SANS 10252-2 (1993) (English): Water supply and drainage for buildings Part 2: Drainage installations for buildings

BLANK PAGE

ICS 91.140.80

ISBN 0-626-09622-7

SABS 0252-2*

***This standard references other standards**

Edition 1

1993

SOUTH AFRICAN STANDARD

Code of practice

SABS 0252-2

Water supply and drainage for buildings

Part 2: Drainage installations for buildings

Published by
THE SOUTH AFRICAN BUREAU OF STANDARDS

Gr 19

ICS 91.140.80

SABS 0252-2
Ed. 1

SOUTH AFRICAN BUREAU OF STANDARDS

CODE OF PRACTICE

WATER SUPPLY AND DRAINAGE FOR BUILDINGS

PART 2: DRAINAGE INSTALLATIONS FOR BUILDINGS

Obtainable from the

South African Bureau of Standards
Private Bag X191
Pretoria
Republic of South Africa
0001

Telephone : (012) 428-7911
Fax : (012) 344-1568
E-mail : sales@sabs.co.za
Website : http://www.sabs.co.za

Printed in the Republic of South Africa by the
South African Bureau of Standards

Notice

This part of SABS 0252 was approved in accordance with SABS procedures on 6 December 1993.

NOTE 1 In terms of the Standards Act, 1993 (Act 29 of 1993), no person shall claim or declare that he or any other person complied with a standard unless

a) such claim or declaration is true and accurate in all material respects, and

b) the identity of the person on whose authority such claim or declaration is made, is clear.

NOTE 2 It is recommended that authorities who wish to incorporate any part of this standard into any legislation in the manner intended by section 31 of the Act consult the SABS regarding the implications.

This part of SABS 0252 will be revised when necessary in order to keep abreast of progress. Comment will be welcome and will be considered when this part of SABS 0252 is revised.

Foreword

Drawings included in this part of SABS 0252 are of a schematic nature and should not be accepted as working drawings for installation purposes.

Annexes A, B and C are for information only.

SABS 0252 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.

Attention is drawn to the normative references given in clause 2 of this standard. These references are indispensable for the application of this standard.

ISBN 0-626-09622-7

Contents

Contents *(continued)*

Contents *(continued)*

Annexes

Contents *(concluded)*

Committee

SABS	VJ Woodlock (Chairman) DC de Villiers (Standards writer) E Coetzee (Committee clerk)
Besaans-du Plessis Pretoria Foundries (Pty) Ltd	E Geldenhuys
BKS Inc.	W Geldenhuys
City Council of Cape Town	RP Donovan
City Council of Port Elizabeth	A Westenberg
City Council of Pretoria	DA de Kock
CSIR Boutek	DW Moore
Dawson & Fraser (Pty) Ltd	MJ Hofman
Department of National Health and Population Development	W van der Merwe
Development Bank of Southern Africa	D Brink
Institute of Plumbing (SA)	GS Meaker
Kieser, Bosman & Kotze Inc.	N Jooste
The Plumbing and Sanitaryware Manufacturers' Association of South Africa	JE Shorbel-Fahry
Van Niekerk, Klein & Edwards	GC Simpson J van de Bank LV Withers
Van Wyk & Louw Inc.	GA Muhl

Blank

Water supply and drainage for buildings

Part 2:
Drainage installations for buildings

1 Scope

This part of SABS 0252 establishes general principles for the design, installation and testing of sanitary drainage installations. It does not purport to cover any special requirements for drainage installations in health care, laboratory or industrial buildings.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of SABS 0252. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this part of SABS 0252 are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards may be obtained from the South African Bureau of Standards.

ISO 9896, *Plastics traps for discharge pipework systems inside buildings* (in course of preparation).

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

SABS 497, *Glazed ceramic sanitaryware.*

SABS 509, *Malleable cast-iron pipe fittings.*

SABS 533-1, *Black polyethylene pipes for the conveyance of liquids - Part 1: Low density black polyethylene pressure pipes.*

SABS 533-2, *Black polyethylene pipes for the conveyance of liquids - Part 2: High density black polyethylene pressure pipes.*

SABS 546, *Cast iron fittings for asbestos-cement pressure pipes.*

SABS 558, *Cast iron surface boxes and manhole and inspection covers and frames.*

SABS 559, *Vitrified clay sewer pipes and fittings.*

SABS 677, *Concrete non-pressure pipes.*

SABS 746, *Cast-iron pipes and pipe fittings for use above ground in drainage installations.*

SABS 791, *Unplasticized polyvinyl chloride (uPVC) sewer and drain pipes and pipe fittings.*

SABS 819, *Fibre-cement pipes, couplings and fittings for sewerage, drainage and low-pressure irrigation.*

SABS 821, *WC flushing cisterns.*

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

SABS 907, *Stainless steel sinks for institutional use.*

SABS 924, *Stainless steel stall urinals.*

SABS 967, *Unplasticized polyvinyl chloride (uPVC) soil, waste and vent pipes and pipe fittings.*

SABS 974-1, *Rubber joint rings (non-cellular) - Part 1: Joint rings for use in water, sewer and drainage systems.*

SABS 975, *Prestressed concrete pipes.*

SABS 1115, *Cast iron gratings for gullies and stormwater drains.*

SABS 1200-DB, *Standardized specifications for civil engineering construction - Part DB: Earthworks (pipe trenches).*

SABS 1200-LB, *Standardized specifications for civil engineering construction - Part LB: Bedding (pipes).*

SABS 1200-LD, *Standardized specifications for civil engineering construction - Part LD: Sewers.*

SABS 1294, *Precast concrete manhole sections and slabs.*

SABS 1321-1, *Non-metallic waste traps - Part 1: Plastics waste traps.*

SABS 1321-2, *Non-metallic waste traps - Part 2: Rubber waste traps.*

SABS 1402-1, *Acrylic sanitary ware - Part 1: Baths.*

SABS 1532, *Vent valves for drainage installations.*

SABS 0102-1, *The selection of pipes for buried pipelines - Part 1: General provisions.*

SABS 0102-2, *The selection of pipes for buried pipelines - Part 2: Rigid pipes.*

SABS 0112, *The installation of polyethylene and unplasticized polyvinyl chloride pipes.*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this part of SABS 0252, the definitions and symbols given in the National Building Regulations and the following definitions apply:

3.1.1 absorption field: An on-site effluent disposal system such as a french drain or evapotranspiration bed (see 3.1.25).

3.1.2 acceptable, adequate, satisfactory or suitable: Acceptable, adequate, satisfactory or suitable in the opinion of the local authority or in relation to any document issued by the authority, in the opinion of the authority.

3.1.3 approved: Approved by any local authority, including approval contemplated in section 7 of the National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977), or approval by the review board in terms of the above Act.

3.1.4 back vent: A ventilation pipe that connects to a vent stack (see 3.1.83), to a stack vent (see 3.1.76), or to a branch discharge pipe to which unvented fixture discharge pipes are connected.

3.1.5 branch drain: Any drain that discharges into the main drain, or conveys sewage towards the main drain.

3.1.6 branch pipe: A horizontal soil or waste pipe.

3.1.7 branch vent: A horizontal ventilation pipe that connects two or more trap vents to a vent stack or to a stack vent.

3.1.8 chemical closet: A closet with a fixed pan and a tank in which excreta are sterilized and broken down by chemicals.

3.1.9 cleaning eye: Any access opening to the interior of a discharge pipe or of a trap, provided for the purposes of internal cleaning, and that remains permanently accessible after completion of the drainage installation.

3.1.10 closed drainage system: A particular single-stack system in which only the minimum number of access points required for cleaning purposes are provided in terms of specific criteria as set out in this part of SABS 0252.

3.1.11 commercial and public type installations: Installations where sanitary fixtures have a considerable horizontal spread and where they are laid out in ranges with extensive horizontal pipework.

3.1.12 common drain: That portion of a drain that conveys sewage other than, or in addition to, the sewage that emanates from the site through which such drain runs.

3.1.13 connecting sewer: A pipe that is vested in the local authority and that connects a drain to a sewer.

3.1.14 conservancy tank: A covered tank that is used for the reception and temporary retention of sewage and that requires emptying at intervals.

3.1.15 cross-vent: A ventilation pipe that connects a discharge stack to a vent stack.

3.1.16 depth of water seal: The depth of water that would have to be removed from a fully charged trap before gases and odours at atmospheric pressure could pass through such trap.

3.1.17 developed length of a pipe: The length between two specified points on a pipe, measured along the centre-line of such pipe and including any bends, junctions or similar fittings.

3.1.18 discharge pipe: Any pipe other than a drain, that conveys the discharge from one or more sanitary fixtures.

3.1.19 discharge (stub) stack: A main discharge pipe fixed vertically except at an offset, where part of it may be fixed in a horizontal plane.

3.1.20 domestic effluent: Sewage that consists of soil water (see 3.1.75) or waste water (see 3.1.87), or both.

3.1.21 drain: That part of an installation that conveys sewage from a building to a common drain, connecting sewer or any other sewage disposal system situated on the site concerned, but excluding the following:

a) a discharge pipe or any portion of a discharge stack that is below ground level; and

b) the bend at the foot of a discharge stack, whether such bend is exposed or not.

3.1.22 drainage installation: An installation that is vested in the owner of a site and that is situated on the site and is intended for the reception, conveyance, storage or treatment of sewage, and that may include sanitary fixtures, traps, discharge pipes, drains, ventilation pipes, septic tanks, sewage treatment works or mechanical appliances associated therewith.

3.1.23 effluent application rate: The rate at which effluent or liquid waste can be applied to the total surface area of an absorption field over a designated period of time (usually expressed as the depth of effluent, in millimetres, that can be applied daily to one square metre of surface area).

3.1.24 electrical sanitary fixture: A device that is connected to an electricity supply and to a water supply to perform a function such as the washing of clothes or dishes, or rendering waste matter suitable for disposal into a discharge pipe, and that includes a food-waste disposer and a sanitary-towel disposer.

3.1.25 evapotranspiration bed: A special type of absorption field that comprises a shallow sand-filled excavation covered with top soil and planted over with suitable vegetation.

3.1.26 fixture branch: A horizontal fixture discharge pipe.

3.1.27 fixture branch vent: A horizontal ventilation pipe that connects an individual trap vent to a vent stack or to a stack vent.

3.1.28 fixture unit: An arbitrary unit of measurement for expressing the hydraulic loading on a drainage installation.

3.1.29 fixture unit rating: The value, in fixture units, assigned to a sanitary fixture from a consideration of the duration of its discharge, the interval between discharges and its mean discharge rate.

3.1.30 floor drain: A pipe fitting into which waste water is discharged and that is normally connected to a branch discharge pipe, which conveys such discharge to a gully, a discharge stack or an open channel.

3.1.31 foot of a discharge stack: The lowest part of a vertical discharge pipe, or the lowest part of a discharge pipe.

3.1.32 french drain: A conventional absorption field that comprises a trench that is filled with suitable material and that is used for the disposal of liquid effluent from a septic tank, or waste water.

3.1.33 fuel oil interceptor [trap]: See light-liquid interceptor (3.1.44).

3.1.34 grease [oil; fat] interceptor: A device that is designed to cool down incoming hot waste water to below 30 °C, to enable grease and fat to separate from the water and to solidify at the surface level of the waste water, and that prevents grease and fat from entering a sewer.

3.1.35 gully: A pipe fitting that incorporates a trap into which waste water is discharged and that is normally connected to a drain.

3.1.36 head of the main drain or any branch drain: The point where the centre-line of the main drain or branch drain and that of any discharge stack, or any vertical fixture discharge pipe connected to such main drain or branch drain, intersect.

3.1.37 horizontal: A pipe inclined at less than 45° to the horizontal.

3.1.38 industrial effluent: Any liquid other than soil water or storm water, whether or not it contains matter in solution or suspension, which is given off in the course of, or as a result of, any industrial, trade, manufacturing, mining or chemical process in any laboratory, research or agricultural activity.

3.1.39 inspection chamber: A chamber not deeper than 1 m and of such dimensions that permanent access may be obtained to a drain without a person's being required to enter into such chamber.

3.1.40 inspection eye: Any access opening to the interior of any pipe or fitting in a drainage installation, provided solely for the purpose of inspection and testing, and to which permanent access after completion of the drainage installation need not be provided.

3.1.41 installation: See drainage installation (3.1.22).

3.1.42 installation work: Work in respect of the construction of, or carried out on, a drainage system.

3.1.43 large-radius bend: A bend of radius at least 600 mm.

3.1.44 light-liquid interceptor: A device that separates light liquids from water, to prevent the light liquids from entering a sewer.

3.1.45 light liquids: Liquids of a lower density than water, that are insoluble or only very slightly soluble in water, are non-saponifiable and non-polar (for example, naphthous, lubricating, diesel and fuel oils (but excluding emulsions), and also vegetable or animal fats and oils).

3.1.46 lip of gully: The lowest portion, inside a gully, of the barrier that enables a water seal to be provided.

3.1.47 main drain: The longest run of drain from a building or buildings on the site concerned to a connecting sewer or common drain, or to a means of sewage disposal situated on the site.

3.4.48 manhole: A chamber of depth exceeding 750 mm and of such dimensions that a person can enter such chamber to obtain access to a drain.

3.1.49 offset in a discharge stack: A deviation of the flow in the vertical plane of the discharge stack.

Commentary

An offset in a discharge stack is normally accomplished with the use of two bends, the first to direct the flow from a vertical direction to a horizontal direction, and the second to direct the flow back to the vertical position.

3.1.50 one-pipe system: A system of piping between sanitary fixtures and a drain, in which both waste water and soil water discharge down a common discharge stack and in which any trap venting or other venting that is required may be through a common vent stack.

3.1.51 outlet of a fixture trap: The point at which the trap ceases to function as such (normally the crown of the trap).

3.1.52 overflow device (gully): A device that permits the overflow of sewage in the event of sewage surcharge, but prevents the ingress of foreign matter, including rainwater from above.

3.1.53 pail closet: A closet with a removable pail that is intended to be systematically emptied or replaced.

3.1.54 percolation rate: The rate at which clean water, under a constant or nearly constant hydraulic head, percolates into the surrounding soil in both vertical and horizontal directions.

3.1.55 permanent access: An entrance to the interior of a drainage installation, that remains accessible after completion of the installation.

3.1.56 pipe: Any number of pipes and fittings joined together to form a pipeline.

3.1.57 pipe vent valve: A valve specifically designed and constructed to be fitted to a ventilation pipe to provide controlled ventilation.

3.1.58 pit latrine: A closet placed over, or adjacent to, an excavation that is of adequate depth and size.

3.1.59 pressure relief: The release of positive air pressure where the air pressure in a pipe exceeds atmospheric pressure.

3.1.60 range: A number of similar closely spaced sanitary fixtures that discharge to a common branch discharge pipe that only receives the discharge from sanitary fixtures in the same range.

3.1.61 regulation: A National Building Regulation.

3.1.62 resealing trap: A trap so designed that some of the water forming its seal is retained during siphonic action, to reseal after siphonage has been broken.

3.1.63 residential type installations: Installations where sanitary fixtures are closely grouped next to the stack, with fairly short branches.

3.1.64 rodding eye: A permanent access opening to the interior of a drainage installation, that permits full-bore access to the interior of a drain for internal cleaning, but does not include an inspection eye or manhole.

3.1.65 sanitary fixture: A receptacle to which water may be permanently supplied, and from which waste water or soil water is discharged.

3.1.66 sanitary group: A combination of sanitary fixtures that comprises not more than one each of a WC pan, bath, shower and sink and either two wash-hand basins or one wash-hand basin and one bidet.

3.1.67 self-cleaning trap: A trap that, when tested with glass balls in accordance with the test method given in annex F of ISO 9896, will allow at least 70 % of the balls to pass.

3.1.68 septic tank: A chamber designed to receive sewage and to retain it for such a time and in such a manner as to secure adequate decomposition.

3.1.69 sewage: Waste water, soil water, industrial effluent and other liquid waste, either separately or in combination, but excluding storm water.

3.1.70 sewer: A pipe or conduit that is the property of, or is vested in, the local authority and that is used or is intended to be used for the conveyance of sewage.

3.1.71 single-stack system: A particular one-pipe system in which trap vents are not required in terms of specific criteria set out in this part of SABS 0252.

3.1.72 soil branch: A branch discharge pipe that conveys soil water.

3.1.73 soil fixture: A sanitary fixture that receives soil wastes and that discharges soil water.

3.1.74 soil pipe: A pipe that conveys soil water.

3.1.75 soil water: Liquid that contains human body wastes such as faeces and urine.

3.1.76 stack vent: A ventilation pipe that connects to a discharge stack above the highest connected discharge pipe.

3.1.77 trap: A pipe fitting or a part of a sanitary fixture that is designed to retain water.

3.1.78 trap vent: A ventilation pipe that connects an individual trap to the open air or to another ventilation pipe.

3.1.79 trap vent valve: A one-way valve specifically designed and constructed to be fitted near the crown of the trap that serves a waste fixture, to protect the water seal of such trap against excessive negative air pressure that arises in a fixture discharge pipe.

3.1.80 two-pipe system: A system of piping between sanitary fixtures and a drain, in which waste water and soil water are discharged through separate discharge pipes and in which any trap venting or other venting that is required is through separate ventilation pipes for the waste-water and soil-water systems.

3.1.81 vent: A ventilation pipe.

3.1.82 ventilation pipe; vent pipe: A pipe, other than a discharge pipe, that leads to the open air at its highest point and that provides ventilation throughout a drainage installation for the purpose of preventing the destruction of water seals.

3.1.83 vent stack: A main vertical ventilation pipe of any part of a drainage installation.

3.1.84 vertical: A discharge pipe or ventilation pipe inclined at 45° or more to the horizontal.

3.1.85 waste fixture: A sanitary fixture from which only waste water is discharged.

3.1.86 waste pipe: A pipe that conveys waste water only.

3.1.87 waste water: Used water, other than storm water, that is not contaminated by soil water or industrial effluent.

3.1.88 water seal: The water in a trap, which acts as a barrier against the flow of any foul air or gas.

3.2 Abbreviations

For the purposes of this part of SABS 0252, the abbreviations given in Regulation A8 of the National Building Regulations and the following definitions apply:

ABS	Acrylonitrile butadiene styrene
BSPT	British standard pipe thread
CA	Copper-alloy
CB	Caulking bush
CCCJ	Cold compound caulked joint
CI	Cast iron
CMJ	Cement mortar joint
COP	Copper
FC	Fibre-cement
FI	Female iron
GI	Galvanized iron
GMS	Galvanized mild steel
HDPE	High density polyethylene
L/CA	Lead to copper-alloy
LCJ	Lead caulked joint
MI	Male iron
MJ	Mechanical joint
MuPVC	Modified unplasticized polyvinyl chloride
OG	Overflow gully or overflow device
PE	Polyethylene
PF	Pitch-impregnated fibre
PP	Polypropylene

SSN Stainless steel shield and rubber gasket coupling

uPVC Unplasticized polyvinyl chloride

VC Vitrified clay

4 Initial considerations

4.1 Information

4.1.1 Information required for the design process

4.1.1.1 The following information, as necessary, should be obtained from the local authority:

a) whether sewers are available and adequate to receive the proposed discharges;

b) the position, size, level, materials, construction and condition of sewers and manholes;

c) the level of the water table and the levels of flood water, including seasonal and other variations of such levels;

d) the location and level where the drain is to be terminated for the connecting sewer;

e) by whom the connecting sewer is to be laid, and

1) if by the local authority, the estimated cost, and

2) if by the developer or contractor, details such as the

i) requirements regarding drains underpassing roads and the repair of such roads thereafter,

ii) requirements regarding control or diversion (or both) of vehicles and pedestrians, where drains cross roads or footpaths, and

iii) location of all existing and relevant future electricity, gas and water supply services;

f) the limits of responsibility for the installation and maintenance of the drainage installation;

g) the physical and chemical nature of the ground to be excavated, particularly as regards the presence of sulfates;

h) whether drain interceptors (see 3.1.33 or 3.1.44) are required; and

i) the soil permeability and the general suitability of the site for the use of alternative sanitation options if no sewer is available or if the water supply is limited.

Commentary

1) Although the owner of a building is responsible for making his own soil survey, the local authority may pass on relevant knowledge.

2) See 7.3.2 for the percolation test method.

4.1.1.2 The following information, as necessary, should be obtained from the owner of the building:

a) building plans and a plan of the site, showing existing and proposed levels, preferably related to the ordnance datum;

b) a schedule of, and the position of, all sanitary fixtures to be installed;

c) the nature and volume of discharges involved;

d) the number of occupants and the periods of occupation;

e) details of any rights of way, including those negotiated where a drain crosses land in other ownership;

f) details of any prior damage to buildings and structures in the vicinity where trenches have to be excavated;

g) the physical and chemical nature of the ground to be excavated, particularly as regards the presence of sulfates; and

h) where alterations or extensions to existing drainage systems are involved, a report that covers the following:

   1) the type of installations in use, and the drain loadings;

   2) detail regarding existing sanitary fixtures connected to the installation, including the position of such fixtures;

   3) detail regarding existing piping, such as type and condition; and

   4) particulars of all existing services, including their position.

Commentary

1) The site plan should indicate the contours of the site, including details of any proposed regrading and paved areas. The location of means of access to the site should be shown and, in particular, rights of way where drains are laid in fields or in other open ground.

2) The right of access and the right to maintain or renew a drain should be specifically included in any right of way arrangements made with the owner of the land.

3) An inspection, preferably with the owners of the property, should be made before any installation work is started, in order to establish the condition of buildings and other services likely to be affected by the work. Visible defects should be recorded and dated and telltales may be placed across any cracks to be kept under observation. Photographic evidence often proves useful.

4.1.2 Information required by the local authority, owner or contractor (or any combination of these)

Where applicable, the following details and information shall be provided:

a) information and plans required in terms of the National Building Regulations and any additional detail that may be required;

b) soil permeability and general suitability of the site for the use of alternative sanitation options if no sewer is available or if the water supply is limited;

c) advice on design principles and the financial consequences of specific decisions; and

d) full detailed drawings for the record of the work as installed.

Commentary

In terms of the National Building Regulations, any drainage service connected to, or used in connection with, a building, whether inside or outside such building, shall be deemed to be part of that building.

4.2 Provision of sanitary fixtures

4.2.1 Classification and designation of occupancies

Any occupancy in any building or any building that contains single occupancy shall be classified and designated according to the appropriate occupancy class as prescribed in regulation A20 of the National Building Regulations.

4.2.2 Population

The population for which a building is designed, or of any room or storey or portion thereof, shall be calculated in terms of regulation A21 of the National Building Regulations.

4.2.3 Number of sanitary fixtures

4.2.3.1 The number of sanitary fixtures to be provided in any building shall be based on the population for which such building is designed, and such population shall be calculated in accordance with 4.2.2, provided that

a) where in any particular occupancy, separate facilities are provided for each sex, the number of sanitary fixtures installed for each shall be based on the population of that particular sex for which such facilities are intended, and if the number of persons of each sex cannot be determined, it shall be assumed that they are in equal proportions,

b) where fixtures are to be situated in separate groups, the number of fixtures in any group shall be based on the calculation of that portion of the total population for which the group is intended, and

c) any building for which the population cannot be determined shall, where the building contains one or more habitable rooms, be provided with at least one WC pan and one wash-hand basin.

4.2.3.2 Subject to the provisions of 4.2.3.1, the minimum number of sanitary fittings to be provided in any building shall be as given in tables 1 to 6, and such fittings shall

a) be situated in places, access to which is convenient, and

b) where necessary, be designated for the use of males or females or both. Any room that contains fixtures designated for the use of both sexes shall be capable of being locked from the inside.

Commentary

1) The scale of provision of sanitary fixtures for different buildings, the selection of particular fixtures best suited to their use and the arrangement of such fixtures within spaces to obtain optimum use of both space and fixtures itself, are all matters that require careful consideration if an effective installation is to be obtained.

2) Table 1 refers to table 3 in most occupancy classifications for the minimum provision to be made for personnel, as distinct from that for the public and visitors. When table 3 is being used, the population *referred to in column 1 of the table is thus only the number of personnel of a particular sex in an occupancy. The total number of personnel will in some cases sensibly be the total population obtained from regulation A21, the public and visitors being very few in number. In other cases, the proportion of personnel to public and visitors will have to be established. The total number of personnel in a shopping complex, or in any particular shop, may be taken as 10 % of the total population for such complex or shop, calculated in terms of regulation A21.*

3) *If the facilities provided in a shopping complex can be suitably so situated that they are available to personnel and the public and visitors, it may not be necessary to provide separate facilities for the personnel in the individual shops. The minimum number of facilities provided should then be the total required in accordance with table 3 for the total number of the personnel of the shops within the complex who make use of these facilities.*

4) *The minimum provision for the public and visitors is given in column 2 of table 1. In some circumstances, this minimum may be considered less than adequate. The view has been taken that rather than be prescriptive, it should be left to the owner to decide what provision he wishes to make above the minimum to satisfy the public and to safeguard his business interests. Table 5 should be used where guidance on any provision above the minimum is required.*

4.2.3.3 In any occupancy where personnel are exposed to a high risk substance, dirt, filth, dust, soot, oil, grease or any similar substance, exposure to which is such that showers are necessary, at least one shower per 15 persons shall be provided separately for each sex and such showers shall be located in, or have direct access to, a change room.

Commentary

When table 1 to table 6 are being used, the population referred to in column 1 of the tables is the population of the particular sex for which the minimum provision is to be determined. Unless the population of each sex is otherwise known, this will be one-half of any total number of persons or total population determined in accordance with 4.2.3.1.

Table 1 — Provision of sanitary fixtures

1	2	3
Occupancy class and population	**Minimum fixtures to be provided**[1)]	**Exceptions**
A1: Personnel Public and visitors	Table 3 Males: 1 WC pan 1 wash-hand basin Females: 1 WC pan 1 wash-hand basin	In primary schools, the indicated number of sanitary facilities shall in each case be increased by one.
A2: Personnel Public and visitors Peak demand No peak demand Participants in sports	Table 3 Table 4 Table 5 Table 6	
A3: Schools: Personnel Pupils Other educational institutions: Personnel Students	 Table 3 Table 3 Table 3 Table 4	

Table 1 *(continued)*

1	2	3
Occupancy class and population	**Minimum fixtures to be provided**[1)]	**Exceptions**
A4: Personnel Public and visitors	Table 3 Males: 1 WC pan 1 wash-hand basin Females: 1 WC pan 1 wash-hand basin	
A5: Public and visitors: Peak demand No peak demand Participants in sports	 Table 4 Table 5 Table 6	
B1, B2 and B3 Personnel Public and visitors	 Table 3 1 WC pan and 1 wash-hand basin	
C1 and C2 Personnel Public and visitors	Table 3 Males: 1 WC pan and 1 wash-hand basin Females: 1 WC pan and 1 wash-hand basin	
D1, D2 and D3 Personnel Public and visitors	 Table 3 No separate provision required	
D4	No provision required	
E1, E2 and E3	Number to be provided depends on type and design of institution. Table 2 may be used as a guide	
F1: Personnel Public and visitors	Table 3 Males: 1 WC pan and 1 wash-hand basin Females: 1 WC pan and 1 wash-hand basin	Separate facilities for the public or visitors are not required: a) within any shop that has a floor area of less than 50 m^2; or b) in any group of shops under one ownership or in any shopping complex on a single site: 1) facilities for personnel may be situated at convenient locations and not necessarily in any particular shop or shops; 2) facilities for the public and visitors may be situated at convenient locations and not necessarily in any particular shop or shops; and 3) facilities for personnel may be grouped or combined with those provided for the use of the public.
F2 and F3 Personnel Public and visitors	Table 6 1 WC pan and 1 wash-hand basin	
G1: Personnel Public and visitors	Table 3 Males: 1 WC pan and 1 wash-hand basin Females: 1 WC pan and 1 wash-hand basin	

Table 1 *(concluded)*

1	2	3
Occupancy class and population	**Minimum fixtures to be provided**[1)]	**Exceptions**
H1: Personnel Public and visitors Residents	Table 3 Males: 1 WC pan and 1 wash-hand basin Females: 1 WC pan and 1 wash-hand basin Table 2	Any single hotel room or suite or any servant's room with its own facilities need not be provided with separate facilities for males and females. Showers may be substituted for baths in the following maximum ratios: Males - two-thirds of total Females - one-third of total
H2: Dormitories or other residential accommodation: Personnel Students or pupils	 Table 2 Table 2	Separate facilities are not required: a) for personnel and students or pupils where all facilities are available to both groups; or b) for classrooms or lecture rooms where facilities in one are available to the other.
H3 and H4 Within each dwelling unit	1 WC pan 1 wash-hand basin 1 bath/shower	
J1, J2, J3 and J4	Table 3	

1) In any building where facilities in accordance with table 3 are available to both personnel and the public or visitors, separate facilities are not required for the public or visitors.

Table 2 — Provision of sanitary fixtures

1	2	3	4	5	6	7	8
For a population of up to	**Number of sanitary fixtures to be installed relative to the population given in column 1**						
	Males				**Females**		
	WC pans	**Urinals**	**Wash-hand basins**	**Baths**	**WC pans**	**Wash-hand basins**	**Baths**
8	1	1	1	1	2	1	1
20	1	2	2	2	3	2	2
40	2	3	3	3	4	3	3
60	3	4	4	4	6	4	4
80	4	6	5	5	9	5	5
100	4	8	6	6	12	6	6
120	5	9	6	6	14	7	7
140	5	10	7	7	15	8	8
180	5	11	8	8	16	8	8
	For a population of more than 180, add 1 WC pan for every 50 persons	For a population of more than 180, add 1 urinal for every 50 persons	For a population of more than 180, add 1 wash-hand basin and 1 bath for every 50 persons		For a population of more than 180, add 1 WC pan, 1 wash-hand basin and 1 bath for every 50 persons		

Table 3 — Provision of sanitary fixtures

1	2	3	4	5	6
For a population of up to	**Number of sanitary fixtures to be installed relative to the population given in column 1**				
	Males			**Females**	
	WC pans	**Urinals**	**Wash-hand basins**	**WC pans**	**Wash-hand basins**
15	1	1	1	2	1
30	1	2	2	3	2
60	2	3	3	5	3
90	3	5	4	7	4
120	3	6	5	9	5
	For a population of more than 120, add 1 WC pan, 1 urinal and 1 wash-hand basin for every 100 persons			For a population of more than 120, add 1 WC pan for every 50 persons	For a population of more than 120, add 1 wash-hand basin for every 100 persons

Table 4 — Provision of sanitary fixtures subject to peak demand

1	2	3	4	5	6
For a population of up to	**Number of sanitary fixtures to be installed relative to the population given in column 1**				
	Males			**Females**	
	WC pans	**Urinals**	**Wash-hand basins**	**WC pans**	**Wash-hand basins**
50	1	1	1	2	1
100	1	2	1	3	2
150	1	3	1	5	3
250	2	4	2	7	4
500	3	7	3	12	6
1 000	3	12	4	16	7
1 500	4	15	5	20	8
	For a population of more than 1 500, add 1 WC pan for every 500 persons	For a population of more than 1 500, add 1 urinal for every 300 persons	For a population of more than 1 500, add 1 wash-hand basin for every 500 persons	For a population of more than 1 500, add 1 WC pan for every 150 persons	For a population of more than 1 500, add 1 wash-hand basin for every 500 persons

Table 5 — Provision of sanitary fixtures not subject to peak demand

1	2	3	4	5	6
For a population of up to	Number of sanitary fixtures to be installed relative to the population given in column 1				
	Males			Females	
	WC pans	Urinals	Wash-hand basins	WC pans	Wash-hand basins
50	1	–	1	1	1
100	1	1	1	2	1
150	1	2	1	3	2
250	2	3	2	5	3
500	2	4	3	6	4
1 000	2	6	5	8	6
1 500	3	7	6	10	7
	For a population of more than 1 500, add 1 WC pan for every 1 000 persons	For a population of more than 1 500, add 1 urinal for every 500 persons	For a population of more than 1 500, add 1 wash-hand basin for every 700 persons	For a population of more than 1 500, add 1 WC pan for every 300 persons	For a population of more than 1 500, add 1 wash-hand basin for every 700 persons

Table 6 — Provision of sanitary fixtures

1	2	3	4	5	6	7	8
For a population of up to	Number of sanitary fixtures to be installed relative to the population given in column 1						
	Males				Females		
	WC pans	Urinals	Wash-hand basins	Showers	WC pans	Wash-hand basins	Showers
10	1	1	1	2	2	1	2
20	1	2	2	2	3	2	2
30	2	2	3	3	5	3	3
40	3	3	3	3	6	3	4
60	3	4	4	5	7	4	5
80	4	5	5	5	9	5	5
100	4	6	5	6	10	5	6
	For a population of more than 100, add 1 WC pan and 1 urinal for every 100 persons		For a population of more than 100, add 1 wash-hand basin for every 100 persons	For a population of more than 100, add 1 shower for every 40 persons	For a population of more than 100, add 1 WC pan and 1 wash-hand basin for every 80 persons		For a population of more than 100, add 1 shower for every 40 persons

4.3 Provision of grease and light-liquid interceptors

4.3.1 Provision of grease interceptors

A grease interceptor shall be provided to take the discharge from any sanitary fixture or appliance where the discharge of such fixture or appliance could contain grease, fat or vegetable oil

a) where such discharge will drain directly to a french drain, or

b) in quantities that could

   1) cause an obstruction to the flow in any drain, or

   2) interfere with the efficient operation of any sewage treatment or disposal system.

Commentary

Grease interceptors should be avoided if practicable because maintenance normally does not take place (owing to the unpleasantness of the task) and as a result they often cause more problems than they solve.

4.3.2 Provision of light-liquid interceptors

A light-liquid interceptor shall be provided to take the waste-water discharge from

a) any sanitary fixture or appliance in a building where such discharge could contain unacceptable levels of light liquids that could

   1) affect the flow in any drain or sewer, or

   2) interfere with the efficient operation of any sewage treatment or disposal system, and

b) any paved area upon which light liquids or washing water contaminated with such liquids can fall. Such area shall slope at a gradient of at least 1 in 200 from all sides towards a floor drain gully, which shall discharge to the light-liquid interceptor.

Commentary

Low viscosity mineral liquids should be separated, since they form explosive vapours when combined with air and they could prevent the transfer of oxygen to waste water.

4.4 Design considerations

4.4.1 Sewage flow

4.4.1.1 The average daily sewage flow from dwelling houses or dwelling units with full in-house water reticulation is given in table 7.

Table 7 — Flow from dwelling houses or dwelling units with full in-house water reticulation

1	2
Description	**Sewage flow** L/day[1)]
Low-income group:	
Per dwelling unit, or	500
Per person per dwelling unit	70
Middle to upper-income groups:	
Per person per dwelling unit, or	160
Dwellings with 2 bedrooms	750
Dwellings with 3 bedrooms	900
Dwellings with 4 bedrooms	1 100
Dwellings with 5 bedrooms	1 400
Dwellings with 6 bedrooms	1 600

1) An allowance of 15 % for storm-water infiltration and other contingencies should be incorporated in the design figures to be used for dwelling houses.

4.4.1.2 The average daily sewage flow from dwelling units that do not have a full in-house water reticulation is given in table 8.

Table 8 — Sewage flow from dwelling units that do not have a full in-house water reticulation

1	2
Level of water supply	**Sewage flow** L/person/day
Public street standpipes	12 to 15
Single on-site standpipe with dry sanitation system	20 to 25
Single on-site standpipe with a WC pan connected to water supply	45 to 55
Single in-house tap with a WC pan connected to water supply	50 to 70

4.4.1.3 The average daily sewage flow from certain non-residential buildings is given in table 9.

Commentary

In the case of erven zoned as general residential (including church sites) and in the absence of other relevant data, the average daily sewage flow may be taken to be approximately 600 L/day for every 100 m^2 *of the erf size. However, when a floor space ratio (FSR) other than approximately 0,6 is applicable, the flow should be adjusted accordingly.*

Table 9 — Sewage flow from non-residential buildings

1	2	3
Type of establishment	**Unit**	**Daily sewage flow** L/unit
Airports	Passenger	10
Bars	Customer	8
Boarding houses	Person	110
(Additional kitchen wastes for non-resident boarders)	Person	23
Cocktail lounges	Seat	70
Country clubs	Visitor	370
	Employee	50
Day schools	Student	37
Department stores	Toilet	1 850
	Employee	40
Dining halls	Meal served	30
Drive-in theatres	Car space	9
Factories (exclusive of industrial waste)	Worker/shift	140
Hospitals, medical	Bed	500
	Employee	40
Hospitals, mental	Bed	400
	Employee	40
Hotels without private bathrooms	Person	110
Hotels with private bathrooms	Person	140
Motels	Bed	90
Offices	Worker/shift	70
Restaurants (toilet and kitchen	Patron	20
wastes)	Vehicle bay	10
Service stations	Parking space	5
Shopping centres	Employee	40
Swimming baths	Person	9
Theatres	Seat	10
Tourist camps or caravan parks with central bathhouse	Person	90

4.4.2 Sewage lifts

4.4.2.1 Where any building is at such a level in relation to the nearest connecting sewer that the drainage installation that serves such building cannot discharge into the connecting sewer by gravitation, the owner of such building shall install an approved appliance for the purpose of raising sewage to a level that will enable it to gravitate to the connecting sewer. Any such non-gravity drainage installation shall be subject to special consideration, in consultation with the local authority concerned.

4.4.2.2 Unless otherwise approved by the local authority, the following criteria shall apply for the design of the pumping station:

a) no part of the drainage installation of a building that can safely discharge into a connecting sewer by gravitation without danger of backflow shall discharge to the pumping station;

b) the pumping station shall be so designed and located as not to be offensive or injurious or dangerous to health;

c) the layout of the pumping station, pumps, pipework and equipment shall be such as to allow easy access for individual items of equipment, without obstruction by pipework;

d) an approved sluice valve shall be so installed on the suction line that the pump (other than a submersible pump) can be isolated from the sump, when required, and both the suction and delivery pipework to the pump shall be so designed that they can be easily erected and dismantled;

e) the velocity of flow in the suction pipework shall not exceed 1,8 m/s;

f) the pumping rate of the pumping station shall not exceed 5 L/s;

g) the discharge from the pumping station and any discharge by gravitation from a building shall be combined before discharge into the connecting sewer; and

h) macerator pumps or vortex pumps may be used, depending on the nature of the sewage to be pumped.

