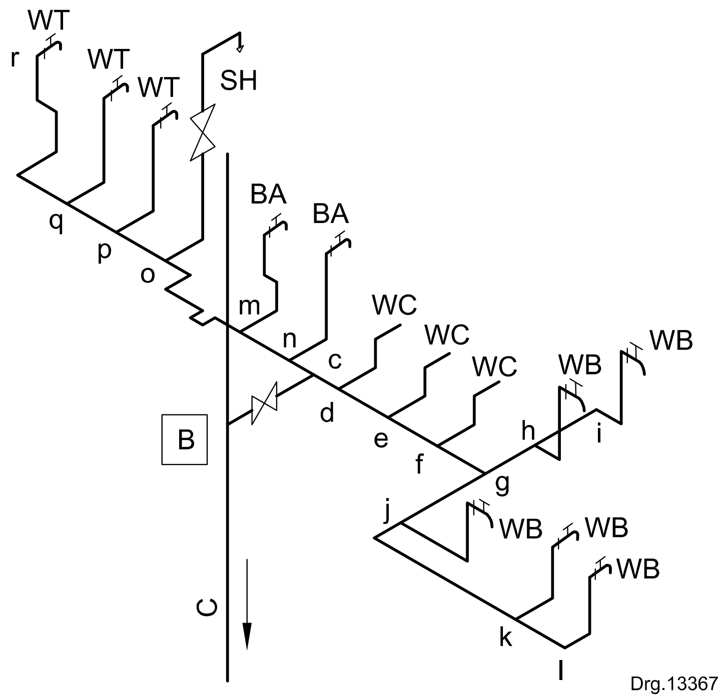
[a] Although Q_p from table H.2 is 37 L/min, assume both bath mixers are operating together. (See note 2 in table H.2.)
[b] Length and friction loss is negligible.
[c] Obtain the value of k^* from the manufacturer.
[d] Residual head upstream of the pressure control valve.
[e] Residual head downstream of the pressure control valve, assuming a 400 kPa rated unit.



NOTE 1 See table H.7 for the sizing of the cold water dropper main.

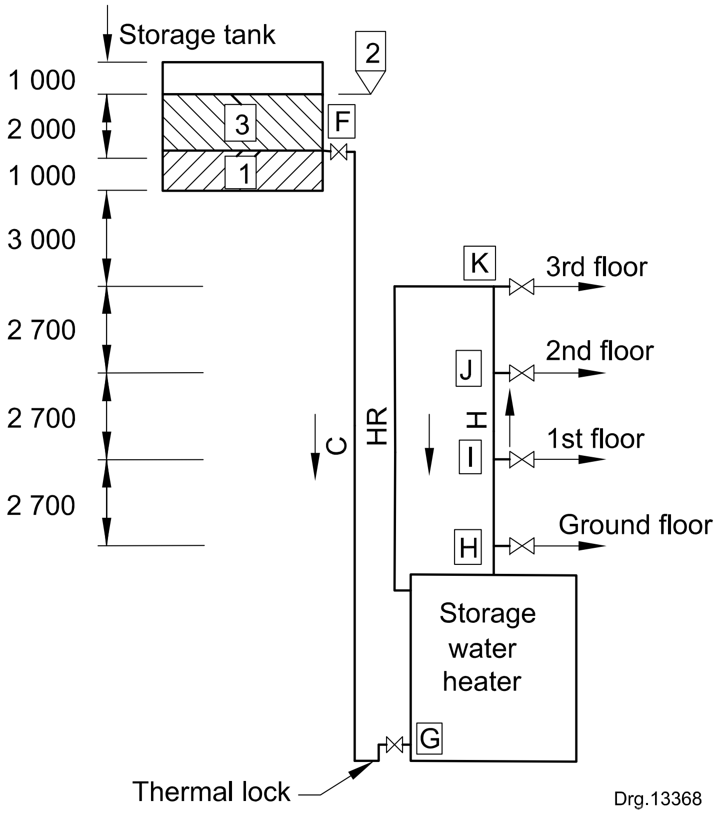
NOTE 2 For elements such as the numbering of nodes, see 7.6.1.4.

Figure H.4 — Schematic arrangement of cold water dropper main



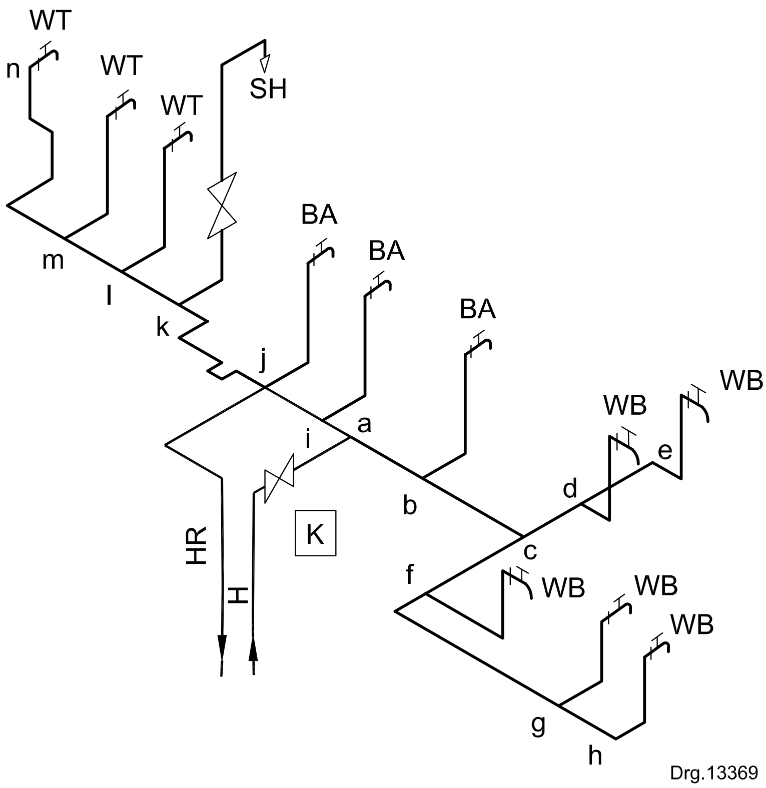
NOTE For elements such as the numbering of nodes, see 7.6.1.4.

Figure H.5 — Schematic arrangement of cold water supply system in third floor ablution facility



NOTE For elements such as the numbering of nodes, see 7.6.1.4.

Figure H.6 — Schematic arrangement of hot water mains



NOTE For elements such as the numbering of nodes, see 7.6.1.4.

Figure H.7 — Schematic arrangement of hot water installation in third floor ablution facility

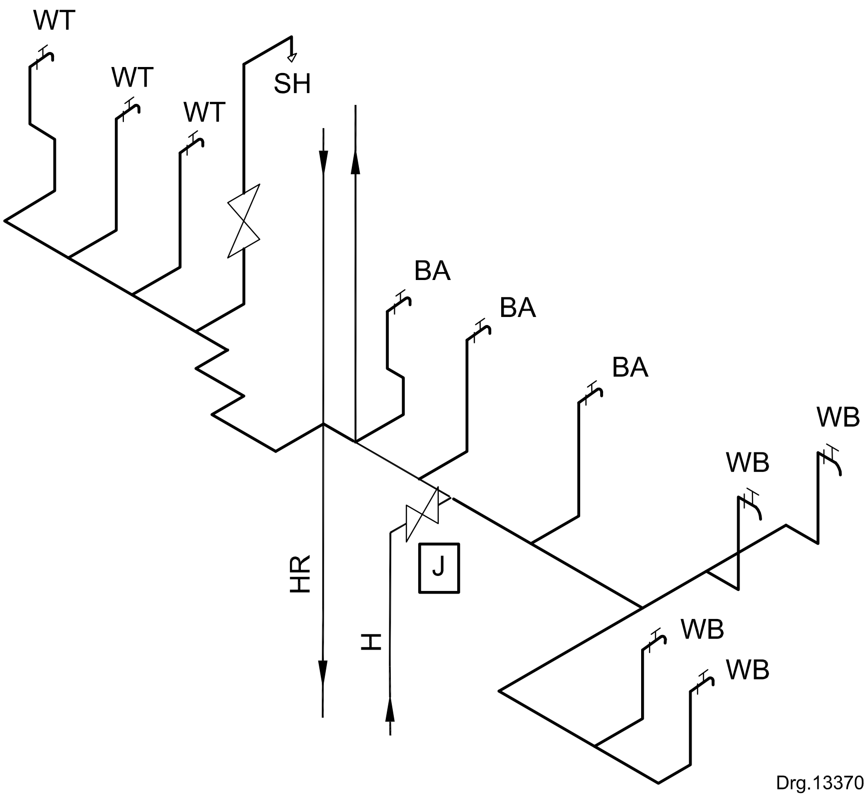


Figure H.8 — Schematic arrangement of hot water installation on second floor ablution facility

Table H.5 — Probable demand in branch pipe at each floor (cold water)

1	2	3	4
Fixture/Fitting	**Number**	**Design flow rate per tap or fitting** (see table 4) L/min	**Maximum demand** *Q* L/min
Wash trough (20 mm taps – aerated outlet)	3	20	60
Showerhead (standard)	1	15	15
Bath (20 mm taps – plain outlet)	3	25	75
WC (float valve)	3	5	15
Wash-hand basin (15 mm taps – plain outlet)	5	10	50
			Total max. demand: ΣQ = 215
NOTE Probable maximum demand Q_p = (ΣQ)0,8 = 73 L/min.			

Table H.6 — Probable demand in branch pipe at each floor (hot water)

1	2	3	4
Fixture/Fitting	**Number**	**Design flow rate per tap or fitting** (see table 4) L/min	**Maximum demand** *Q* L/min
Wash trough (20 mm taps – aerated outlet)	3	20	60
Showerhead (standard)	1	15	15
Bath (20 mm taps – plain outlet)	3	25	75
Wash-hand basin (15 mm taps – plain outlet)	5	10	50
			Total max. demand: ΣQ = 200
NOTE Probable maximum demand Q_p = (ΣQ)0,8 = 69 L/min.			

H.3.3 Sizing procedures

H.3.3.1 From table H.7, the residual head at B is 5,05 m. This appears to be sufficient to supply the cold water terminal fittings in the third floor ablution areas.

H.3.3.2 The next step is to size the cold water pipes on the third floor. Because the wash trough taps are large (20 mm) and the showerhead is elevated above the floor, these fittings are critical and should be investigated first. The pipes are sized as shown in table H.8.

H.3.3.3 From table H.8, the required residual head at B is 5,15 m, whereas the available residual head at B (table H.7) is 5,05 m. The actual residual head at the showerhead during peak demand is therefore 0,10 m less than the required 2,00 m, i.e. 1,90 m, which is within acceptable limits. The pipe sizes can be reduced for the lower floors where the available residual head is greater.

H.3.3.4 The sizing procedure for the cold water dropper main that supplies the water heater and the hot water riser main is given in table H.9.

H.3.3.5 From table H.9, the residual head at K (see figure H.7) is 5,21 m.

H.3.3.6 The next step is to size the hot water pipes on the third floor. Because of the restriction on the length of dead legs (see clause 7), a preliminary calculation of the pipe volume necessitated a portion of the piping (a to j) to be included in the circulating loop (see figure H.7).

The hot water pipes are sized as shown in table H.10, starting with the shower, which is a critical point, and working back to the riser (point K).