Commentary

1) Where low maintenance is required, the less efficient vortex pumps are generally preferred.

2) Macerator pumps are limited in their maximum pressure head and the blades of most of the pumps require regular adjustment.

3) Grinder/cutter pumps often do not always work as well as they should.

4.4.2.3 Unless otherwise approved by the local authority, the following criteria shall apply for the design of the rising mains:

a) the velocity of flow in a rising main shall be not less than 1 m/s and not more than 2,5 m/s;

b) detention periods in the rising main shall be as short as possible;

c) the diameter of a rising main shall be at least 100 mm;

d) wherever practicable, a rising main shall be

   1) so graded as to avoid the use of air and scour valves, and

   2) as short as possible;

e) a stilling chamber (see figure 2) shall be provided at the heads of all rising mains and shall be so designed that the liquid level always remains above the level of the soffit of the rising main where the soffit enters the chamber. Such chambers should be ventilated;

f) the rising main shall discharge to the sewer in such a way that back-flooding of the rising main is prevented; and

g) pumping heads should be kept as low as possible, preferably less than 30 m, to reduce the wear and tear on pumps.

Commentary

The stilling chamber, also called a splitter box, should be designed to reduce the energy of the flow entering the chamber before the gravity link to the sewer.

4.4.2.4 Unless otherwise approved by the local authority, the following criteria shall apply for the design of the sump of any pumping station:

a) a minimum emergency storage capacity that represents a capacity equivalent to the greater of at least 24 h sewage flow at the average flow rate from the building, or at least 1 kL, shall be provided over and above the capacity available in the sump at normal top liquid level (i.e. the level at which the pump cuts in). Emergency storage may be provided inside or outside the pumping station;

b) the pumping station shall be so sized and the pump controls so placed as to restrict pump starts to not more than six per hour. In order to prevent sewage from becoming septic, the pump shall start at least twice per hour, even if the liquid level in the sump has not reached the normal level at which the pump cuts in;

c) care shall be taken in the design of the pumping station to avoid flooding of the dry well (see figure 1) or of electrical installations (or of both) by storm water or infiltration;

d) adequate protection, where necessary, in the form of screens or metal baskets shall be provided at the inlet to the pumping station, for the protection of the pumping equipment;

e) the pumping station shall be so designed that a minimum volume of the liquid remains in the sump before the pump cuts out;

f) the height of the rising main shall be such that

   1) the invert of the pump line on a site is at least 500 mm above the manhole cover of the nearest sewerage manhole cover of the local authority, and

   2) the soffit of the pump line is at least 75 mm below the cover of an inspection chamber or manhole on the site; and

g) an approved gate valve or ballvalve followed by a T-piece that has a nominal diameter of at least 100 mm shall be installed on the rising main. The open leg of the T-piece shall be sealed off with an approved steel flange. Both the valve and the T-piece shall be accessible, to ensure that a transportable pump can be placed within 3 m of the T-piece. In cases where the suction height will exceed 5 m, access, at least 2 m wide, shall be provided from a street to the pumping station.

4.4.2.5 The pumping station shall be provided with at least one stand-by pump of a capacity of not less than that of the largest duty pump. The duty pump and the stand-by pump shall operate on a rotational basis. However, if one pump or its driving motor fails to come into operation, the other pump shall automatically come into operation. The pumping station shall be provided with a pump-faulty alarm for early warning should any of the pumps become inoperative.

Commentary

1) The design of sewage lift pumping stations requires special attention with respect to operational maintenance and safety.

2) The velocity of flow in the rising main should be as high as permitted by 4.4.2.3(a) (the pipe diameter should be as small as possible), in order to achieve short detention times.

3) Where it is necessary to lift the sewage, the method of discharge to the drainage installation of the building should be such that the rate of flow and the location of the discharge will not cause pressure fluctuations which might adversely affect the performance of the gravity system.

4) *When approved by the local authority, an emergency high level relief overflow connection that discharges to a storm-water system may be advisable under certain conditions.*

5) *The discharge of foul air requires careful consideration and, in certain conditions, an in-line odour control unit may be required. Exhausted compressed air from pneumatic ejectors should be directly discharged to the atmosphere.*

6) *A typical dry well sewage pumping station is illustrated in figure 1(a) and a submersible sewage pumping station is illustrated in figure 1(b). A typical layout of a rising main and stilling chamber is illustrated in figure 2.*

7) *The use of dry well sewage pumping stations is usually preferred.*

8) *Information needed for the approval of a pumping station may, apart from the particulars referred to in 4.1, include the following:*

   a) *particulars regarding the makes of the appliances, the names of their manufacturers or distributors and the purpose for which they have been designed;*

   b) *the power rating, in kilowatts (kW), and the speed of motors;*

   c) *the rate of flow and the total pressure head;*

   d) *pump characteristic curves that indicate design points;*

   e) *the size of the rising main and the velocity of flow in the rising main;*

   f) *the capacity and detail regarding the sump of the pumping station (such as maximum and minimum liquid heights); and*

   g) *a description of control devices such as float or surface sensors and alarm devices.*

4.4.3 Performance requirements for the drainage installation

Any drainage installation shall be inherently functional and stable in operation and shall comprise the minimum piping required to remove sewage from sanitary fixtures in a building, rapidly, quietly and without nuisance or health risk. Therefore, the performance requirements given in 4.4.3.1 to 4.4.3.9 shall be applicable.

4.4.3.1 Discharge

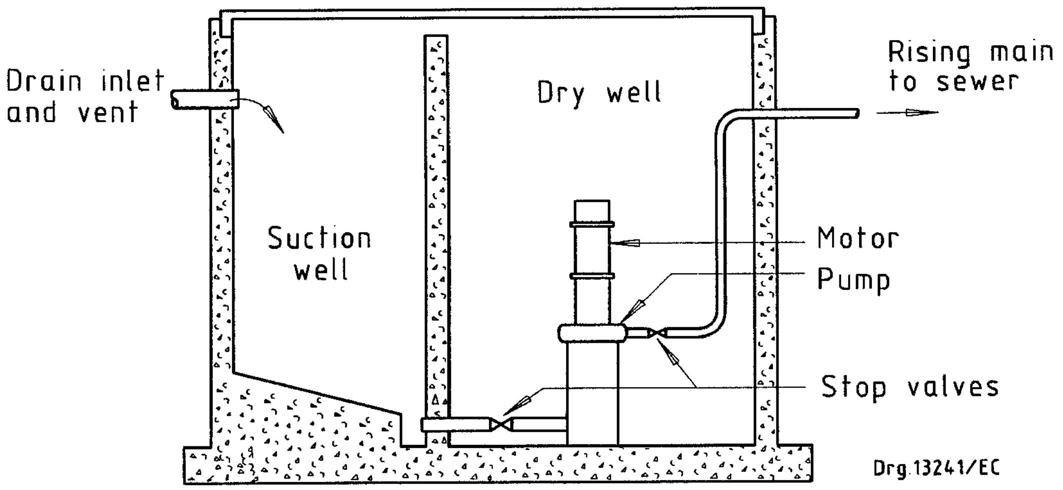
Outlets, traps and piping shall be of a size that will not unnecessarily limit the outflow from sanitary fixtures. The probability of the possible simultaneous discharge of sanitary fixtures served by a common discharge pipe shall be taken into account when the size of any such discharge pipe is being determined.

4.4.3.2 Containment of water and air

The pipework, fittings, fixtures and appliances shall prevent the leakage of any contaminated water and foul air into the building.

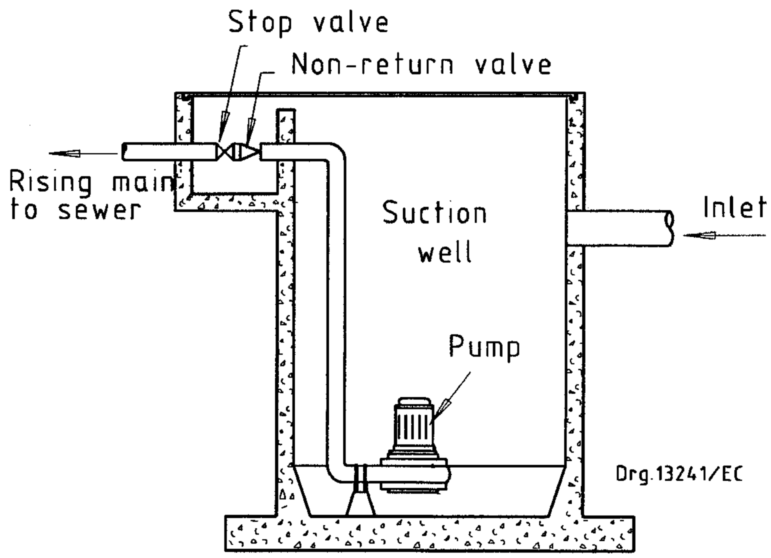
4.4.3.3 Limitation of noise

Noise generated by discharge pipes shall be so limited as to maintain the environmental quality in buildings.



NOTE - The pump operates when the volume of sewage equals one-fifth of the storage capacity. The emergency storage capacity above the level at which the pump cuts in should be equivalent to the greater of at least 24 h flow at the average flow rate from the building, or at least 1 kL .

a) Dry well sewage pump



b) Submersible sewage pump

Figure 1 — Typical sewage pump stations

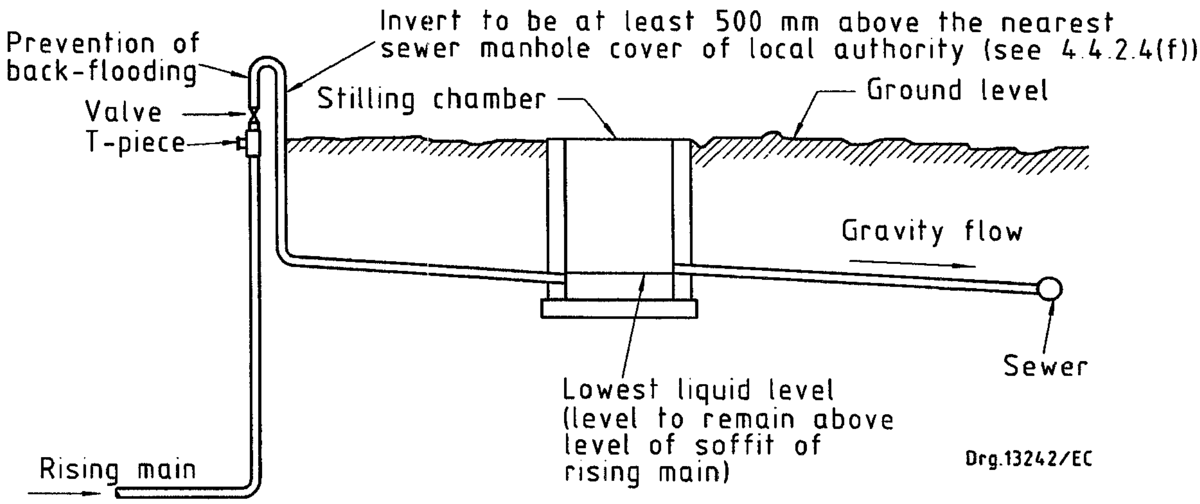


Figure 2 — Layout of a typical rising main

4.4.3.4 Resistance to blockage

The discharge pipework shall be so designed and installed as to minimize the risk of blockage.

4.4.3.5 Durability

The discharge system, including materials, joints, supports and fixings, shall be durable under operating conditions and shall have an expected lifetime at least equal to that of the building, without allowing foul water or air to penetrate the building.

4.4.3.6 Access for maintenance

The piping shall be designed and installed in a way that will permit all sections of the installation to be easily traced and the interior of all sections to be readily accessible to cleaning equipment. Easy access to the pipework for cleaning and maintenance equipment shall be provided to permit cleaning or clearing of all parts of the installation.

4.4.3.7 Replacement

The pipework system and fittings shall be so selected and installed that defective parts can be replaced without undue difficulty.

4.4.3.8 Accessibility for testing

Adequate access shall be provided for testing of the installation (see 6.8.2).

4.4.3.9 Aeration

The discharge system shall be so designed and installed to enable the passage of air to reduce pressure fluctuations adequately and to ensure replacement of air.

Commentary

1) *The purpose of a drainage installation should be to provide an economical, problem-free, hygienic and easily maintained system of removing sewage from a building. Since conventional gravity discharge drainage installations rely on water-filled traps at the sanitary fixtures for the exclusion of foul air from buildings, water seal depths must be adequate to prevent foul air from escaping from discharge pipes. The possible reduction of water seals owing to evapotranspiration and pressure fluctuations should be taken into account when water seal depths are being determined.*

2) *Pipework designed to limit pressure fluctuations will tend to be quiet. Noise generated as a result of the flow of water in discharge pipes may be reduced by sound insulation, and by isolating the pipework from the building or ductwork.*

4.4.4 Rational designs

4.4.4.1 If the drainage system is the subject of a rational design calculation, the following formulae are acceptable to calculate

a) normal flow in drains:

   1) Manning (n = 0,012);

   2) Crimp and Bruges (n = 0,012);

   3) Colebrook-White (K_s = 0,600); and

   4) Kutter (n = 0,012);

   provided that any formula can be used as long as it produces values approximately the same as the equivalent Colebrook-White formula that uses a K_s value of 0,600 mm, and

b) continuous flow and sometimes full flow in drain pipes:

   - Colebrook-White (K_s = 1,5 mm).

4.4.4.2 The following design criteria shall be applicable to any dwelling unit:

a) peak factor = 2,5;

b) percentage allowance for extraneous flow = 15 %;

c) the following equation shall be used to calculate the average daily flow rate:

   $Q = A/21600$

   where

   Q is the average daily flow rate, in litres per second; and

   A is the average daily flow, in litres per day;

d) the peak flow rate is equal to the average daily flow times the peak factor; and

e) the design flow rate is equal to the peak flow rate plus provision for extraneous flows.

Commentary

1) *The minimum design velocity of flow needed to obtain self-cleansing of drains is 0,6 m/s and the optimum flow velocity for the prevention of sewer corrosion under average conditions is from 0,8 m/s to 1,4 m/s.*

2) *The optimum design depth of flow in a drain is approximately 0,62 to 0,67 times the pipe diameter.*

3) *The drain should be designed to have a maximum design depth of flow of 0,75 times the pipe diameter, to ensure adequate air movement.*

4) *Branch discharge pipes should be designed for a design depth of flow of 0,5 times the pipe diameter.*

5) *Turbulence in, for example, sewage sumps is advantageous when sewage is fresh but should be avoided after the sewage has become septic (e.g. in septic tanks).*

4.4.5 Interceptor drains

4.4.5.1 Only waste water that requires separation shall discharge into an interceptor drain (see 3.1.33 and 3.1.44).

4.4.5.2 Any discharge into an interceptor drain shall only flow into the drain of the building after it has passed through the appropriate interceptor.

Commentary

1) *Sanitary fixtures that should discharge through an interceptor include kitchen sinks, dishwashers, garbage can washers, floor drains that might receive greasy wastes and any other fixtures that might discharge greasy wastes (see figure 3).*

2) *See also commentary to 4.3.1.*

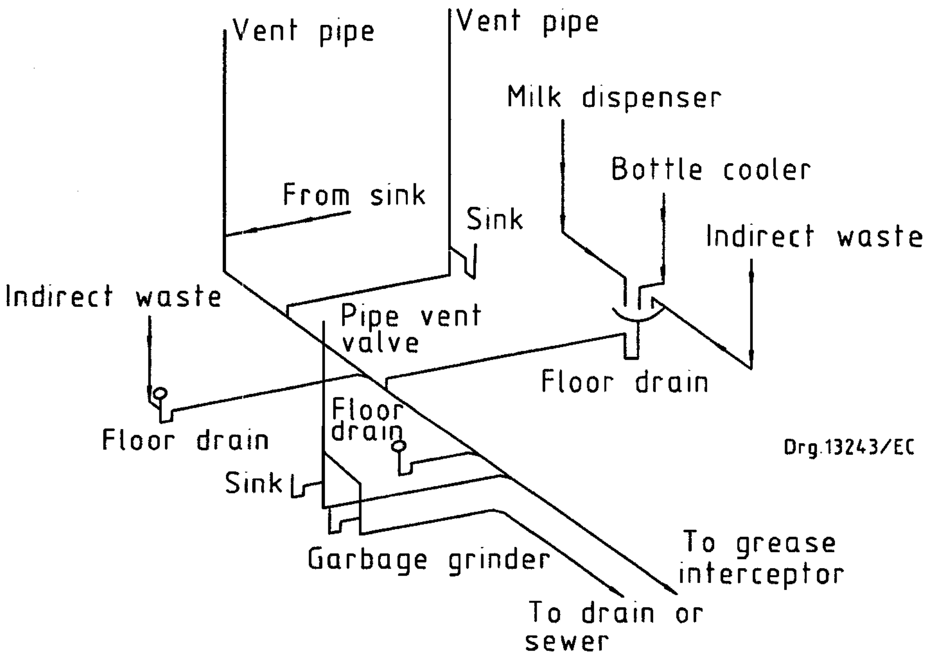


Figure 3 — Commercial kitchen equipment discharge schedule

5 Materials, components and sanitary fixtures

5.1 Materials and components

5.1.1 General

5.1.1.1 Pipes, fittings, sanitary fixtures and materials shall be

a) selected to operate effectively under all normal conditions likely to be experienced in the specific installation for the anticipated life of such installation, and

b) used in strict accordance with the manufacturer's recommendations.

5.1.1.2 If it is desired or deemed necessary to use materials, pipes, components or fittings not covered by this part of SABS 0252, or in the absence of an acceptable standard,

a) approval shall be obtained to use such materials or workmanship in the area concerned, and

b) if required, proof of quality and performance of the material or workmanship shall be established by tests or by reference to other standards.

5.1.1.3 Materials, pipes, components and fittings that bear the certification mark of the SABS in respect of the relevant standard issued by the SABS are normally deemed to be acceptable.

5.1.1.4 The following materials or components are, subject to the provisions of 5.1.1.3, deemed to be acceptable:

a) rubber joint rings that comply with the relevant requirements of SABS 974-1, provided that the rubber joint rings have the dimensions, composition and hardness that are suitable for the particular application;

b) stainless steel sinks with draining boards, that comply with the relevant requirements of SABS 242;

c) WC flushing cisterns that comply with the relevant requirements of SABS 821;

d) stainless steel wash-hand basins and wash troughs that comply with the relevant requirements of SABS 906;

e) stainless steel sinks for institutional use, that comply with the relevant requirements of SABS 907;

f) cast iron fittings for asbestos-cement pressure pipes, that comply with the relevant requirements of SABS 546;

g) cast iron surface boxes and manhole and inspection covers and frames, that comply with the relevant requirements of SABS 558;

h) cast iron gratings for gullies and storm-water drains, that comply with the relevant requirements of SABS 1115;

i) precast concrete manhole sections and slabs that comply with the relevant requirements of SABS 1294;

j) plastics waste traps and rubber waste traps that comply with the relevant requirements of SABS 1321-1 and SABS 1321-2 respectively;

k) acrylic sanitary ware that complies with the relevant requirements of SABS 1402; and

l) pipe vent valves for supplementary or alternative venting of drainage installations, that comply with the relevant requirements of SABS 1532.

5.1.1.5 Plastics traps for discharge pipework systems inside buildings, that comply with the relevant requirements of ISO 9896, are deemed to be acceptable.

5.1.1.6 The components of any grease interceptor or light-liquid interceptor shall be of materials that are resistant to the type of liquids and waste water to be intercepted.

5.1.2 Pipes

5.1.2.1 Pipes shall have adequate strength to comply with loading requirements, and shall be sufficiently robust to withstand site handling and sufficiently durable to remain watertight for the anticipated life of the installation.

Commentary

1) *Electrolytic corrosion can occur where dissimilar metals are in contact in the presence of moisture (see also table A.1, table A.2 and table A.3). Where any two metals are combined, the upper one can be subjected to attack by any lower metal in the following scale:*

   - zinc

   - iron

   - lead

   - brass

   - copper

   - stainless steel.

2) *The following waste pipe materials are commonly used, or have been used:*

   a) *lead (now largely outdated);*

   b) *galvanized mild steel (GMS) in conjunction with screwed fittings;*

   c) *cast iron (CI);*

   d) *copper (COP) in conjunction with brass fittings (mostly in coastal areas);*

   e) *unplasticized polyvinyl chloride (uPVC) and modified unplasticized polyvinyl chloride (MuPVC);*

   f) *polyethylene (PE), high density polyethylene (HDPE) and polypropylene (PP) (are largely used in special chemical drainage systems); and*

   g) *acrylonitrile butadiene styrene (ABS).*

3) *For information regarding the different types of piping material, reference should be made to the appropriate SABS standards and to product manuals that are readily available from the manufacturers and suppliers of the various pipes and fittings.*

5.1.2.2 Rigid pipes for buried pipelines shall be selected in accordance with the requirements of SABS 0102-1 and SABS 0102-2.

5.1.2.3 The following factors, where relevant, shall be taken into account when pipes are being selected for a particular purpose:

a) expected conditions of use and the nature of the liquids to be conveyed (e.g. the possibility of erosion by solids in the flow, or of chemical attack);

b) the physical and chemical characteristics of the drainage materials themselves;

c) the nature of the ground and the resultant possibility of chemical attack;

d) the ambient conditions of the installation;

e) the quality of workmanship that can be expected and the degree of supervision to be provided; and

f) the diameters and lengths of pipes available, the weight, the ease of cutting, the simplicity of the jointing system, the range of fittings available, the ease of unloading and assembly or positioning in the trench, the physical strength of the pipes and the maintenance requirements of the pipework.

5.1.2.4 The following pipes and fittings are, subject to the provisions of 5.1.1.3, deemed to be acceptable:

a) vitrified clay pipes and fittings that comply with the relevant requirements of SABS 559;

b) reinforced concrete pipes that comply with the relevant requirements of SABS 677;

c) prestressed concrete pipes that comply with the relevant requirements of SABS 975;

d) fibre-cement (FC) pipes and fittings that comply with the relevant requirements of SABS 819, provided that the FC fittings have a compressive strength that is equal to, or better than, that of the pipes to which they are coupled;

e) uPVC pipes for use above ground, that comply with the relevant requirements of SABS 967, provided that the solvent cement and primary fluid used for jointing uPVC pipes and fittings are appropriate to the material being jointed and for the particular application;

f) uPVC sewer and drain pipes and pipe fittings that comply with the relevant requirements of SABS 791;

g) malleable cast iron fittings that comply with the relevant requirements of SABS 509;

h) black polyethylene pipes that comply with the relevant requirements of SABS 533-1 or SABS 533-2; and

i) cast iron pipes and pipe fittings for use above ground in drainage installations, that comply with the relevant requirements of SABS 746.

Commentary

1) Rigid pipes can show linear, brittle stress-strain behaviour and can be weak in tension (or shear). They do not deform appreciably under their design load. Their ability to support the total load transmitted to them should be established by reference to actual crushing tests.

2) Flexible pipes can show ductile stress-strain characteristics and can deform under load. The extent of the deformation depends upon the stiffness of the pipe and the compaction of the immediate surrounding fill.

5.1.2.5 When a type of pipe other than the one on which the design is based (metal or plastics) is installed, the loading capacity of critically sized elements of the installation shall be checked.

Commentary

Neither the bore of metal and plastics pipes, nor their loading capacities are equivalent.

5.1.2.6 Copper pipes shall not be used to take the discharges from urinals only, or in connection with grease interceptors.

Commentary

Copper pipes may be used to take the discharge from urinals, provided that such flow is diluted by discharges from other upstream sanitary fixtures.

5.1.2.7 Galvanized steel pipes and fittings shall not be used to take the discharge from soil fixtures.

5.1.2.8 Vitrified clay pipes and fittings shall not be used above ground surface, except where installed as a riser for the purpose of connecting a fixture, in which case the pipe may be extended up to 1 m above ground surface, provided that

a) the complete joint is below ground level, and

b) exposed pipework is protected from damage.

Commentary

The use of polyethylene piping above ground where it is exposed to sunlight is not recommended.

5.2 Sanitary fixtures

5.2.1 General

5.2.1.1 Any sanitary fixture shall

a) be made of impermeable, non-corrosive material,

b) have a smooth and readily cleanable surface, and

c) be so constructed and fitted as to discharge through a trap into a soil pipe or waste pipe, as the case may be.

5.2.1.2 The water supply outlet to any sanitary fixture (other than to a bidet) shall be situated at least 20 mm above the flood-level rim of such fixture.

5.2.2 WC pans

5.2.2.1 Any WC pan that complies with the relevant requirements of SABS 497 is deemed to be acceptable; however, any WC pan that has a horizontal outlet spigot (where the connection between such spigot and the soil pipe connected to it is made by an adaptor that can provide a downwards slope at a gradient of at least 1 in 40 towards the inlet of such soil pipe) may be installed in any building.

5.2.2.2 Any WC pan of the pedestal type shall be manufactured as a single unit, and, where a pan is installed in such a position that the joint between its outlet spigot and the soil pipe into which it discharges is concealed, there shall be ready access to the joint.

5.2.2.3 Any WC pan of the wall-mounted type shall be manufactured as a single unit and shall be so constructed that it can be firmly attached to a wall or can be rigidly supported by a bracket.

5.2.2.4 Any WC pan shall be served by its own separate flushing device.

5.2.2.5 Any seat associated with any WC pan shall have a smooth non-absorbent surface and shall be held in place by fasteners made of corrosion-resistant material.

Commentary

1) *A wide range of patterns is available, but they can all be divided into two basic types:*

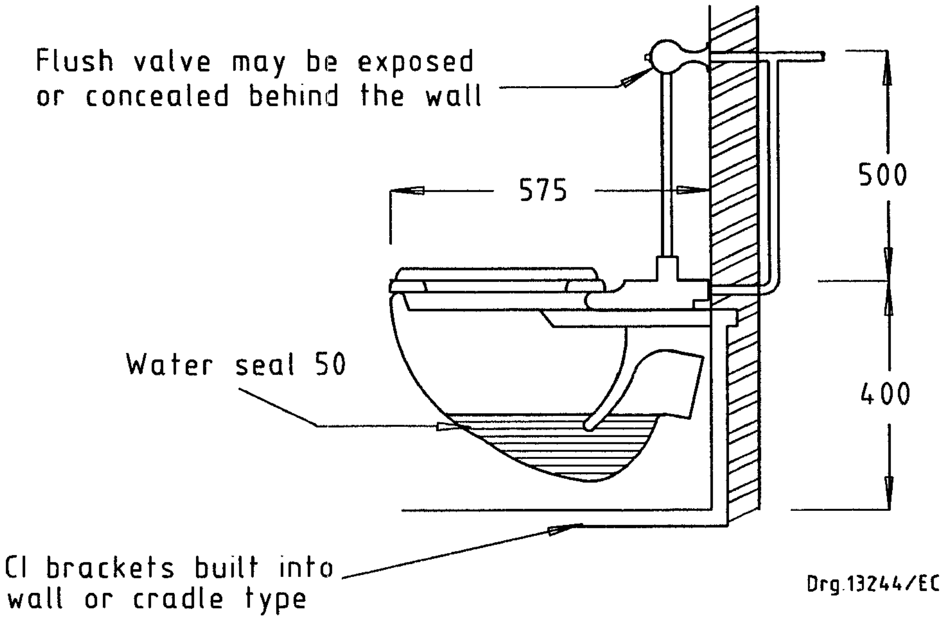
   a) *wash-down pans (see figure 4(a)): in wash-down pans, the flush water washes the contents of the pan through the trap and down the soil pipe. Such WC pans are efficient and simple and do not easily become blocked as a result of misuse; and*

   b) *siphonic WC pans (see figure 4(b)): the trap of the siphonic pan is so arranged that the water discharge causes siphonic action through pressure fluctuation in the trap. A less powerful but quieter flush is obtained than is the case with the wash-down-type WC pan. Siphonic action is usually produced by a restriction in the outlet, and hence siphonic WC pans tend to block more easily than wash-down-type pans. While more expensive than the wash-down-type pan, the siphonic pan is popular when coupled direct to the flushing cistern.*

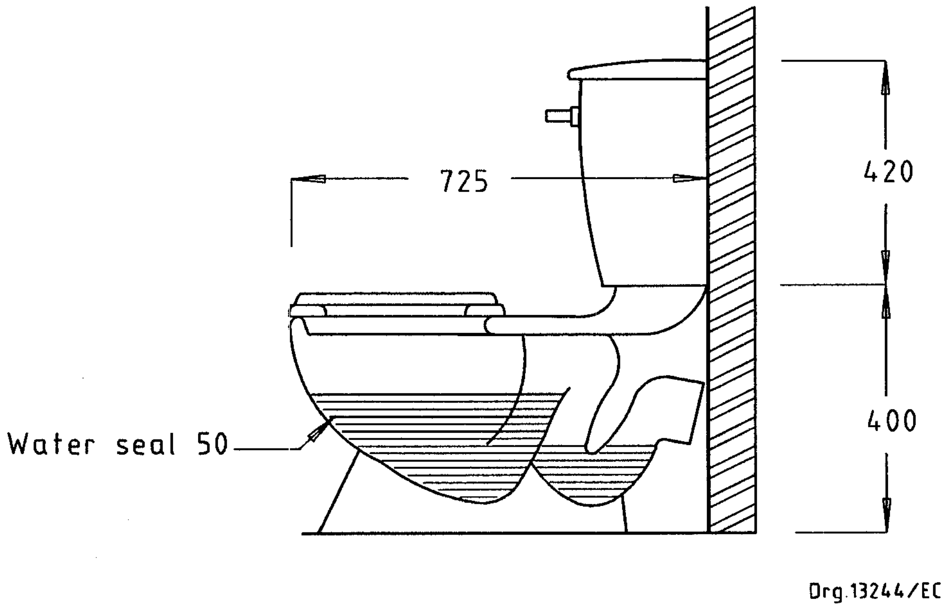
2) *Either type may be of the usual pedestal variety or of the cantilever wall-hung or cradle-hung type, the latter type allowing for a clear clean floor. The wall-hung types are particularly useful in multistorey developments where cleaning of the associated soil pipework or replacement of the pan is facilitated because the pan can be unbolted from the wall or partition.*

3) *Commonly, outlets of WC pans are of the "P" trap type. The slope of the outlet tail of WC pans with "P" traps is usually constant, since manufacturers have standardized on a WC pan branch angle of 14° above the horizontal. However, this does not apply to wall-hung WC pans that are made with horizontal outlet spigots. "S" trap and side outlet pans may not be readily available in the type required. In the case of the siphonic water closet, the adaptation of the outlet to different angles other than the usual "P" is done by means of an adaptor external to the fixture itself, and this often causes difficulty in installation and also increases the possibility of blockage.*

Dimensions in millimetres



a) Wash-down pan



b) Siphonic pan

Figure 4 — Water closet pans

5.2.3 Urinals

5.2.3.1 Any urinal shall consist of either one or more slabs, or a stall, trough, bowl or other suitable receptacle that has a smooth and readily cleanable non-absorbent surface. Where a slab type or trough type urinal is provided, a 600 mm length of such slab or trough shall be deemed to be equivalent to one urinal stall or bowl.

5.2.3.2 Any urinal or group of urinals shall

a) be provided with a flushing device (This provision shall not apply with regard to any urinal that is specifically designed and constructed as a flushless urinal.), and

b) not be provided with tipping tanks.

5.2.3.3 When any urinal is made of stainless steel, it shall be made as a single unit and shall be so constructed that

a) all welds have a degree of corrosion resistance not less than that of the parent material, and

b) any removable corner is attached by means of a corrosion-resistant fastener.

5.2.3.4 The channel fitted to any slab or stall type urinal shall slope at a gradient of at least 1 in 100, and the outlet to this channel shall

a) serve not more than 4,8 m of slab urinal, or 8 urinal stalls, and

b) be provided with a trap, which shall be provided with a corrosion-resistant grating designed to retain solid matter without obstruction of the flow of liquids. Any such grating shall not be installed in the case of any trap that serves any siphonic urinal.

5.2.3.5 Any joint between parts of a urinal shall be urine resistant and watertight.

5.2.3.6 Any urinal of the wall-mounted type shall be

a) so constructed that it discharges by gravity and has the following minimum dimensions:

   1) a vertical distance of 300 mm from the outlet of the bowl to the lowest point of discharge of flushing water into the urinal;

   2) an external width of 300 mm at the widest point; and

   3) a horizontal distance of 230 mm from the front of the lip to the wetted face immediately opposite the centre point of such lip.

   However, any urinal that has a dimension that is less than those given in (1) and (3) above may be installed, provided that a trapped floor drain is installed in the same room, and

b) manufactured as a single unit, and where it is a urinal flushed by a wash-down action, it shall be provided with a separate trap, or where it is flushed by siphonic or jet action, it shall have an integral trap.

5.2.3.7 Any flushless urinal shall

a) be constructed of inert material,

b) be so constructed that the inner surface of any bowl and outlet is smoothly curved to ensure that any flow of urine into any trap is unimpeded and cannot pond in any such urinal, and

c) have waste fittings and discharge piping made of plastics material or other inert material that is resistant to corrosion.

5.2.3.8 Any stainless steel stall urinal that complies with the appropriate requirements of SABS 924 is deemed to be acceptable.

Commentary

1) Urinals of the slab or stall type or wall-hung bowl type are available (see figure 5). Slab or stall type urinals are usually installed at 600 mm centres. Ceramic, acrylic and stainless steel are the usual materials of construction. Where stainless steel is used, provision should be made for backing, to prevent drumming. Joints should be avoided as far as possible. Stall type urinals require a floor channel and this necessitates the installation of a step to accommodate the urinal so as not to interfere with the floor slab. Bowl urinals are typically constructed of ceramic or fibreglass. Bowl type urinals have either an integral trap or an individual trap attached, which discharges direct to a soil water pipe. The outlet can be reverse trapped to retain water, which dilutes urine and reduces odours. It should be noted that for reverse mounted traps, no minimum scouring velocity can be obtained.

2) The mounting height of bowl urinals depends on the height of the user. In places where men and boys are likely to use the same convenience, bowls should be fitted at two or more heights. Difficulties with deep floor drainage do not arise with bowl urinals, and pipework is accessible.

5.2.4 Flexible connectors for WC pans

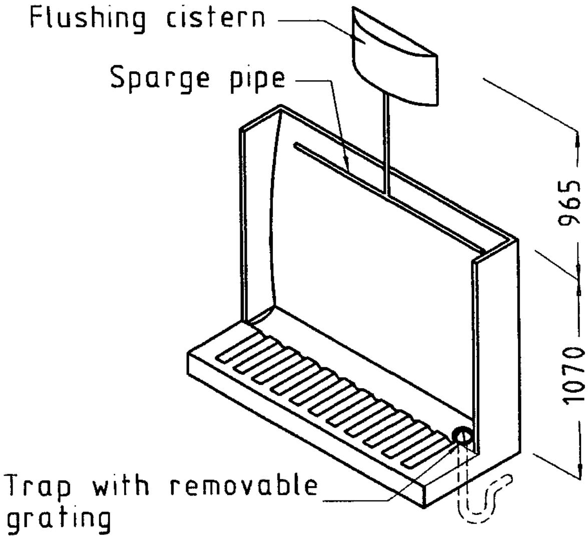
Any flexible connector

a) that is used to connect the outlet spigot of a WC pan to any soil pipe shall not permit any leakage of soil water at the joint, and

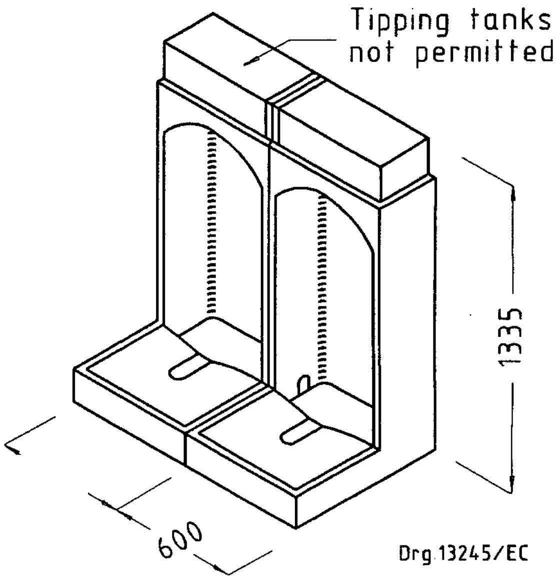
b) shall have a maximum water absorption of 2 % and shall be flexible to accommodate any dimensional variations between, and any surface irregularities of, such spigot and pipe.

The provisions of (a) and (b) above shall be deemed to be satisfied if the flexible connector complies with the appropriate requirements of SABS 974-1.

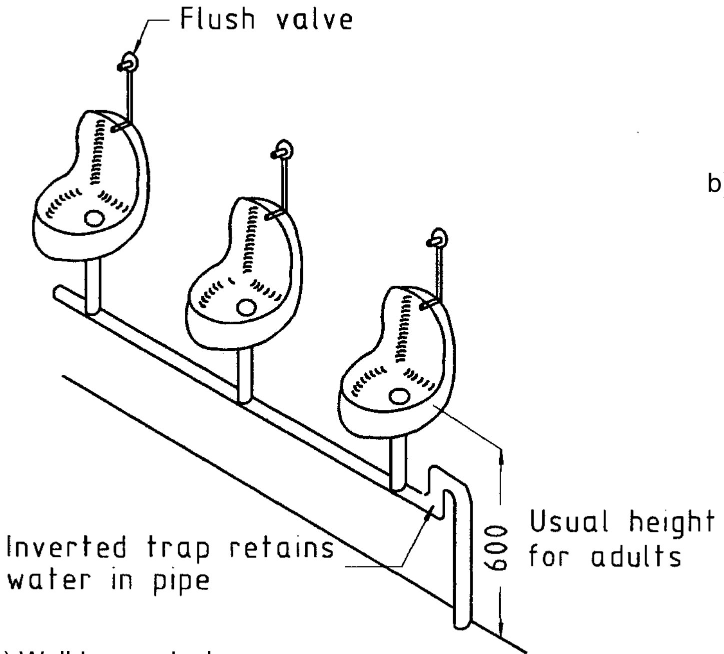
Dimensions in millimetres



a) Slab urinal



b) Stall urinal



c) Wall-hung urinal

Figure 5 — Examples of urinal installations

5.2.5 Electrical waste-water fixtures

5.2.5.1 Any clothes washing machine or dishwashing machine that is permanently connected to any drainage installation shall discharge into a waste pipe through a trap that has a depth of water seal of not less than the relevant depth given in 6.6.1.4.

5.2.5.2 A mechanical food-waste disposal unit or other disposal unit or a garbage grinder, that has a power capacity in excess of 500 W, shall not be incorporated into any drainage installation unless

a) the owner of the building has registered such a unit or grinder with the local authority, and it is shown on an approved plan and such local authority is satisfied that the working of any sewerage treatment system will not be impaired by its connection to the sewerage system, and

b) such unit or garbage grinder has been installed in compliance with the appropriate requirements of the compulsory specification for the safety of electrical appliances, published by Government Notice 466 (Government Gazette No. 7464) of 13 March 1981, and is of a type that will not cause impairment of the drainage system.

5.2.5.3 Any food-waste disposal unit installed shall

a) discharge through a tubular trap that has a depth of water seal of not less than the relevant depth given in 6.6.1.4, and

b) not impair the work of any part of the sewerage system.

Commentary

See also annex A.2.4 and A.2.5.

5.2.6 Macerator type sanitary-towel disposers

5.2.6.1 In any room that contains sanitary fixtures designed for the use of females, suitable means shall be provided for the disposal of sanitary towels.

5.2.6.2 Any macerator type sanitary-towel disposer shall discharge to a soil pipe through a tubular trap that has a depth of water seal of not less than the relevant depth given in 6.6.1.4.

5.2.7 Grease interceptors

5.2.7.1 Any grease interceptor required for a given building or commercial establishment shall serve only that building or establishment.

Commentary

Two types of grease interceptors (traps) exist, namely those designed for installation inside a building or room and those designed for installation outside a building.

a) grease interceptors for inside installation: small restaurants or other similar establishments that generate small amounts of grease would most likely use a grease interceptor that is installed inside the building or room (see figure 6). Such grease interceptors would normally be small factory-constructed units that may be floor mounted or installed below the floor. The design of such units should provide means to ensure that the flow of waste water at no time exceeds the rated capacity of the unit.

b) *grease interceptors for outside installation: commercial or other larger establishments that generate large volumes of waste water containing grease and fat accumulations usually require grease interceptors to be located outside the building because of their size, although smaller grease interceptors may also be located outside (see figure 7).*

5.2.7.2 Any grease interceptor shall be so located that it is easily accessible for inspection and cleaning purposes, and that intercepted fat, grease and oil can be removed hygienically. The location shall be such that

a) there will be no need to use ladders or to move bulky objects to check or service it, and

b) it is possible to completely empty and clean the interceptor.

5.2.7.3 Unless otherwise approved, a grease interceptor situated below ground outside a building shall not be located within 1,0 m of any building foundation or property boundary.

Commentary

1) *A grease interceptor should achieve maximum efficiency in promoting cooling, coagulation and retention of the grease within the separation compartment. Interceptors that do not serve single dwelling units should be designed to*

   a) *produce a separation performance of at least 92 % when waste water mixed with linseed oil is discharged through the interceptor, and*

   b) *store at least 40 L of light substances such as grease, fat and oil per through-flow in litres per second.*

2) *The size of the grease interceptor should be such that the velocity of flow of the waste water through the interceptor allows grease to separate and collect on the surface of the water in the separation chamber.*

3) *The following are recommended for grease interceptors built in situ:*

   a) *the separation compartment of grease interceptors that do not serve single dwelling units should comprise at least 0,25 m^2 of water surface per through-flow in litres per second;*

   b) *the ratio of the width to length of the separation compartment should be 1:1,8; and*

   c) *grease interceptors that serve catering establishments should be sized to handle a basic waste-water flow of at least 2 L/s and the following additional allowances in waste-water flow should be made for catering establishments that prepare more than 400 meals per day:*

      1) per additional 100 meals : 0,25 L/s; plus

      2) per dishwasher compartment : 1,0 L/s; or

      3) per industrial dishwasher : 2,0 L/s.

4) *The temperature of the waste water at the outlet from the grease interceptor should not exceed 30 °C, in order to allow grease and fat to separate and collect on the surface of the water in the separation compartment.*

5) *Generally, the size of a grease interceptor is dictated by the hydraulic loading, the relative density of the substances to be separated and the grease storage capacity required. The nature of the waste matter discharged should also be considered, since the use of detergents could impair the process of separation.*

6) *When the product to be separated has a relative density of up to 0,937, the following volumes for the separation compartment are suggested:*

   a) *at least 3 min flow for a flow rate of 2 L/s to 9 L/s;*

   b) *at least 4 min flow for a flow rate of 10 L/s to 19 L/s; and*

   c) *at least 5 min flow for a flow rate of 20 L/s and over.*

7) *If the rising speed of the substances to be intercepted differs considerably from that of linseed oil (4 mm/s), the capacities suggested in (6) above should be adjusted accordingly.*

5.2.7.4 All parts of the grease interceptor, including the inlet and outlet sockets, shall be easily accessible for cleaning purposes. The interceptor shall be fitted with a removable lid or a manhole cover that permits easy and effective removal of grease, fat, solid matter or fine sludge, and that seals airtight.

Commentary

For maintenance purposes, a full-size lid or two covers of 600 mm diameter may be provided - one over the inlet pipe and one over the outlet pipe.

5.2.7.5 Any grease interceptor shall be vented to prevent it from becoming air locked. The design and construction of the interceptor shall be such that the air space above the separation compartment is ventilated through the inlet pipe.

5.2.7.6 Only waste water that requires separation shall discharge into a grease interceptor or sludge trap. Water or waste water that promotes the process of separation may also be discharged through such trap.

Commentary

1) *Grease interceptors do not usually require local ventilation pipes, since adequate air can pass freely through the ventilation pipes of the sanitary fixtures they serve.*

2) *Grease interceptors used in areas subject to vehicular traffic should be fitted with traffic lids designed to provide adequate reinforcement to support the additional weight.*

3) *The following design detail is suggested for grease interceptors:*

   a) *waste water should enter the grease interceptor subject to a drop of 20 mm;*

   b) *the grease interceptor should not be capable of being sucked empty through the outlet pipe to an extent that light substances reach the outlet pipe;*

   c) *parts that are essential for the operation of the grease interceptor, such as suspended pipes or immersion plates, should be constructed in such a manner that they cannot be removed; and* *d) it is recommended that a grease interceptor incorporate a sludge trap. If a sludge trap is incorporated, the following is recommended:*

1) the sludge trap should function independently of the grease interceptor (before the interceptor); and

2) the sludge trap should be provided with a strainer that has a solid floor and has slots in only the upper half of its walls.

4) If the sludge trap and grease interceptor are rectangular, waste water should enter

a) the sludge trap over the full width, subject to a drop of 100 mm, and

b) the grease interceptor over the full width, subject to a drop of 20 mm.

5) The grease interceptor may be provided with a 50 mm diameter valve fitted approximately 150 mm below the maximum liquid line, to drain fat and oil on a daily basis (before the intercepted oil and fat have time to solidify).

6) In the case of grease interceptors bricked-up or concreted on site, it is recommended that the lower edge of the immersion walls on the inlet side be located at least 100 mm below the lower edge of the minimum storage space required.

7) The outlet from the grease interceptor should be provided with a water seal of approximately 60 mm, but no seal should be provided on the inlet side.

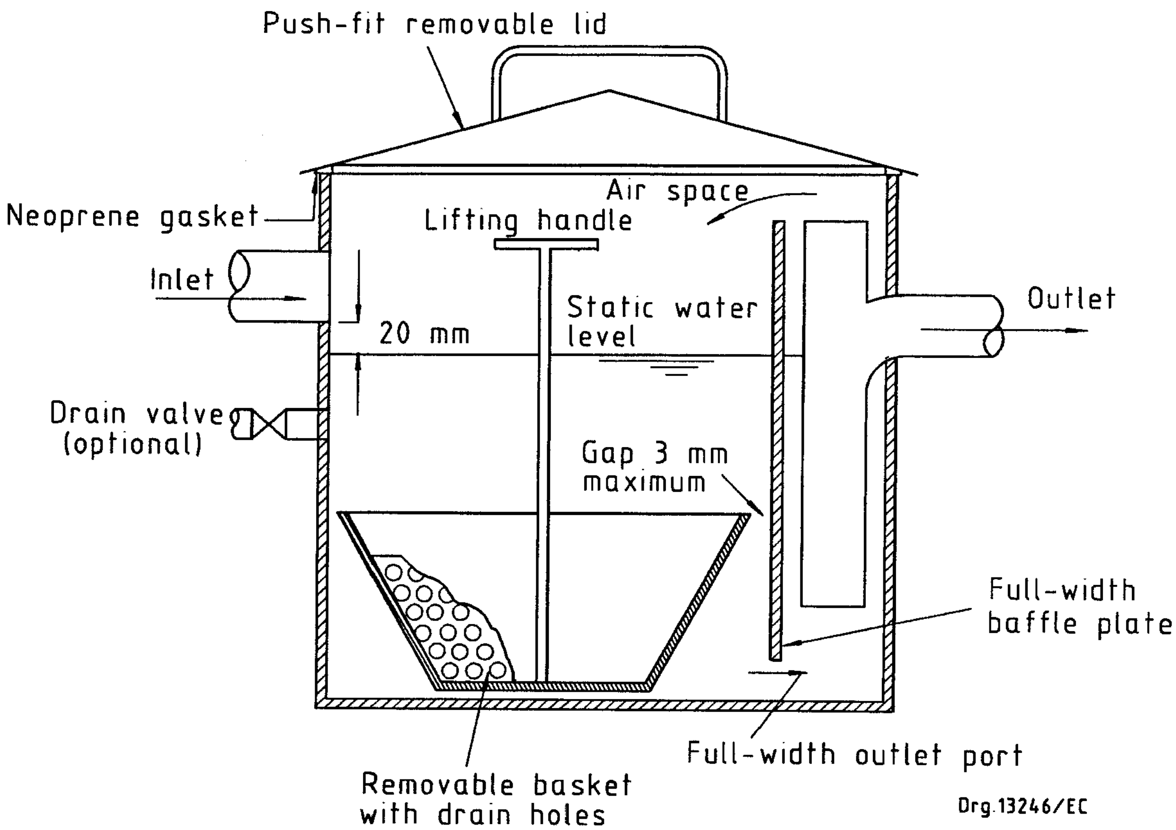


Figure 6 — Typical grease interceptor for inside installation

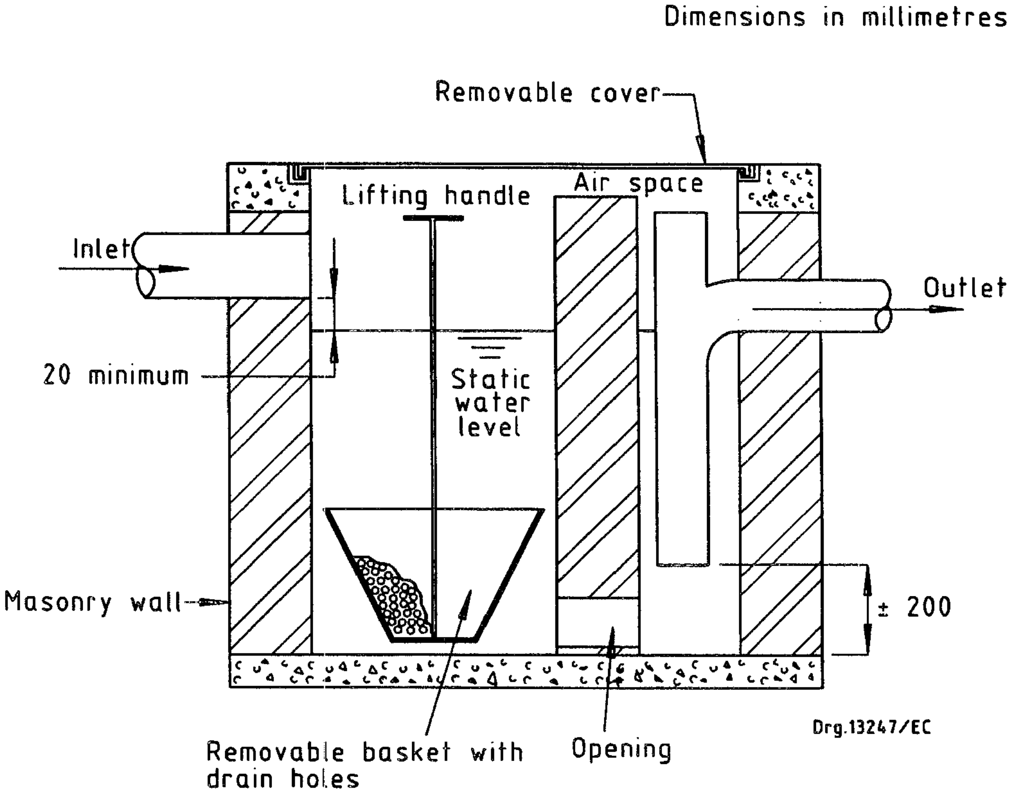


Figure 7 — Typical grease interceptor for outside installation

5.2.8 Light-liquid interceptors

5.2.8.1 Access to the automatic closure valves of light-liquid interceptors fitted with such valves shall be secured by a seal.

5.2.8.2 The air space of the light-liquid interceptor shall not be ventilated, but the outlet pipe from the interceptor shall be ventilated with a vent pipe that has a diameter at least half that of the outlet pipe.

Commentary

The interceptor should have a water seal of at least 100 mm at both the inlet and outlet.

5.2.8.3 Light-liquid interceptors shall be covered in a tight and traffic-safe manner. Covers shall

a) be non-flammable,

b) not be secured, and

c) permit the removal of fine sludge and light liquids.

Commentary

A sand seal should be sufficient for a tight cover.

5.2.8.4 It shall not be possible

a) to draw waste water off through the outlet pipe to such an extent that the separated light liquid reaches the outlet pipe, and

b) for the intercepted light liquid to flow back into the inlet pipe.

5.2.8.5 Only waste water that requires separation shall discharge into a light-liquid interceptor, and the interceptor shall discharge into a drain.

Commentary

1) The use of interceptors with non-self-closure valves is not recommended, since their maintenance can be easily neglected.

2) A light-liquid interceptor for light liquids that have a density of up to 0,85 kg/L, such as petrol, diesel and fuel oil, is illustrated in figure 8.

3) The nominal size of the light-liquid interceptor should be increased as the density of the liquid to be intercepted increases, because such liquid requires a longer retention time to separate from the water and rise to the surface. For example, if the effective size of an interceptor that is needed to intercept a light liquid that has a density not exceeding 850 g/L is taken as 1 unit, an interceptor that has a size of 2 units will be needed to intercept liquids that have a density of between 851 g/L and 900 g/L and one of 3 units will be needed for liquids that have a density of between 901 g/L and 950 g/L.

4) A light-liquid interceptor should be designed to attain a light-liquid intercepting performance of at least 97 %.

5) The following design criteria are suggested for the design of light-liquid interceptors:

a) the ceiling of the light-liquid interceptor should be horizontal or should rise towards the outlet;

b) the storage capacity of the interceptor should relate to the flow rate that the interceptor is designed to handle. For example,

1) for a design inflow rate of 1 L/s, at least ± 20 L,

2) for a design inflow rate of 5 L/s, at least ± 100 L,

3) for a design inflow rate of 10 L/s, at least ± 200 L, and

4) for a design inflow rate of 20 L/s, at least ± 500 L;

c) flow through the interceptor compartment should be uniform and the intercepted liquid should not be agitated or subjected to the inflow of new water;

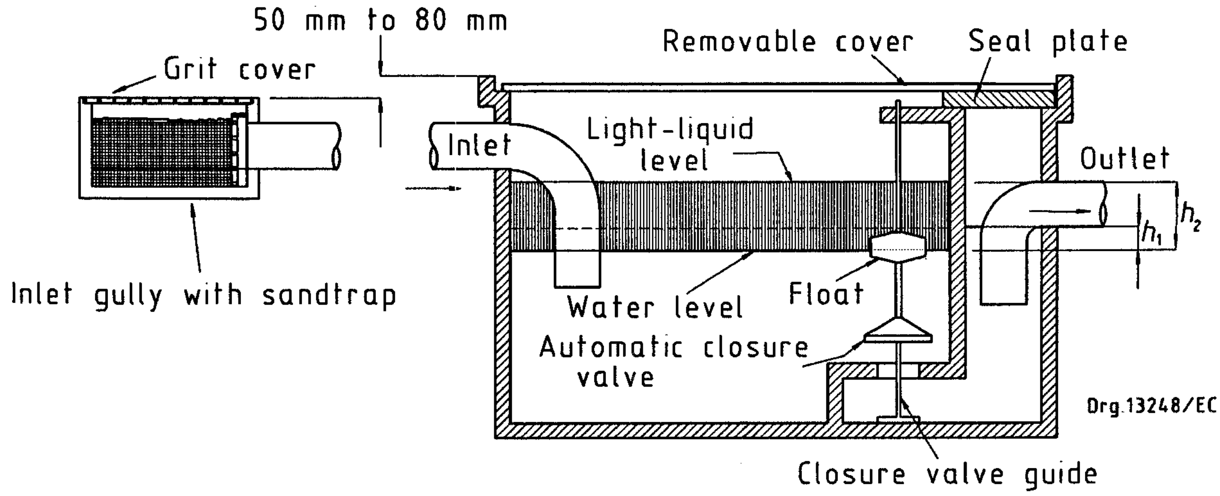
d) the interceptor should not be equipped with a strainer or a sand/sludge trap on the inside; and

e) the automatic closure device (e.g. a float valve manufactured from stainless steel) should be

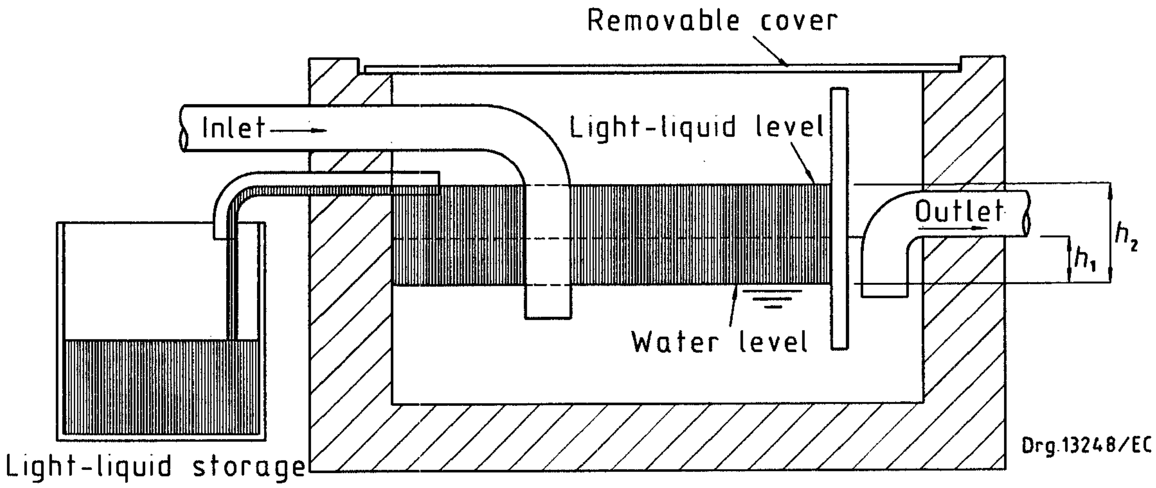
1) removable and replaceable,

2) set to close only when in contact with a light liquid, and only if at least 3 L of water is being displaced by such liquid, and

3) installed in such a manner that when the interceptor operates, the separating line between the water and the light liquid is situated at least 30 mm above the sealing surface of closure.



a) Light-liquid interceptor fitted with automatic closure valve



b) Light-liquid interceptor with no mechanical parts

NOTE - h_1/h_2 represents the density of the light liquid.

Figure 8 — Typical light-liquid interceptors

5.2.8.6 Liquid entry into the interceptor shall be through a floor drain or floor channel and a sludge trap. The sludge trap shall be

a) installed before the liquid enters the interceptor, to retain substances capable of precipitating, and

b) so designed and installed that it can be easily cleaned when necessary.

Commentary

1) In order to limit the fire (explosion) risk, it is recommended that liquid enter the light-liquid interceptor through a floor drain (or floor channel) that is provided with an integrated sand trap.

2) The sand trap should be so designed and installed that sand cannot enter the light-liquid interceptor and that the sand can be easily replaced when necessary.

3) The surface of the sand trap should be located at least 80 mm below the cover of the interceptor, in order to indicate timeously that the interceptor requires cleaning and to prevent the interceptor from overflowing with liquid.

6 Waterborne sewerage

6.1 Selection of the type of installation

6.1.1 General

The type of installation selected shall

a) be appropriate for the particular type of building being served, and

b) satisfy the provisions of 4.4.3.

Commentary

No one system has all the answers and most systems can be used in most buildings.

6.1.2 Cost-benefit analysis

When deemed necessary, a detailed cost-benefit analysis shall be carried out in order to select the most suitable drainage system for a particular building, and all relevant factors, including the following, shall be considered:

a) usage requirements;

b) layout of the installation; and

c) capital expenditure, maintenance and long-term running costs.

Commentary

An appropriate method for the 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. On economical grounds, it can almost be given as a rule that the use of ventilation pipes should be avoided as far as possible.

6.2 Types of systems and system requirements

6.2.1 Two-pipe system

The following provisions shall apply with regard to the two-pipe system:

a) any soil pipe shall be connected to another soil pipe, or direct to a drain;

b) any waste pipe shall discharge into another waste pipe, or to a gully that is connected to a drain; and

c) any waste and soil fixture traps shall be separately ventilated.

Commentary

1) *In the two-pipe system, soil water and waste water are separated before the water enters a drain. Soil fixtures discharge to a soil stack that is connected direct to the underground drain, and waste fixtures discharge into a waste stack (see figure 9). The waste discharge stack then has to discharge into a gully that is located between the discharge pipe that serves the lowest waste fixture that discharges into such stack, and the bend at the base of the stack where such stack connects to the drain. All trap seals have to be separately vented.*

2) *The two-pipe system is used in situations where*

   a) *there are many sanitary fixtures in ranges, or where such fixtures are widely dispersed, and*

   b) *it is impracticable to provide discharge stacks near to sanitary fixtures.*

3) *Although the two-pipe system functions satisfactorily, it is not commonly used, owing to the high cost of the pipework.*

6.2.2 One-pipe system

The following provisions shall apply with regard to any one-pipe system (including the fully ventilated stack system and the single-stack system):

a) any soil pipe shall be connected to another soil pipe, a stack or direct to a drain;

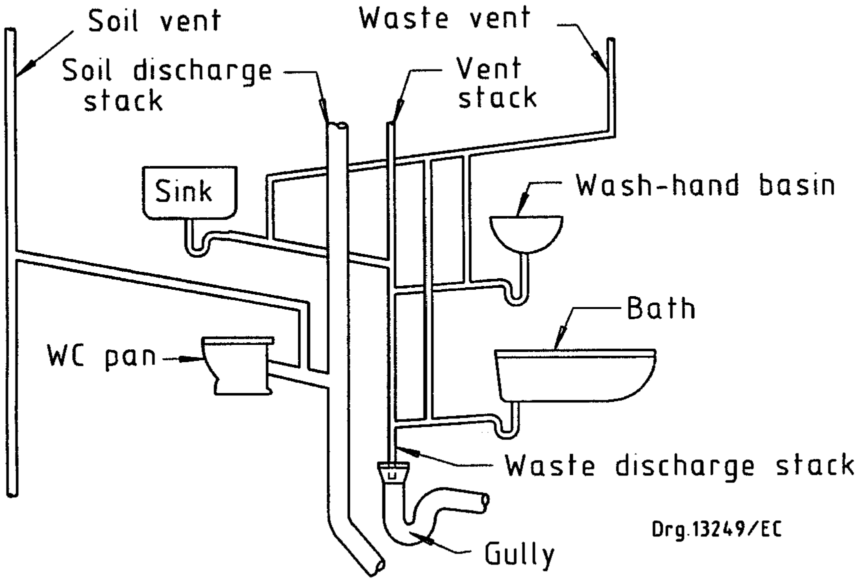
b) any waste pipe shall be connected to another waste pipe, a soil pipe, a stack, direct to a drain, or to a gully that is connected to a drain; and

c) traps of waste fixtures and soil fixtures may be served by a common ventilation pipe.

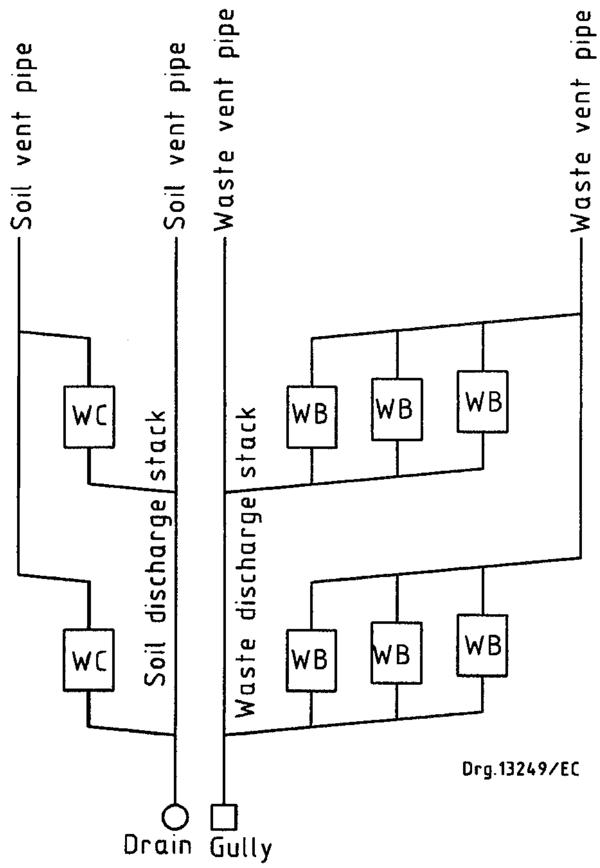
Commentary

1) *In any one-pipe system, soil fixtures and waste fixtures discharge into a common stack and the system is served by a common ventilation pipe.*

2) *The fully ventilated stack system is used in situations where close grouping of sanitary fixtures makes it practicable to provide branch vents without the need for trap vents or where the design provisions of the single-stack system cannot be met. Trap seals are safeguarded by means of extending discharge stacks to the atmosphere and by cross-connecting ventilation stacks to discharge stacks. All waste fixtures normally have to be provided with anti-siphonage pipes as illustrated in figure 10, but back venting is permitted, provided that waste branches are kept separate from soil branches, and provided that sanitary fixtures are installed in ranges.*

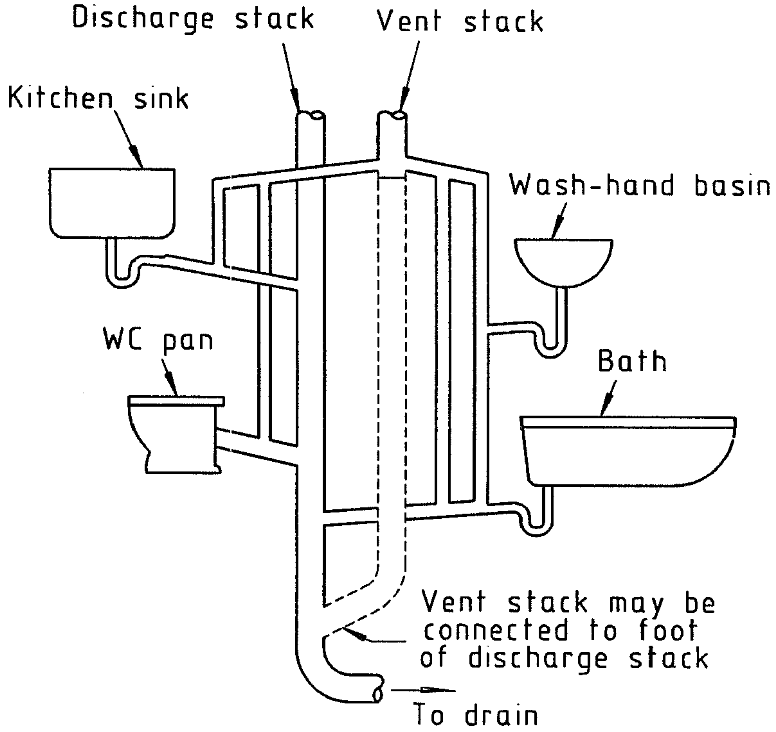


a) Group of sanitary fixtures

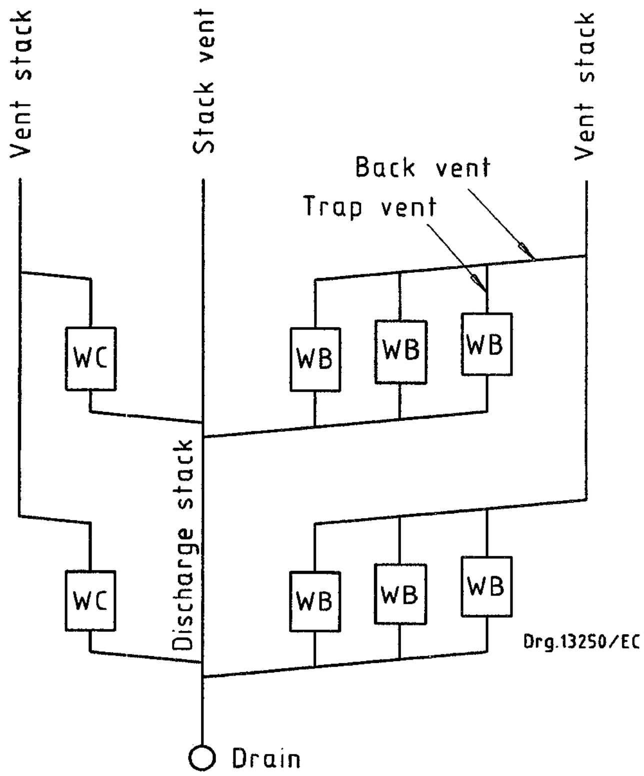


b) Ranges of sanitary fixtures

Figure 9 — The two-pipe system



a) Group of sanitary fixtures



b) Ranges of sanitary fixtures

Figure 10 — The one-pipe fully ventilated system

6.2.3 Single-stack system

Commentary

The single-stack system is essentially an unvented one-pipe drainage system in the sense that individual traps are not ventilated and that one stack serves as both the main discharge component and the ventilating component of the installation (see figure 11). The single-stack system is technically appropriate for residential class buildings from 1 storey to 30 storeys in height, that are served by groups of sanitary fixtures, and for commercial or public class buildings from 1 storey to 24 storeys in height, that are served by ranges of sanitary fixtures. The system can afford great savings in pipework, duct space and labour, and where pipework is exposed, the appearance is more aesthetic. This is the most simple and most economical system available for use in the majority of buildings, provided that the provisions of this subclause are complied with. Residential class buildings served by ranges of sanitary fixtures (such as hostels) and deep-plan buildings with complicated drainage arrangements (such as hospitals, factories and laboratories) are usually not suited to this system. Generally, the single-stack system is the more economical system for buildings of up to approximately 10 storeys in height. When the limits of the single-stack system are exceeded, the design requirements for the fully ventilated stack system should be reverted to. The single-stack system in its basic form is illustrated in figure 11(b).

6.2.3.1 The following provisions shall apply with regard to the single-stack system:

a) it shall only be installed in a building of the commercial or public class, with sanitary fixtures installed in ranges, or of the residential class, with sanitary fixtures installed in groups;

b) it shall not be installed in any residential building of height exceeding 30 storeys, or in any building of the commercial or public class exceeding 24 storeys in height above the lowest ground level abutting such building;

c) no trap vents for the protection of any water seals shall be required in terms of this subclause, or in terms of 6.4.1.2 or 6.4.1.3;

d) every waste fixture trap shall either be a "P" trap that has a water seal of at least 75 mm in depth, or a resealing trap of the "P" type, or a ventilated "S" trap that has a water seal of at least 75 mm;

e) any supplementary vent stack contemplated in 6.2.3.2(e) and 6.2.3.3(a) shall be cross-connected at each storey with the discharge stack above the level of the highest branch discharge pipe connection to the discharge stack;

f) any discharge stack other than a stub stack (see 3.1.19) shall be continued upwards to form a stack vent;

g) the radius of the centre-line of any bend at the foot of any discharge stack, or of any bend of an offset in the stack, shall be at least 300 mm;

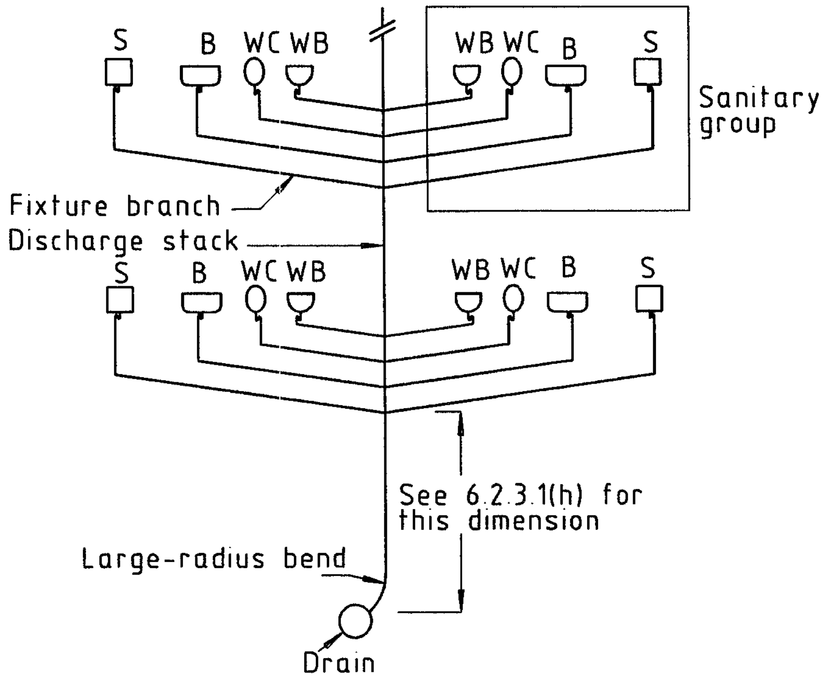
h) the vertical distance between the invert of the lowest branch discharge pipe or fixture branch connected to any discharge stack, and the invert of the bend at the foot of the stack, shall be at least 450 mm, provided that it is not less than

   1) 750 mm for any stack or part of a stack that has a vertical height of

      i) two storeys and that serves more than two sanitary groups on any storey,

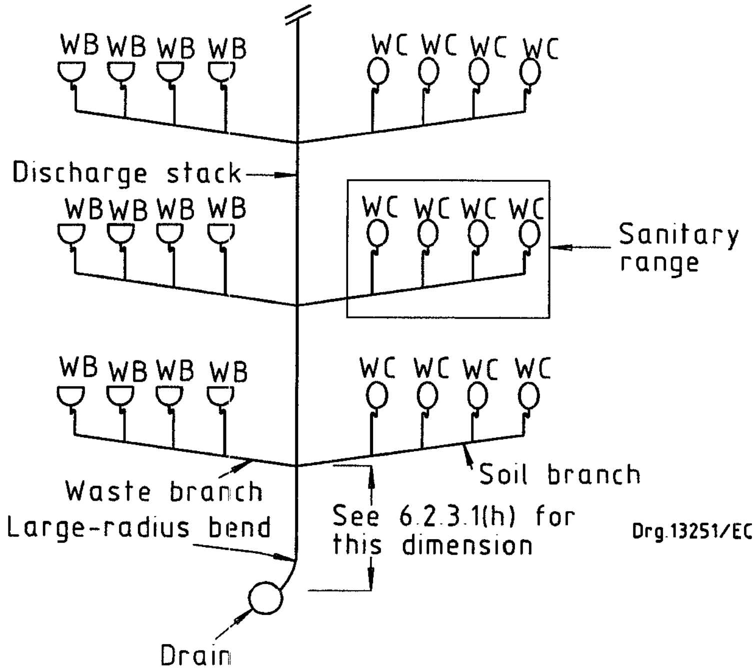
      ii) more than three storeys and up to five storeys in any building where the occupancy is of the residential class, or

      iii) up to five storeys in other buildings, and



NOTE - All fixture branches to be separately connected to the stack.

a) Group of sanitary fixtures in a residential type building



NOTE - Soil branches and waste branches to be separately connected to the discharge stack

b) Ranges of sanitary fixtures in a commercial type building

Figure 11 — The single-stack system

2) one storey in height for any stack or part of a stack that has a vertical height of more than five storeys in any building;

i) no connection shall be made on the horizontal part of the stack or drain within 2,5 m of the stack discharging into it;

j) no connection shall be made on the horizontal part of an offset within 450 mm of the receiving stack or on the receiving stack within 600 mm below the horizontal part of the offset;

k) where any waste branch and any opposed soil branch from a WC pan are connected to a discharge stack, the centre-line of the waste branch shall not intersect the centre-line of such stack within 200 mm below the intersection of the centre-line of the soil branch with the centre-line of the stack;

l) the inlet of any branch discharge pipe that joins a discharge stack of equal diameter shall be swept in the direction of flow with a radius of at least 50 mm, or shall be at an angle not exceeding 45°; and

m) any stub stack

1) shall have a nominal diameter of at least 100 mm, with a full-diameter cleaning eye positioned above the highest branch or fixture discharge pipe connection direct,

2) that requires ventilation shall be ventilated with a ventilation pipe that has a nominal diameter of at least 40 mm and that is fitted as an offshoot to the stub stack, in order to facilitate easy rodding.

Commentary

1) A single-stack system where supplementary vent stacks are provided is often referred to as a modified single-stack system (see figure 12). This system is actually an extension of the single-stack system, with the aim being to provide supplementary dry-venting to the stack when its wet-vented capacity is exceeded. It can be used where the disposition of sanitary fixtures on a branch discharge pipe could cause loss of their trap seals. The supplementary vent stack need not be connected direct to the discharge stack and can be smaller in diameter than the discharge stack.