H.3.3.7 From table H.10, the required residual head at K is 5,41 m, whereas the available residual head at K (table H.9) is 5,21 m. The actual residual head at the showerhead during peak demand is therefore 0,20 m less than the required 2,00 m, i.e. 1,80 m, which is just acceptable. The actual available head at a (see table H.10) is 4,74 m.

The remaining pipes are sized as further shown in table H.10, using the 4,74 m residual head at a (see table H.10).

The residual heads at the other three critical points: n, e and h (see table H.10), are 3,66 m, 4,41 m and 4,32 m respectively, which are adequate.

H.3.3.8 The design should now be checked for compliance with 7.7.1.3 in respect of the internal volume of dead legs. The calculation of the volumes is shown in table H.11.

The volume of the most critical dead leg (j – n) is less than the required limit of 4 L. This could not have been achieved if pipes a – i (35 mm diameter) and i – j (28 mm diameter) had been included in the dead leg.

Figure H.8 shows the routing of the main riser pipe in order to ensure that the dead-leg volume on the second floor does not exceed the required limit.

Table H.7 — Sizing cold water dropper main (see figure H.4)

1	2	3	4	5	6	7	8	9	10	11	12	13
Pipe	**ΣQ** L/min	**Q_p** L/min	**Pipe material nominal diameter**	**Pipe length** m	**Pipe friction loss h_1** m/m	**Secondary energy loss**				**Total head loss** (5) × (6) + 10 m	**Static head** m	**Residual head** (12 − 11) m
						Fittings	k* (see table 18)	V m/s	$\frac{k^* V^2}{2g}$ m			
A – B	4 × 215 = 860	223	GMS (med) 50 mm	5,0	0,070	1 × Tank outlet 1 × Sluice valve 2 × 90° elbows 1 × Tee	1,00 0,12 2,00 1,20	1,65	0,60	0,95	6,00	5,05
B – C	3 × 215 = 645	177	GMS (med) 50 mm	2,7	0,047	1 × Tee	0,35	1,35	0,03	0,13 + (0,03 + 0,95) = 1,11	8,70	7,59
C – D	2 × 215 = 430	128	GMS (med) 40 mm	2,7	0,090	1 × Tee	0,35	1,60	0,05	0,24 + (0,05 + 1,11) = 1,40	11,40	10,00
D – E	215	73	GMS (med) 32 mm	2,7	0,060	1 × 90° elbow	1,00	1,20	0,07	0,16 + (0,07 + 1,40) = 1,63	14,10	12,47

NOTE Obtain the value of k* from the manufacturer.

Table H.8 — Sizing of piping in ablution area (cold water — 3rd floor) (see figure H.5)

1	2	3	4	5	6	7	8	9	10	11	12
Pipe	**ΣQ** L/min	**Q_p** L/min	**Pipe material, pressure class and nominal diameter**	**Pipe length** m	**Pipe friction loss h_1** m/m	**Secondary energy loss** **Fittings**	 **k^*** (see table 18)	 **V** m/s	 $\frac{k^* V^2}{2g}$ m	**Total head loss** (5) × (6) + 10 m	**Residual head required** m
r – q	20	20	GMS (med) 20	[b]	[b]						
q – p	40	40	GMS (med) 20	[b]	[b]						
p – o	60	40[a]	GMS (med) 20	[b]	[b]						
o – SH	15	15	GMS (med) 20	3,0	0,057	1 × Tee 2 × 90° elbows 1 × Stopcock	1,20 2,00 10,0	0,75	0,38	0,55	2,00[c] (at SH) 4,55[d] (at O)
n – o	75	40[a]	GMS (med) 32	2,5	0,022	1 × Tee 6 × 90° elbows	0,35 6,00	0,70	0,16	0,22	4,77
m – n	100	40	GMS (med) 32	1,8	0,022	1 × Tee	0,35	0,70	0,01	0,05	4,82
b – m	125	48	GMS (med) 32	1,0	0,029	1 × Tee	0,35	0,80	0,01	0,04	4,86
B – b	215	73	GMS (med) 32	1,0	0,070	2 × Tees 1 × Gate valve	2,40 0,12	1,30	0,22	0,29	5,15 (at B)

NOTE Obtain the value of k^* from the manufacturer.

[a] Q_p maintained at 40 L/min until Q_p = 0,8 exceeds 40 L/min.
[b] Length and friction loss is negligible.
[c] Requires 2,00 m residual head at showerhead which is the most critical fitting.
[d] Required residual head at o (see figure H.5), is the height of showerhead above 0 (= 2,00 m) plus required residual head at SH (= 2,00 m), plus head loss in pipe o-SH.

Table H.9 — Sizing cold water supply main (see F to G in figure H.6) **and hot water riser main** (see H to K in figure H.6)

1	2	3	4	5	6	7	8	9	10	11	12	13
						Secondary energy loss				**Total head loss** (5) × (6) + 10	**Static head**	**Residual head** (12 – 11)
Pipe	ΣQ L/min	Q_p L/min	**Pipe material nominal diameter**	**Pipe length** m	**Pipe friction loss** h_1 m/m	**Fittings**	k^* (see table 18)	V m/s	$\frac{k^* V^2}{2g}$ m	m	m	m
F – G	4 × 200 = 800	210	GMS (med) 65 mm	18,3	0,018	1 × Tank outlet 1 × Sluice valve 4 × 90° elbows 1 × Sudden enlargement	1,00 0,12 4,00 1,00	0,95	0,20	(0,33 + 0,28 = 0,61)		
H – K	4 × 200 = 800	210	Copper (class 0 76 mm	8,6	0,01	1 × Sudden contraction 3 × Tees (inline) 1 × Tee (line to branch)	 1,05 0,80	0,80	0,08	(0,09 + 0,09 + 0,61) = 0,79	6,00	5,21

NOTE Obtain the value of k^* from the manufacturer.

Table H.10 — Sizing of piping in ablution (hot water – 3rd floor) (figure H.7)

1	2	3	4	5	6	7	8	9	10	11	12
Pipe	**ΣQ** L/min	Q_p L/min	**Nominal pipe diameter** mm	**Pipe length** m	**Pipe friction loss h_1** m/m	**Secondary energy loss**				**Total head loss** (5) × (6) + 10 m	**Residual head required** m
						Fittings	**k*** (see table 18)	**V** m/s	$\frac{k^* V^2}{2g}$ m		
m – n	20	20	22	2,5	0,075	5 × 90° elbows	5,00	1,05	0,28	0,47	3,66 (at n)
l – m	40	40	28	1,0	0,073	1 × Tee	0,35	1,2	0,03	0,10	4,13
k – l	60	40[a]	28	1,2	0,073	1 × Tee	0,35	1,2	0,03	0,11	4,23
k – SH	15	15	22	3,0	0,043	1 × Tee[b] 2 × 90° elbows 1 × Stopcock	1,20 2,00 10,0	0,75	0,38	0,51	2,00[c] (at SH) 4,51[d] (at k) Actual 4,74
j – k	75	40[a]	28	2,5	0,07	1 × Tee 6 × 90° elbows	0,35 6,00	1,2	0,47	0,64	5,15 (at j)
i – j	100	40	28	1,8	0,07	1 × Tee	0,35	1,2	0,02	0,15	5,30 (at i)
a – l	125	48	35	1,0	0,034	1 × Tee[b]	1,20	0,9	0,05	0,08	5,38 (at a) Actual 7,74
K – a	200	69	42	1,0	0,028	1 × Gate valve	0,12	0,95	0,01	0,03	5,41 (at K) Actual 5,22
a – b	75	32	22	0,3	0,17	1 × Tee	0,35	1,65	0,05	0,10	5,28
b – c	50	23	22	1,1	0,095	1 × Tee	0,35	1,18	0,02	0,13	5,15 (at c)
c – d	20	20	22	0,3	0,075	1 × Tee[b]	1,20	1,05	0,07	0,09	5,06
d – e	10	10	15 15	3,0	0,14	1 × Tee 3 × 90° elbows	0,35 3,00	1,15	0,23	0,65	4,41 (at e)
c – f	30	20	22	0,5	0,075	1 × Tee	1,35	1,05	0,02	0,06	5,00
f – g	20	20	22	1,8	0,075	1 × 90° elbow	0,35	1,05	0,08	0,21	4,79
g – h	10	10	15	1,9	0,14	3 × 90° elbows	3,00	1,15	0,20	0,47	4,32 (at h)

[a] Q_p maintained at 40 L/min until Q_p 0,8 exceeds 40 L/min.
[b] Line to branch to line sharp-edge tee.
[c] Requires 2 m residual head at showerhead which is the most critical fitting.
[d] Required residual head at *k** is the height of showerhead above *k** (= 2 m) plus required residual head at SH (= 2 m) plus head loss in pipe K-SH.

Table H.11 — Internal volume of dead legs in pipes
(see figure H.7, table H.10 and table 19)

1	2	3	4
Pipe	**Length** m	**Diameter and type of pipe** mm	**Internal volume** L
j – m m – n	4,7 2,5	28 Cu 22 Cu	2,6 0,8
Total for j – n			3,4
a – g g – h	3,7 1,9	22 Cu 15 Cu	1,2 0,3
Total for a – h			1,5

H.4 Determining hot water replenishment/storage capacities, using graphs

H.4.1 Design criteria

Determine the required water heater size for a 300-bed women students' hostel using the following criteria:

a) storage system to have a minimum replenishment rate;

b) storage system to have a replenishment rate of 2,6 mL/s per student; and

c) an additional requirement of a cafeteria, to serve a maximum of 300 meals/h with a minimum replenishment rate combined with the information given in (a), and a replenishment rate of 1,1 mL/s/max. meals/h, combined with the information given in (b).

H.4.2 Solution

The minimum replenishment rate from figure E.15 for women's hostels is approximately 1,2 mL/s/student, giving a total of 360 mL/s. The storage required is 45 L/student or 13 500 L of storage. The necessary tank size on a 70 % net usable basis is 19 300 L.

NOTE Example based on ASHRAE Handbook (see note 1 to E.5).

The same curve shows storage of approximately 20 L/student at a replenishment of 2,6 mL/s/student or approximately 8 600 L of storage on a 70 % net usable basis, with a replenishment rate of 780 mL/s.

The additional requirement for a cafeteria with the storage replenishment capacities added to that for the hostel, can be determined from figure E.19.

In the case of the minimum replenishment rate, the cafeteria requires 0,47 × 300 = 141 mL/s replenishment rate and 28 × 300 × 1/0,7 = 12 000 L, additional storage. The entire building therefore requires 501 mL/s replenishment capacity and 31 300 L storage capacity.

With 1,1 mL/s replenishment rate per maximum meals per hour, the additional replenishment capacity required is 330 mL/s and the additional storage capacity required is 7,5 × 300 × 1/0,7 = 3 214 L.

Therefore, by combining 330 mL/s with the information given in H.4.1(b), the entire building requires 1 110 mL/s replenishment capacity and 11 800 L storage capacity.

H.5 Example schedule of information

The position and size of every pipe and the location of every water fitting, storage tank, pump, overflow and item of equipment or plant that uses water as a heat exchange medium and is connected to the water installation should be shown on the drawings.

Further information required can be provided in the form of schedules on the drawings. Examples of such schedules are given in tables H.12 and H.13.