2) A system where access to the installation is limited, and where the discharge stack is not continued upwards without a reduction in the diameter to form a stack vent, is often referred to as a closed-drainage system. In this system, above-ground piping is connected to drains by stub stacks (see figure 13). The principle underlying the design of a closed-drainage system is to reduce to a minimum the possibility of foreign substances penetrating the piping. Only a minimum number of access points are provided for cleaning purposes and open gullies are eliminated. As a rule, only one overflow device or gully is provided for each installation. The closed-drainage system is suitable for all dwelling houses and for buildings of up to two storeys in height above the lowest ground level abutting such building, and for connecting those sanitary fixtures that are installed on the ground floor of high-rise buildings and that cannot be connected to the main discharge stack of the single-stack system.

3) The bend at the foot of a discharge stack or part of a discharge stack at an offset should preferably be constructed using two large-radius 45° bends.

4) Offsets in the wet portion of a discharge stack should preferably be avoided. When unavoidable, the offset should be vented as shown in figure 14.

5) The vertical height contemplated in 6.2.3.1(h)(2) should preferably be increased to two storeys for buildings of more than 20 storeys in height.

6) *The restricted connection area contemplated in 6.2.3.1(h), 6.2.3.1(i) and 6.2.3.1(j) is illustrated in figure 15.*

7) *The restricted connection area contemplated in 6.2.3.1(k) is illustrated in figure 16. (See also annex A.1.8.4 and figure A.12 for alternative solutions.)*

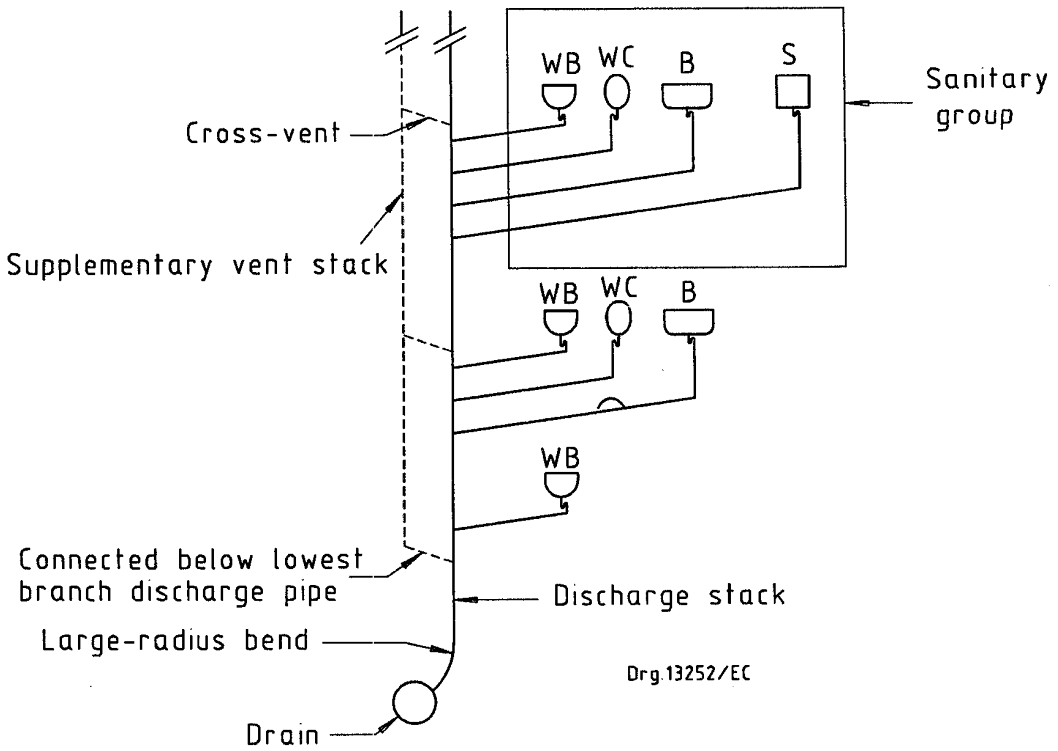


Figure 12 — Supplementary vent stacks and cross-connections on the modified single-stack system

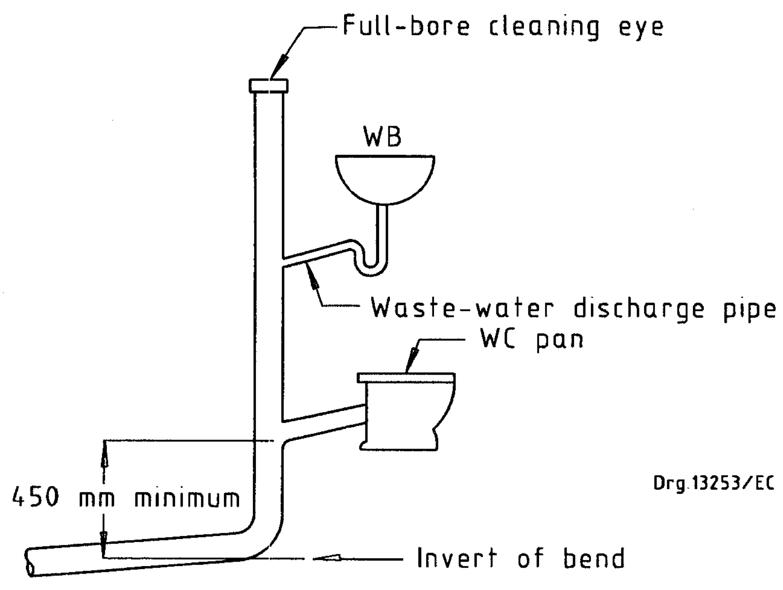


Figure 13 — Connection of fixtures to stub stacks

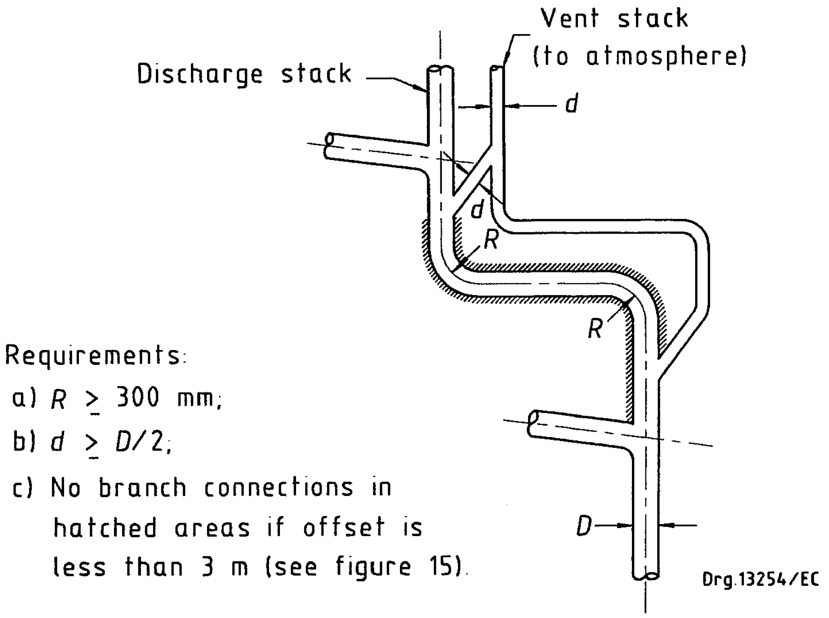
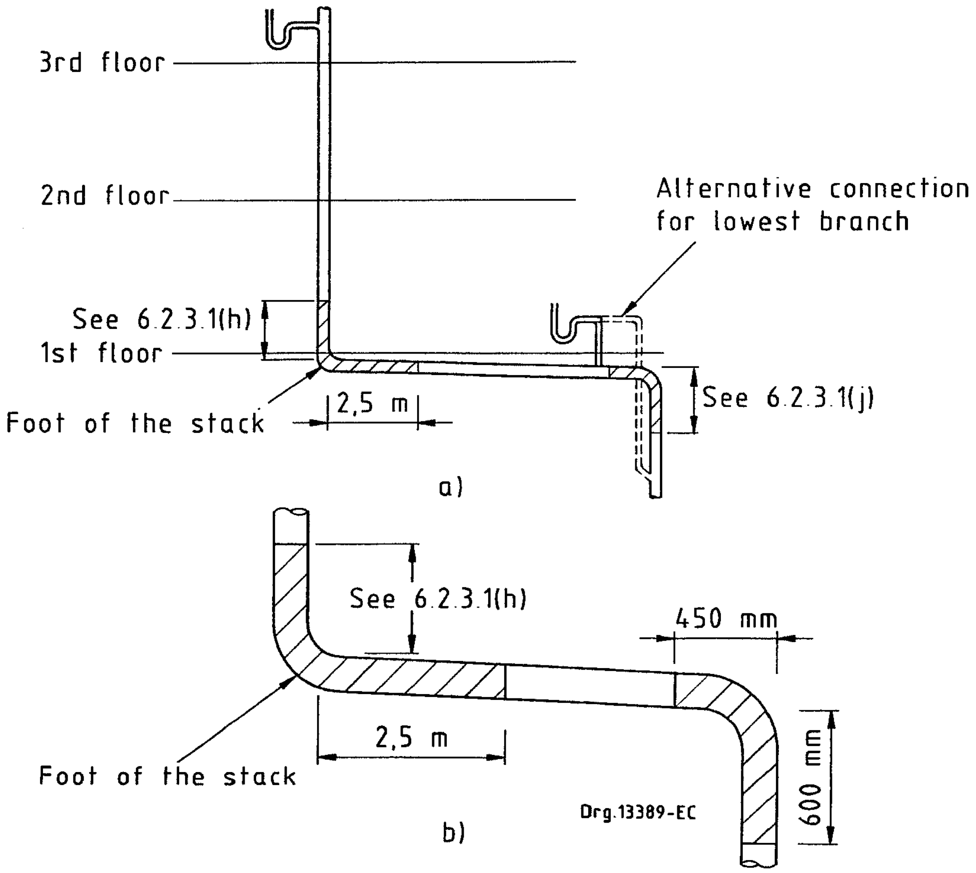
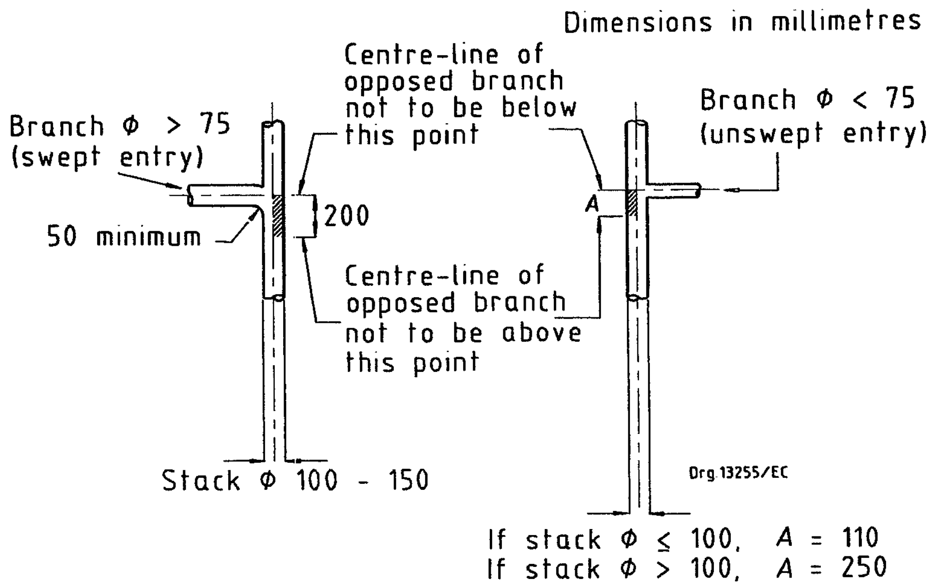


Figure 14 — Venting of offsets in discharge stack



NOTE - No connections permitted within hatched areas.

Figure 15 — Restricted connection area on a discharge stack



NOTE - No connections permitted within hatched areas.

Figure 16 — Restricted connection area of opposed connections

6.2.3.2 The following additional provisions shall apply with regard to any single-stack installation in any building where the occupancy is of the residential class and where sanitary fixtures are not installed in ranges:

a) the fixture branch of any sanitary fixture in any sanitary group shall be separately connected to a discharge stack;

b) the following shall apply to any wash-hand basin:

   1) where the trap fitted to any wash-hand basin has a nominal diameter of 32 mm, the internal diameter of the fixture discharge pipe that serves such wash-hand basin shall be at least 40 mm; and

   2) any fixture discharge pipe that serves a wash-hand basin and that discharges to a stub stack shall not

      i) lie at an angle that exceeds 2,5° (44 mm/m),

      ii) be longer than 3 m, and

      iii) contain more than two bends with a minimum radius of 75 mm;

c) not more than two sanitary groups per storey shall be connected to the same discharge stack;

d) the following shall apply to any stub stack:

   1) it shall not receive the discharge from any discharge pipe of height more than two storeys; and

   2) an unventilated stub stack shall not receive the discharge from more than one sanitary group and a ventilated stub stack shall not receive the discharge from more than two sanitary groups; and

e) the minimum size of any discharge stack and, where required, the minimum size of any supplementary vent stack, including cross-ventilation provisions, shall be as prescribed in table 10.

Table 10 — Minimum discharge stack sizes and supplementary vent stack sizes and vent stack requirements for single-stack systems for residential class occupancy

1	2	3
Number of storeys served by discharge stack	**Nominal diameter of discharge stack** mm	**Minimum nominal diameter of a supplementary vent stack serving not more than two sanitary groups in each storey, with a cross-vent at each floor** mm
Up to 10	100	None
11 to 15	100 150	50 None
16 to 30	150	None

6.2.3.3 The following additional provisions shall apply with regard to any single-stack installation in any commercial or public class building, or where sanitary fixtures are installed in ranges:

a) in the case of sanitary fixtures that are installed in ranges as contemplated in column 2 of table 11, the minimum nominal diameter of any discharge stack, and of any supplementary vent stack, where required, shall be as given in column 3 and column 4, respectively, for the number of storeys served by such discharge stack as given in column 1;

b) only sanitary fixtures of the same type as referred to in (a) above shall be connected to a common branch discharge pipe and any such common branch discharge pipe shall be separately connected to the discharge stack;

c) for the purposes of table 11, any number of urinals not exceeding four may be regarded as equal to one WC pan;

d) any common branch discharge pipe connected to a stub stack shall

1) not receive the discharge from more than four sanitary fixtures,

2) when serving a range of

i) wash-hand basins, have a diameter of at least 50 mm, lie at an angle not exceeding 2,5° (44 mm/m) and contain not more than two bends with a minimum radius of 75 mm, and

ii) urinals, have a diameter of at least 75 mm in the case of channel urinals, and 50 mm in the case of bowl urinals; and

e) any fixture discharge pipe that serves a wash-hand basin and that discharges to a stub stack, or a common branch discharge pipe that discharges to a stub stack shall not

1) lie at an angle that exceeds 2,5° (44 mm/m),

2) be longer than 3 m, and

3) contain more than two bends with a minimum radius of 75 mm.

Commentary

Where both a range of fittings on one floor and a group of fittings on another floor is connected to the same discharge stack, the minimum nominal diameter of the discharge stack should be taken as the largest size required in terms of table 10 or table 11.

Table 11 — Minimum discharge stack sizes and supplementary vent stack sizes and requirements for single-stack systems: commercial and public class buildings

<table>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>Number of storeys served by discharge stack</th><th>Maximum number of sanitary fixtures in a range in each storey</th><th>Min. nominal diameter of discharge stack
mm</th><th>Min. nominal diameter of supplementary vent stack
mm</th></tr>
<tr><td>1 - 4</td><td>Not exceeding 5 WC pans and 5 wash-hand basins</td><td rowspan="7">100</td><td rowspan="2">Vent stack not required</td></tr>
<tr><td rowspan="3">5 - 8</td><td>Not exceeding 2 WC pans and 2 wash-hand basins</td></tr>
<tr><td>3 WC pans and 3 wash-hand basins</td><td>32</td></tr>
<tr><td>Exceeding 3 WC pans and 3 wash-hand basins but not exceeding 5 WC pans and 5 wash-hand basins</td><td>40</td></tr>
<tr><td rowspan="2">9 - 12</td><td>Not exceeding 2 WC pans and 2 wash-hand basins</td><td>32</td></tr>
<tr><td>Exceeding 2 WC pans and 2 wash-hand basins but not exceeding 4 WC pans and 4 wash-hand basins</td><td>40</td></tr>
<tr><td>1 - 8</td><td>Not exceeding 5 WC pans and 5 wash-hand basins</td><td rowspan="2">150</td><td>Vent stack not required</td></tr>
<tr><td>9 - 24</td><td>Exceeding 3 WC pans and 3 wash-hand basins but not exceeding 5 WC pans and 5 wash-hand basins</td><td>75</td></tr>
<tr><td colspan="4">NOTE - Where there are fewer wash-hand basins than WC pans in a storey, the number of WC pans shall determine the supplementary vent stack requirements.</td></tr>
</table>

6.3 Discharge pipes and drains

6.3.1 Hydraulic load

6.3.1.1 The hydraulic load discharged into, or carried by, any discharge pipe or any drain shall be calculated in units, referred to as fixture units.

6.3.1.2 The hydraulic load at any point in any discharge pipe or drain shall be the sum of the fixture unit ratings of all sanitary fixtures, the discharges from which enter the discharge pipe or drain upstream of such point.

6.3.1.3 The hydraulic load discharged from any sanitary fixture specified in column 1 of table 12 shall be as given in column 3, and in the case of any sanitary fixture not listed in the column, the diameter of the trap outlet of such a fixture, when identified in column 2, shall indicate the hydraulic load, given in column 3, that is to be prescribed for such a fixture.

Commentary

1) *The fixture unit rating given in table 12 for each type of fixture is a measure of the hydraulic load, and takes into account the duration of discharge, the interval between discharges and the mean discharge rate of the particular fixture.*

2) The hydraulic load for a sanitary group given in table 12 is not the same as the sum of the hydraulic loads for the individual fixtures comprising such group, because the assumption made regarding the interval between discharges is different in each case.

3) It is essential that pipe sizes in large installations be determined correctly, so as to be large enough to accept the required flow, but not oversized and hence uneconomical. Oversizing leads also to depositing in pipes, since scouring velocities are not attained, resulting in increased maintenance. Therefore, the calculation of pipe sizes for such installations is often the subject of a rational design.

Table 12 — Fixture unit ratings of sanitary fixtures

1	2	3
Examples of sanitary fixtures	**Nominal diameter of trap** mm	**Hydraulic load in fixture units**
Wash-hand basin, bidet, wall-mounted urinal (separate trap)	32	1
Bath, sink, shower, wash trough	40	2
Wall-mounted urinal with integral trap, commercial electrical sanitary fixtures	50	3
	75 or 80	5
WC pan	100	8
Sanitary group		12

6.3.2 Sizing of drains

6.3.2.1 The following provisions shall apply with regard to the sizing of any drain:

a) the nominal diameter of any drain shall in no case be less than 100 mm;

b) the hydraulic load carried by any drain that has a gradient given in column 1 of table 13, and a nominal diameter given in columns 2 to 14, as the case may be, shall not exceed the number of fixture units given in the table for such diameter and gradient of drain; and

c) where, owing to the slope of the ground, any drain is required to be laid at a gradient steeper than 1 in 5, the hydraulic load carried by the drain shall not exceed that given in column 2 of table 13 for a gradient of 1 in 5.

6.3.2.2 For the purposes of table 13 and table 14, any waste pipe that has a diameter of 100 mm or greater and any soil pipe shall, subject to the provisions of 6.3.3.2, be deemed to be a drain from that point downstream of which the gradient of such pipes, or of any drain to which it is connected, does not once more exceed 45° below the horizontal, except where such pipe or drain is connected to any connecting sewer.

Commentary

The provision of 6.3.2.2 is illustrated in figure 17.

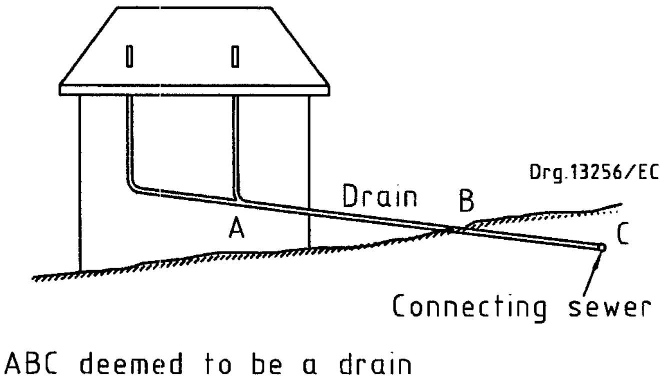


Figure 17 — Discharge pipe deemed to be a drain

Table 13 — Maximum permissible drain loading

1	2	3	4	5	6	7	8
Gradient of drain	**Maximum load** fixture units						
	Nominal pipe diameter mm						
	100 (110 OD)[1]	**150 (160 OD)**[1]	**200**	**225**	**250**	**300**	**375**
1 in 5	12 000	40 000	75 000	105 000	–	–	–
1 in 10	9 000	27 000	56 000	76 000	100 000	165 000	295 000
1 in 20	6 400	19 000	40 000	54 000	72 000	117 000	210 000
1 in 40	4 500	13 500	28 500	38 000	51 000	82 000	148 000
1 in 60	3 650	11 000	23 000	31 000	41 000	67 000	125 000
1 in 80	3 150[2]	9 500	20 000	27 000	36 000	58 000	104 000
1 in 100	2 800[2]	8 400	18 000	24 000	32 000	52 000	93 000
1 in 120	2 550[2]	7 700	16 500	22 000	29 000	47 500	85 000
1 in 150	np	6 900	15 000	19 500	26 000	42 500	76 000
1 in 200	np	6 000	13 000	17 000	22 500	37 000	66 000
1 in 300	np	np	10 600	14 000	18 500	30 000	54 000
1 in 400	np	np	np	np	16 000	26 000	47 000
1 in 500	np	np	np	np	np	23 500	42 000

1) Nominal outside diameter for non-metallic pipes.
2) Special permission required from local authority. It is essential that a detailed cost benefit study be done, taking into account the cost of a regular systematic maintenance and silt/sand removal programme that would be required when pipes are laid to such flat grades (resulting in lower flow velocities) as against the higher initial capital cost required to maintain steeper grades.
np means not permitted.

6.3.3 Sizing of discharge pipes

6.3.3.1 The following provisions shall apply with regard to the sizing of any discharge pipe:

a) the nominal diameter of any discharge pipe shall be not less than the internal diameter of any pipe or outlet of any sanitary fixture that discharges into it. However, where the nominal diameter of any horizontal pipe in an offset is more than that of the discharge stack that discharges into it, the nominal diameter of the stack downstream of the offset may be less than that of the horizontal pipe;

b) the internal diameter of any soil pipe other than a soil pipe from any urinal shall be at least 100 mm;

c) the internal diameter of any waste pipe shall be at least 32 mm if it serves a wash-hand basin, bidet or drinking fountain, and at least 40 mm if it serves any other waste fixture;

d) in the single-stack system, the internal diameter of any waste pipe shall be at least 40 mm;

e) the hydraulic load carried by any discharge pipe that has a nominal diameter given in column 1 of table 14 shall not exceed the number of fixture units given in columns 2, 3 or 4, as the case may be. However, where a discharge stack is connected to a horizontal pipe that is of larger diameter than the stack, the bend that connects the horizontal pipe to the stack shall have a nominal diameter equal to that of the horizontal pipe; and

f) the limiting gradient for any discharge pipe shall be as given in table 15.

Commentary

See commentary to 4.4.4 regarding self-cleansing velocities.

6.3.3.2 Where the diameter of any horizontal pipe at the base of a discharge stack exceeds that of the drain into which it discharges, the horizontal pipe shall have a length of at least 2,5 m, measured from the centre-line of the discharge stack, before it is reduced in diameter and connected to the drain.

Commentary

1) Since a drain that carries a given flow might have a smaller diameter than a discharge stack that carries the same flow, a 2,5 m transition length of piping corresponding to the larger diameter must be provided to assist in balancing the flows (see figure 18).

2) Enlarging the drain pipe from the base of the stack for the first 20 pipe diameters allows a hydraulic jump to form without the pipe running full. This ensures that venting can take place and prevents surges in the drain and the stack.

Dimensions in millimetres

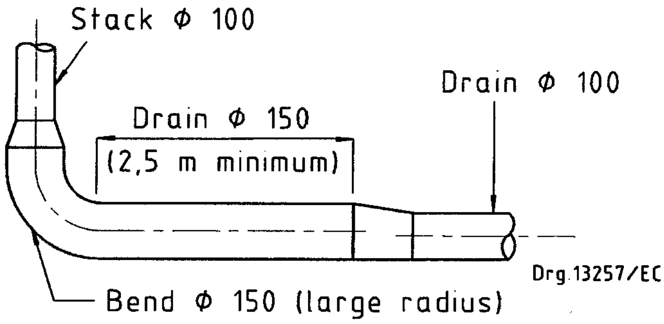


Figure 18 — Transition length of piping at the foot of a stack

Table 14 — Maximum permissible discharge pipe loading

1	2	3	4
Nominal pipe diameter mm	**Maximum loading** fixture units		
	Discharge stacks	**Discharge pipes other than those referred to in column 4**	**Branch discharge pipes**
32	2	1	1
40	6	2	3
50	18	5	8
65	84	18	35
75	140	29	60
100	680	120	280
125	2 400	350	870
150	6 000	760	2 100
NOTE - Currently, no pipes with a 125 mm nominal diameter are used.			

Table 15 — Limiting gradients of discharge pipes

1		2		3		4		5	
Limiting gradients									
Waste branches				**Soil branches**				**Horizontal fixture discharge pipes**	
Single-stack system		**Ventilated one-pipe or two-pipe system**		**WC pan**		**Other soil fixtures**		**All systems**	
Min.	**Max.**[1)]	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
1,25° (1/46)	5° (1/11,5)	1,25° (1/46)	5° (1/11,5)	1,43° (1/40)	14° (1/4)	1,43° (1/40)	5° (1/11,5)	2,5° (1/23)	45° (1/1)
1) The maximum gradient of a waste pipe serving one or more wash-hand basins only shall be 2,5° (1/23).									

6.4 Ventilation

6.4.1 Trap venting and back venting

6.4.1.1 In order to preserve the water seal in the trap of any soil fixture under working conditions, the water seal shall, subject to the provisions of 6.2.3.1(c), be protected by a trap vent where the discharge from such soil fixture is conveyed by

a) an unventilated branch drain or unventilated soil pipe that has a fall exceeding 1,2 m to its point of connection to a ventilated soil discharge stack or ventilated drain and within 2,4 m of the outlet of the soil fixture trap, or

b) a discharge stack that receives, at a higher level, the discharge from any other soil fixture, or

c) an unventilated branch drain or unventilated soil pipe that receives the discharge from any other soil fixture. However, the trap vent may be omitted in the case where a soil fixture discharges to a soil branch where

   1) the hydraulic load carried by such soil branch is not more than 50 fixture units, and

   2) such soil branch is served by a back vent of 100 mm in diameter, and

   3) not more than 16 soil branches discharge into the same discharge stack.

Commentary

1) The provision of trap vents to soil fixtures is illustrated in figure 19 and figure 20.

2) In the case of the single-stack system, no trap vents are required for the protection of water seals.

3) Trap vents are by definition ventilation pipes and they should therefore be sized in accordance with 6.4.3.

6.4.1.2 In order to preserve the water seal contained in the trap of any waste fixture under working conditions, such water seal shall, subject to the provisions of 6.2.3.1(c), be protected by a trap vent. However, in the case of any installation on the two-pipe system, such trap vent may be omitted

a) where a resealing trap is fitted to such waste fixture, or

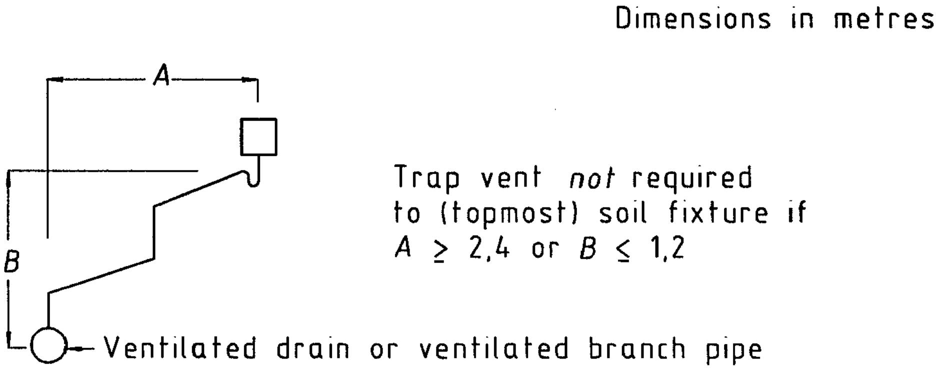
b) in the case of a single bath, shower or sink that discharges independently into a gully and that is situated within 2 m vertically above and 3 m horizontally from such gully.

6.4.1.3 The water seal in the trap of any waste fixture or of any urinal that is required to be protected in terms of 6.4.1.2 may, as an alternative, be protected by a trap vent valve, provided that the trap vent valve is able to handle the required rate of flow of air.

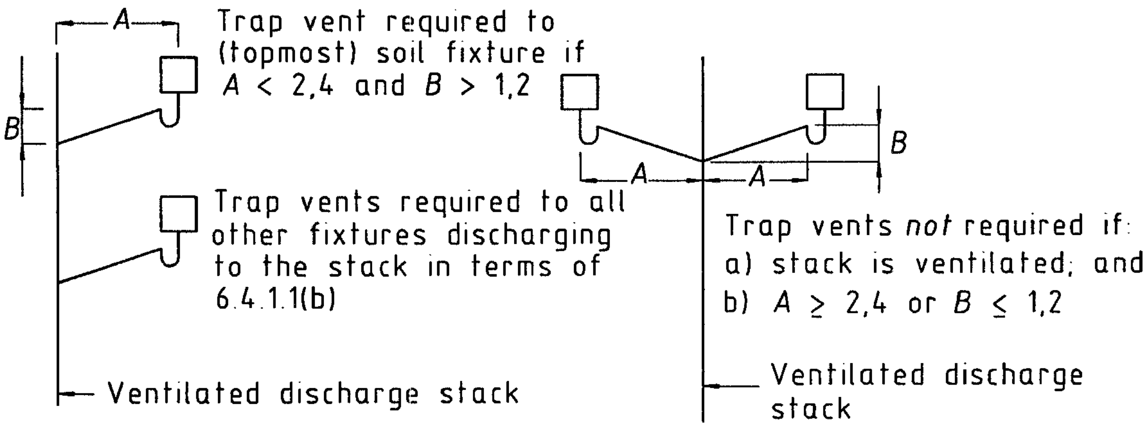
Commentary

1) A typical trap vent valve is illustrated in figure 21.

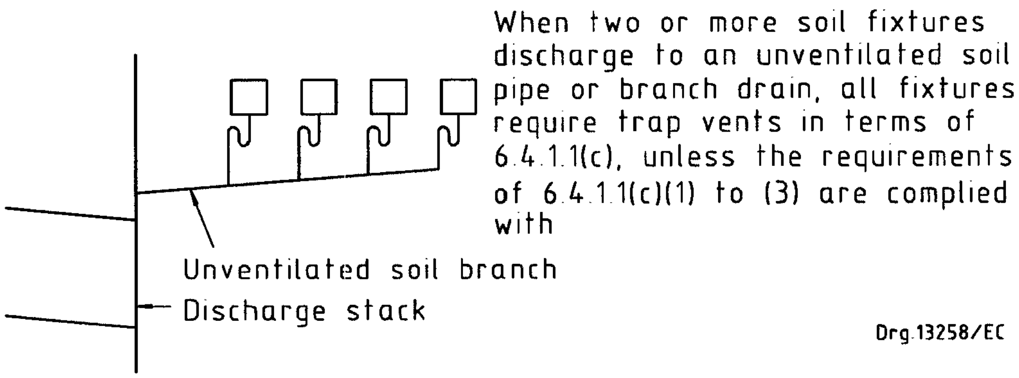
2) The various discharge pipes and ventilation pipes are illustrated in figure 22.



a) Single soil fixtures

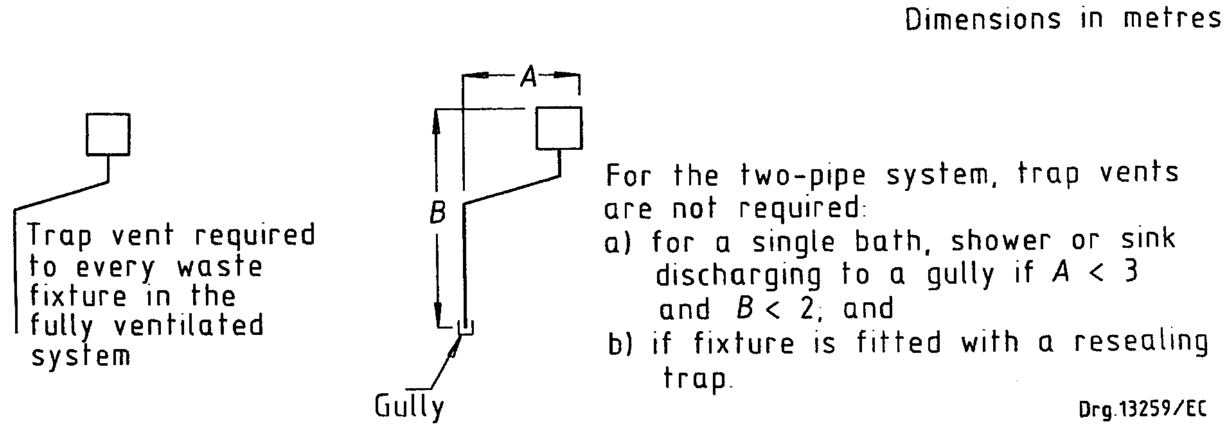


b) Two or more soil fixtures discharging to a stack



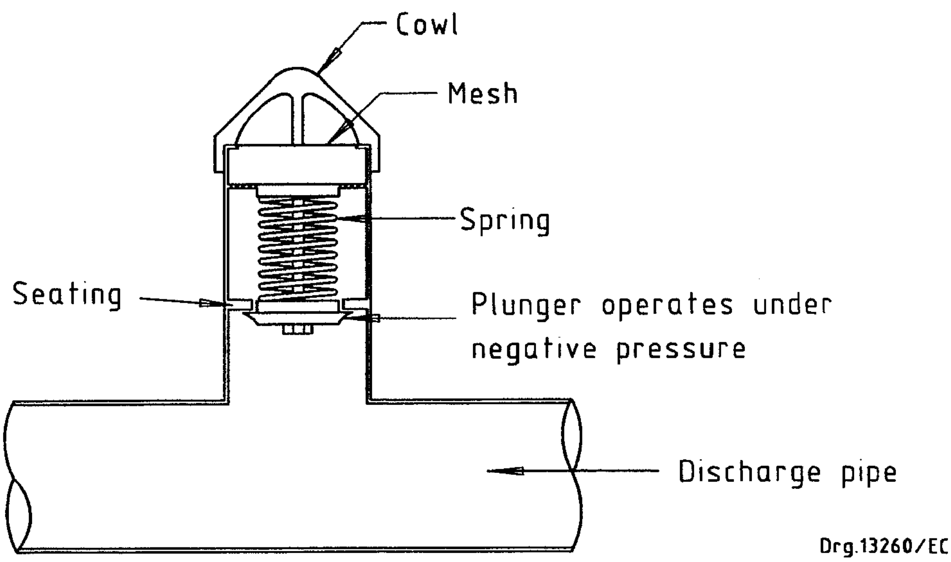
c) Two or more soil fixtures discharging to an unventilated
soil pipe or unventilated branch drain

Figure 19 — Provision of trap vents to soil fixtures



a) General rule b) Exceptions applicable only to the two-pipe system

Figure 20 — Provision of trap vents to waste fixtures



NOTE - See 6.7.5.7 for the installation of trap vent valves.