Table H.12 — Schedule of water pressures (to be shown on the drawing)

1	2
Type of installation	**Working pressure** kPa
General installation Fire installation	800 900

Table H.13 — Schedule of elements such as pipes and fittings
(to be shown on the drawing)

1	2	3
Item	**Reference No.**[a]	**Details**
Pipes underground:		
Diameter < 75 mm		HDPE class 10
Diameter < 75 mm		FC class 18
Pipes above ground:		
All diameters		Cu class 0
Water fittings (terminal):		
Wash-hand basin taps	HB/1-6	15 mm pillar tap (plain outlet)
Bath taps	BA/1-4 BA/4,5	20 mm pillar tap (aerated outlet) 15 mm pillar tap (plain outlet)
Showers	SH/1-3 SH/4	15 mm mixer taps and standard showerhead set 15 mm thermostatically controlled mixing valve and water-saving showerhead set
Water closets	WC/1-6	Cistern
Bidets	BT/1	15 mm mixing valve
Urinals	UR/1-3	Automatic shut-off flush valve for washdown type
Sink taps	SK/1-4	15 mm bib tap (plain outlet)
Wash trough taps	WT/1-4	20 mm bib tap (plain outlet)
Float valves	FV/1	15 mm (5 mm seat bore)
External taps	ET/1,2	15 mm hose bib cock
Water fittings (in-line):	WH/1,2	
Water heaters	PR/1-3	200 L SANS 151 type 3 fixed electric storage heater 400 kPa rated 3 kW element
Pressure reducing valves	PC/1,2	30 kPa to 500 kPa rated adjustable. Set at 300 kPa outlet pressure
Pressure control valves	LCV/1	400 kPa rated
Level control valves	ST/1	50 mm inlet diameter
Storage tanks	ST/2	6 000 L capacity 13 000 L capacity
Pumps	PU/1	Booster pump for fire installation
[a] Reference number shown next to the item on a drawing.		

Annex I
(informative)

Friction loss curves and general tables

I.1 Properties of various substances and materials

I.1.1 Table I.1 gives certain properties of water.

Table I.1 — Properties of water

1	2	3	4	5	6
Temp. °C	**Density** kg/m^3	**Specific weight**[a] kN/m^3	**Bulk modulus** kN/mm^2	**Kinematic viscosity** mm^2/s	**Vapour pressure** kPa
0	1 000	9,81	2,00	1,79	0,62
15	1 000	9,81	2,15	1,14	1,72
20	999	9,80			
30	997	9,78			
50	990	9,71	2,29	0,56	11,7
100	960	9,42	2,07	0,30	101,2
[a] Assuming *g* = 9,81 m/s^2.					

I.1.2 Table I.2 gives the heat properties of substances that are suitable for use as heat transferring mediums.

Table I.2 — Heat properties

1	2	3
Material	**Specific heat** kJ/kg °C	**Volumetric specific heat** kJ/m^3 °C
Water	4,2	415
Mercury	0,13	188
Alcohol	2,93	262
Petroleum	2,10	174
Glycol	3,24	355
Air	1,01	1,2
Iron[a]	0,46	355
[a] Given for comparison purposes.		

I.1.3 Table I.3 gives the calorific values of various fuels.

Table I.3 — Calorific values of various fuels

1	2	3	4
Type of fuel	**Calorific value**		**Density**
	MJ/kg	GJ/m³	kg/m³
Solid fuel:			
Anthracite	35	29	33
Bituminous coal	30	24	800
Bituminous coke	28	11	400
Oil:			
Domestic (35 s)	45	37	83
Light (200 s)	42,6	40	940
Town gas	–	0,02[a]	–
Natural gas	–	0,04[a]	–
Electricity	3,5 MJ/kWh		–
[a] At standard temperature and pressure.			

I.1.4 Table I.4 gives the expansion coefficients of various materials.

Table I.4 — Expansion coefficients of materials

1	2
Material	**Coefficient of expansion** °C
Mild steel	11,9.10-6
Copper	166,0.10-6
Water at 0 °C	−67,0.10-6
Water at 20 °C	206,0.10-6
Water at 40 °C	308,0.10-6
(Mean 0 °C to 40 °C)	192,0.10-6

I.2 Climatic data

I.2.1 Table I.5 gives the climatic data for selected cities in the Republic of South Africa.

NOTE Taken from the paper on *Heat-pump hot water systems at educational institutions* (see bibliography).

I.2.2 Table I.6 gives the mean daily hours of sunshine for selected cities for the months of January to December.

Table I.5 — Climatic data for selected cities

1	2	3	4	5	6	7	8
City	**Average annual wet bulb temp.**[a] °C	**Equivalent low wet bulb ambient temperature at stated probabilities between stated hours** °C				**Expected temperature of water in mains**[b] °C	
		1 % 0:00 – 24:00	**1 % 09:00 – 21:00**	**2,5 % 0:00 – 24:00**	**2,5 % 09:00 – 21:00**	**Low**	**High**
Alexander Bay	15,5	7,6	9,3	8,1	9,6	[c]	[c]
Beaufort West	13,5	1,3	4,0	2,3	5,0	13,0	32,5
Bloemfontein	12,0	−0,8	1,9	0,2	2,8	8,5	24,0
Cape Town	15,0	6,1	8,7	7,0	9,5	13,0	28,0
Durban	19,0	9,8	12,7	10,8	13,8	[c]	[c]
East London	16,5	[c]	[c]	[c]	[c]	15,0	24,0
George	[c]	7,4	9,8	7,6	9,9	[c]	[c]
Johannesburg	12,0	1,1	2,9	1,7	3,1	11,0	21,5
Kimberley	13,0	0,3	3,2	1,4	4,2	[c]	[c]
Port Elizabeth	15,5	8,4	10,8	9,2	11,6	15,0	24,5
Pietersburg	14,0	4,3	6,7	5,1	7,6	[c]	[c]
Pretoria	14,0	2,7	5,5	3,6	6,3	12,0	24,5
Richards Bay	20,0	[c]	[c]	[c]	[c]	18,0	27,0
Upington	14,5	0,5	4,3	2,0	5,4	13,5	33,5
Windhoek	12,0	1,4	3,2	1,6	3,6	13,5	26,0

[a] Based on weather data between the hours of 09:00 and 21:00 (13 h); information accuracy of ± 0,5 °C.
[b] From the city mains supply at ± 0,5 °C.
[c] Information not available.

Table I.6 — Mean daily hours of sunshine for selected cities for the months of January to December

1	2	3	4	5	6	7	8	9	10	11	12	13
City	**Mean daily sunshine** h											
	Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Alexander Bay	10,24	9,72	9,09	8,94	6,12	8,50	7,51	8,28	9,11	9,55	10,16	10,28
Bloemfontein[a]	9,79	9,24	8,52	8,80	8,77	8,74	5,72	6,42	7,16	8,87	9,85	11,10
Cape Town[a]	10,94	10,47	9,10	6,92	5,92	5,96	5,72	6,42	7,16	8,87	9,85	11,10
Durban[a]	6,49	6,74	6,17	6,83	7,40	6,94	6,87	6,91	5,83	5,24	5,75	5,97
Keetmanshoop	11,44	10,34	9,92	10,15	9,94	9,65	9,84	10,51	10,92	11,32	11,97	11,95
Kimberleya	9,69	9,48	8,87	8,96	8,64	8,82	9,05	9,71	9,67	9,70	10,20	10,54
Pietersburg[a]	7,99	7,55	7,55	8,06	8,61	8,91	8,63	8,64	8,72	8,73	8,23	8,13
Port Elizabeth	8,55	8,23	7,51	7,57	6,91	6,85	7,15	7,61	7,44	7,67	8,29	8,93
Pretoria	8,35	8,08	7,68	8,69	9,27	9,23	9,36	9,91	9,26	8,90	9,02	9,05
Upington	11,52	10,51	9,53	9,67	9,18	8,97	9,10	10,00	10,61	10,92	11,63	11,65
Windhoek	9,26	8,98	9,05	9,09	10,04	10,25	10,50	11,01	10,75	10,30	9,85	9,21

[a] Airport.

I.2.3 Table I.7 gives the mean daily total available solar radiation on a horizontal surface.

Table I.7 — Mean daily total available solar irradiation on horizontal surfaces

1	2	3	4	5	6	7	8	9	10	11	12	13
Station	Mean daily total available solar radiation on horizontal surfaces MJ/m^2											
	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Alexander Bay	30,2	27,4	23,2	18,6	15,1	13,0	13,2	16,7	21,4	25,8	29,6	30,4
Bloemfontein	26,9	24,7	21,1	17,7	14,7	13,4	14,4	17,8	21,9	24,7	27,4	28,6
Cape Town	29,0	25,7	21,5	15,2	10,8	9,1	9,7	12,5	17,5	22,4	27,3	29,1
Durban	20,6	19,8	17,9	14,6	11,9	11,1	11,6	13,6	15,4	17,4	18,8	20,9
Grootfontein – Cape	28,3	23,3	20,6	16,8	13,6	12,2	13,4	16,4	21,0	25,0	27,7	30,0
Keetmanshoop	30,0	27,6	23,7	20,7	17,2	15,4	16,3	19,3	23,7	27,3	30,5	31,3
Kimberley	26,5	25,5	20,9	17,7	14,2	12,6	13,7	17,7	21,6	25,7	27,8	28,9
Maun	23,1	21,2	20,1	18,7	17,3	16,0	17,0	20,0	22,6	23,0	23,7	22,6
Nelspruit	20,6	22,2	20,6	16,4	15,0	14,4	14,7	16,7	18,6	19,7	19,0	20,8
Pietersburg	25,6	23,3	21,9	18,8	16,8	15,4	16,4	18,6	21,5	25,5	25,4	25,7
Port Elizabeth	25,0	22,9	18,5	14,2	11,1	9,7	10,5	13,1	16,8	20,9	24,7	25,9
Pretoria – Forum	24,2	22,8	20,3	16,7	15,2	13,9	14,9	18,0	21,7	22,9	23,9	25,2
Pretoria – Lynnwood	23,7	22,0	20,1	17,6	15,1	14,2	15,0	18,1	20,7	22,1	23,7	23,9
Roodeplaat	24,7	23,1	20,8	16,8	15,2	13,8	14,9	17,8	21,3	23,1	24,1	25,2
Upington	25,9	26,2	22,1	18,3	15,2	13,7	14,4	17,8	21,7	25,5	29,0	27,1
Windhoek	25,7	24,1	21,8	20,7	13,9	17,3	18,5	21,2	24,3	26,1	27,3	27,8

I.3 Friction loss curves

Friction loss (hydraulic gradient) versus flow rate (flow velocity) graphs are given for pipes of the following materials:

a) figure I.1: hard-drawn copper pipes, class 0 (SANS 460);

b) figure I.2: heavy-wall copper pipes, class 3 (SANS 460);

c) figure I.3: galvanized steel pipes, medium class (SANS 62-1);

d) figure I.4: PVC-U pipes, class 4 (SANS 966-1);

e) figure I.5: PVC-U pipes, class 6 (SANS 966-1);

f) figure I.6: PVC-U pipes, class 9 (SANS 966-1);

g) figure I.7: PVC-U pipes, class 12 (SANS 966-1);

h) figure I.8: PVC-U pipes, class 16 (SANS 966-1);

i) figure I.9: PE pipes, 6,5 MPa PN 4 (SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5);

j) figure I.10: PE pipes, 6,5 MPa PN 6 (SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5);

k) figure I.11: PE pipes, 6,5 MPa PN 10 (SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5);

l) figure I.12: PE pipes, 6,5 MPa PN 12.5 (SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5); and

m) figure I.13: PE pipes, 6,5 MPa PN 16 (SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5).