Figure 21 — Typical trap vent valve for a waste fixture or urinal

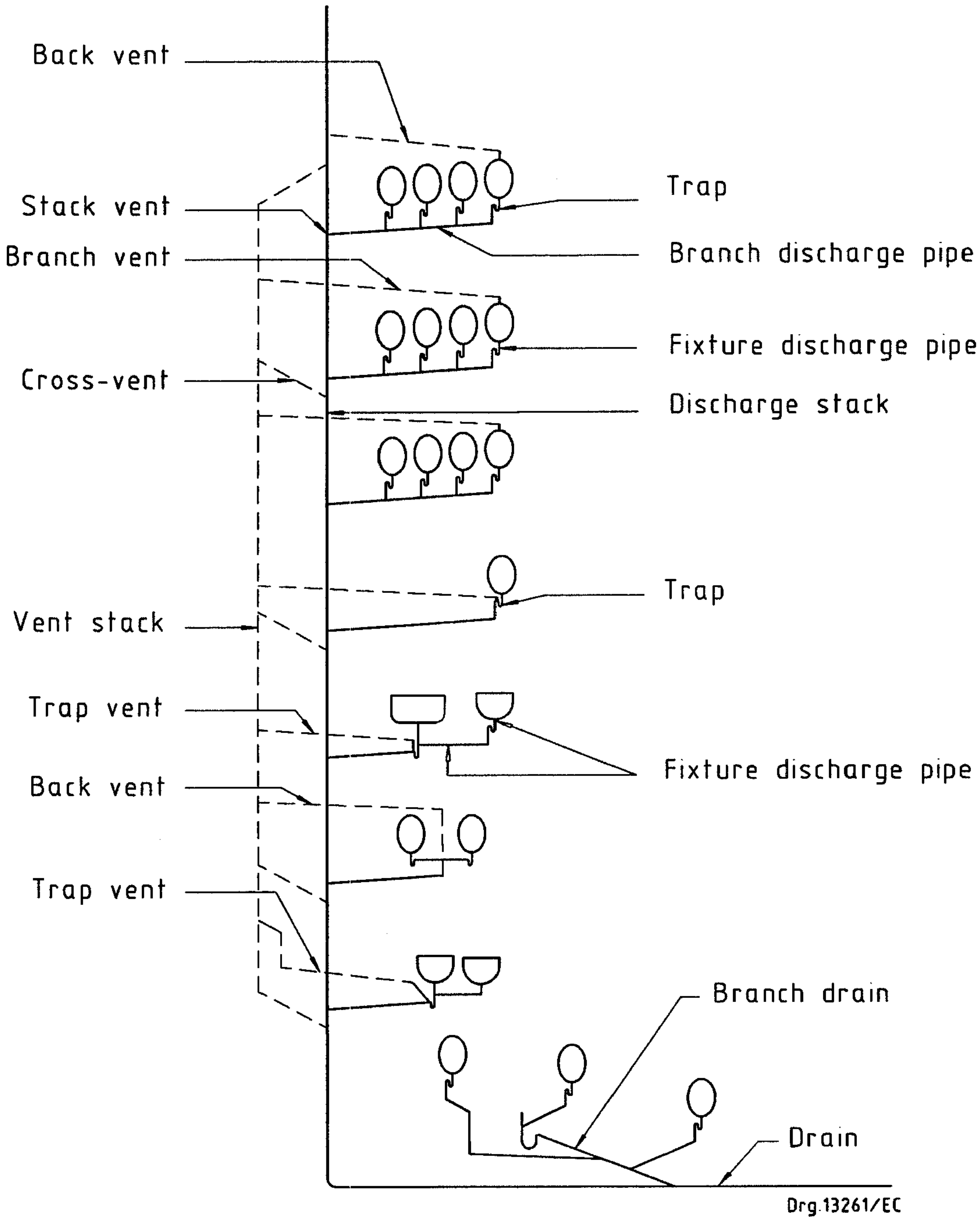


Figure 22 — Discharge pipes and ventilation pipes

6.4.2 Provision of ventilation pipes

6.4.2.1 A ventilation pipe shall be provided

a) at a point not more than 6 m from

   1) the head of the main drain,

   2) the head of any branch drain (but a ventilation pipe shall not be required for any branch drain where the length, measured along such branch drain from its head to the point of connection to any ventilated drain or to any ventilated discharge stack, does not exceed 6 m),

   3) the outlet of the trap of a sanitary fixture that discharges to any branch discharge pipe (but a ventilation pipe shall not be required where the length, measured along such branch discharge pipe from the outlet of the trap of the sanitary fixture to the point of connection to a ventilated discharge stack, does not exceed 6 m), and

   4) the outlet of the trap of a sanitary fixture that discharges to any fixture discharge pipe (but such ventilation pipe shall not be required

      i) where the length, measured along such fixture discharge pipe from the outlet of the trap of the sanitary fixture to its point of connection to a ventilated drain or to a ventilated discharge stack, does not exceed 6 m, or

      ii) in the case of waste fixtures, where the length, measured along such waste fixture discharge pipe from the outlet of the trap of the waste fixture to its point of connection to a ventilated drain or to a ventilated discharge stack does not exceed 10 m, and, where the minimum diameter of a waste fixture discharge pipe as contemplated in column 1 of table 14, is increased by one nominal pipe size), and

b) for any stub stack, where

   1) the outlet of any WC trap that discharges to such stack is more than 1,5 m above the invert of the bend at the base of such stack,

   2) the outlet of any sanitary fixture trap, other than a WC trap that discharges to such stack, is more than 2 m above the invert of the bend at the base of such stack,

   3) the stack serves more than one group of sanitary fixtures, or

   4) the stack serves any common branch discharge pipe to which a range or ranges of sanitary fixtures are connected.

Commentary

1) All discharge stacks (other than stub stacks) on the single-stack system have to be ventilated (see 6.2.3.1(f)).

2) The types of ventilation pipes are illustrated in figure 23 and the provisions of 6.4.2.1 in figure 24.

3) The provision of 6.4.2.1(a)(4) reduces the flow velocity in the drain and could result in deposits in the pipe. For maintenance purposes, it can be more advantageous to provide a vent pipe instead of increasing the nominal pipe diameter.

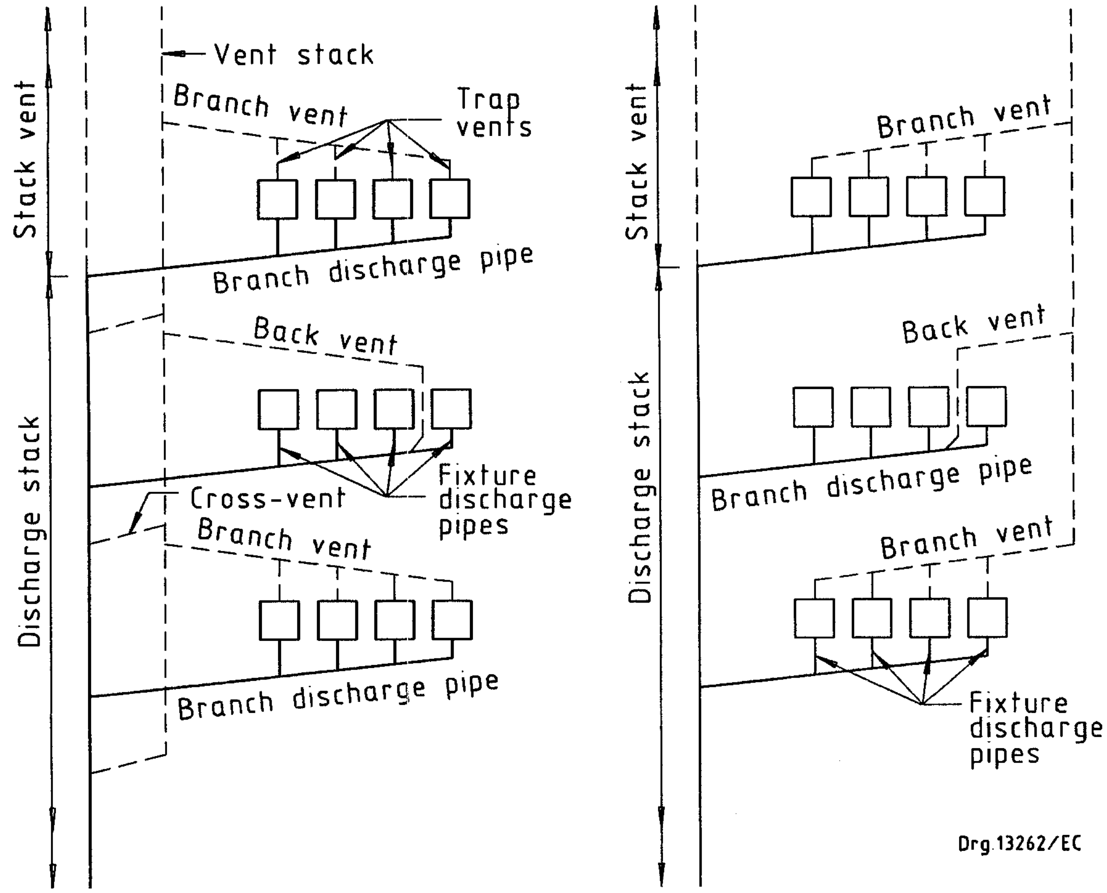


Figure 23 — Types of ventilation pipes

6.4.2.2 When deemed acceptable, an approved pipe vent valve or valves may be used to provide controlled ventilation to supplement, or, in some circumstances, to replace any ventilation pipe required in terms of 6.4.2.1, subject to the following:

a) any drainage installation shall be provided with at least one open ventilation pipe, preferably at the head of the main drain, in accordance with 6.4.2.1(a)(1) and 6.7.5.6;

b) any pipe vent valve that provides pressure relief shall not be installed inside any habitable building space, or in any other space where foul air could cause discomfort or danger to health as a result of the operation of such valve;

c) any pipe vent valve shall be able to handle the flow of air that is required to prevent unacceptable pressure fluctuations in the drainage installation; and

d) any ventilation pipe that requires pressure relief shall be fitted with a pipe vent valve or valves that can provide both pressure relief and vacuum relief.

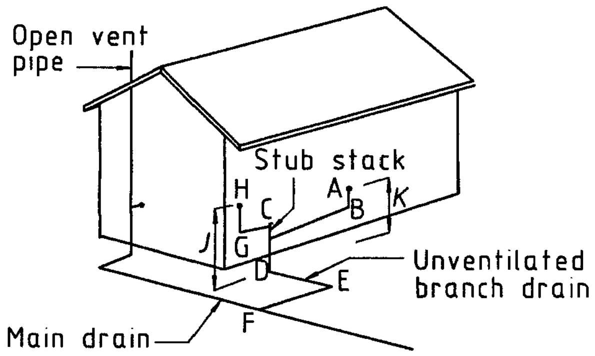
Commentary

1) Any pipe vent valve that provides pressure relief can release foul air from the drainage installation and careful consideration should therefore be given to its positioning.

2) Discharge pipes that may be surcharged normally require both vacuum relief and pressure relief.

3) See 6.7.5.8 for particulars on the installation of pipe vent valves.

Dimensions in metres

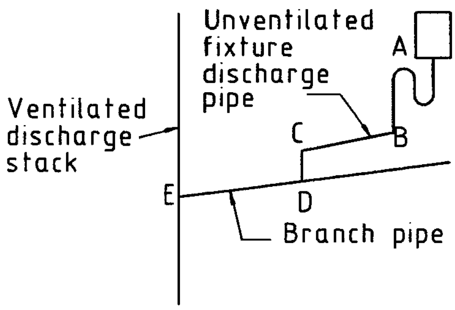


Ventilation pipe not required within:

a) 6,0 of point C if length CDEF < 6,0;
b) within 6 of point A if length ABCDEF < 6;
c) within 6 of point H if length HGCDEF < 6; or 10 if 6.4.2.1(a)(4) applies;
d) C if height *K* < 1,5; and
e) C if height *J* < 2,0.

A = soil fixture
H = waste fixture

a) Venting of drains and branch drains

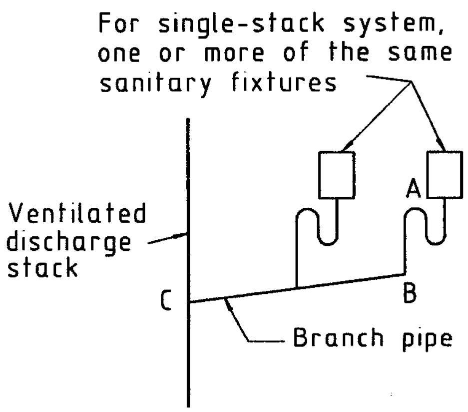


For a ventilated branch pipe, ventilation pipe not required within 6 of point A if length ABCD < 6
For an unventilated branch pipe, ventilation pipe not required within:

a) 6 of point A if length ABCDE < 6; or
b) 10 of point A if length ABCDE < 10 when 6.4.2.1(a)(4)(bb) applies to a waste fixture.

Note - Trap vents may be required.

b) Venting of waste fixtures



Ventilation pipe not required within 6 of point A if length ABC < 6

Note - Trap vents may be required.

Drg.13263/EC

c) Venting of soil fixtures

Figure 24 — Provision of ventilation pipes

6.4.3 Sizing of ventilation pipes

6.4.3.1 The developed length (see 3.1.17) of any

a) branch vent shall be measured between the point of its connection to a vent stack or stack vent and the furthest trap vent connected to such branch vent,

b) back vent shall be measured between the point of its connection to a vent stack or stack vent and the furthest point of its connection to any discharge pipe, and

c) vent stack shall be measured between its open end or, where the vent stack is connected to a stack vent, between the greater of the open end of the stack vent and the furthest point of connection to any discharge pipe.

6.4.3.2 The following provisions shall apply with regard to the sizing of any ventilation pipe:

a) any drain or branch drain or any part thereof that carries a hydraulic load not exceeding 50 fixture units shall, when venting is required in terms of 6.4.2, be vented with a ventilation pipe that has a nominal diameter of at least 40 mm;

b) the nominal diameter of any ventilation pipe shall be at least that given in table 16 for the relevant developed length of the pipe and the sum of the fixture units derived from any sanitary fixtures whose traps are ventilated, either direct or indirect, by such ventilation pipe;

c) the nominal diameter of any stack vent shall be at least that of the discharge stack to which it is connected. However, the nominal diameter of any stack vent connected to the following types of discharge stacks may be less than that of the discharge stack, but not less than 40 mm:

   1) a stub stack, where a stack vent is required; and

   2) a discharge stack of up to 2 storeys in height, that serves a maximum of two groups of sanitary fixtures; and

d) where any stack vent is connected to the top of any discharge stack, such connection shall be at a point at least 150 mm above the flood level of the highest positioned sanitary fixture in the drainage installation that discharges to such discharge stack. The nominal diameter of the stack vent shall be the greater of at least that of the discharge stack, or at least that required in terms of (c) above.

Commentary

The connection of a stack vent to a discharge stack is illustrated is figure 25.

Table 16 — Minimum nominal diameter of ventilation pipes

1	2	3	4	5	6	7	8	9	10	11	12	13
Maximum number of fixture units served	**Minimum nominal diameter of ventilation pipe** mm											
	32	**40 (OD)**	**40**	**50 (OD)**	**50**	**65**	**75 (OD)**	**75**	**110 (OD) 100**	**125**	**160 (OD) 150**	**200**
	Maximum developed length of ventilation pipe m											
2	*											
6		*										
16		9	30	51								
48			9	30	51							
84			5	9	21	51	75					
128				7	15	36	60	90				
190				5	7	27	51	75				
1 000						7	18	24	96			
2 200						5	9	15	57	177		
3 800							5	7	27	75	195	
7 200									7	21	57	222

* Minimum vent size, unlimited length

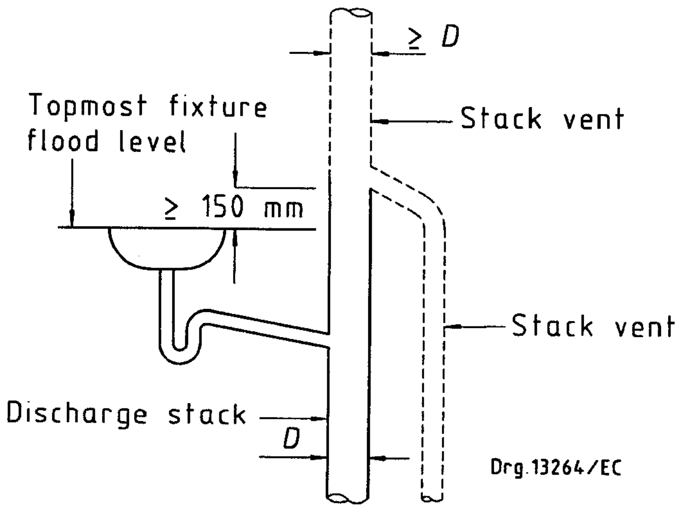


Figure 25 — Connection of a stack vent to a discharge stack

6.5 Access

Commentary

One of the principle requirements for drains is the avoidance of blockage. However, any gravity drainage system can block, particularly if unsuitable materials are discharged into the pipework. Blockages are not only inconvenient and a health hazard, but are also expensive because of the high labour costs for removal. Some form of access into the drain is therefore essential. Such access should be so designed and installed that it provides for easy and quick clearance of the blockage, with the minimum hazard to health.

6.5.1 Provision of access

6.5.1.1 Any drainage installation shall, subject to the provisions of 6.5.2, permit ready and adequate access to the interior of any pipe in the installation, for the purposes of inspection, testing or internal cleaning, as the case may be.

Commentary

In order to be deemed adequate, any access opening should be of such size, shape and position as to permit ready access for the purposes of inspecting, testing and cleaning.

6.5.1.2 Permanent access shall be provided for cleaning purposes to the interior of any

a) discharge pipe where such pipe enters the ground, and within 2 m above ground level, and

b) part of a drainage installation that passes under a building. Such access shall be provided outside of, and as near as possible to, the building at each point of entry to, and exit from, the building. Unless otherwise approved, no means of access shall be provided from within the building.

6.5.1.3 A rodding eye shall be installed

a) where there is a change of direction in any drain, that exceeds 45°. The rodding eye may be omitted where the change of direction is made by using a large-radius bend and if not more than two such changes of direction of up to 90° each take place between any two rodding eyes required in terms of (b), (c), (d) and (e) below,

b) at a point within 1,5 m of the connection of any drain to a connecting sewer, common drain or to a means of sewage disposal situated on the site, and an inspection eye shall be installed immediately downstream of such point,

c) at such intervals along any drain that no rodding distance between points of permanent access (such as manholes, inspection chambers and rodding eyes), when measured along the line of such drain, is more than the distances given in table 17,

d) on all stub stacks in a closed drainage system, directly above the highest branch connection to such stub stack, and

e) at the highest point of any drain that is not connected at that point to a stub stack or to a roddable overflow gully.

Table 17 — Maximum spacing of access points

1	2		3	4	5
From	**Maximum spacing** m				
	To				
	Access fitting		**Junction or branch**	**Inspection chamber**	**Manhole**
	No. 1	**No. 2**			
Start of external drain[1)]	12	12	-	25	45
Rodding eye	25	25	25	45	45
Access fitting No. 1: Min. 150 mm x 100 mm or 100 mm diameter	-	12	12	25	25
Access fitting No. 2: Min. 225 mm x 100 mm	12	-	25	45	45
Inspection chamber	25	45	25	45	45
Manhole	25	45	45	45	90

1) Connection from ground floor fixture or outlet from discharge stack.

6.5.1.4 Access to any drain as contemplated in 6.5.1.3 may, subject to the provisions of 6.5.2.6, be provided by the installation of an inspection chamber or a manhole.

6.5.2 Access requirements

6.5.2.1 Where any drain or discharge pipe passes through or under a room that is used for the preparation, handling, storage or sale of food, any means of access to such drain or discharge pipe for cleaning purposes shall be situated outside such room. This provision does not apply in the case of a waste pipe that serves any waste fixture contained in such room.

6.5.2.2 Any rodding eye shall

a) join the drain in the direction of flow at an angle of not more than 45°, continue up to ground level and, where inclined, be adequately supported, and

b) be adequately marked and protected.

Commentary

1) *For installations in a closed-drainage system, a conventional 45° rodding eye at ground level may be used, but this should preferably be placed against a wall as in the case of a stub stack (see figure 26).*

2) *A distinction should be made between rodding eyes that are supported in floor slabs and are subject to light pedestrian traffic (see figure 27(a)) and those that are installed in the open and are subject to heavy vehicle loads (see figure 27(b)). In the latter case, the rodding eyes should be terminated below ground in a protective chamber with its own load-bearing cover.*

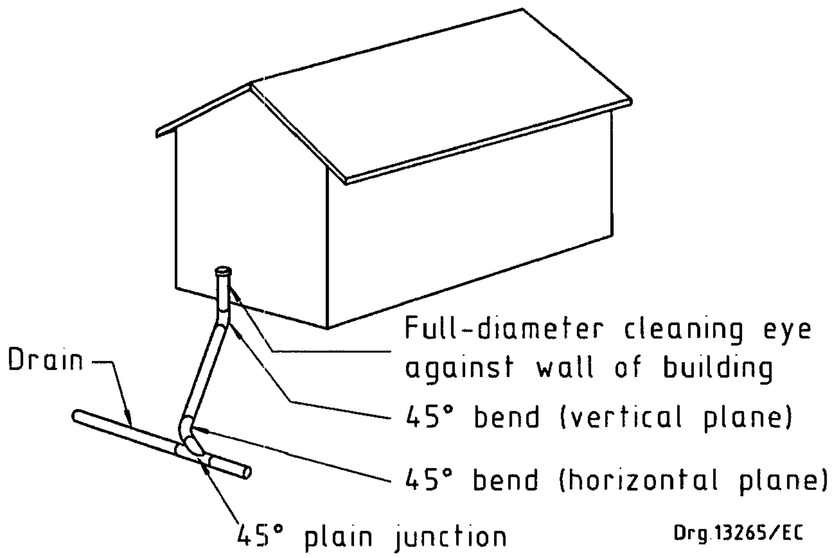


Figure 26 — Intermediate cleaning eye in a closed-drainage system

6.5.2.3 When any access is to be deemed to be permanent, such access shall

a) be lasting after the completion of the drainage installation,

b) when gained, cause no lasting damage to any component or fitting in the installation, and

c) be easily restorable to its former state, by means of reinstalling the same components that were removed to gain such access.

6.5.2.4 Where any permanent access provided is covered by paving or ground, such access shall be covered by an adequate and appropriately marked removable device.

6.5.2.5 Any means of access provided to any drainage installation, other than a manhole or inspection chamber, shall

a) be so designed and constructed that it will sustain any normal load that could be imposed upon it, without transferring this load to the pipework connected to it,

b) be so sealed as to remain effective under any working conditions and exclude the ingress or egress of water, and

c) when within any building, be so designed and constructed as to seal airtight and remain watertight when subjected to an internal water pressure of up to 50 kPa.

Commentary

When appropriate, any access opening should be covered by an adequately screwed or bolted airtight removable cover.

6.5.2.6 Any manhole or inspection chamber shall be

a) located in an open-air space,

b) so constructed and covered as to prevent the ingress of water, and

c) of sufficient strength to sustain any load that may normally be imposed upon it.

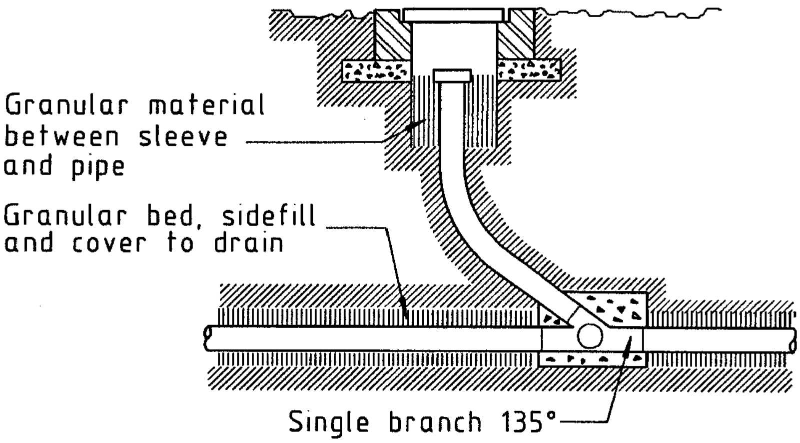
6.5.2.7 Any rodding eye, access fitting, inspection chamber and manhole shall have minimum plan dimensions in accordance with table 18.

Commentary

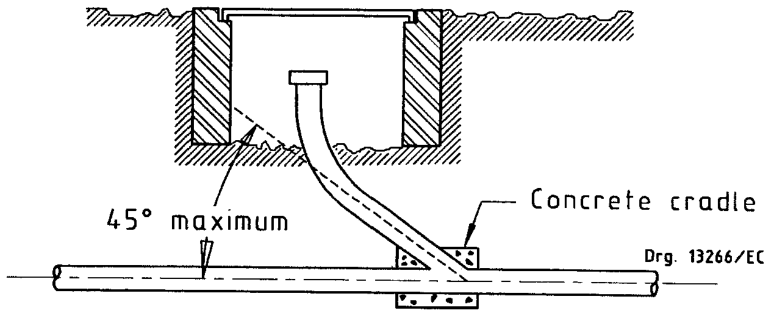
1) *The requirement that any manhole or inspection chamber be located in an open-air space should not be taken to preclude location under the roof of a carport or any similar well ventilated area outside the building.*

2) *The construction of inspection chambers or manholes requires a high degree of skill and is relatively expensive. However, manufacturers of sanitary pipes and appliances have developed factory-made manholes and other alternative forms of access that can be easily installed.*

3) *Inspection chambers or manholes should not be installed in a closed-drainage installation, since this will undermine the underlying principle of reducing the possibility of foreign substances from penetrating the piping.*



a) Rodding eye only subjected to light pedestrian traffic



b) Rodding eye installed in the open and subject to vehicle loads

Figure 27 — Rodding eyes

Table 18 — Minimum dimensions for rodding eyes, access fittings, inspection chambers and manholes

Dimensions in millimetres

1	2	3	4	5	6
Type of access	**Minimum dimensions**				
	Recommended max. depth to invert of drain	**Internal dimensions**		**Nominal cover size**	
		Rectangular length x width	**Circular diameter**	**Rectangular length x width**	**Circular diameter**
Rodding eye		Preferably same size as drain, but not less than 100 mm diameter			
Access fitting	600 except when situated in a chamber	150 x 100 or 225 x 100	150 –	150 x 100 335 x 100	150 –
Inspection chamber	1 000	450 x 450	450	450 x 450	450
Manhole		1 200 x 750	1 050	600 x 600	600

6.6 Fixture traps, floor drains and gullies

6.6.1 Fixture traps

6.6.1.1 Any sanitary fixture shall be provided with a self-cleaning trap integral with, or immediately at, its outlet, except where such fixture is a bath, wash-hand basin or shower that discharges into

a) an open channel that

1) is made of impervious material,

2) has a semi-circular cross-section of diameter at least 100 mm,

3) is accessible for cleaning throughout its length, and

4) is fixed immediately beneath the point of discharge, or

b) a gully, or

c) an open channel that serves a urinal, where the bath, wash-hand basin or shower is installed in the same room as the urinal.

6.6.1.2 Any trap that is integral with a sanitary fixture shall

a) be so constructed that no change from one cross-section to another obstructs the passage of solids, and

b) have a smooth waterway.

6.6.1.3 Any trap that is not integral with a sanitary fixture shall

a) have an outlet diameter that is at least that of its inlet,

b) have a clearance of at least 8 mm at all points for traps that have a nominal diameter not exceeding 32 mm, and 10 mm for traps that have a nominal diameter exceeding 32 mm,

c) be made of non-absorbent and corrosion-resistant material,

d) be so constructed that it has a smooth waterway, and

e) have a means of access for cleaning, preferably at its lowest point. This provision does not apply where the trap is made of rubber or other similar material.

Commentary

The provision of traps that can be readily removed and dismantled for the purposes of inspection, cleaning and maintenance can be advantageous.

6.6.1.4 The minimum nominal diameter of a trap that is connected to, or serves, any sanitary fixture and the minimum depth of its water seal shall be in accordance with the values given in table 19 for the relevant fixture and installation, provided that the maximum depth of the water seal contained in any trap is 100 mm.

6.6.1.5 Where any trap that serves any WC pan is provided with a vent horn, the nominal diameter of such horn shall be at least 40 mm and it shall be located at the side of, and at least 75 mm from, the crown of such trap on its outlet side.

Commentary

1) Bottle traps (see figure 28(a)): the division between the inlet and outlet legs in this type of trap can be formed by a dip tube or vane within the body of the trap. The lower part of the bottle trap can normally be removed to gain access. This type of trap should be so designed that there is no reduction in the flow area through the trap. Bottle traps are often used in conjunction with wash-hand basins where the trap is exposed, or where there may be difficulty in fitting a tubular trap.

2) Resealing traps (see figure 28(b)): these are specially designed traps for unventilated small size discharge pipes that are fitted to fixtures where, because of the arrangement of the pipework, siphonage would otherwise occur.

3) Tubular traps: these traps have a uniform cross-sectional area throughout. Examples are the "P" trap illustrated in figure 28(c) and the "S" trap illustrated in figure 28(d).

6.6.2 Floor drains

Commentary

1) A floor drain is regarded as a fixture trap and should be distinguished from a gully.

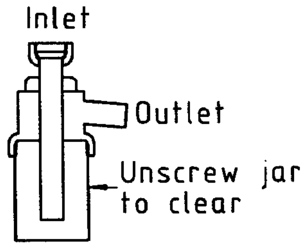
2) A floor drain that is located inside a building is usually connected to a waste branch of nominal diameter at least 75 mm, that discharges into a gully.

3) Trapped floor drains should preferably be provided.

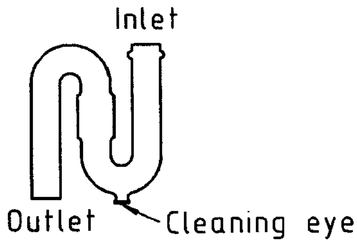
Table 19 — Minimum diameter and water seal depths of traps

1	2	3	4	5
Type of trap	**Type of sanitary fixture**1)	**Type of installation**	**Minimum nominal diameter** mm	**Minimum depth of water seal** mm
Integral	WC pan, hospital fixture	All	100	50
	Wall-mounted urinal		50	50
Non-integral	Bidet, drinking fountain, wash-hand basin, wall-mounted urinal	Two-pipe system or One-pipe system	32	40
		Single-stack system	32	75
	Bath, shower, sink (hospital, kitchen or laboratory type), laundry trough, clothes washing machine, dish-washing machine, food-waste disposal unit (all of the domestic type), sanitary-towel disposer	Two-pipe system	40	40
		One-pipe system	40	65
		Single-stack system	40	75
	Clothes washing machine, dish-washing machine, food-waste disposal unit, floor drain (all of the commercial type)	All	50	75
	Urinal of slab or stall type up to 3 units or 1,8 m in length	All	50	50
	Urinal of slab or stall type (all other), gully	All	75	50

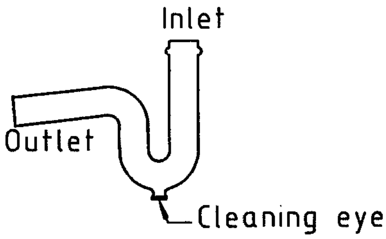
1) Commercial electrical sanitary fixtures can have throughlet traps of nominal diameter 40 mm and up to 80 mm.



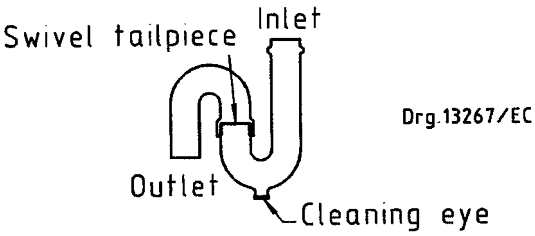
a) Bottle trap



b) Resealing rubber trap



c) Typical "P" trap



d) Typical "S" trap

Figure 28 — Trap types

6.6.2.1 Any floor that is served by a floor drain as a waste-water outlet, shall, subject to the provisions of 4.3.2(b), slope at a gradient of at least 1 in 200 from all sides towards such floor drain.

6.6.2.2 Any floor drain shall

a) be provided with a removable grating, the open area of which shall be at least two-thirds of the area of the waste pipe into which the floor drain discharges,

b) be so located that it is accessible for maintenance and cleaning,

c) be made of non-absorbent and corrosion-resistant material, and

d) if it is a trapped floor drain,

   1) be provided with a trap in accordance with the provisions of 6.6.1.4 and 6.6.1.5,

   2) have its water seal maintained by means of

      i) a tap situated above it, or

      ii) a waste fixture that discharges into the floor drain at a point above the surface of the water seal. Where the floor drain is located inside a building, the waste fixture shall be located in the same room as the floor drain.

6.6.3 Gullies

Commentary

Gullies may be installed to provide relief in the event of sewage discharge (overflow relief gully) or to provide a disconnection between any waste discharge pipe and a drain (disconnector gully).

6.6.3.1 Any drainage installation shall be provided with an overflow device or a gully, to provide overflow relief in the event of sewage discharge. The overflow level of such overflow device or gully shall be at least 100 mm below

a) the lip of the lowest trap in such installation (This provision shall not apply to a trap that serves any sanitary fixture where the discharge from such sanitary fixture is raised to at least 150 mm above the overflow level of such overflow device or gully.), and

b) the overflow level of any floor drain.

Commentary

1) Although 6.6.3.1 calls for the installation of one gully, this does not preclude more gullies from being fitted, should they be required.

2) For a closed-drainage system, house installations other than extended installations should preferably include no more than one overflow gully, of diameter 100 mm (preferably at the lowest stub stack in the installation).

3) An overflow gully connected to a stub stack in a closed-drainage system is illustrated in figure 29.

6.6.3.2 Any overflow device or gully shall be

a) situated outside a building, or in a place that is permanently open to the outside air,

b) so situated that any overflow discharge does not have any detrimental effects, and

c) so located that it is accessible for cleaning and maintenance purposes.

6.6.3.3 Any gully head

a) shall consist of an overflow fitting covered with a removable cover that fits over the gully head, to prevent the direct ingress of foreign matter from above, or that has a hopper covered with a removable grating set in the gully head. Any such overflow fitting or grating set in the gully head shall provide an effective open area of size at least that of the cross-sectional area of the trap of the gully, and the spaces between the bars of any such grating shall be not less than 10 mm and not more than 12 mm, and

b) if of vitrified clay or plastics material, shall be protected from damage at ground level by means of a concrete surround of at least 100 mm and of thickness at least 100 mm below ground level. If the gully head is dished, the overflow level of the dish shall be at least 75 mm above the level of the grating of the gully.

6.6.3.4 The overflow level of any overflow device or gully shall be at least

a) 50 mm below floor level, and

b) 100 mm above the surrounding ground, or

c) 50 mm above any permanent surrounding paving, which shall be such as to ensure drainage away from such overflow device or gully.

6.6.3.5 The following provisions shall apply with regard to the trap of any overflow device or gully:

a) the minimum nominal diameter of the trap of an overflow device or gully, and the minimum depth of its water seal, shall be in accordance with 6.6.1.4;

b) the surface level of the water seal shall not exceed 450 mm below the head of the overflow device or gully. If compliance with this provision is impracticable, the trap of any gully shall be located in a manhole with walls of height at least 100 mm above the surrounding ground, and the access to such manhole shall be covered with a metal grating of sufficient strength to sustain any load that normally may be imposed upon it;

c) any overflow device or gully shall have its water seal maintained by means of

   1) a tap situated above it, or

   2) at least one waste fixture that discharges into such overflow device or gully at a point above the surface of such water seal, but not more than 80 mm above the level of any grating. Unless otherwise approved, no more than four individual waste discharge pipes shall discharge into any one gully; and

d) any waste discharge pipe that discharges direct into an overflow device or gully shall discharge in such a manner as not to cause any overflow of waste water.

Commentary

Typical gullies are illustrated in figure 30.

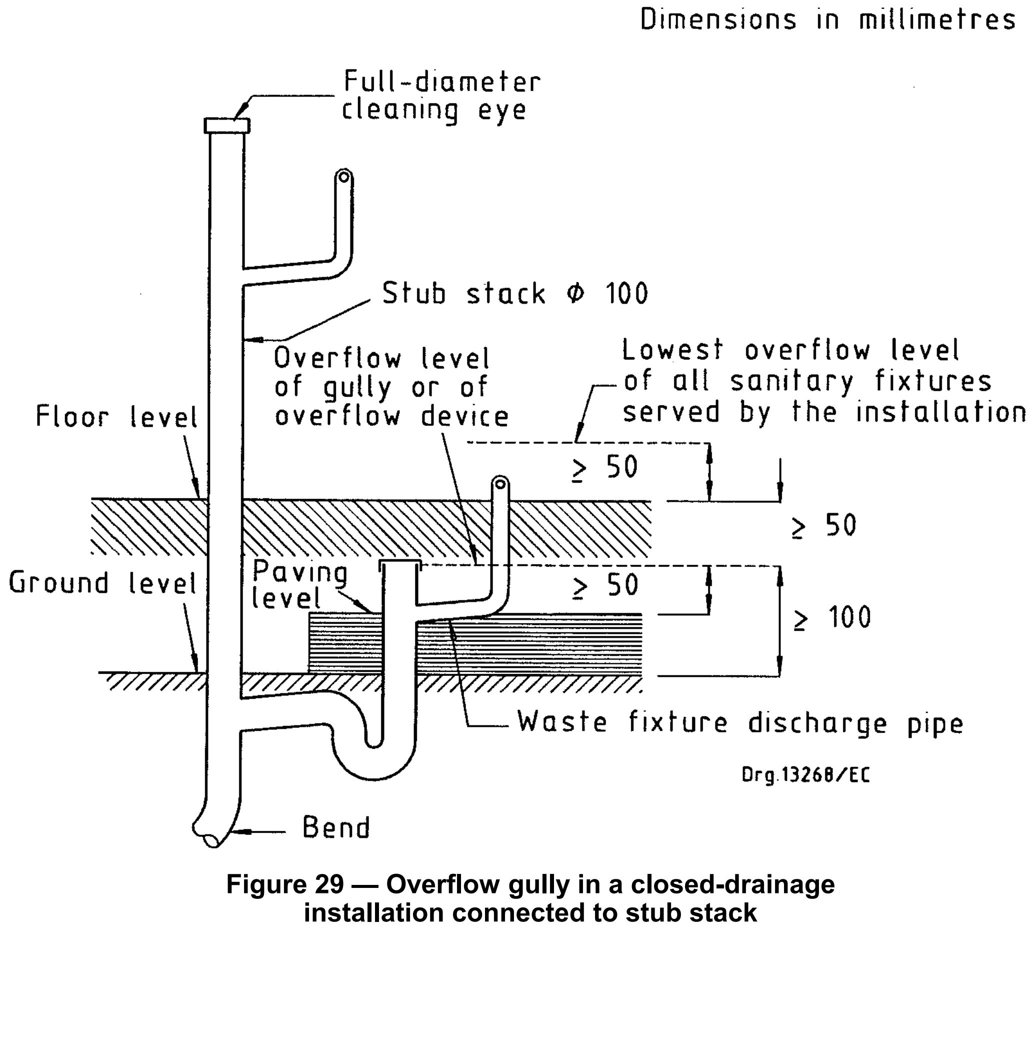


Figure 29 — Overflow gully in a closed-drainage installation connected to stub stack

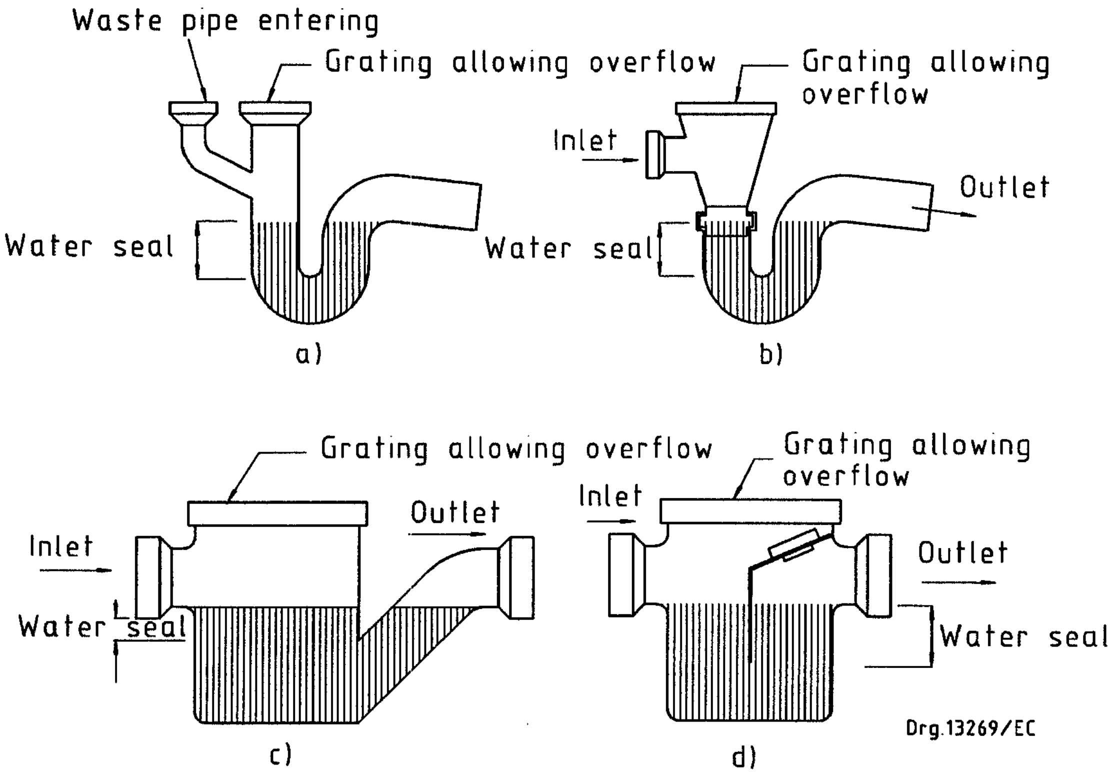


Figure 30 — Typical gully traps

6.7 Installation

6.7.1 General

6.7.1.1 Every care shall be taken during construction to protect any drainage installation work and to prevent the entry of foreign matter into any part of the installation. Pipework shall not be allowed to carry any external load either during or after construction.