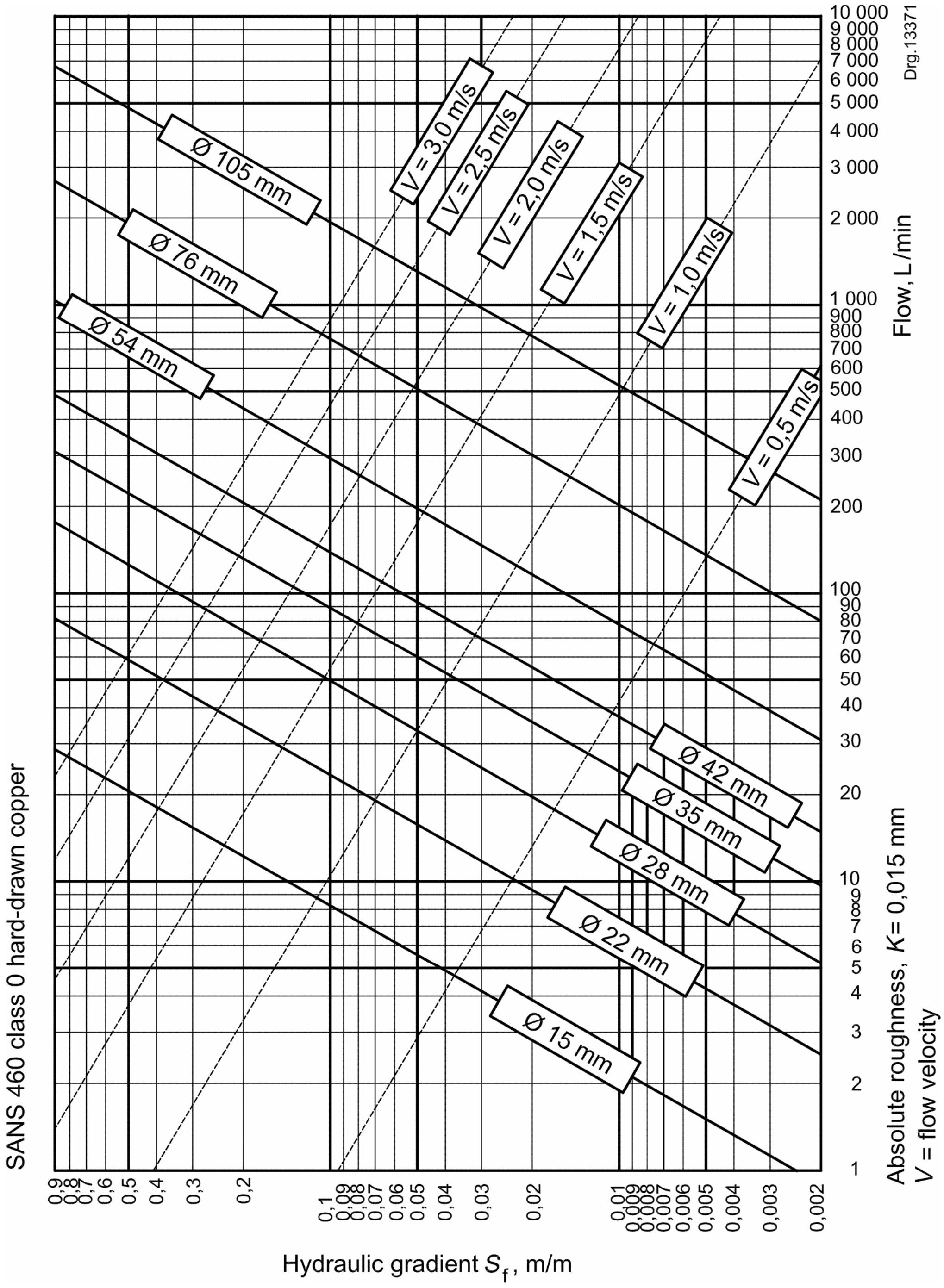


Figure I.1 — Friction losses for hard-drawn copper pipes that comply with SANS 460 class 0

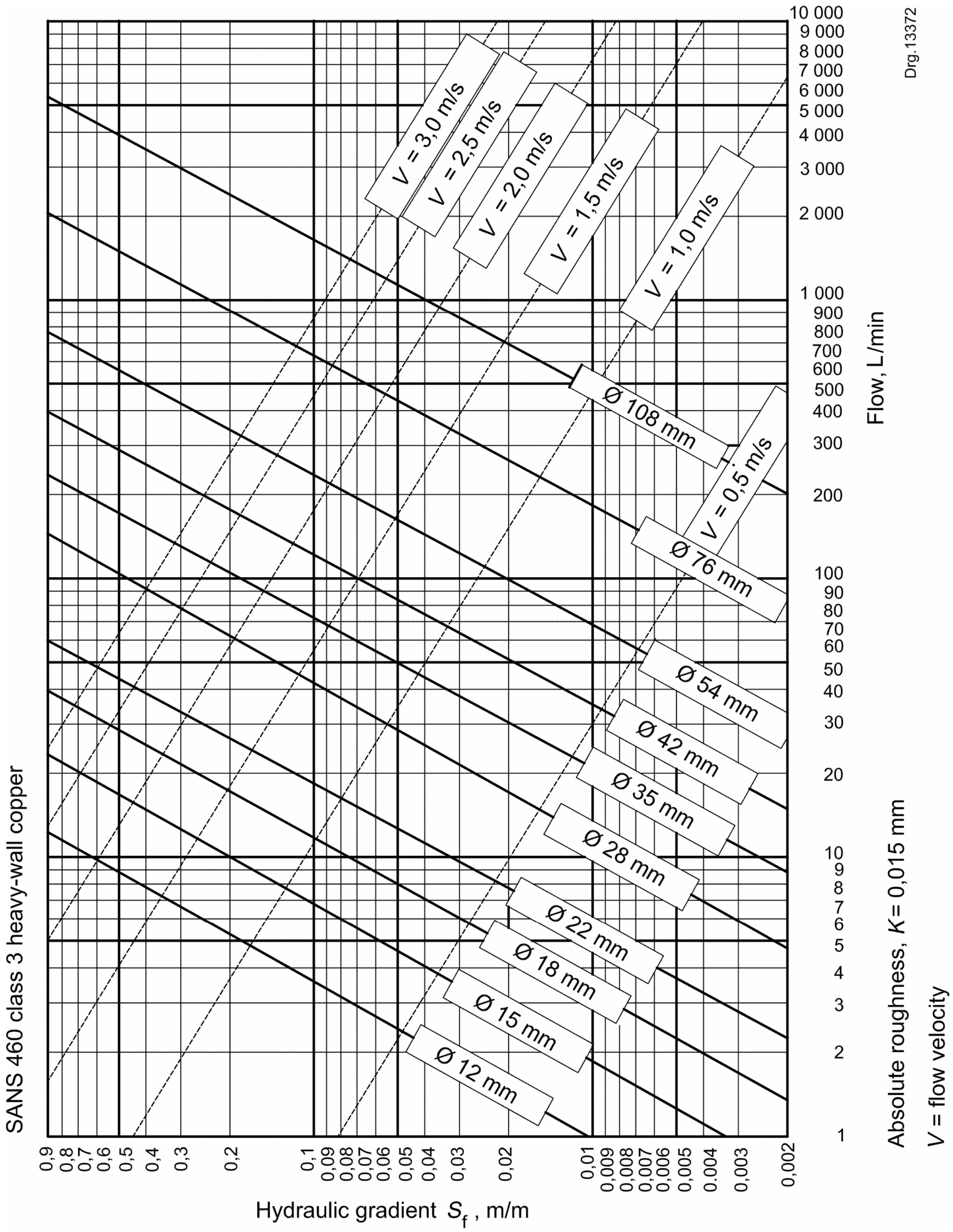


Figure I.2 — Friction losses for heavy-wall copper pipes that comply with SANS 460 class 3

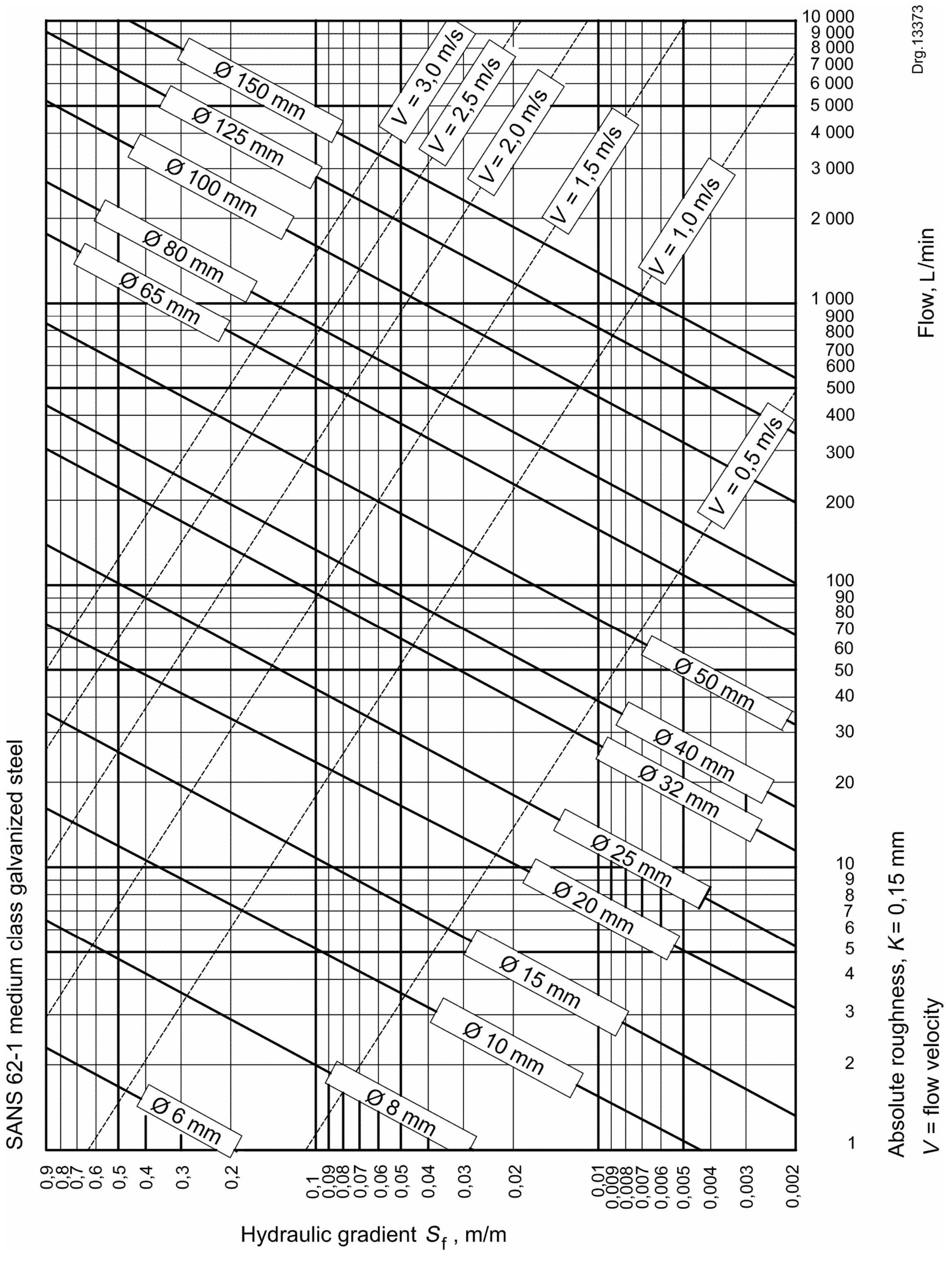


Figure I.3 — Friction losses for galvanized steel pipes that comply with SANS 62-1 medium class

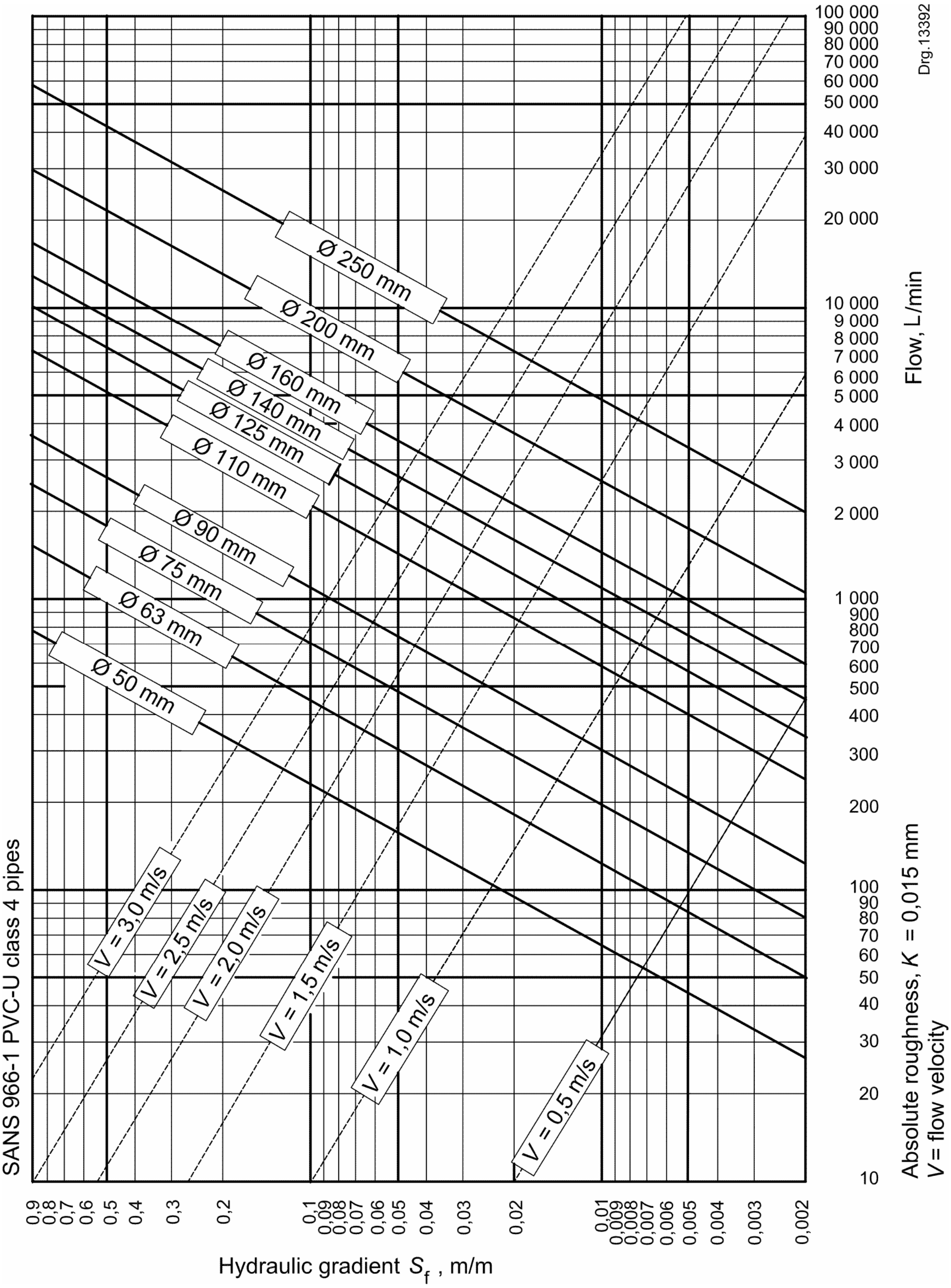


Figure I.4 — Friction losses for PVC-U class 4 pipes that comply with SANS 966-1

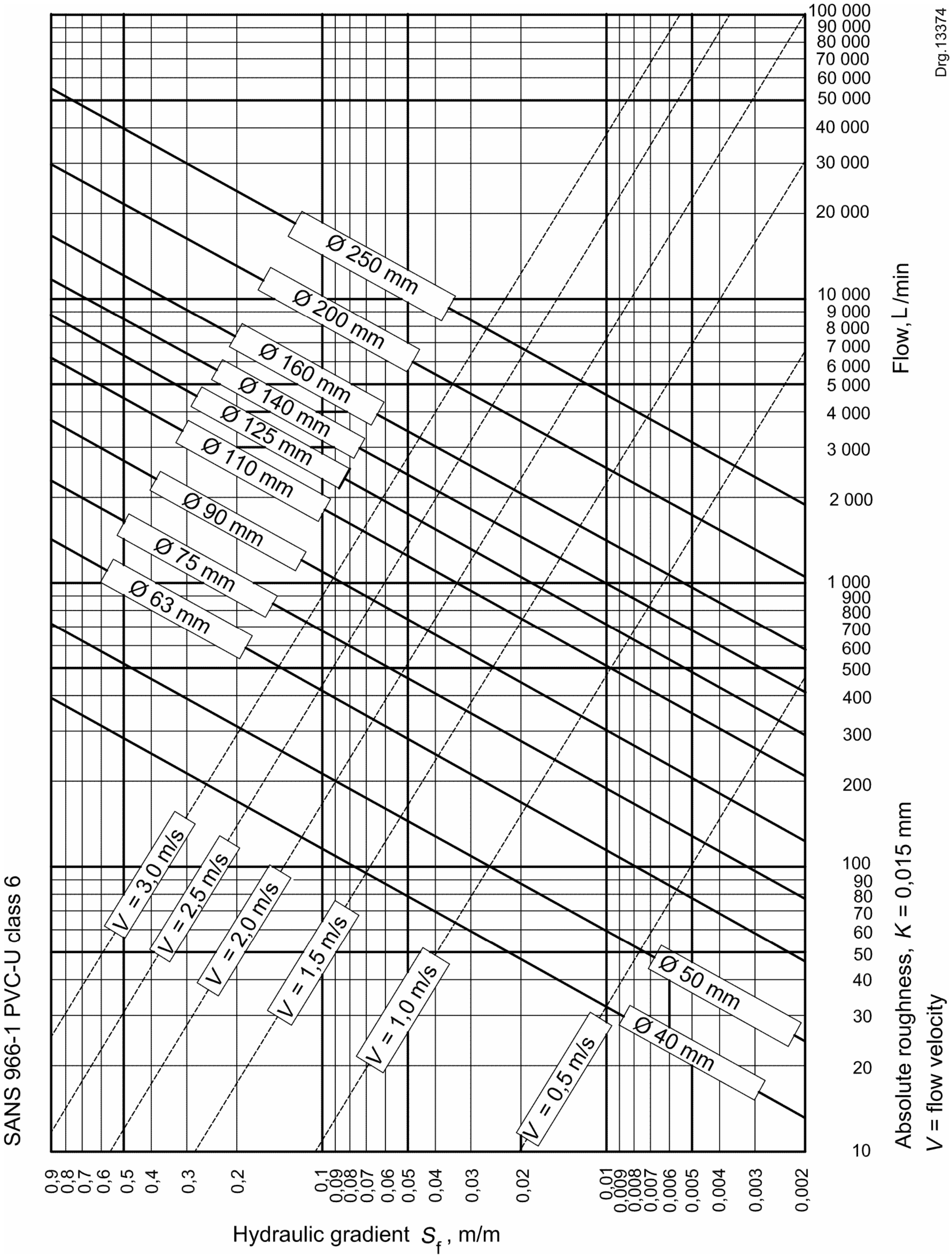


Figure I.5 — Friction losses for PVC-U class 6 pipes that comply with SANS 966-1

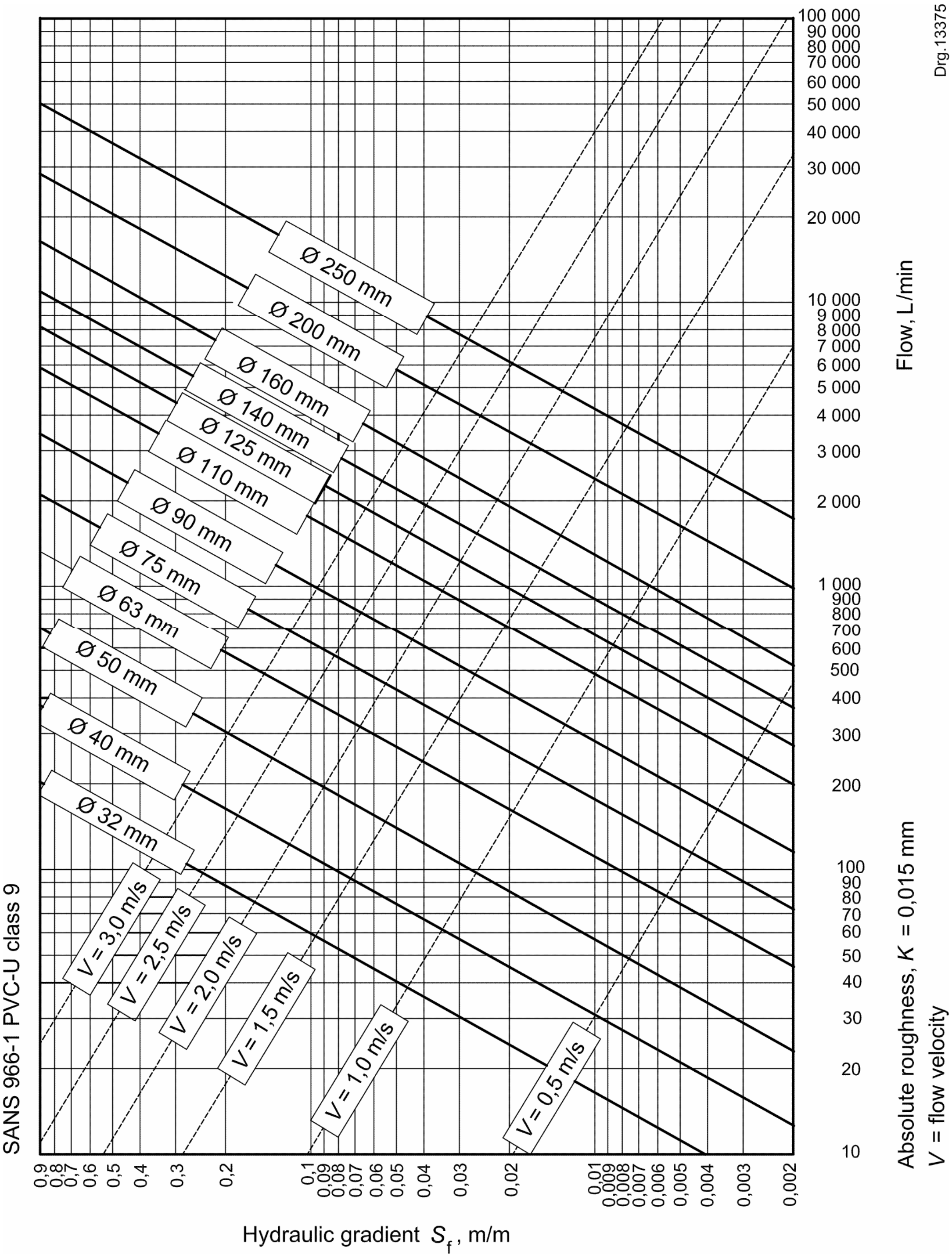


Figure I.6 — Friction losses for PVC-U class 9 pipes that comply with SANS 966-1