6.7.1.2 Any access that is provided to the inside of a drainage installation shall be adequately sealed at the time of installation, to prevent the entry of foreign matter into any part of the installation. The access shall be finally fixed and sealed after testing.

6.7.1.3 Sanitary fixtures, pipes and components shall be handled carefully to reduce damage. The following shall be considered:

a) where necessary, products shall be protected from impact when they are used in exposed positions, and care shall be exercised when connections are made to brittle products; and

b) special care shall be taken with pipe systems with ring seal joints, to ensure that deflection of joints does not occur after the pipework has been assembled.

Commentary

The manufacturers' advice should be followed as to the loading, transportation, unloading and storage of their products.

6.7.1.4 Polyethylene and uPVC pipes shall be installed in accordance with the relevant requirements of SABS 0112.

6.7.2 Jointing of pipework and fittings

6.7.2.1 The following provisions shall apply in general for jointing operations:

a) any jointing operation shall be performed in such a way as not to disturb the gradient of the line;

b) pipes shall be joined to one another in such a way that the

   1) continuity of the bore is maintained, and

   2) flow in the interior of the drain is not obstructed;

c) pipes and fittings to be jointed shall be internally clean, therefore

   1) no jointing material shall project inside the bore of the pipes, fixtures or components,

   2) burrs shall be removed from the ends of pipes, fixtures or components, and

   3) measures shall be taken to prevent jointing materials from entering the bore of pipes, fixtures or components;

d) all proprietary joints shall be made in accordance with the manufacturer's instructions. Joints between pipes, or between pipes and fittings, shall

   1) be appropriate for the materials from which such pipes and fittings are made,

   2) under normal working conditions, remain watertight to the standard set in 6.8.2, and

   3) be able to withstand, without leaking, an internal water pressure of 50 kPa and an external water pressure of 30 kPa;

e) any joint shall withstand the penetration of roots and shall not deteriorate when in contact with sewage or water;

f) in the assembly of sanitary pipework, provision shall be made to accommodate any thermal or differential movement between the pipes and any building or ground, or other construction, that form part of the drainage installation; and

g) joints shall accommodate any pipe movement that takes place throughout the expected life of the drainage installation.

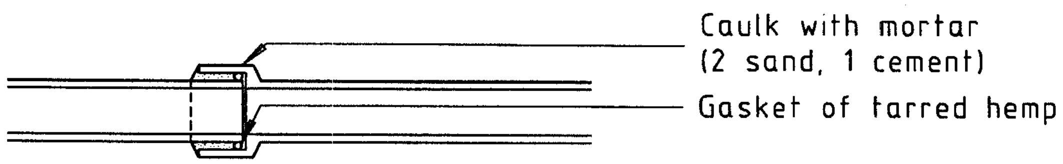
Commentary

1) It is particularly important to accommodate and control movement in the case of pipes made of plastics or copper.

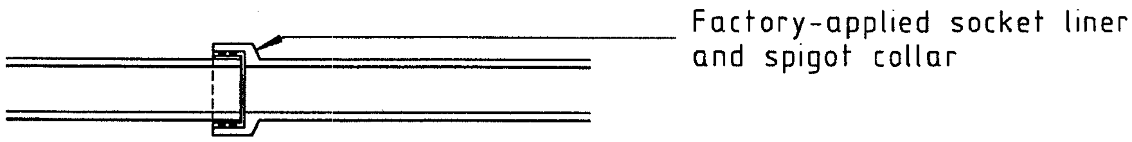
2) Flexible joints are generally available for the range of materials used for drains and they can accommodate angular deflection, axial displacement and draw within the joint. They are designed to resist shear loads without loss of watertightness.

3) The range of materials used for sanitary pipework and fittings requires many different jointing methods and the methods of jointing will vary with the type of pipe materials, the sizes of the pipes and whether spigot or socket ends are to be connected. Manufacturers' recommendations should be followed in this regard. Annex A.4 contains some information for general guidance.

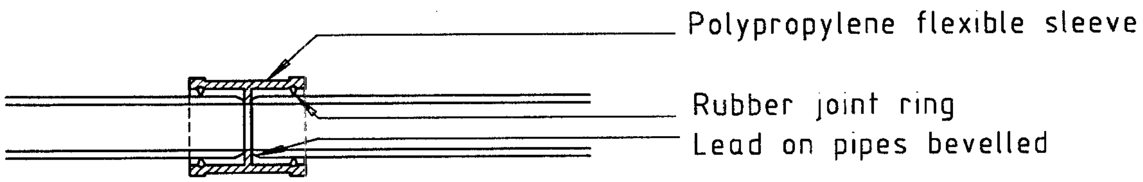
4) Examples of jointing methods are illustrated in figure 31.



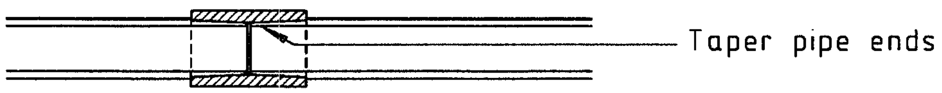
a) Cement mortar caulked joint



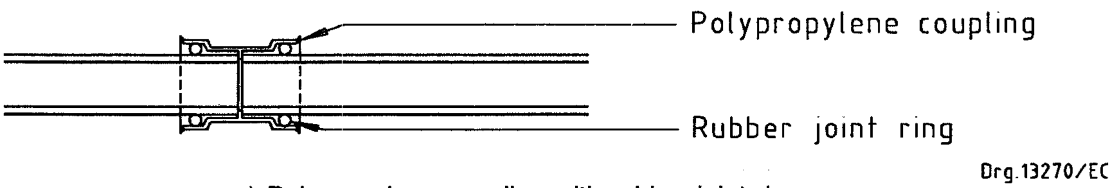
b) Flexible push-fit joint



c) Plain-ended pipes with flexible coupling



d) Tapered collar "knock-on" coupling



e) Polypropylene coupling with rubber joint rings

Figure 31 — Examples of jointing methods

6.7.2.2 Joints between cast iron pipes and fittings shall be

a) spigot and socket types caulked with molten lead, fibrous lead yarn or cold caulking compounds, or

b) spigot and socket types with rubber joint rings, or

c) flanges cast integrally with the pipes and fittings, coupled with galvanized steel or copper-alloy bolts and nuts, and fitted with suitable gaskets, or

d) in the case of pipes without sockets, by means of suitable couplings such as

1) cast iron clamp and rubber set, or

2) stainless steel or other corrosion-resistant shield with rubber gasket, or

e) as otherwise approved.

6.7.2.3 Unless otherwise approved, joints between

a) any copper tubes or between any copper tube and fitting shall be

1) of the compression fitting type (manipulative or non-manipulative),

2) capillary-type joints, or

3) bronze welded or silver brazed, and

b) heavy gauge copper pipes or between such pipes and fittings shall be

1) screwed joints,

2) bronze welded or silver brazed, or

3) copper flange joints coupled by gunmetal or extruded brass bolts and nuts.

Commentary

Follow the manufacturer's instructions scrupulously, particularly as regards the grade of solder to be used for capillary fittings.

6.7.2.4 Galvanized steel pipes shall not be welded or brazed unless galvanizing is done afterwards. Joints between galvanized steel pipes and between galvanized steel pipes and fittings shall be

a) screwed joints, provided that after jointing, exposed threads are suitably protected against corrosion,

b) flanged joints, or

c) as approved.

Commentary

Exposed threads may be painted, or, where the pipes are installed underground, thickly coated with bituminous paint or other suitable paint to prevent corrosion.

6.7.2.5 Lead pipes joints shall either be lead-welded, or wiped joints using plumbers' solder.

6.7.2.6 In the case of the jointing of unplasticized polyvinyl chloride (uPVC) pipes, the following shall apply:

a) the solvent cement to be used for solvent cement welded joints shall be appropriate for the composition of the piping material;

b) pipes of sizes 50 mm and greater shall be jointed by means of push-fit integral elastomeric ring seals that are compressed when the plain-ended pipes are inserted into the adjoining sockets. Pipe ends shall be

   1) chamfered when plain, and shall be cleaned and lubricated before they are inserted into the adjoining socket, and

   2) inserted either fully into the adjoining socket, except where provision is made for expansion, or as far as any locating mark drawn on the spigot end by the manufacturer; and

c) compression joints shall only be used with uPVC piping of sizes up to and including 50 mm. Such joints shall be of the non-manipulative type and shall not be over-tightened.

Commentary

1) A solvent weld system is one where a solvent weld technique is used for the majority of the joints. This normally applies to all socketed fittings used 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 may in some situations be necessary to introduce expansion joints into the pipework. The manufacturer's advice should always be closely followed for successful solvent weld jointing.

2) Mechanical joints are preferable to solvent joints in use below ground or in confined spaces, owing to the difficulty in making satisfactory solvent cement joints in such adverse conditions.

3) Various designs of joint rings are available. Joint rings from different manufacturers are generally not interchangeable and it is therefore essential that the rings used be those designed for the system concerned. A joint ring socket contains a ring seal near the mouth of each socket, which may or may not be locked in position. Sealing is achieved when the spigot of the pipe or fitting is introduced into the socket, compressing the joint ring in the annular groove or housing.

4) An alternative method of applying compression to the joint ring to provide an airtight and watertight seal is to use a coupling nut that locks the ring seal in the annular space in the socket housing. This latter design is often used for the outlet connection of traps fitted to sanitary fixtures.

6.7.2.7 Polyethylene pipes shall be jointed by

a) compression-type fittings suitable for the class of pipes being used, or

b) joint ring methods of assembly, or

c) fusion welding or butt welding, or

d) a method as otherwise approved.

Commentary

Polyethylene pipes and fittings cannot be jointed by solvent weld methods.

6.7.2.8 Pipework of plastics material other than HDPE and uPVC shall not be threaded for jointing purposes.

6.7.2.9 In the case of the jointing of fibre-cement pipes, the following shall apply:

a) joints between fibre-cement pipes shall be of the spigot and socket type with a rubber joint ring, or bolted gland, or as approved; and

b) joints between fibre-cement pipes and metal pipes shall be bolted gland, or lead caulked only when jointing fibre-cement spigots to metal sockets, or as approved.

6.7.3 Ductwork

6.7.3.1 Ducts shall be large enough to allow for the pipework to be fixed at the required gradients, without access requirements being adversely affected.

6.7.3.2 Provision shall be made for thermal movement of pipework. The ambient temperature in any duct shall be controlled where pipework is of plastics material that could be damaged by a high ambient temperature, or where the flow in any discharge pipe located in such duct is small and intermittent.

6.7.3.3 Discharge pipes shall be installed at least

a) 75 mm from a hot-water pipe if such pipe is insulated against heat transfer, and

b) 150 mm from a hot-water pipe if such pipe is not insulated against heat transfer.

Commentary

1) If the flow in a discharge pipe is small and intermittent, a high ambient temperature in the duct could result in a "dry out" of the discharge pipe between discharges. Such "dry out" can lead to a build-up of deposits in the pipe and thus bring about pipe blockage. In situations where the discharge pipe receives hot water, high ambient temperatures will inhibit heat loss through the pipe wall.

2) Special consideration should be given to movement caused by temperature changes in pipework and adequate provision should therefore be made for expansion, especially in the case of plastics, pitch-impregnated fibre and copper pipes.

6.7.3.4 Where any discharge pipe is located within any building and it is desired that such pipe be enclosed, it shall be enclosed within a duct, and

a) the duct shall either be of a size and shape that any person can readily enter it and work in it, or shall be provided with covers that can be readily removed to enable access to be gained to all junctions, bends and cleaning eyes. The removal of any component of the building for the purpose of gaining access to any pipe shall not endanger the structural stability of the building, and

b) a means shall be provided inside the duct to direct the discharge of any released liquid or matter from the area inside the duct to a point where it preferably is readily detectable, should any leak develop inside such duct. Any part of the pipe may be built into brickwork or concrete, provided that the interior of the part is rendered readily accessible for cleaning and maintenance.

Commentary

An outlet opening at the floor of the duct, for example, can be provided as a leakage detector.

6.7.4 Support and fixing of pipes

6.7.4.1 Any external pipework and fittings manufactured from materials that require protection against atmospheric corrosion shall be so fixed as to provide free access of at least 30 mm all round the pipe or fitting, for the application of paint or other protective coating.

6.7.4.2 All fixings shall be accurately aligned and properly secured to a wall or other supporting structure.

Commentary

Fixings may be built in, nailed or screwed to a wall.

6.7.4.3 The distance between pipe supports shall not exceed the distances given in table 20 and table 21, provided that

a) there is at least one pipe support bracket at each storey in vertical pipe runs,

b) in the case of horizontal pipework where the layout occasionally requires shorter lengths than the maximum specified length, support distances are adjusted to suit such shorter lengths, and

c) between any two joints, at least two pipe supports are provided on a pipe length.

6.7.4.4 Supports shall be adjacent to joints and of adequate strength to carry the mass of the pipe plus its contents.

6.7.4.5 The type of fixing used shall be appropriate to the type of material of the pipe that is being supported. Unless otherwise approved,

a) cast iron pipes shall be fixed by means of holderbats of cast iron, malleable iron or steel and stainless steel,

b) copper tubes shall be fixed by means of copper-alloy holderbats, strap clips of copper, copper-alloy or other suitable material, or purpose-made straps or hangers,

c) galvanized steel pipes shall be fixed by means of malleable iron "schoolboard" pattern brackets, malleable iron pipe rings (with either back plate plugs or girder clips), or purpose-made straps or hangers,

d) lead pipes shall be fixed by means of double or single cast lead tacks soldered (or lead-welded) to the pipe, or milled lead tacks of sheet lead, of mass at least 28 kg/m^2 for pipes of up to 50 mm in diameter, and 40 kg/m^2 for pipes from 63 mm to 100 mm in diameter,

e) the fixing of pitch-impregnated fibre pipes shall be done by means of standard holderbats, brackets, clips or straps, and

f) the fixing of plastics pipes shall be done by means of holderbats of metal, plastics-coated metal or suitable plastics material. In multistorey dwellings, vertical pipes shall be supported by metal brackets because of their greater fire resistance.

Commentary

Care should be taken to ensure that the pipe clip, when tightened, does not bite into the external surface of the pipe. Where anchor points are required to control thermal movement, the holderbats are usually fitted on the pipe sockets between special ribs. Intermediate guide brackets fitted to the pipe barrel should allow thermal movement to take place.

Table 20 — Maximum spacing of pipe supports for straight pipe lengths

1	2	3	4
Pipe material	**Pipe diameter** mm	**Maximum spacing[1] of supports** m	
		Vertical pipes	**Horizontal pipes**
Cast iron	all sizes	2,0	1,2
Copper, copper-alloy	< 32 32 to 40 > 40	2,4 3,0 3,0	1,8 2,0 2,5
Galvanized steel	< 40 40 to 65 > 65	3,0 3,7 4,6	2,4 3,0 3,8
uPVC[2]	< 50 ≥ 50	1,5 1,8	0,6 1,0

1) The maximum spacing should be confirmed with the relevant pipe manufacturer.
2) uPVC pipes intended for above-ground use, and that comply with the requirements of SABS 967.

Table 21 — Maximum spacing of supports for polyethylene pipes containing water at 20 °C

1	2	3
Nominal diameter of pipe mm	**Distance between supports[1]** m	
	Low density[2]	**High density[2]**
40 50 60	0,45 0,55 0,55	0,7 0,85 0,85
75 100 150	0,6 0,7 0,85	0,9 1,1 1,3
200 250 300	1,1 1,3 1,5	1,6 2,0 2,3

1) Details of the manner of fixing pipes and providing controlled movement will vary from one manufacturer's system to another. The pipe supports provided by the manufacturer for his particular system should always be used and the installation of the piping should be carried out strictly in accordance with his instructions. Closer supports are required for pipes that carry liquids of temperatures above 20 °C, and continuous support is necessary for pipes that carry liquids at temperatures of 40 °C and above. In the case of vertical pipes, these support distances can be doubled. Closer spacings will be necessary when liquids of higher relative density or greater hazard are to be carried by the pipe.
2) See SABS 533-1 and SABS 533-2.

6.7.5 Installation of discharge and ventilation pipes

6.7.5.1 Any discharge or ventilation pipe shall be so located that it

a) does not interfere with the normal operation of any door, window or access opening, or with any other aspects of the normal operation of a building,

b) does not cause inconvenience or injury to persons,

c) is not immediately above any potable water storage tank,

d) is as close as practicable to the wall of any building or supporting structure, and

e) is adequately protected from mechanical damage.

6.7.5.2 Any discharge pipe or ventilation pipe installed shall

a) not cause electrolytic corrosion due to any association of dissimilar metals,

b) not be deformed in any way that would restrict flow,

c) be safely supported at intervals along its length, without restraint of thermal movement, and

d) have a means of access for internal cleaning.

6.7.5.3 Any discharge pipe or ventilation pipe shall be so installed

a) that no bend forms an acute angle and that the bend has the largest practicable radius of curvature, with no change in the cross-section of the pipe throughout such bend,

b) that the gradients, where applicable, are within the limits given in table 15, and

c) as to be capable of withstanding the test referred to in 6.8.2.

6.7.5.4 Where pipes pass through walls or solid floors, such pipes shall

a) be protected by a layer of inert material, or

b) be accommodated in sleeves of inert material, that extend through the full finished thickness of the floor or wall.

6.7.5.5 Any discharge pipe or any ventilation pipe shall be adequately protected against damage by vehicular impact.

6.7.5.6 Any ventilation pipe shall be

a) carried upwards without any reduction in diameter and shall be vertical throughout its length or so graded as to provide a continuous fall from its open end back to the discharge pipe or drain to which it is connected, and

b) so installed that its open end is at least

1) 2,5 m above the finished ground level,

2) 100 mm above the closest part of the roof covering of the building through which it passes or to which it is attached,

3) 2 m above the head of any window, door or other opening in the same building or in any other building, whether on the same site or not, within a horizontal distance of 5 m of the open pipe end, and

4) 2,5 m above the surface level of any roof slab covering the building that it serves, if the slab can at any time be occupied by human beings.

Commentary

The height required for ventilation pipes is illustrated in figure 32.

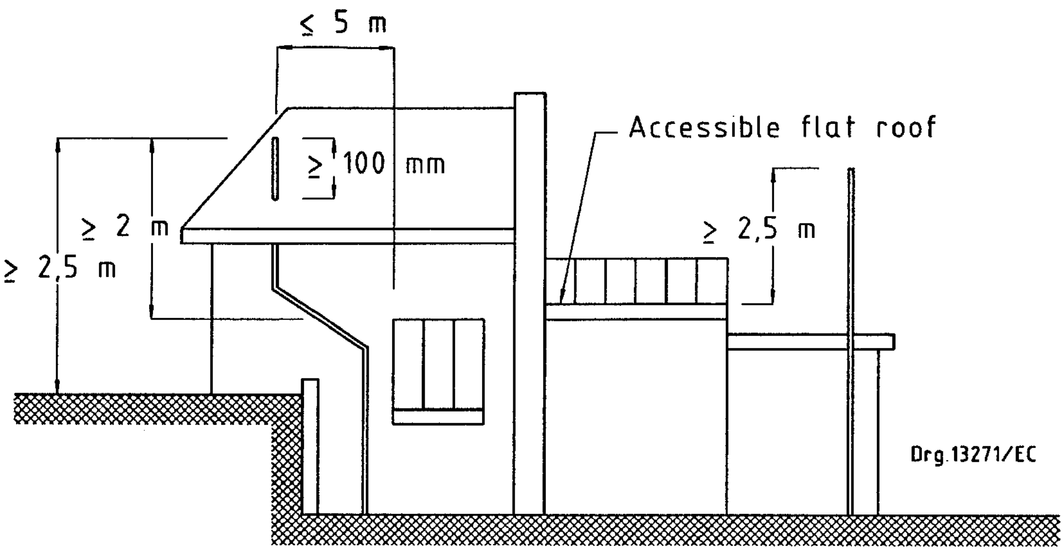


Figure 32 — Height of ventilation pipes

6.7.5.7 Any trap vent valve

a) shall be connected to the crown of the fixture discharge pipe on the outlet side of the protected trap at a point not less than 75 mm and not more than 750 mm from the crown of such trap, and

b) or back vent shall, unless carried up independently, be connected to another ventilation pipe at a point at least 150 mm above the flood level of the

1) sanitary fixture served by such trap vent, or

2) highest sanitary fixture served by such back vent,

as the case may be.

6.7.5.8 Any pipe vent valve shall be connected to the open end of a ventilation pipe at a point at least 150 mm above the flood level of

a) any sanitary fixture served by such ventilation pipe, or

b) the highest sanitary fixture served by such ventilation pipe,

as the case may be.

6.7.5.9 Where a two-pipe system is installed, no ventilation pipe that serves any soil pipe or soil fixture shall be connected to a ventilation pipe that serves any waste pipe or waste fixture.

6.7.5.10 Where any supplementary vent stack is installed in addition to, and adjacent to, any discharge stack, the vent stack shall be connected to the discharge stack at a point below the lowest branch discharge pipe connection to the discharge stack and shall be continued upwards, either independently or interconnected with the discharge stack, as prescribed in 6.2.3.1(e).

6.7.5.11 The interconnection between any ventilation pipe and any discharge pipe or drain shall be so located and made that no soil water or waste water can, under any circumstances, be discharged through any ventilation pipe.

6.7.6 Installation of drains

6.7.6.1 Where any drain and any pipe that convey potable water

a) are laid underground horizontally next to each other, they shall be laid at least 500 mm apart, and

b) cross each other, the line of the drain shall be laid at least 100 mm below that of the pipe conveying such potable water.

6.7.6.2 No service pipe or any service cable shall be installed within 100 mm of any drain.

Commentary

The service pipes and cables contemplated in 6.7.6.2 will include, amongst others, gas pipes, storm-water pipes, electric cables and telecommunication cables.

6.7.6.3 Where pipes are buried, the following shall apply:

a) trench excavations that are carried out in accordance with SABS 1200-DB and SABS 0112 shall be deemed to be acceptable;

b) rigid drain pipes shall be laid and appropriate bedding constructed in accordance with 5.2 of SABS 1200-LB;

c) pipes shall be so laid that they are evenly supported throughout their length and that they do not rest on their sockets, or on bricks, tiles or other makeshift supports; and

d) flexible drain pipes shall be laid and appropriate bedding constructed in accordance with 5.3 of SABS 1200-LB.

Commentary

When flexible pipes are laid and backfilling is selected as recommended in annex A.4, the pipes will not generally deform by more than 5 % of their nominal diameter, which is considered to be acceptable.

6.7.6.4 Secondary forces shall be eliminated, wherever possible, rather than an attempt being made to resist them.

Commentary

1) *Apart from vertical loads imposed on a pipeline by the trench or embankment fills and by surface surcharge, other forces can be active, each contributing its own particular component to the total stress. Some additional sources of stress that commonly occur are*

   a) *volume changes in clay soils, due to wetting and drying,*

   b) *impact forces,*

   c) *non-uniformity in the foundation (and bedding),*

   d) *differential settlement,*

   e) *settlement of building and other structures,*

   f) *thermal and moisture changes in the material of the pipes, joints and bedding,*

   g) *restraints caused by bends, branches, connections, etc., and*

   h) *vibration caused by traffic, etc.*

2) *Relaxation of some secondary forces can be achieved when joints permit some freedom of movement to individual pipes, both axially and transversely.*

6.7.6.5 Where any drain or any portion of a drain

a) is constructed adjacent to, or under a structural part of, any building, adequate measures shall be taken to ensure that the trench in which the drain is laid in no way impairs the stability of any building or interferes with, or affects, any existing services,

b) passes under any building, such portion shall

   1) be protected against the transmission of any load to it,

   2) be laid without change of direction or gradient, and

   3) not be provided with any means of access for cleaning from inside such building, and

c) passes through a building, it shall be

   1) supported throughout its length, without restriction of thermal movement, and the support means shall be securely attached to the building, and

   2) so placed that any junction or bend or any point of access into it is readily accessible.

Commentary

1) Any portion of a drain that passes under a building should be

a) encased in concrete in accordance with 5.4 of SABS 1200-LB, or

b) supported on, and placed in, a selected granular material constructed in accordance with 5.3 of SABS 1200-LB.

2) A drain trench may be positioned as shown in figure 33, in order to ensure that the stability of a building is not jeopardized.

3) Drainage pipes should not be installed within the cavity of any cavity wall, or pass through concrete expansion or contraction joints.

4) Since some flexibility is desirable where there is a possibility of movement of a pipeline (e.g. where a pipe or a portion of pipe passes under a building), provision should, where necessary, be made in the assembly of the pipework to accommodate and control movement. Where a portion of pipe

a) is laid within any floor, or where piping is concealed, it should be possible to remove/replace that portion of pipe without endangering the building structure, and

b) passes through any foundation, the portion should be installed inside a sleeve that has an internal diameter that exceeds the outside nominal diameter of the pipe by at least 15 mm.

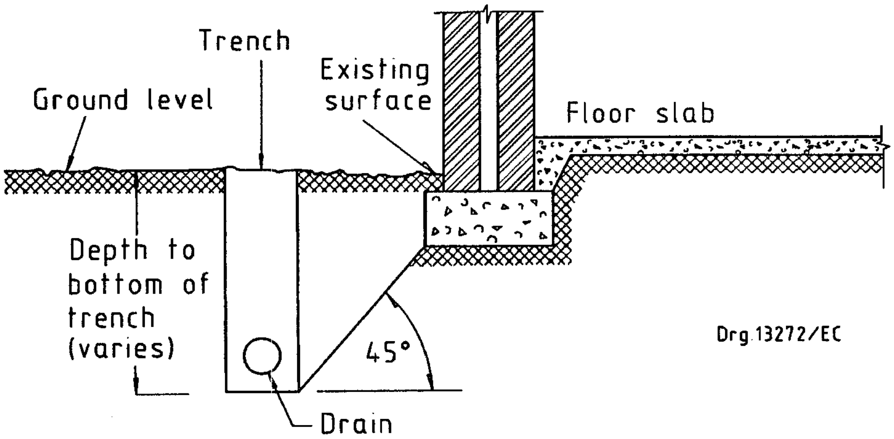


Figure 33 — Typical trench detail

6.7.6.6 Any drain shall

a) in plan, be laid on a straight line between points at which a change of direction occurs, or on a curve between two points, provided that the radius of the curve is the greater of at least 30 m or the recommended minimum radius of curvature for the type of pipe being used, and

b) be laid at a gradient suitable for the hydraulic load as given in table 13 to be carried by the drain, and

c) where its gradient exceeds 1 in 10, have anchor blocks at the bend or junction at the top and bottom of the inclined drain and at intervals not exceeding 3 m along the drain, to fix it securely in place. The anchor blocks shall have a minimum plan dimension of at least 300 mm and shall be embedded into the sides and bottom of the trench for at least 150 mm.

Commentary

1) *In the case of flexible pipes, the curvature can be distributed along the length of the pipe, while in the case of rigid pipes, the curvature should be achieved by deflection at the pipe joints.*

2) *In principle, drains can be laid on a curve both in plan and in elevation, provided that details are clearly shown on the design drawings and adequate gradients are maintained.*

3) *Positive anchorage is not possible for example in the case of socketless clay pipes and hubless cast iron pipes.*

6.7.6.7 Where the connection between two sections of any drain is at different levels, necessitating a steep drop, the

a) maximum angle against the horizontal plane shall be 45°, and

b) change shall be effected by one or more 22,5° bends that are connected to the shortest possible length of drain pipe, which is connected, in turn, through one or more 22,5° bends, to the lower drain.

Commentary

1) *Steep drops should be avoided wherever possible, but where this is unavoidable, e.g. when two drains at different levels are being connected, such a drop should be accommodated as illustrated in figure 34.*

2) *The provisions of 6.7.6.7 are illustrated in drawing LD-3.2 of SABS 1200-LD.*

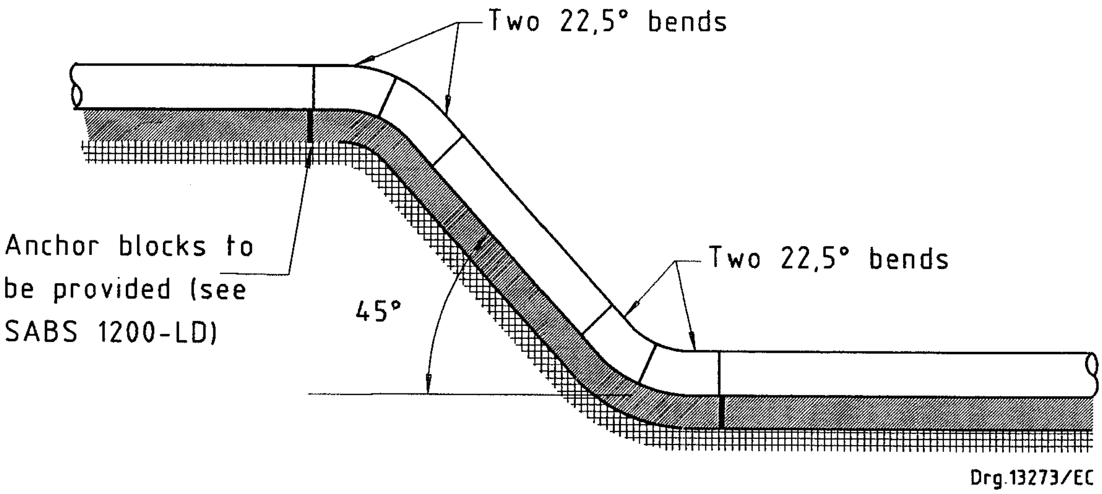


Figure 34 — Steep drops in drains

6.7.6.8 Any drain should have a soil cover of at least 300 mm over the outside of the drain. However, if the soil cover is less than 300 mm, the following shall apply:

a) in cases where the drain pipe may be subjected to heavy vehicular loadings, reinforced precast or cast-in-situ concrete slabs of thickness at least 100 mm and wide enough to prevent excessive superimposed loads from being transferred direct to the pipe shall be placed over the drain. The concrete slab shall be isolated from the crown of the pipe by a soil cushion of thickness at least 100 mm, or by means of synthetic material of sufficient thickness; and

b) in all other cases not referred to in (a) above, concrete slabs, or brick or paving blocks of thickness at least 50 mm shall be placed over such drain. The concrete slabs shall be isolated from the crown of the pipe by a soil cushion of thickness at least 50 mm, or by means of synthetic material of sufficient thickness.

6.7.6.9 Where any drain has a branch drain connected to it, the connection shall

a) be by means of a junction fitting other than a saddle junction,

b) enable the flow from the branch drain to enter the main drain obliquely in the direction of flow, so that the included angle between the axes of the two drains does not exceed 45°, and

c) be such that, where a branch drain connects to a main drain of larger diameter, the soffit of the branch drain is at the same level as the soffit of the main drain.

6.7.7 Common drains

Drainage installations on any two or more sites, whether such sites are in the same ownership or not, may, at the discretion of the local authority, be permitted to discharge into a connecting sewer through a common drain.

Commentary

1) The responsibility for clearing blockages should be considered before common drains are installed.

2) A common drain is illustrated in figure 35. Local authorities would prefer to call ABC a sewer and place it in a registered servitude. Rodding eyes should be provided at points A and C.

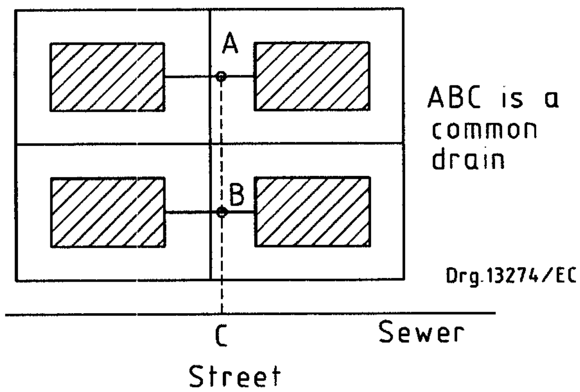


Figure 35 — Common drains

6.8 Inspection, testing and maintenance

6.8.1 Inspection

6.8.1.1 The drainage installation shall be inspected by the local authority as prescribed in regulation A22 of the National Building Regulations.

6.8.1.2 The drainage installation should be inspected by the owner or by his representative, as the installation work proceeds. On completion of the installation, before any work is concealed or covered, it should be ensured that

a) all pipes, fixtures and fittings comply with all the appropriate provisions of this part of SABS 0252 and are free from defects,

b) all pipework and fittings are clear of debris and superfluous matter,

c) no jointing material projects into any pipe bore and that all joints maintain the continuity of the bore, and

d) pipework is properly placed, positioned and secured.

6.8.2 Testing

6.8.2.1 Prefabricated units shall be tested at the works or place of fabrication and shall be inspected on delivery at the site.

6.8.2.2 After the inspection as contemplated in 6.8.1 and after the drainage installation has been backfilled, the soundness of the installation shall be tested in accordance with the procedure given in 6.8.3. The installation (or part of the installation) tested shall be deemed to have passed the air test if the pressure, after 3 min, is at least 0,25 kPa (25 mm head of water).

6.8.2.3 Without prejudice to the provisions of 6.8.2.2, the performance of any installation shall be tested in accordance with 6.8.4. when deemed necessary.

Commentary

When deemed necessary, a performance test may be carried out in order to determine whether

a) all sanitary fixtures, whether discharged singularly or in groups, drain speedily, quietly and completely, and

b) adequate water seals are retained in sanitary fixture traps during peak working conditions.

6.8.3 Air test

The following test procedure shall be followed when the installation or part of the installation, as the case may be, is tested:

a) fill the traps of all the sanitary fixtures in the installation (or in part of the installation) with water;

b) plug the open ends of all ventilation pipes in the installation (or in part of the installation);

c) either

   1) fit one of the plugs with a T-piece fitted with cocks on its other two branches, or

   2) pass a flexible tube, which is connected to a T-piece fitted with cocks on its other two branches, through the water seal of any sanitary fixture;

d) connect one of the branches of the T-piece to a manometer by means of a flexible tube. Ensure that any water trapped in the tube is removed before the tube is connected to a manometer;

e) pump air into the installation (or into part of the installation) through the remaining branch of the T-piece until a pressure of 0,35 kPa (35 mm head of water) is recorded on the manometer;

f) close the air inlet cock; and

g) after 3 min, read the pressure in the installation (or in part of the installation).

Commentary

1) The air test (soundness test) should preferably be completed in one operation. However, for large multistorey systems, testing in sections is normally necessary.

2) To ensure that there is a satisfactory air seal at the base of the stack, or, if only a section of the pipework is to be tested at the lowest plug or bag in the stack, a small quantity of water sufficient to cover the plug or bag can be allowed to enter the system.

3) Defects revealed by the air test can be located as follows:

a) a smoke-producing machine can be used, which will introduce smoke under pressure into the defective pipework. Leakage can be observed as the smoke escapes. Smoke cartridges that contain special chemicals should be used with caution, care being taken that the ignited cartridge is not in direct contact with the pipework and that the products of combustion do not have a harmful effect upon the materials used for the pipe discharge system. Smoke testing of plastics pipework should be avoided owing to the fact that naphtha has a detrimental effect, particularly on ABS, uPVC and MuPVC. Rubber jointing components can also be adversely affected;

b) the pipework can be subjected to an internal pressure, a soap solution can be applied to the pipes and joints and leakage can then be detected by the formation of bubbles; and

c) water can be used to test the installation. The test should not be applied to the whole of the installation, but only to that part of the installation where the defect is most probably located. Before the pipes are filled with water, test plugs should be inserted to seal off the part under test from the rest of the installation. Care should be taken to ensure that the static head at any point in any part of the installation under test does not exceed 5 m.

6.8.4 Performance test

Commentary

The primary object of the performance test is to determine whether a loss of water seal from the traps of sanitary fixtures, normally served by a common discharge pipe or drain, would be experienced due to the development of negative pressures (which may cause self-siphonage or induced siphonage (or both) to take place).

6.8.4.1 The number of fixtures that are served by a common discharge pipe or drain and that are to be discharged simultaneously, shall be determined in accordance with table 22. Discharges from baths shall be ignored unless the discharge pipe serves baths only, when the number of baths to be discharged simultaneously shall be the same as for kitchen sinks.

6.8.4.2 The location of the sanitary fixtures to be discharged simultaneously, as contemplated in 6.8.4.1, shall be so selected as to cause the worst pressure conditions in the discharge pipe concerned.

6.8.4.3 The following test procedure shall apply:

a) ensure that the traps of all sanitary fixtures that are served by the common discharge pipe or drain to be tested are filled with water;

b) ensure that all the sanitary fixtures to be discharged simultaneously are filled with water to overflowing level;

c) simultaneously discharge all the sanitary fixtures contemplated in (b) above (flush WC pans, and discharge sanitary fixtures by removing their plugs);

d) at the end of the discharge, use a dip stick or small diameter transparent tube to measure the depth of the water seal that remains in the traps of all the fixtures that are served by the discharge pipe or drain; and

e) repeat steps (a) to (d) at least three times.