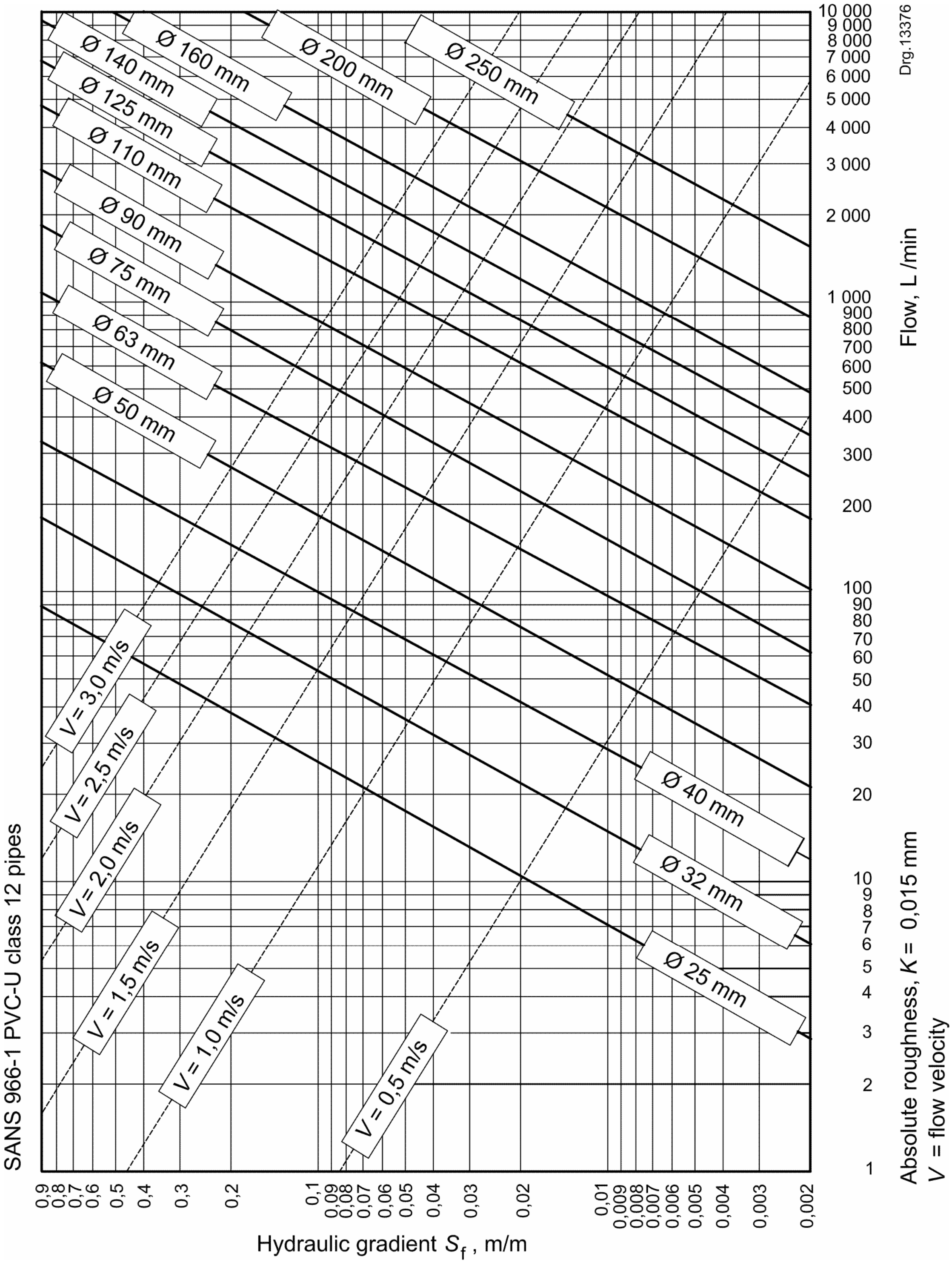


Figure I.7 — Friction losses for PVC-U class 12 pipes that comply with SANS 966-1

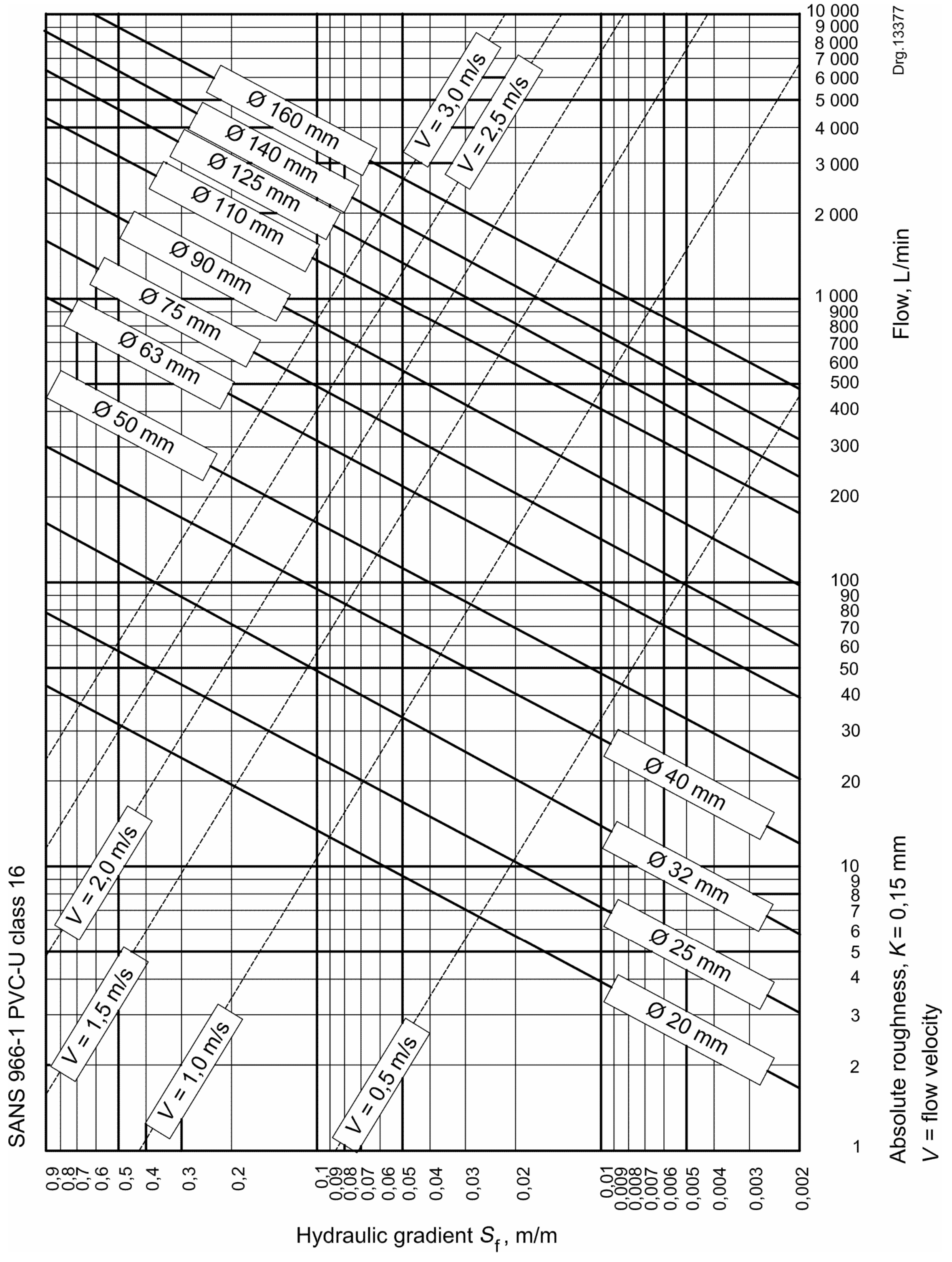


Figure I.8 — Friction losses for PVC-U class 16 pipes that comply with SANS 966-1

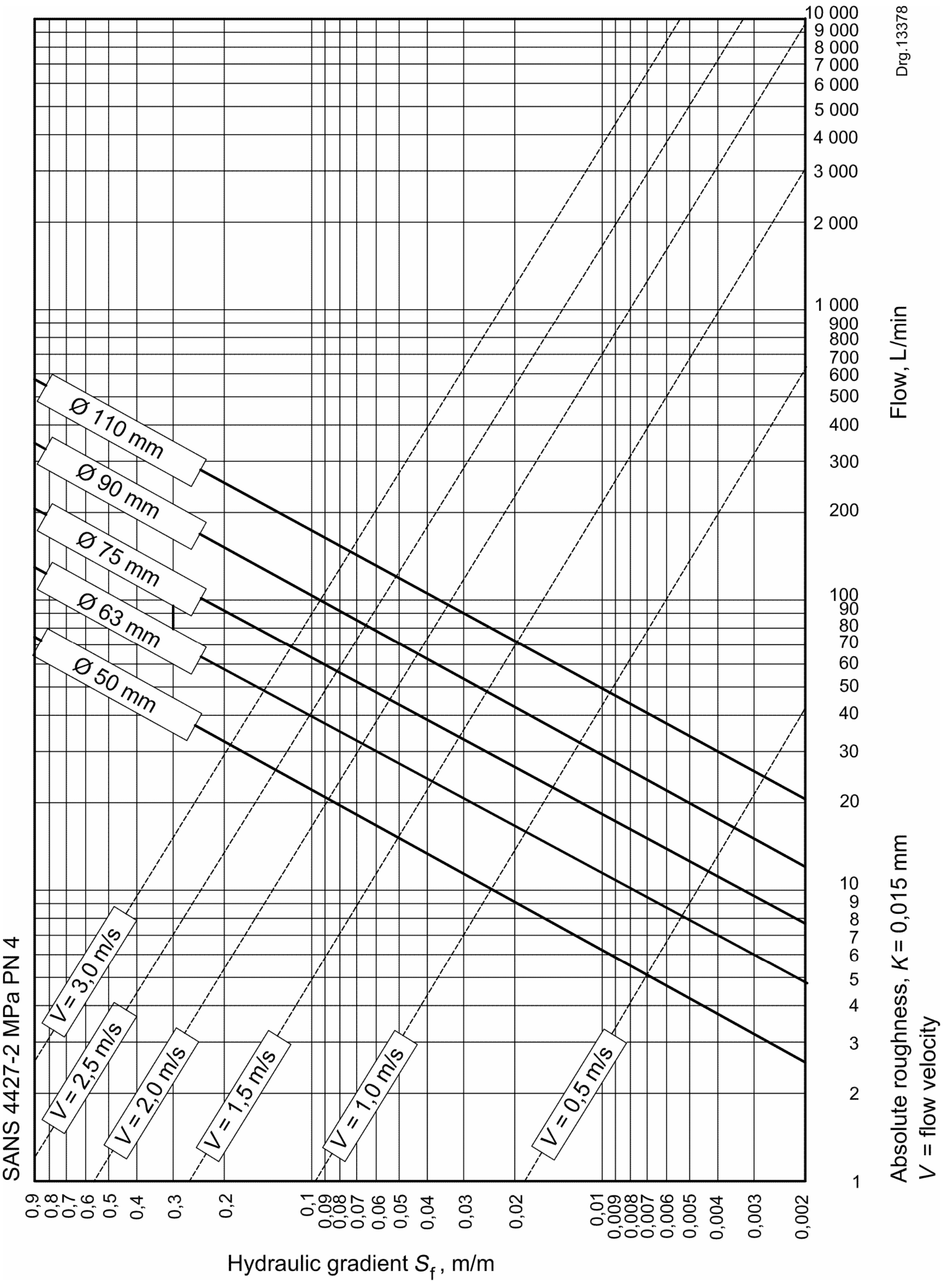


Figure I.9 — Friction losses for PN 4 polyetylene pipes that comply with SANS 4427-2

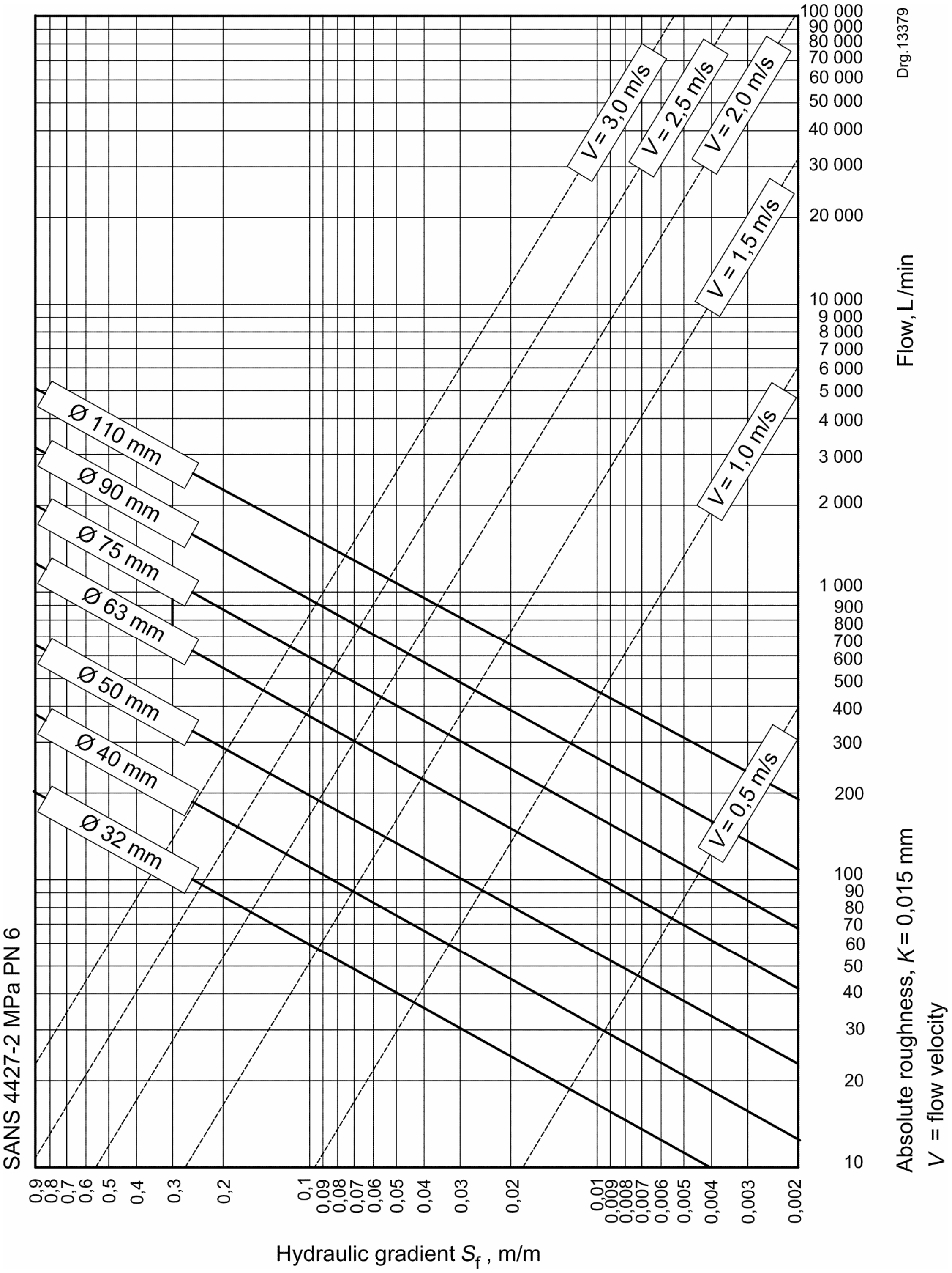


Figure I.10 — Friction losses for PN 6 polyetylene pipes that comply with SANS 4427-2

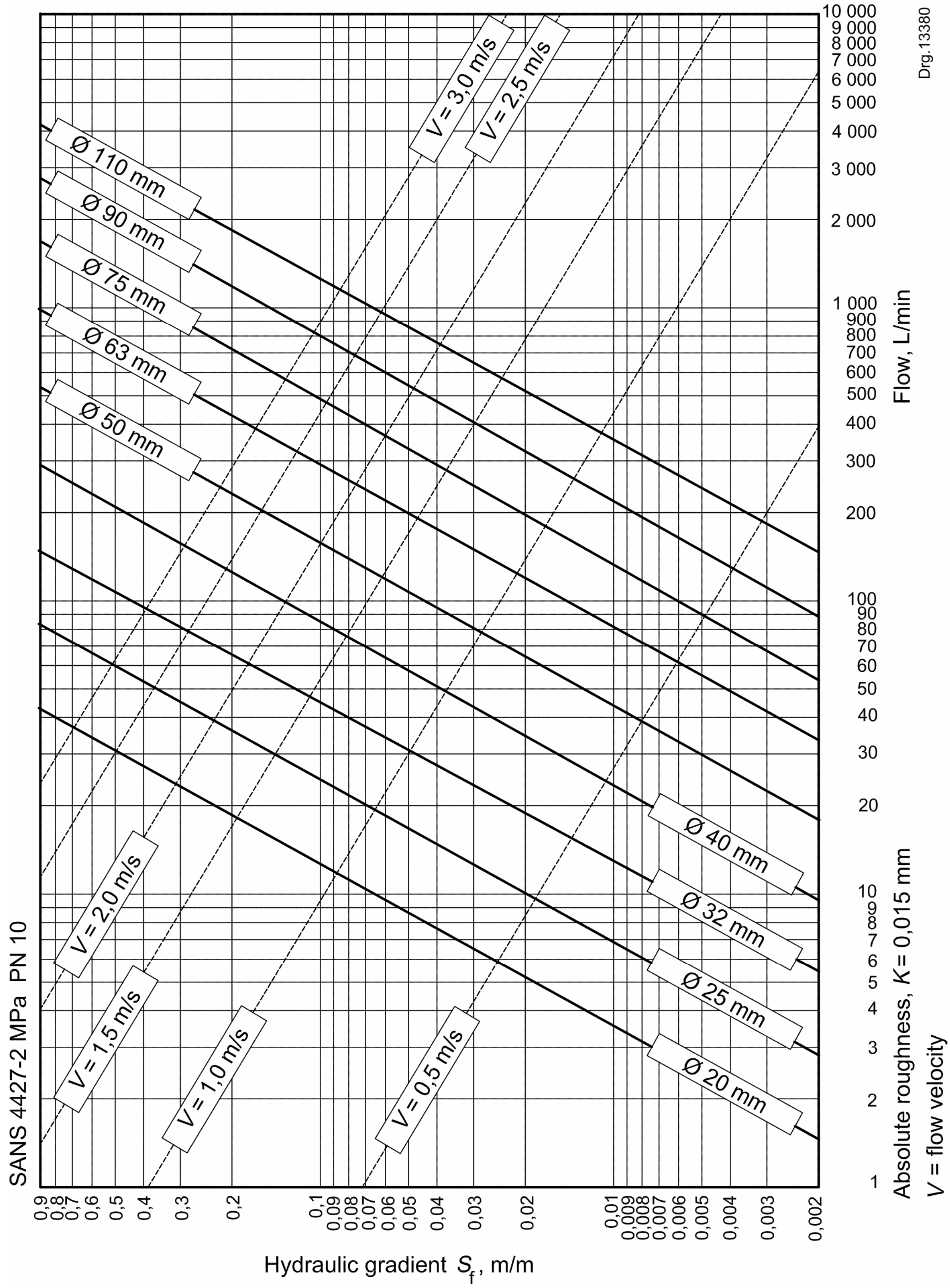


Figure I.11 — Friction losses for PN 10 polyetylene pipes that comply with SANS 4427-2

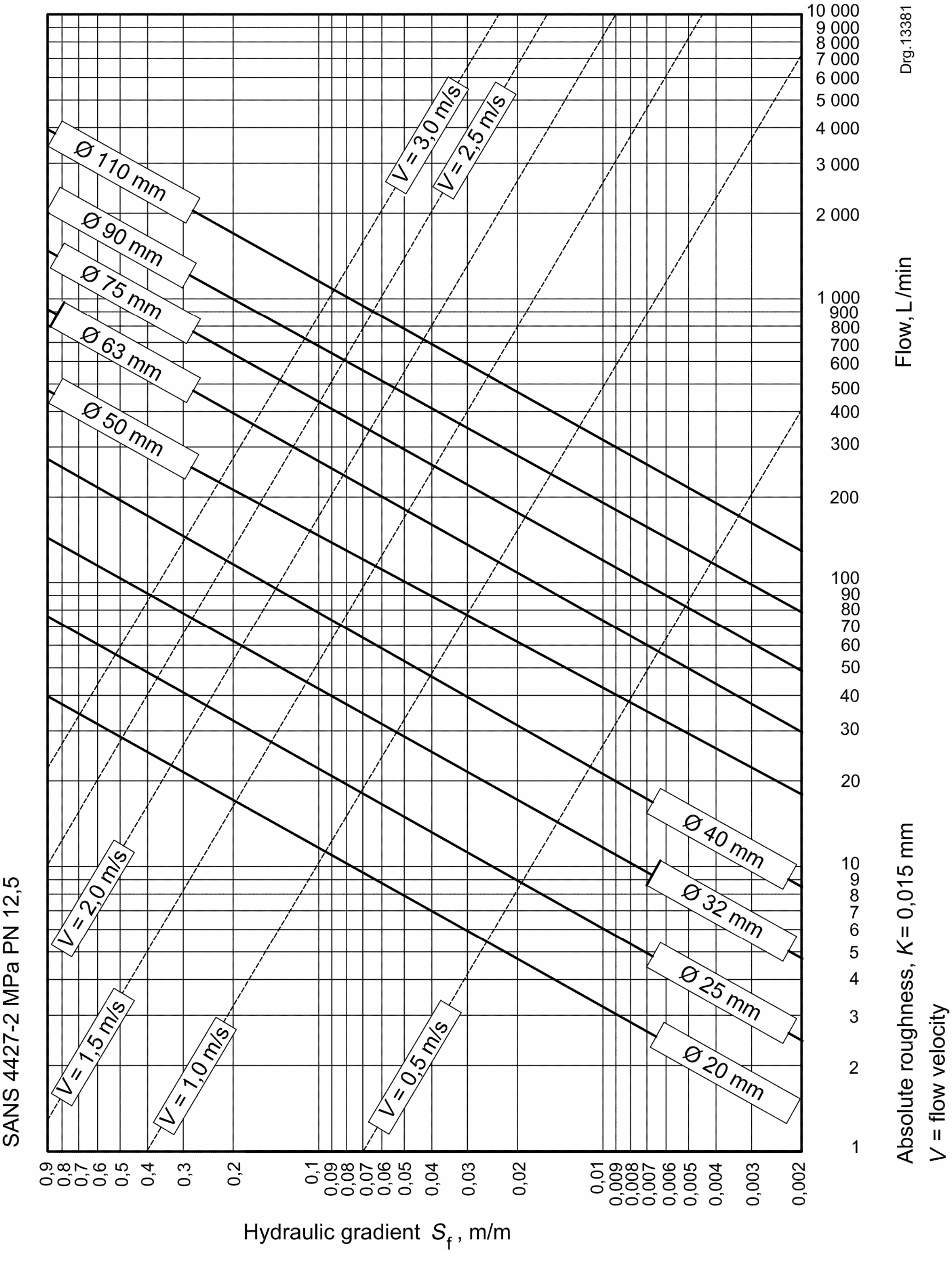


Figure I.12 — Friction losses for PN 12,5 polyetylene pipes that comply with SANS 4427-2