6.8.4.4 The maximum loss of seal in any one test, as measured, shall be taken as a significant result. The installation (or part of the installation) tested shall be deemed to have passed the performance test if a seal depth of not less than 25 mm is retained in the traps of all the sanitary fixtures that are served by the installation (or by part of the installation) after each of the tests. Where the resulting trap seal depth of a fixture, or group of fixtures, is less than 25 mm, additional ventilation shall be provided.

Commentary

1) *In the case of discharge pipes, the worst condition usually occurs when the fixtures selected are located at the upstream end of the discharge pipe.*

2) *In the case of discharge stacks, the worst condition usually occurs when the fixtures selected are located close to the top of the stack on adjacent floors. For example, in the case of a block of flats of nine storeys, with the stack serving one sanitary group (a WC pan, a wash-hand basin, a kitchen sink and a bath) on each floor, the test would consist of the simultaneous discharging of one WC pan, one wash-hand basin and one kitchen sink on the top floor. If the stack serves two such sanitary groups on each floor, the discharge test would consist of the simultaneous discharging of one WC pan, one wash-hand basin and two kitchen sinks. The WC pan, wash-hand basin and one kitchen sink would be discharged on the top floor and the remaining kitchen sink would be discharged on the floor immediately underneath.*

3) *The number of fixtures to be discharged simultaneously, as given in table 22, is based on a criterion of satisfactory service of 99 %. In practice, where installations serve mixed sanitary fixtures, the probable hydraulic loading is slightly overestimated. The flow load from urinals, spray tap basins and showers is usually small in such installations, and therefore these appliances need not normally be discharged. For the purposes of this test, baths are ignored since their use is spread over a relatively long period. Hence they do not materially add to the normal peak flow on which table 22 is based. Flows from showers are small and can usually be ignored for stacks that serve mixed sanitary fixtures. Similarly, for non-domestic buildings, spray tap basins and urinals need not be included in the test when the stack also serves other fixtures.*

Table 22 — Number of sanitary fixtures to be discharged simultaneously

1	2	3	4	5
Type of use	**Number of fixtures of each kind on the stack**	**Number of fixtures to be discharged simultaneously**		
		9 L WC pan	**Wash-hand basin**	**Kitchen sink**
Residential	1 to 9	1	1	1
	10 to 24	1	1	2
	25 to 35	1	2	3
	36 to 50	2	2	3
	51 to 65	2	2	4
Commercial or Public	1 to 9	1	1	
	10 to 18	1	3	
	19 to 26	2	3	
	27 to 52	2	3	
	53 to 78	3	4	
	79 to 100	3	5	
Congested	1 to 4	1	1	
	5 to 9	1	2	
	10 to 13	2	2	
	14 to 26	2	3	
	27 to 39	3	4	
	40 to 50	3	5	
	51 to 55	4	5	
	56 to 70	4	6	
	71 to 78	4	7	
	79 to 90	5	7	
	91 to 100	5	8	

6.8.5 Maintenance

All pipework shall be kept in a clean and sound condition in order to maintain maximum efficiency. The following shall be considered:

a) when access covers or caps or cleaning eyes are removed, damaged packings, joint rings, washers or any other damaged component shall be renewed before replacement;

b) care shall be taken with the use of chemical descaling agents, which are often of a corrosive nature. Pipework materials used in the installation shall be clearly identified before treatment, to ensure that they are not subject to damage by chemical attack;

c) hand-operated rods for removing blockages in discharge pipes shall be capable of passing through the installation without damaging the internal surfaces of pipes and fittings;

d) mechanized rodding equipment shall only be used by properly trained operators. The pipework to be cleared shall be thoroughly examined beforehand to enable selection of appropriate cleaning attachments; and

e) in the renewal of paintwork, care shall be taken to retain any distinguishing colours that may have been used for identification purposes.

7 On-site sewage storage or disposal

7.1 Conservancy tanks

7.1.1 Provision

Any conservancy tank shall, subject to the availability of approved clearing services,

a) have a capacity as prescribed by the local authority and shall be impervious to liquid,

b) be provided with a means for clearing, as prescribed by the local authority, and

c) be provided with means of access for clearing purposes, as prescribed by the local authority.

7.1.2 Siting

Any conservancy tank to be used on a site for the reception of sewage shall be so sited

a) and so designed that it is not likely to become a source of nuisance or danger to health, and

b) as not to endanger the structure of any building or any services on the site.

7.2 Septic tanks

7.2.1 General

7.2.1.1 Industrial effluent shall not be allowed to flow into any septic tank.

7.2.1.2 Any septic tank shall, subject to the provisions of 7.3.1, discharge to an absorption field, or shall be appropriately treated before it discharges to an approved location.

7.2.1.3 Any septic tank shall have a soil cover of at least 150 mm.

7.2.2 Capacity

Unless otherwise required by the local authority, the design capacity of a septic tank shall, when the tank serves

a) a single dwelling house or dwelling unit, be the greater of at least

   1) 1,7 m^3, or

   2) the expected daily sewage flow, and

b) any building not contemplated in (a) above, be at least three times the expected daily sewage flow.

7.2.3 Design, construction and siting

7.2.3.1 Any septic tank to be used for the reception of sewage shall be so designed and

a) constructed that it will be impervious to liquid, and

b) sited

1) that it is not likely to become a source of discomfort or of danger to health, and

2) as not to endanger the structure of any building or any services on the site.

7.2.3.2 Unless otherwise approved, a septic tank shall be so sited that

a) it is no closer than twice its depth to building foundations or site boundaries,

b) access is adequate for the purposes of emptying and cleaning, and

c) its location facilitates, where possible, the eventual connection of the building drain or septic tank outlet to a sewerage reticulation system, should this become available.

7.2.3.3 Any septic tank shall be so constructed that

a) the depth of the receiving chamber below the outlet invert is not less than 1,0 m and not more than 1,8 m,

b) there is an air space of at least 200 mm between the surface of the liquid contained in the chamber and the underside of the top cover of such chamber, and

c) all compartments and fittings are readily accessible for inspection and cleaning.

Commentary

1) If manholes are to be provided, they should give access both to inlet and to outlet pipes (where blockages can occur). Alternatively, access can be provided through removable cover slabs.

2) Guidance for the design of septic tanks is given in annex B.

7.2.4 Incoming drain pipe

7.2.4.1 The incoming drain pipe to any septic tank shall

a) have an inside diameter of at least 100 mm,

b) be laid at a gradient not exceeding 1 in 60 (1,67 %) for the last 10 m before it enters the tank, and

c) be fitted with a T-piece at the point of discharge into the receiving chamber. The diameter of the vertical arms of such T-piece shall be at least that of the incoming drain.

7.2.4.2 The invert of the outlet shall be 50 mm to 75 mm below that of the inlet.

7.2.4.3 The incoming drain to the septic tank shall be ventilated.

7.2.5 Watertightness test

When deemed necessary, a newly built septic tank shall be tested for watertightness by filling it with water prior to use and allowing it to stand for one day, to detect any possible leaks.

7.3 Absorption fields

7.3.1 General

7.3.1.1 An absorption field shall

a) not be provided on a site where the effluent discharged into it cannot be disposed of in an inoffensive way and where it is likely to become a danger to health,

b) be so sited and constructed as not to cause the pollution of any public stream, spring, well or water source that is used, or that is likely to be used, for drinking, domestic or kitchen purposes,

c) be sited at least 3 m from any building, or from the boundary of the site on which it is situated, and

d) not be sited where it could endanger the structure of any building or any services on the site.

7.3.1.2 A french drain shall not be provided on a site where the percolation rate of the ground, when evaluated in terms of 7.3.2, is

a) less than 12 mm/h, or

b) more than 1 000 mm/h,

unless approved measures are taken to prevent the possible pollution of ground water.

Commentary

1) *The septic tank only partially treats the sewage and it is the function of an absorption field to provide the final treatment before disposal of the effluent.*

2) *A proper site evaluation is fundamental to the design of a french drain. Sites that are not suitable for the construction of french drains are, for example, those where the effluent may surface on any site, or where the height of the water table is, or could be, such that adequate treatment of effluent is not possible.*

3) *As a rule, the susceptibility of a water source to pollution decreases sharply as its distance from a french drain increases, except in areas with fissured rock, limestone or very coarse soil.*

4) *French drains should, where possible, be located uphill of a water source such as a borehole or spring. Where location uphill of such water source is not possible, french drains should be located at least 15 m from the water source. However, if the distance between the ground-water table and the base of the french drain is less than 5 m, the drain should be located at least 30 m from the water source. (See also annex B.)*

7.3.2 Percolation test

Commentary

The percolation test measures the rate at which clean water, under constant or nearly constant hydraulic head, percolates into the surrounding soil in both the vertical and the horizontal direction. The test is designed to quantify the rate at which water moves into the soil, and percolation will therefore change as moisture conditions change.

7.3.2.1 The percolation test shall be carried out on at least four test holes spaced uniformly throughout the area of a proposed absorption field. Where soil conditions are highly variable, more test holes could be required in terms of 7.3.2.5(e).

7.3.2.2 Each test hole shall have a diameter of approximately 150 mm (or shall be of size approximately 150 mm) and shall have a depth of approximately 400 mm.

7.3.2.3 Test holes shall be dug vertically downwards from the bed of the proposed absorption field area.

Commentary

The size of the absorption field should also be taken into account when the minimum number of percolation test holes required is being determined.

7.3.2.4 Once the test holes have been dug, they shall be prepared for the percolation test as follows:

a) thoroughly scarify the sides and bottom of each test hole with a sharp pointed instrument, to break up unnatural (such as smeared) soil surfaces, and carefully remove all loose material from each test hole;

b) line each test hole with a polyester filter fabric and cover its bottom surface with a 50 mm layer of pea-sized gravel in order to protect the soil surface from scouring when water is added; and

c) carefully fill each test hole with water to a depth of 300 mm above the gravel layer, and maintain the water surface at this level for at least 8 h and until the percolation rate of the water into the soil becomes constant. In sandy soils where the water seeps away in less than 10 min after the test hole has been filled to a depth of 300 mm above the gravel, proceed as follows:

    1) fill the hole at least twice, to a depth of 300 mm above the gravel, and allow it to seep away after each filling; and

    2) determine the percolation rate as in 7.3.2.5.

Commentary

Automatic siphons or float valves can be used to maintain the water level as contemplated in (c) above.

7.3.2.5 The percolation rate of the absorption field shall be determined as follows:

a) allow the water level above the gravel in individual test holes to drop to 180 mm above the gravel. From this point onwards, measure further drops in the water level at constant intervals of between 5 min and 60 min to the nearest millimetre from a fixed reference point.

Commentary

The interval chosen should be increased as the percolation rate decreases.

b) if the depth of the water above the gravel in an individual test hole decreases to 130 mm, add water to return the depth to 180 mm and continue with the measurement. The level of the water above the gravel in the test hole shall never be allowed to drop below 130 mm, or to rise above 180 mm;

c) continue with measurements until the drop in the water level between two successive intervals does not vary by more than 10 %;

d) calculate the percolation rate for each test hole by dividing the magnitude of the last drop in water level, in millimetres, by the time taken, in hours, for this drop to take place;

e) if the percolation test rates of individual test holes vary by more than 10 %, a variation in soil type is suggested. Increase the number of the test holes to at least eight, so that a more reliable site percolation rate can be determined, and repeat the test procedure; and

f) regard the average of the percolation test rates that were obtained for the individual test holes as the site percolation rate.

Commentary

The average percolation rate should preferably be calculated using the geometric mean method (the n-th root of the product of the measurements), because high values have less influence on the geometric mean than on the arithmetic mean.

7.3.3 Effluent application rates

7.3.3.1 Unless otherwise approved, a french drain shall be so sized that the rate of application of effluent to the infiltration area does not exceed the rate given in column 3 of table 23, appropriate to the percolation rate given in column 2.

Commentary

1) The effluent application rates given in table 23 do not take transpiration and evapotranspiration into account and are only applicable to septic tank effluent from domestic sources. In the case of effluent that is significantly different in character, a factor of safety should be introduced.

2) Effluent dosing frequencies are not critical.

7.3.3.2 Effluent shall be distributed as uniformly as possible over the surface of the french drain, in order to promote transpiration and evapotranspiration.

Table 23 — Effluent application rates for french drains

1	2	3
Soil texture	**Percolation rate** mm/h	**Application rate** L/m²/day[1)]
Silty clay, clay, loam	< 50	Unsuitable
Loam, porous silt loam	50 - 75	20 - 30
Sandy loam	75 - 100	30 - 50
Sandy loam, fine sand	100 - 200	50 - 70
Sand	200 - 500	70 - 90
Sand, fine gravel	500 - 1 000	90 - 110
Gravel, coarse sand	> 1 000	Unsuitable[2)]

1) Based on the total infiltrative surface area of the french drain.
2) Not permitted unless approved measures are taken against possible ground-water pollution when deemed necessary.

7.4 Other means of sanitary disposal

7.4.1 General

7.4.1.1 Where waterborne sewage disposal is not available, other means of sewage disposal should be permitted by the local authority, provided that in the case of chemical or pail closets, a satisfactory means is available for the removal and disposal of sewage from such closets.

7.4.1.2 No person shall construct any pit latrine without the permission of the local authority.

7.4.1.3 Any other means of sewage disposal shall be so constructed, sited and provided with access that the health and convenience of users are not adversely affected.

7.4.1.4 The number of sanitary receptacles shall be adequate for the population of the building served by such receptacles.

7.4.2 Construction

7.4.2.1 The material used for the construction of the floor, walls and roof of any latrine shall be adequate for its purpose and such latrine shall provide adequately for user privacy and shall protect the user and the seat from the weather. Where provided, latrine doors shall be lockable from the inside. Superstructures without doors shall be so designed that someone standing at the entrance of the latrine cannot see a user occupying the latrine.

Commentary

Latrine doors should preferably be self-closing, and also lockable from the outside.

7.4.2.2 Rainwater, soil, garbage and other foreign material shall not be able to enter the system.

7.4.2.3 Any sanitary fixture such as a pan, pail, container and other fitting related thereto, shall be adequate for its intended purpose.

7.4.2.4 Any latrine shall be provided with a seat and a riser of such height that a space of not more than 25 mm is left between the underside of the seat and the top of the receptacle. If the users prefer to use squatting plates, such plates shall be provided in the place of any seat.

7.4.2.5 The seat and riser contemplated in 7.4.2.4 shall be so designed that the aperture at the top of the seat is not less than 250 mm and not more than 300 mm in diameter. For children, a seat that has an aperture of between 150 mm and 200 mm may be provided.

7.4.2.6 The aperture contemplated in 7.4.2.5 shall be fitted with a flyproof lid.

7.4.3 Ventilation of superstructures

The latrine shall be provided with an opening, or openings, of area at least 0,2 m^2 for the purposes of natural lighting and through-ventilation. However, the inside of the latrine shall be adequately dark to discourage flies from entering.

Commentary

1) *Openings dissipate odours and allow the ventilation pipes of pit latrines to function properly. Any such opening, or openings, should preferably be screened to prevent flies from entering the superstructure.*

2) The gap between latrine doors and floors should preferably be small enough to prevent vermin and snakes from entering the superstructure.

3) A typical pit latrine is illustrated in figure 36.

Dimensions in millimetres

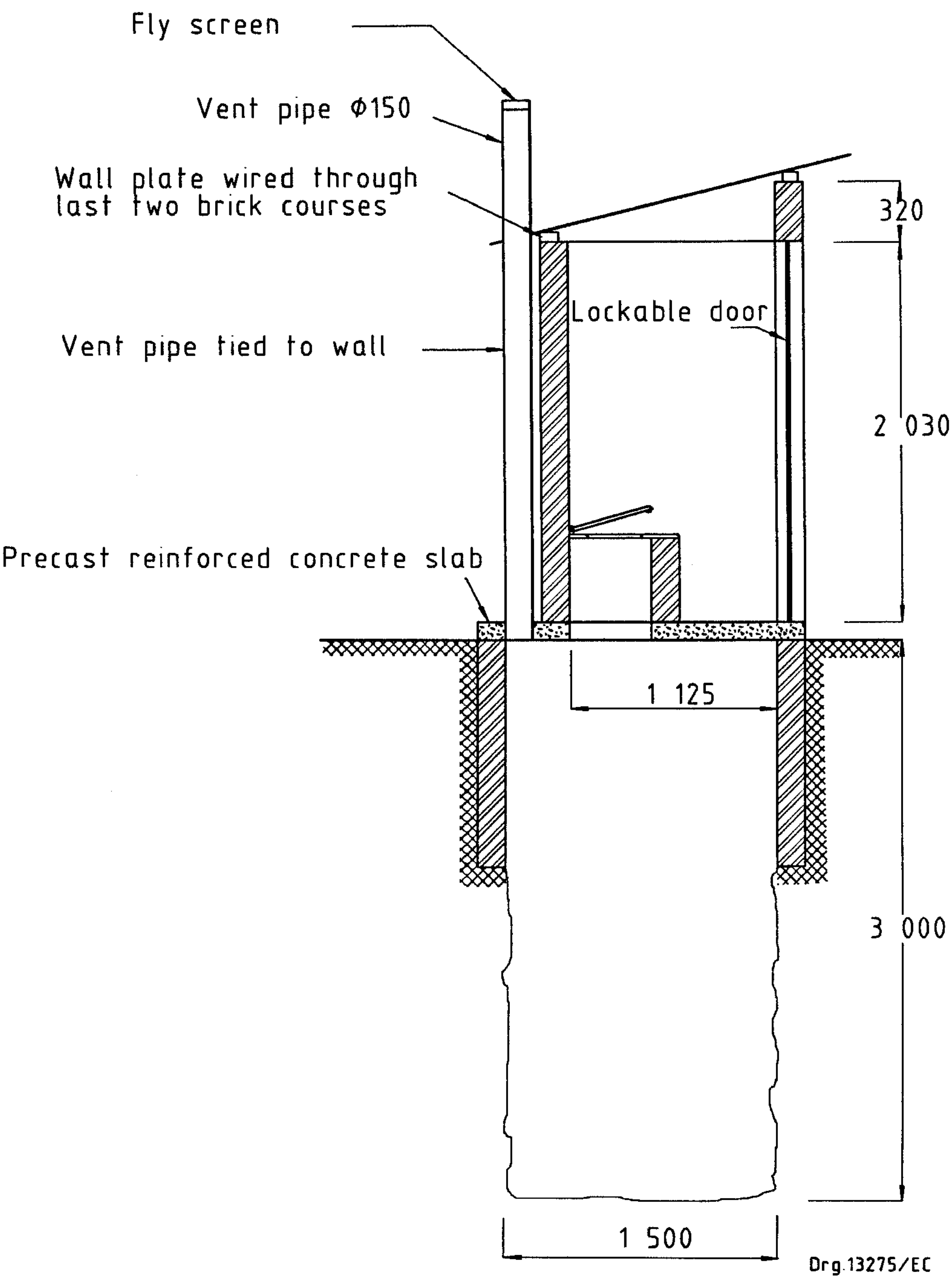


Figure 36 — A ventilated pit latrine

7.4.4 Ventilation of substructures

7.4.4.1 Any substructure shall be ventilated with a suitable ventilation pipe of nominal diameter at least 50 mm. Pits of pit latrines shall be ventilated with a ventilation pipe of nominal diameter at least 100 mm.

Commentary

Substructures would include the pits of pit latrines, digester tanks, etc.

7.4.4.2 All ventilation pipes shall be screened with a non-corrosive material, to prevent insects from entering or from escaping from substructures. The apertures in the mesh of screens over the ventilation pipes shall be small enough to trap insects, but large enough to achieve proper ventilation of the substructure.

7.4.4.3 It shall not be possible for leaves and other debris to accumulate on top of the screen.

7.4.4.4 The ventilation pipe shall be so installed that its open end is at least

a) 2,5 m above the finished ground level, and

b) 100 mm above the closest part of the roof covering of the superstructure. The open end of the ventilation pipe of a pit latrine shall be of sufficient length so that the roof does not interfere with the action of the wind across the top of the pipe. Therefore the top of the pipe shall be at least 500 mm above the highest point of the roof.

Commentary

1) The ventilation pipes of pit latrines should preferably be situated on the sunny side of the superstructure and painted black.

2) A typical pedestal seat is illustrated in figure 37 and squatting plates in figure 38.

Dimensions in millimetres

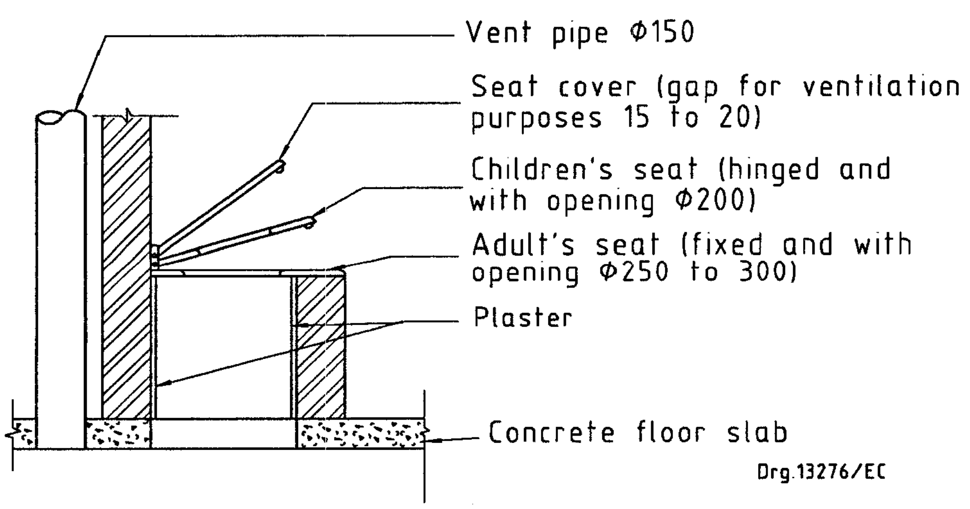


Figure 37 — Pedestal seat for pit latrines

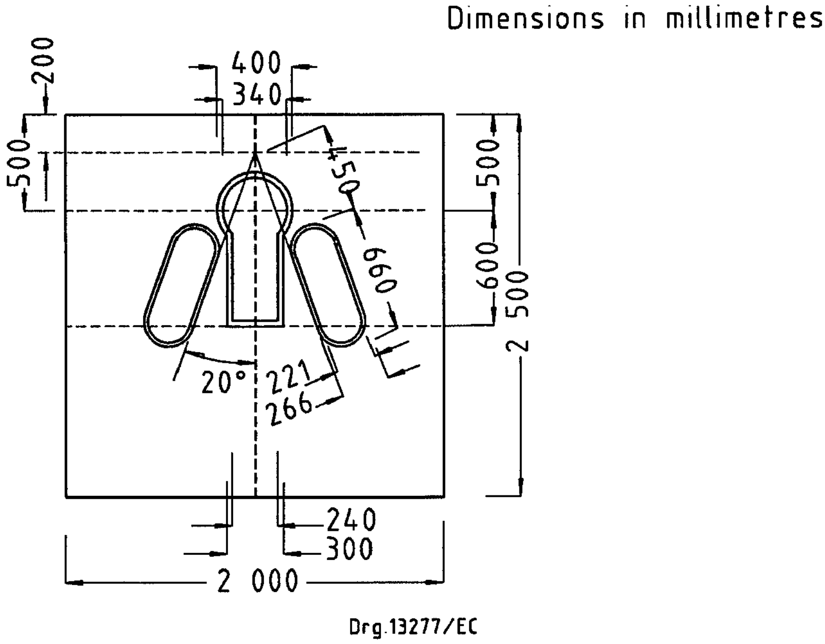


Figure 38 — Squatting plates

7.4.5 Discharged wastes within the system

7.4.5.1 Wastes shall be contained in a manner that minimizes the risk of disease transmission. Therefore,

a) there shall be no contact by humans with raw wastes within the system,

b) the possibility of animal or insect contact with wastes shall be minimal. To ensure this,

1) cover slabs or manhole covers shall seal tightly,

2) holes in the slabs where the pedestal seat, ventilation pipe, etc., fit, shall seal properly, and

3) subsoil percolation systems, where provided, shall get rid of the effluent in a safe and inoffensive way.

7.4.5.2 Any on-site sanitation system shall be such that it has the capacity, is so constructed and contains suitable material as to adequately receive and retain discharged wastes within the system.

7.4.6 Reliability

7.4.6.1 The system shall be able to accept, without malfunctioning, commonly used personal cleansing material.

7.4.6.2 The system shall be compatible with local water supply levels.

7.4.6.3 Substructure walls shall be stable under any conditions; otherwise, ground conditions, etc., shall be specified.

7.4.7 Maintenance

The system shall be easy and simple to clean.

Commentary

Sanitary fixtures that can become soiled should preferably be of smooth, easily cleaned materials.

7.4.8 Siting

7.4.8.1 Excavations for on-site sanitation systems shall be so sited as not to endanger the structure of any building or any services on the site, or of any building or services on the boundary of the site on which the sanitation system is located.

7.4.8.2 The system shall be designed and sited to prevent contamination of clean drinking water supplies and unacceptable contamination of either surface or ground water.

Commentary

See figure 39, figure 40 and the commentary to 7.3.1.

7.4.8.3 Where any closet, other than a chemical closet, forms part of any dwelling house, such closet shall be so positioned and constructed as to prevent the transmission of odours to the rest of the house.

7.4.8.4 No closet, other than a chemical closet or a closet that has a clean water trap, shall open direct into any habitable room.

7.4.8.5 Any closet, other than a chemical closet or a closet that has a clean water trap, shall have direct access from the open air or from a permanently ventilated space.

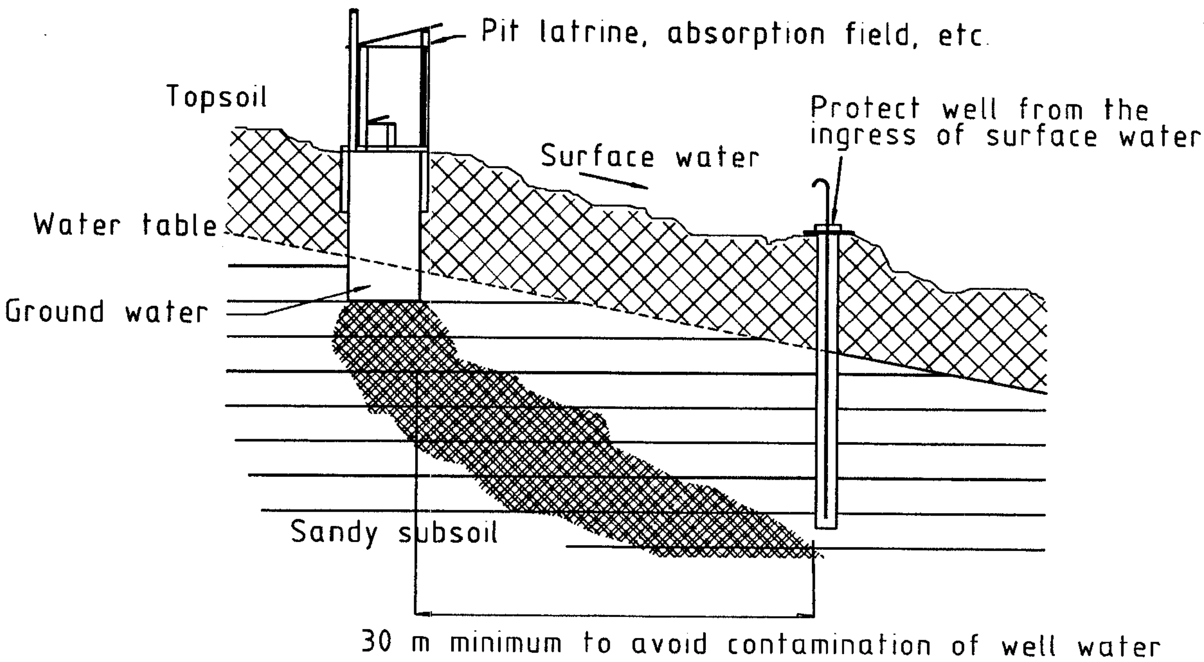


Figure 39 — Siting of pit latrine relative to potable water supplies

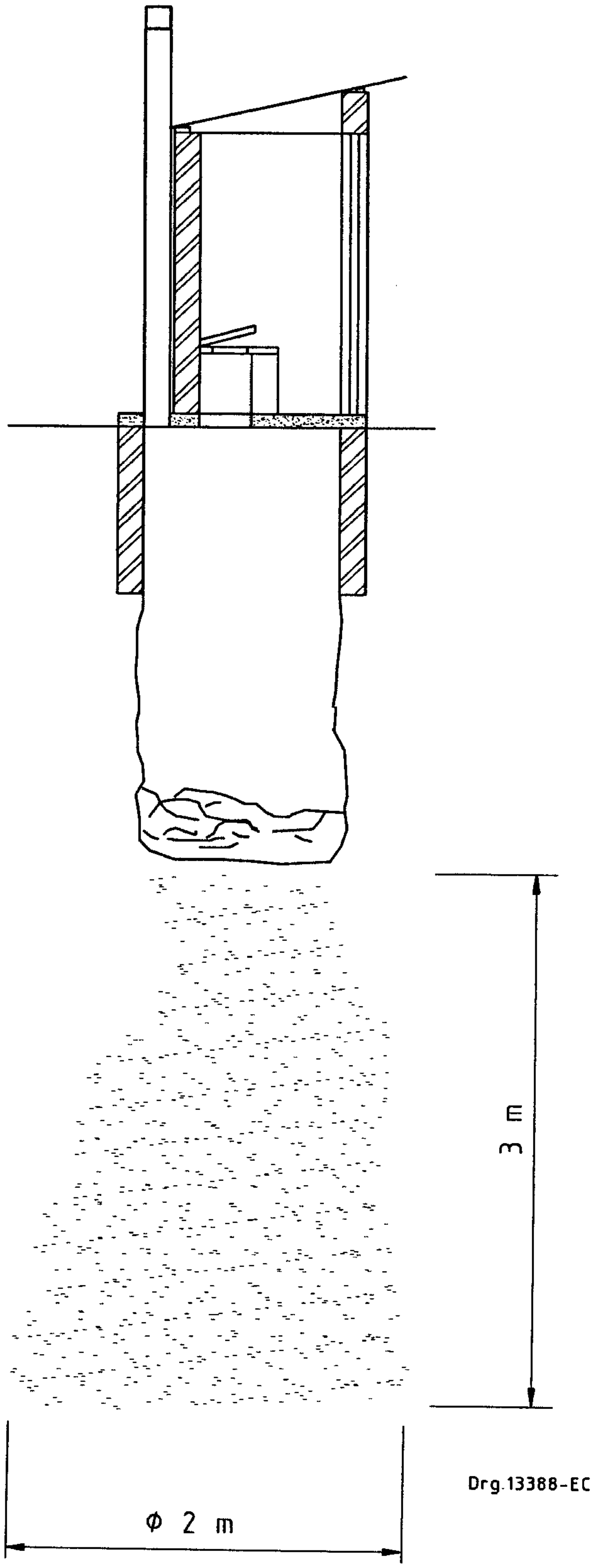


Figure 40 — Likely spreading of pit latrine pollution in dry soil

7.4.9 Closets that contain a removable pail

7.4.9.1 Any closet that contains a removable pail shall be provided with access to the pail for replacement purposes, so that the pail is not carried out through the doorway of such closet. Such access shall be provided with a self-closing flyproof lid.

7.4.9.2 Guides shall be provided, either in the floor of the closet, or on the underside of the seat of the closet, for the purpose of guiding the pail into its central position beneath the aperture in the seat.

Annex A
(informative)

Design, layout, installation and maintenance of waterborne drainage installations

A.1 Design and layout

A.1.1 Pipe ducts

Space for pipes and maintenance workers has to be adequate (see 6.7.3). The practice of saving space by reducing duct sizes should be avoided, since the difficulties experienced with installation and maintenance are likely to offset any advantages gained. Ducts that are accessible from balconies, etc., could be shallow and may be closed by removable panels. A metal grid should be placed across ducts at each floor, to allow for easy maintenance and the placing of ladders. Where maintenance workers have to climb into ducts, a duct width of approximately 1 m is recommended for ducts that contain pipework on one side and a width of 1,2 m for ducts that contain pipework on both sides.

The positioning of pipework should accommodate the need for access for rodding and the likelihood of escape of liquid during this operation. In horizontal ducts, the pipework should, if possible, be positioned below all other services. The pipework should also be so arranged that any escape of the pipe contents cannot damage electrical insulation or equipment.

A.1.2 Rational layouts

A drainage installation has to satisfy the performance criteria given in 4.4.3 in the most cost-effective way, the cost of maintenance being included. The layout of the sanitary fixtures has a direct influence on the layout of the pipework and on the cost of the installation and it therefore has to receive special attention when the building is being designed, particularly with regard to the grouping of fixtures around ducts.

Where possible, fixture entry points should be closely grouped to allow for the speedy combination of discharges from the various fixtures. This will assist the flow of sewage and result in economical water supply pipework to, and discharge pipework from, sanitary fixtures. In large multistorey installations, the rational layout of pipework could become crucial, and the following general observations may be useful:

a) group the fittings together;

b) group the facilities and locate them back to back around pipe ducts;

c) stack the facilities vertically;

d) simple layouts will reduce cost, improve hydraulic performance, cut down on maintenance and lend themselves to prefabrication;

e) place water closets as close as possible to the vertical stack;

f) position fittings with low level traps, i.e. urinals, baths and showers, as near as possible to ducts, to accommodate pipe falls more easily; and

g) avoid short offsets around columns, etc., and short-radius bends.

A.1.3 Rational designs

The aerator junction system, where aerator junction fittings are used to increase the capacity of discharge stacks, is only permitted when it is the subject of an acceptable rational design, unless the aerator fittings themselves are used only as multiport fittings in a conventional single-stack system where hydraulic loadings do not exceed the allowable loadings for a single-stack system. When they are the subject of a rational design, aerator junction fittings are used at junctions of branches with stacks on particular floors, in order to reduce discharge stack sizes and to eliminate the need for supplementary stack venting in high-rise buildings. An aerator junction fitting is illustrated in figure A.1(a) and the system is diagrammatically presented in figure A.1(b). The use of aerator junction fittings could become economical where a building exceeds 10 storeys, when supplementary vent stacks may have to be introduced on the conventional single-stack system. A cost-benefit analysis is often necessary to determine whether an aerator junction system is economically justifiable.

A.1.4 Pressure fluctuation

Pressure fluctuations in pipes should be limited as far as possible, since they can adversely affect the trap seals of sanitary fixtures connected to the installation (see figure A.2). For example,

a) in a branch pipe where a negative pressure (suction) develops,

   1) a loss of water seals from the trap of a discharging sanitary fixture can result from self-siphonage when full-flow occurs in the branch at the outflow from the fixture concerned, as illustrated in figure A.3(a), and

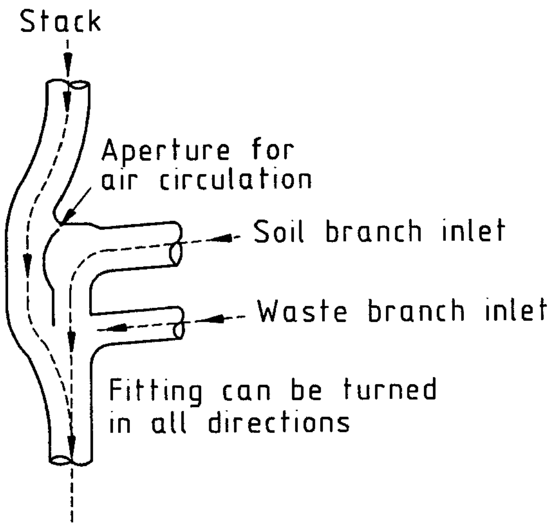
   2) a loss of water seals from the traps of sanitary fixtures that are not discharging can result from induced siphonage when full-flow occurs in a common branch pipe to which a series of sanitary fixtures is connected, as illustrated in figure A.3(b), and

b) in a discharge stack where

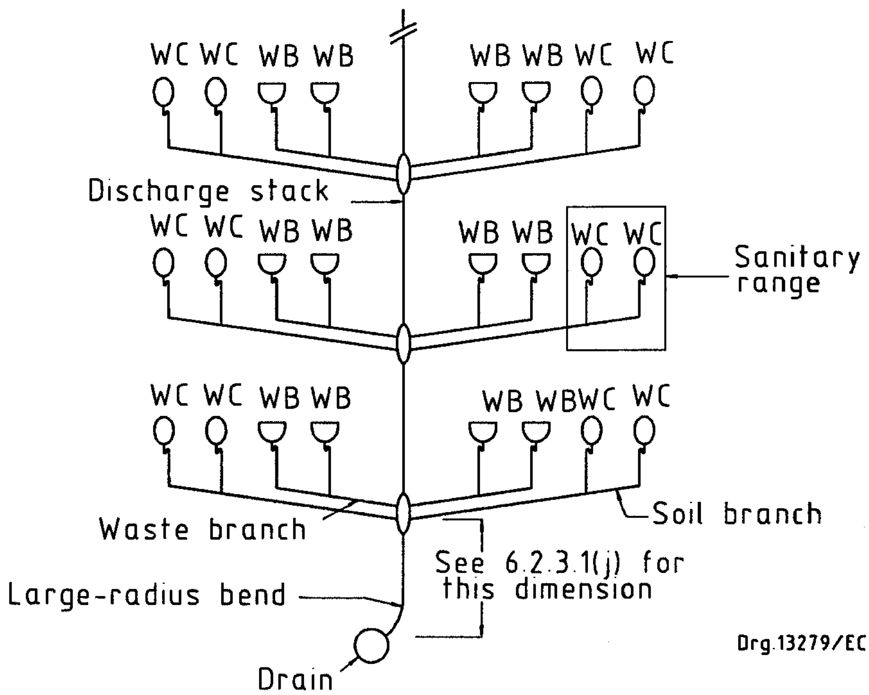
   1) a negative pressure develops in the stack below the point where a branch pipe is connected to it, a loss of water seals from the traps of sanitary fixtures can result owing to induced siphonage, and

   2) a positive pressure or back pressure develops in the discharge stack, foul air can be blown through the traps of sanitary fixtures served by the stack concerned.