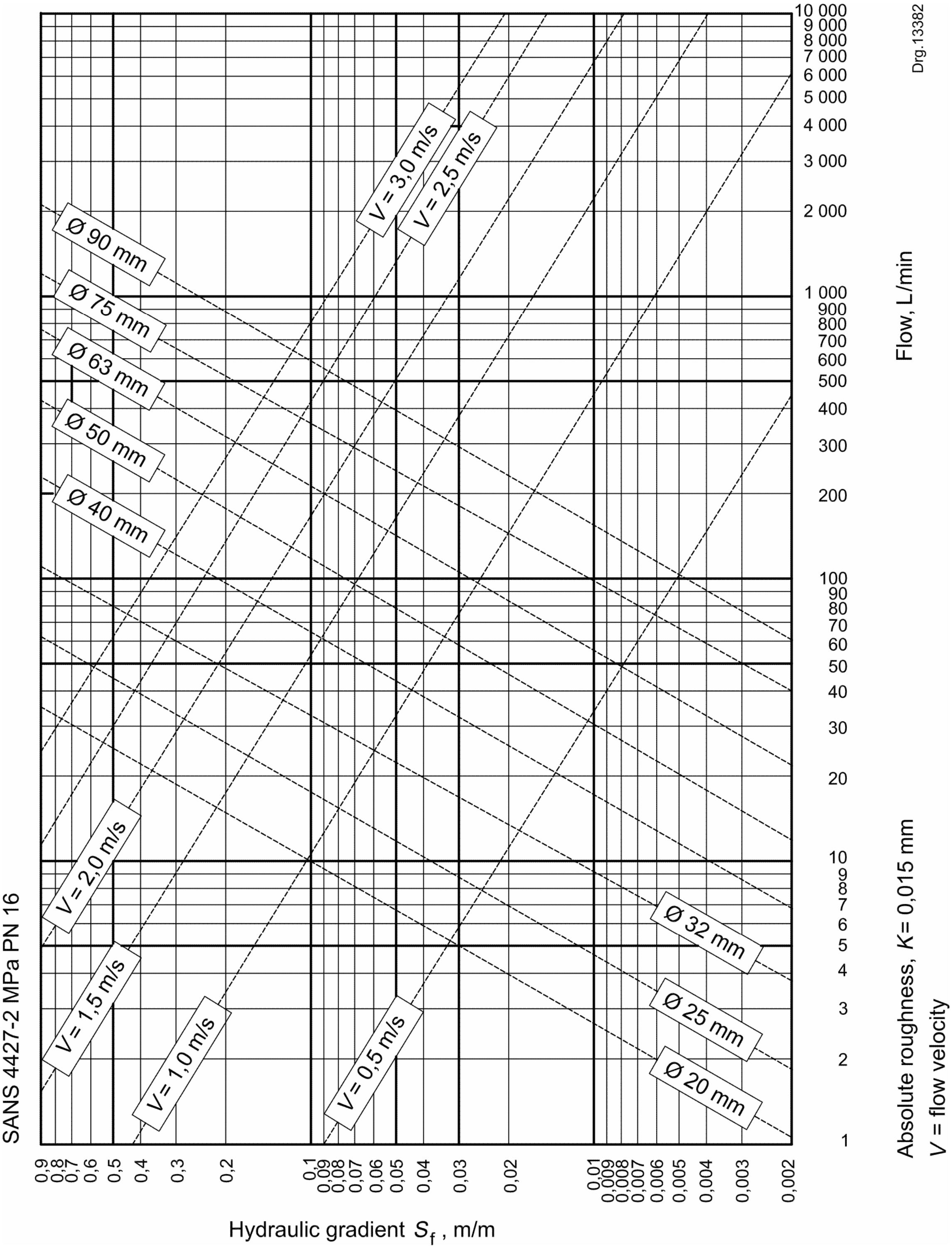


Figure I.13 — Friction losses for PN 16 polyetylene pipes that comply with SANS 4427-2

Annex J
(informative)

Extract from the Pressure Equipment Regulation in terms of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)

17. Gas reticulation equipment and systems

1. No person shall -

   (a) handle, store or distribute any gas in any manner, which includes the filling of a container, other than in accordance with the relevant health and safety standard incorporated into these Regulations under section 44 of the Act;

   (b) install or remove an appliance, pressure equipment or system for gas in any manner other than in accordance with the relevant safety standard incorporated into these Regulations under section 44 of the Act;

   (c) install or remove a gas appliance, or a gas system or a gas reticulation system, unless such person is an authorised person; or

   (d) use pressure equipment or systems for gas in any manner other than in accordance with the relevant safety standard incorporated into these Regulations under section 44 of the Act.

2. After installation or re-installation, and before commissioning a gas system, the user shall ensure that an external inspection and a leak test are performed by an authorised person or an approved inspection authority as applicable in terms of sub-regulations (1)(c).

3. An authorised person or an approved inspection authority shall issue a certificate of conformity after completion of a gas installation, modification, alteration or change of user or ownership in the form of Annexure 1.

Bibliography

Standards

ASTM E 96, *Standard test methods for water vapour transmission of materials.*

ASTM C 692, *Standard test method for evaluating the influence of thermal insulations on external stress corrosion cracking tendency of austenitic stainless steel.*

BS 5422, *Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range −40 °C to +700 °C.*

BS 5970, *Code of practice for thermal insulation of pipework and equipment in the temperature range of −100 °C to +870 °C.*

BS 417-2, *Specification for galvanized low carbon steel cisterns, cistern lids, tanks and cylinders – Metric units.*

BS 1564, *Specification for pressed steel sectional rectangular tanks.*

SANS 24, *Soft solders.*

SANS 121/ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles − Specifications and test methods.*

SANS 185, *Immersion-type heating units for electric appliances.*

SANS 191, *Cast steel gate valves.*

SANS 558, *Cast iron surface boxes and manhole and inspection covers and frames.*

SANS 676, *Reinforced concrete pressure pipes.*

SANS 710, *Acid-cored solders.*

SANS 975, *Prestressed concrete pipes.*

SANS 1056-3, *Ball valves – Part 3: Light duty valves (not fire-safe).*

SANS 1117, *Plastics wrappings for the protection of steel pipelines.*

SANS 1130, *Fibre reinforcing material for pipe wrapping.*

SANS 1178, *The production of coated steel pipes using fibre reinforced bitumous materials.*

SANS 1190, *Malleable iron castings.*

SANS 1303-1, *Wrought copper alloys – Part 1: Chemical composition of copper-zinc alloys (non-leaded and leaded).*

SANS 1804-1, *Induction motors – Part 1: IEC requirements.*

SANS 1804-2, *Induction motors – Part 2: Low-voltage three-phase standard motors.*

SANS 1804-3, *Induction motors – Part 3: Low-voltage three-phase intermittently-rated wound-rotor motors.*

SANS 1804-4, *Induction motors – Part 4: Single-phase induction motors.*

SANS 10102-1, *The selection of pipes for buried pipelines – Part 1: General provisions.*

SANS 10102-2, *The selection of pipes for buried pipelines – Part 2: Rigid pipes.*

SANS 10177-5, *Fire testing of materials, components and elements used in buildings – Part 5: Non-combustibility at 750 °C of building materials.*

SANS 10243, *The manufacture and erection of timber trusses.*

Other publications

Ackers, P. *Charts for the hydraulic design of channels and pipes*. 1963. Hydraulics research paper No. 2, Hydraulics Research Station, Department of Scientific and Industrial Research, H.M.S.O. London: UK.

ASHRAE Handbook, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers Inc.

Chatered Institution of Building Services Engineers (CIBSE).1985. *The selection and application of heat pumps*.London:UK.

Colebrook, C.F. and White C.M. *The reduction of carrying capacity of pipes with age*. Journal of the Institution of Civil Engineers (UK), Volume 99. 1937/1938.

Gebhardt, D.S. 1973. *Plastics pipes for urban water supplies*. Municipal Engineer, July/August 1973.

Joint Acceptance Scheme for Water Installation Components (JASWIC) acceptance list

Manual of British Water Engineering Practice. 1963, Vol. 11, W Heffer & Sons Limited. Cambridge: United Kingdom.

Nel, Van Wyk & Louw Inc. September 1986. Paper on *Heat-pump hot water systems at educational institutions*.

Plumbing services design guide. Published by the Institute of Plumbing: UK.

Williams, P.G. *Chlorination of small-scale water supplies*. Publication RW 924. Division for Water Research. CSIR: Pretoria.

SABS – Standards Division

The objective of the SABS Standards Division is to develop, promote and maintain South African National Standards. This objective is incorporated in the Standards Act, 2008 (Act No. 8 of 2008).

Amendments and Revisions

South African National Standards are updated by amendment or revision. Users of South African National Standards should ensure that they possess the latest amendments or editions.

The SABS continuously strives to improve the quality of its products and services and would therefore be grateful if anyone finding an inaccuracy or ambiguity while using this standard would inform the secretary of the technical committee responsible, the identity of which can be found in the foreword.
Tel: +27 (0) 12 428 6666 Fax: +27 (0) 12 428 6928

The SABS offers an individual notification service, which ensures that subscribers automatically receive notification regarding amendments and revisions to South African National Standards.
Tel: +27 (0) 12 428 6883 Fax: +27 (0) 12 428 6928 E-mail: sales@sabs.co.za

Buying Standards

Contact the Sales Office for South African and international standards, which are available in both electronic and hardcopy format.
Tel: +27 (0) 12 428 6883 Fax: +27 (0) 12 428 6928 E-mail: sales@sabs.co.za
South African National Standards are also available online from the SABS website http://www.sabs.co.za

Information on Standards

The Standards Information Centre provides a wide range of standards-related information on both national and international standards, and is the official WTO/TBT enquiry point for South Africa. The Centre also offers an individual updating service called INFOPLUS, which ensures that subscribers automatically receive notification regarding amendments to, and revisions of, international standards.
Tel: +27 (0) 12 428 6666 Fax: +27 (0) 12 428 6928 E-mail: info@sabs.co.za

Copyright

Details and advice can be obtained from the Senior Manager.
Tel: +27 (0) 12 428 6666 Fax: +27 (0) 12 428 6928 E-mail: info@sabs.co.za