Since changes in the direction of flow can cause pressure fluctuations in pipes that convey liquids, such changes should, as far as possible, be avoided, particularly in the wet section of a discharge stack. Discharge stacks should be designed to flow not more than a quarter full. When a change of direction of flow in the wet section of a discharge stack cannot be avoided, no connections may be made to the stack within the areas indicated in figure 15 and figure 16. The radius of the bend at the foot of a stack has to be large (see figure A.4).



a) The aerator fitting



NOTE - Soil branches and waste branches to be separately connected to the aerator fitting.

b) Ranges of sanitary fittings in an office building

Figure A.1 — An aerator junction system

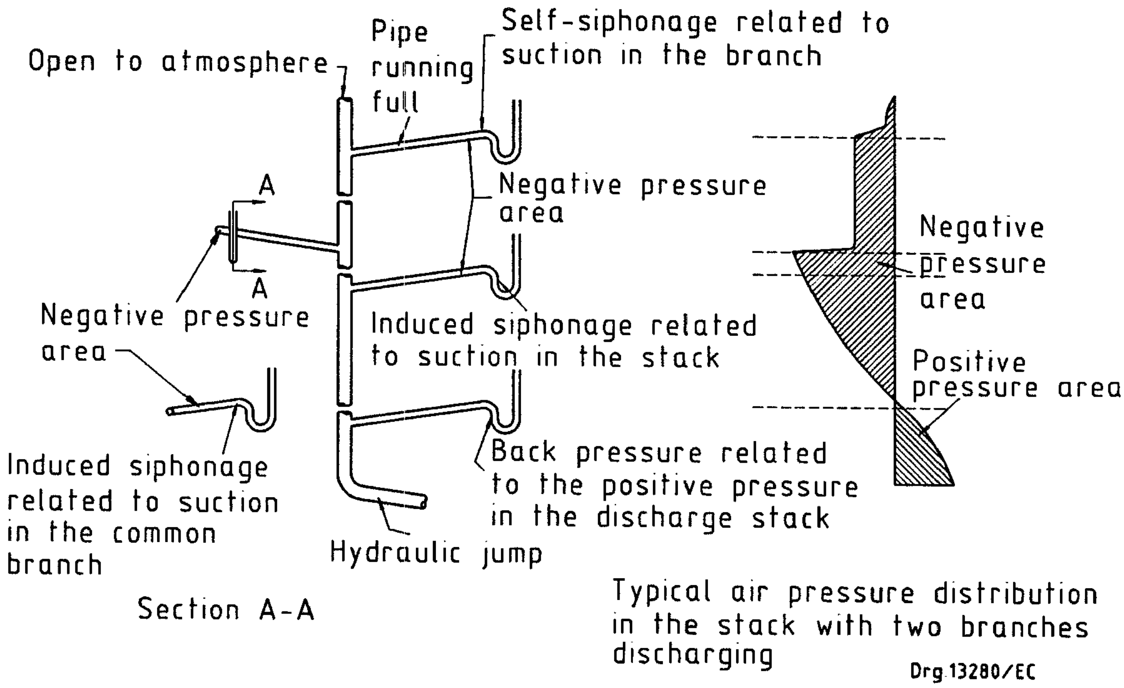
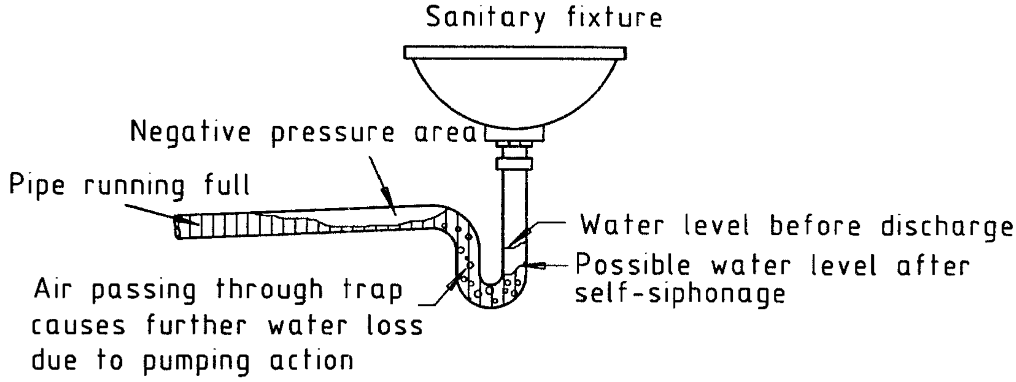
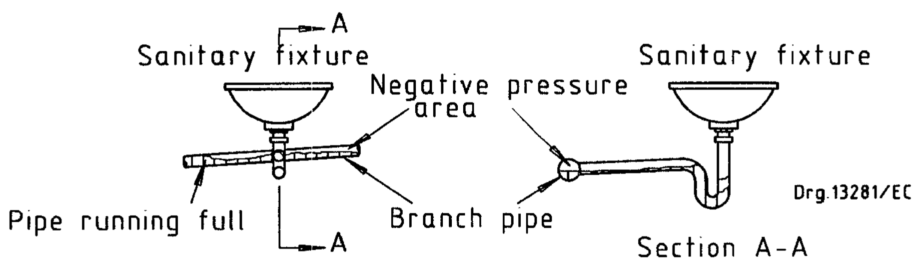


Figure A.2 — Pressure effects that may change the depth of water in the sanitary fixture traps

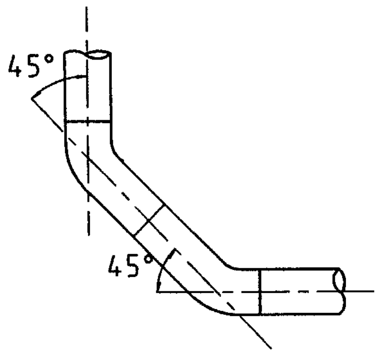


a) Self-siphonage (at the end of a fixture discharge)

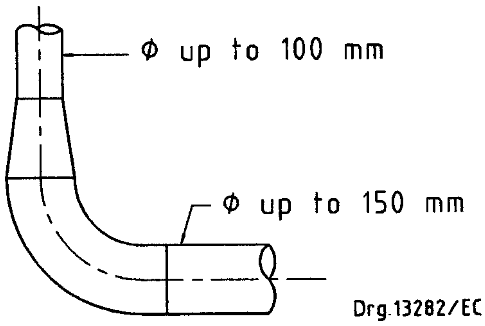


b) Induced siphonage (due to full-bore flow in the main branch discharge pipe)

Figure A.3 — Seal loss due to flow in branches



a) Two 45° bends (recommended)



b) Enlargement of the bend (can lead to oversizing of the drain)

Figure A.4 — Bend at base of discharge stack

A.1.5 Flow

The flow regime in drainage pipes is a very complex mixture of solids, fluid and air. It can therefore not be described in general hydraulic and pneumatic terms. An empirical approach is usually followed, based on the premise that pressure fluctuations in the piping should not exceed a water gauge of 38 mm above or below the external air pressure, in order to retain at least 25 mm of water seal in sanitary fixture traps, under the worst likely discharge conditions.

For design purposes and for convenience, it is best (because of their different performance characteristics) to consider separately the effect of flow in branch discharge pipes, discharge stacks and drains, with reference to figure A.2. Flow in sanitary pipes is intermittent, even when they serve a large number of fixtures.

Flow in a pipe is normally of a wave form close to the point of connection of a pipe that discharges to it. As a wave travels along any pipe, its velocity and depth decrease. The above attenuation depends on many factors, such as

a) the hydraulic load carried by the pipe, which is determined by the number, type, distribution and usage patterns of fixtures connected or discharging to the pipe,

b) the size, length and gradient of the pipe itself,

c) the position and design of the pipe fittings, particularly bends and the shape and size of inlets from other pipes discharging to such pipe,

d) whether the pipe is ventilated, and if so, the way in which it is ventilated,

e) the design features of the sanitary fixtures discharging to the pipe, such as shape, e.g. funnel-shaped fixtures increase the chance of self-siphonage,

f) the shape and design features of sanitary fixture traps, e.g. the grid design and the cross-sectional area of the outlet, and

g) the presence of fixture overflow pipes when they are connected to the fixture outlet or to the fixture trap.

As with pipes, flow in drains is intermittent even when they serve large numbers of sanitary fixtures. The discharge flow in a branch drain is normally of wave form close to the point of connection of a discharge stack or fixture, especially a WC pan. As the wave travels along the drain, its velocity and depth decrease, the attenuation depending on the volume of flow, the gradient, bore, hydraulic roughness of the drain and the presence of pipe fittings. It could also be affected by simultaneous discharges from other fixtures connected to the installation. The probability theory is used to estimate the design peak flow rates from fixtures and for other design purposes. Flow through the drain is normally assumed to be steady without attenuation, although it does not reflect the above flow conditions. (See also 4.4.4.)

Drain sizes and gradients determined in accordance with 6.3.2 result in adequate pipe sizes at positions of maximum flow depth. However, some oversizing downstream of connections in installations with long pipe runs could result. This is usually acceptable in that it provides a factor of safety and enables future connections to be made without causing surcharge. Drainage installations of dwelling houses are usually overdesigned since the standard size WC pan necessitates a minimum diameter of 100 mm for drains at outlets because of the provision that no branch pipe or drain may be narrower than the outlet of any sanitary fixture discharging into it.

Figure A.5 can be used as a design chart for drains and provides the fixture unit loadings that can be carried by pipes of various diameters at various gradients. Figure A.6 illustrates the relationship between flows expressed in terms of litres per minute (L/min) and fixture units.

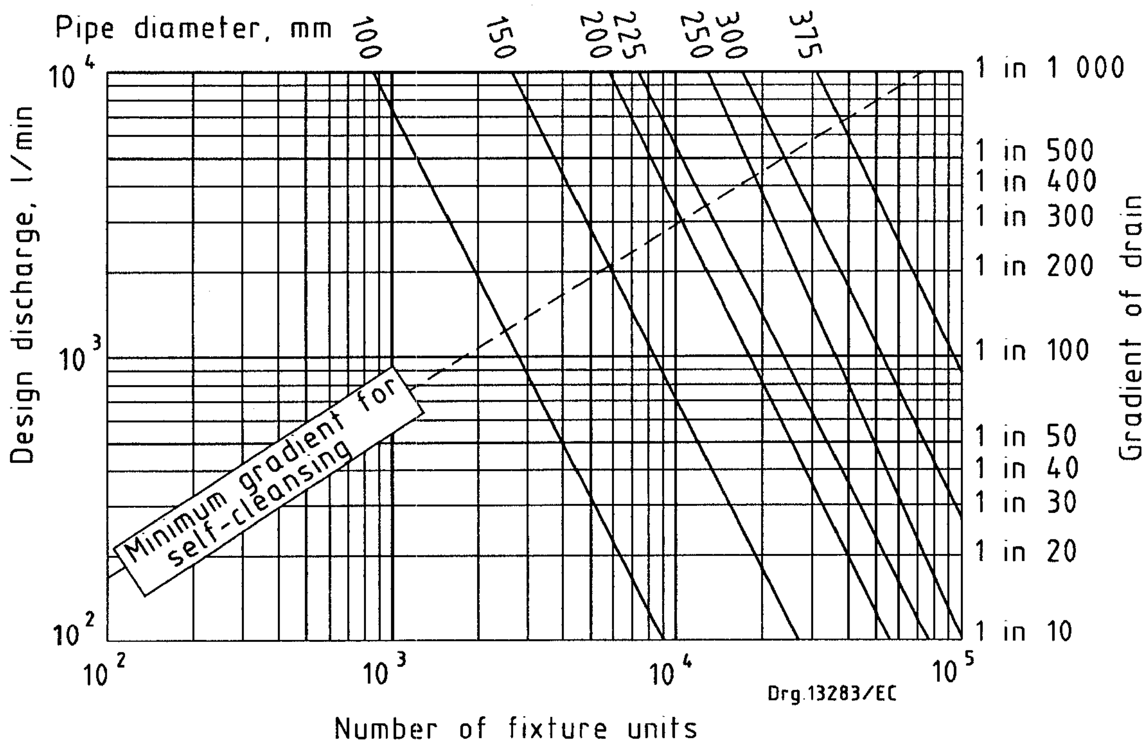
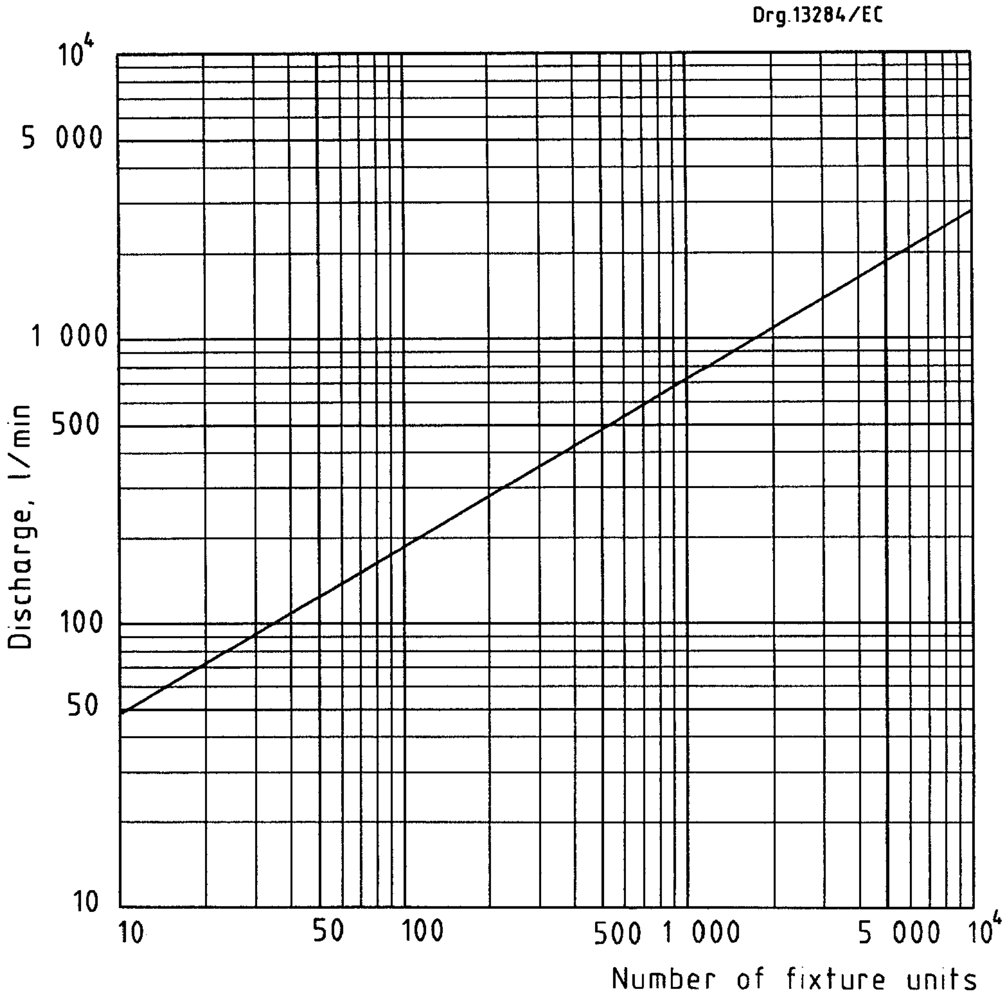


Figure A.5 — Design chart for drains



NOTE - Discharge equals 12,14 x $F^{0,585}$, where *F* is the number of units.

Figure A.6 — Relationship between fixture units and flow, in litres per minute

A.1.6 Ventilation pipes

A.1.6.1 General

Ventilation pipes lead to open air at their highest point and provide ventilation throughout a drainage installation for the purpose of preventing the destruction of water seals. Venting of installations with ventilation pipes and trap vents is needed to ensure that air pressures in pipes are not appreciably greater, or less, than atmospheric pressure so as to prevent trap seals from being reduced in depth, or even from being drawn out completely. The various types of ventilation pipes are illustrated in figure 23.

A.1.6.2 Trap vents, back vents and branch vents

The circumstances in which a trap vent has to be provided are set out in 6.4.1. Trap vents have to be connected to a fixture discharge pipe on the outlet side in accordance with 6.7.5.7 (see figure A.7). They should be so installed that they have a continuous fall back into the branch discharge pipe, to safeguard the movement of air through the vent system, to minimize the risk of internal corrosion and to prevent the possibility of condensation waterlock. An exception is the venting method shown in figure A.7(c), in which the fall is towards the vent stack. Trap vents and branch vents have to be sized in accordance with 6.4.3.

A.1.6.3 Ventilation pipes and stack vents

In a single-stack system where the stack extends to open air, the whole stack (including both the "wet" and "dry" portions) may be defined as a "ventilation pipe", while only the "dry" vertical portion of the stack that extends to the atmosphere is referred to as a stack vent. The stack vent acts as the main vertical ventilation pipe of the installation or of part of the installation, as the case may be. Since a discharge stack on a single-stack installation serves both as the main discharge component and the ventilation component of the system, a supplementary stack vent may be incorporated into the design to provide supplementary dry-venting of the discharge stack when its wet-vented capacity is exceeded. Offsets and bends in the "dry" portion of any ventilation pipe (offsets and bends above the topmost branch connection to a stack) do not adversely affect the performance of the ventilation pipe.

Ventilation pipes have to be provided and sized in accordance with 6.4.2 and 6.4.3, respectively.

A discharge stack on a single-stack installation has to be carried upwards, without any reduction in diameter, to form a stack vent, unless such discharge stack is a stub stack (see 6.2.3.1(f) and 6.7.5.6(a)). Any stub stack that requires venting on a closed-drainage system should be ventilated with a ventilation pipe of diameter at least 40 mm, fitted as an offshoot to the stack, as illustrated in figure 29.

A.1.6.4 Supplementary stack vents

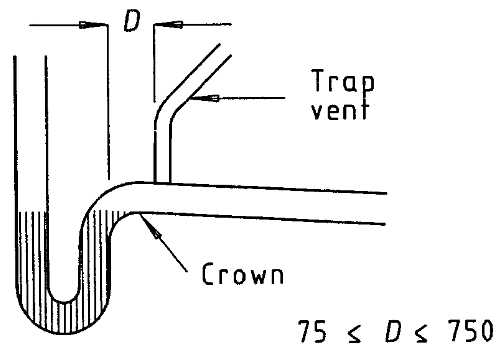
Supplementary stack vents on single-stack installations have to be provided and sized in accordance with 6.2.3.2(e) and 6.4.3.2(d), respectively (see figure 12 and figure A.8). Any supplementary stack vent has to be cross-connected in accordance with 6.2.3.1(e). Any such cross-connection has to slope upwards from the discharge stack, as illustrated in figure A.9, to prevent discharge water from entering the vent system. Where any supplementary stack vent is installed adjacent to a discharge stack, the lowest end of the stack vent has to be connected to the discharge stack at, or below, the lowest branch discharge pipe connection (see 6.7.5.10 and figure A.10) in order to prevent the possibility of a condensation waterlock. The upper end of the stack vent has to be connected to the discharge stack at a distance of at least 150 mm above the spillover level of the topmost sanitary fixture discharging to such stack (see 6.4.3.2(d) and figure 25), unless it passes through the roof to the atmosphere.

A.1.6.5 Ventilation pipe outlets

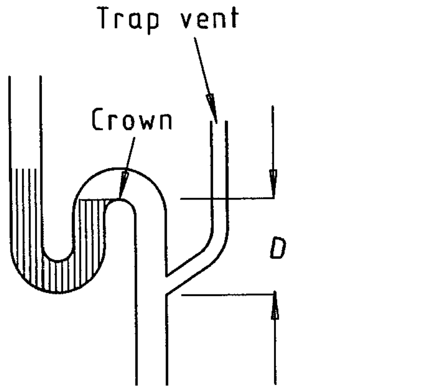
Since wind blowing across roofs can produce pressure fluctuations in the vicinity of parapets and corners of buildings, the outlets of ventilation pipes to the atmosphere have to be carefully positioned (see figure 32 and 6.7.5.6), to prevent foul air from entering buildings. Guards, dome cages or other covers fitted to the outlets of stack vents should not unduly restrict the flow of air.

Pipe vent valves can be used to provide controlled ventilation in accordance with 6.4.2.2. The use and positioning of vent valves that provide pressure relief should be carefully considered, to ensure that foul air does not cause inconvenience or a health hazard. In terms of 6.4.2.2(a), any drainage installation has to have at least one ventilation pipe that provides both pressure and vacuum relief. (See 6.7.5.7 regarding the installation of vent valves.)

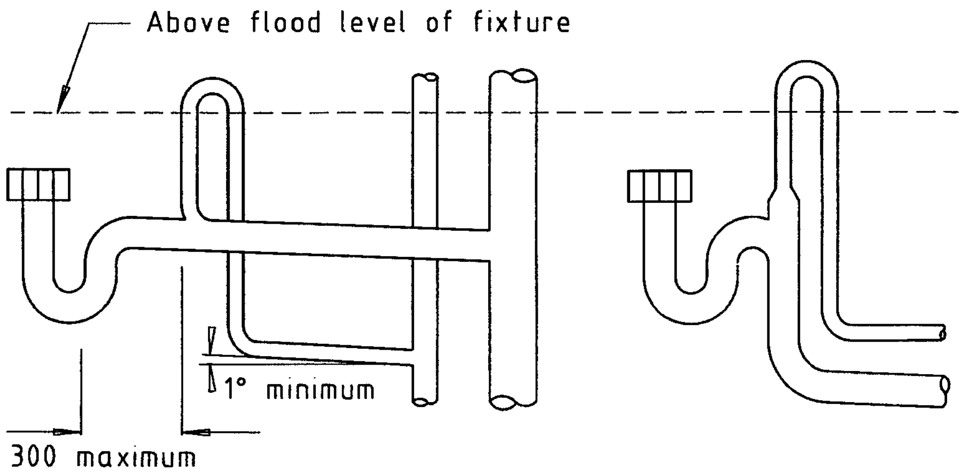
Dimensions in millimetres



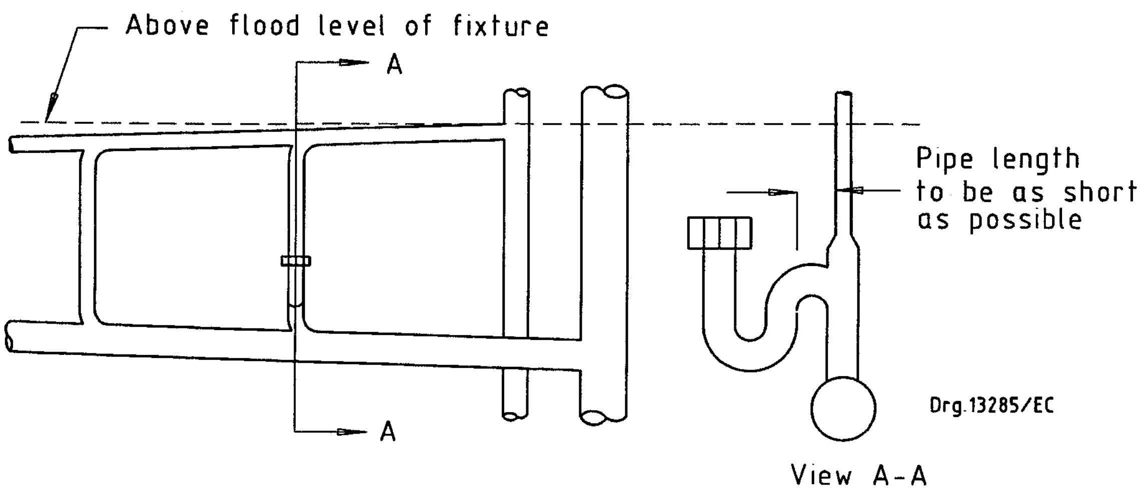
a) Trap vent to "P" trap



b) Trap vent to "S" trap



c) Trap vent to a "P" trap to avoid unsightly pipes



d) Trap vents to ranges of sanitary fixtures

Figure A.7 — Connection of trap vents

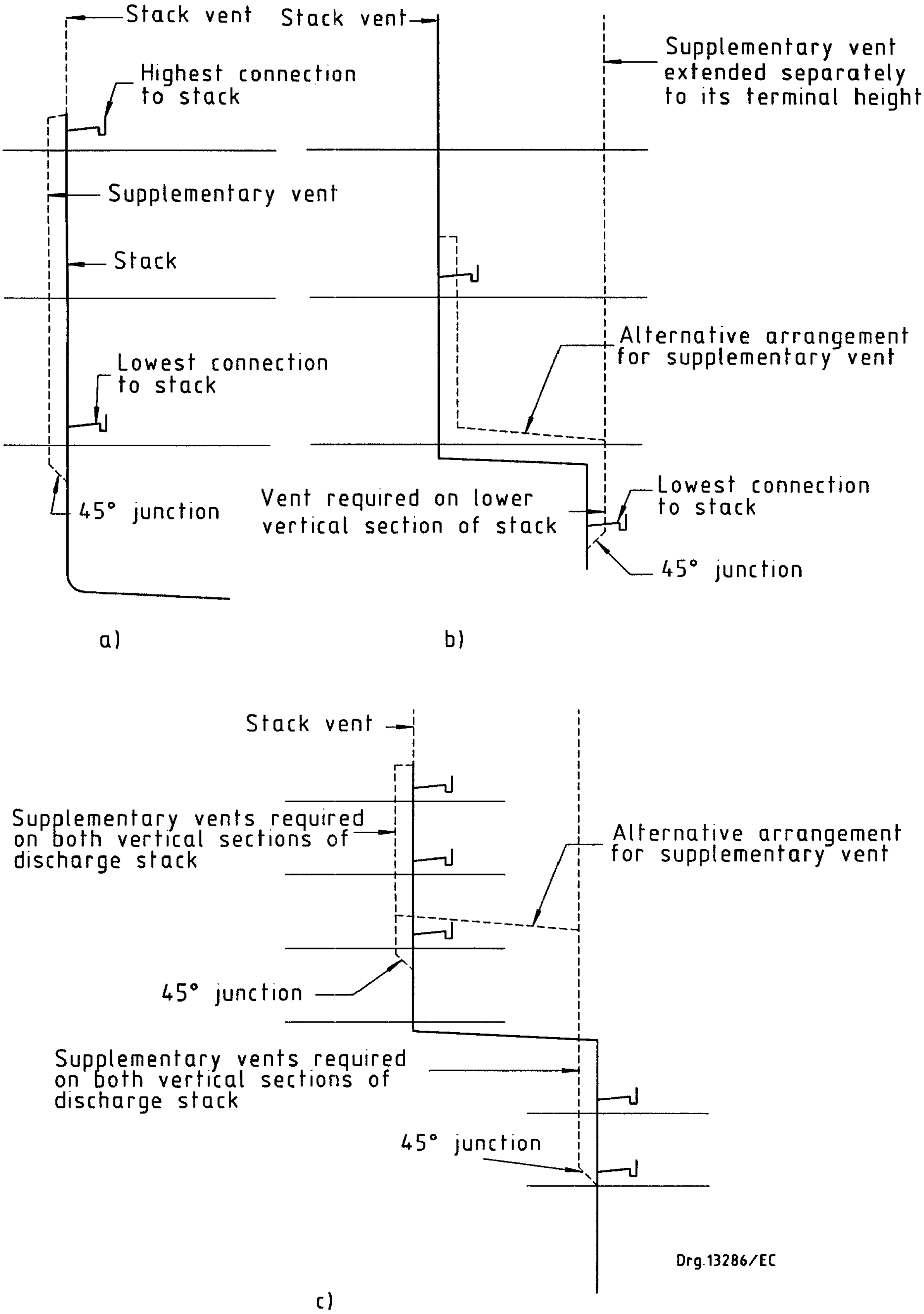
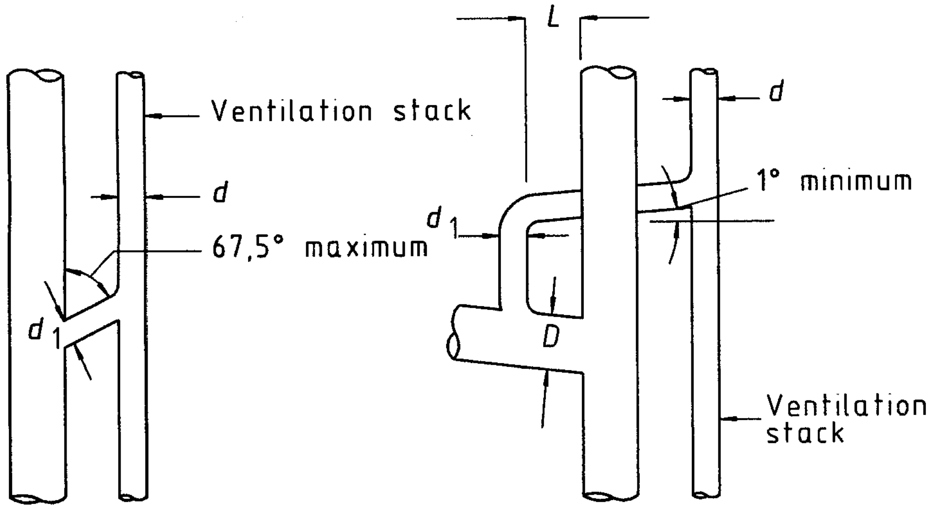


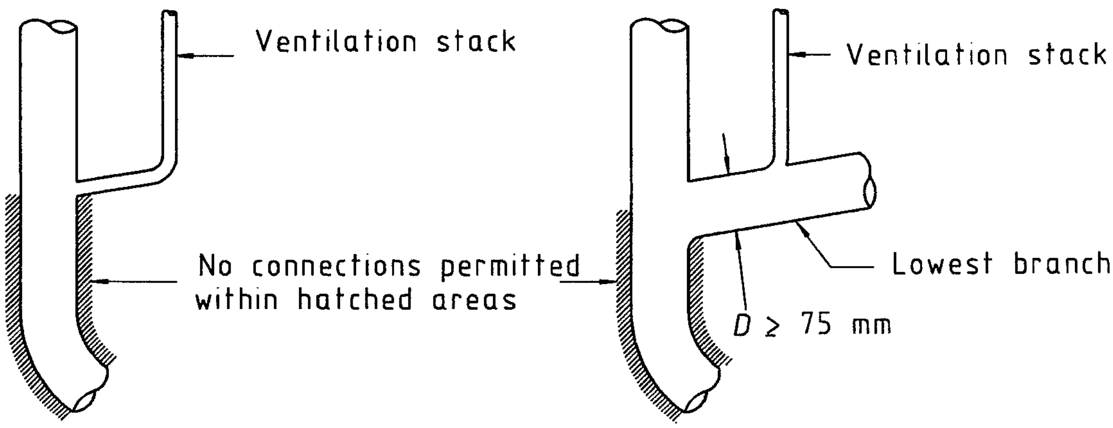
Figure A.8 — Typical supplementary vent requirements



a) Method (a)   b) Method (b)

NOTES
1 $d_1 = d$
2 $D > 75$ mm (if $d < 50$ mm, method (b) is preferable)
3 L to be as small as practicable

Figure A.9 — Typical installation of cross-connections for stack between floors, etc.



Drg.13288/EC

Figure A.10 — Cross-connection at bottom of stacks

A.1.7 Direct connections to drains

A.1.7.1 General

Direct connections to a drain for individual fixtures, or for stub stacks, should only be made when the drain is adequately ventilated, to safeguard trap seals.

A.1.7.2 Gullies

Any drainage installation has to be provided with one gully (see 6.6.3.1), mainly to serve as a telltale of blockages downstream. It may be desirable to provide more gullies in extended installations. When stub stacks are used, the overflow gully should preferably be provided at the lowest stub stack in the installation. Where dished gullies are provided, special care has to be taken to prevent the ingress of rainwater into the drain, since open gullies often contribute largely to high flows in sewers in wet weather. The general use of open gullies for connecting branch discharge pipes indirectly to drains is not recommended.

In the case of discharge pipes from individual sanitary fixtures to gullies, it is usually required that a certain length be vertical, or near vertical, and this can result in self-siphonage of trap seals and cause some noise. The former is not likely with baths and sinks, because the trail off at the end of discharges will refill the traps sufficiently. However, wash-hand basins may require venting. In suitable circumstances, resealing traps can be fitted to overcome the problem of self-siphonage. Noisy discharges can only be prevented by venting.

A.1.7.3 WC pan connections

A WC pan can be connected direct to a drain and individual venting of its trap is not required, provided that the vertical distance from the crown of the trap to the invert of the drain does not exceed 1,5 m.

A.1.7.4 Stub stacks

In the case of single-storey buildings, a short, straight, 100 mm discharge stack, with the top closed by an access fitting, can be used to connect sanitary fixtures such as baths, wash-hand basins, sinks, washing machines and WC pans to a drain. The same applies to ground floor sanitary fixtures in buildings where it is considered undesirable to connect them to a main discharge stack because of the effects of positive pressure at the base of the stack.

A.1.8 Branch and fixture discharge pipes

A.1.8.1 Pipe sizes and gradients

Branch pipe sizes and gradients that are interrelated have to be determined in accordance with 6.3.3. They have to be installed in accordance with 6.7.5 and their diameter may not be reduced in the direction of flow. Oversizing of branch discharge pipes to avoid self-siphonage problems can be uneconomical and can lead to an increase in the rate of deposit accumulation. Pipe gradients, although usually tied to the standard deflection angles of pipe fittings, should be uniform and adequate to drain the pipe efficiently. Flat gradients are undesirable, since the adequate self-cleansing of pipes is only possible with high flow rates (e.g. flow rates of at least 2,5 L/s) and workmanship of a high standard.

A.1.8.2 Pipe lengths

Branch discharge pipes, especially those that serve wash-hand basins and urinals, should be kept as short as practicable, to reduce both self-siphonage effects and the accumulation of deposits. Branches of large diameter that serve WC pans present fewer problems in these respects.

A.1.8.3 Bends

Bends in fixture discharge pipes should be avoided, especially where the pipes serve wash-hand basins, since bends can cause blockages and increase the risk of self-siphonage. Where the use of bends is unavoidable, they should be of large radius. A branch discharge pipe that serves wash-hand basins or bidets should preferably have no more than two bends in the horizontal plane and two bends in the vertical plane. (See 6.2.3.3.(d) for installations in the closed-drainage system.) Discharge pipes that serve other sanitary fixtures should preferably have no more than two bends in the horizontal plane and three bends in the vertical plane.

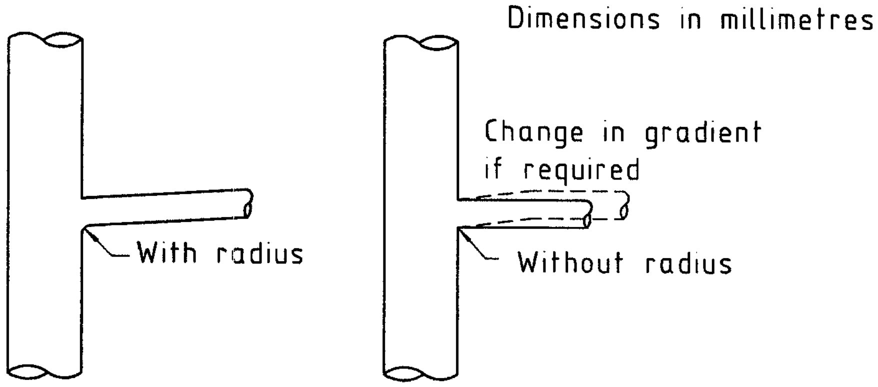
A.1.8.4 Branch pipe connections

The vertical distance between the invert of the lowest branch discharge pipe that is connected to a discharge stack (or to part of a vertical discharge stack) and the invert of the bend at the foot of the stack has to comply with 6.2.3.1(h), 6.2.3.1(i) and 6.2.3.1(j) (see figure 15).

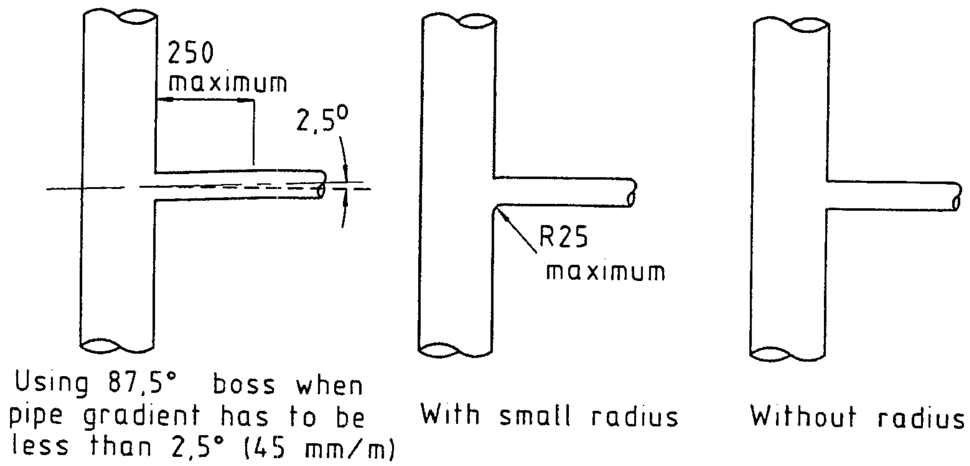
A branch or fixture discharge pipe in the single-stack system that joins a discharge stack of equal diameter has to be swept in the direction of flow in accordance with 6.2.3.1(l), or has to be at an angle of 45° or less. Branch discharge pipes of diameter not exceeding 65 mm can be connected to stacks of diameter 75 mm or larger, by swept or unswept branch connections, and some change in gradient close to the stack is permissible, to allow the use of a standard 87,5° branch boss (see figure A.11(a) and figure A.11(c)). However, 32 mm pipes that serve wash-hand basins should not have a sweep radius exceeding 25 mm (see figure A.11(b)) and the change in gradient should be within 250 mm of the stack.

Any junction between a fixture discharge pipe and a branch discharge pipe of approximately the same diameter should be swept in the direction of flow, using 45° branches (see figure A.12(a)) or using swept entry branches that have a root radius preferably equal to that of the smallest branch, but of at least 25 mm. To minimize the risk of blockage, fixture discharge pipes of diameter up to 40 mm that join a branch pipe of diameter 100 mm and larger should, if practicable, be connected to the upper part of the branch pipe wall. Where a wash-hand basin is connected to a common branch pipe, the shape of a T-junction fitting, unless swept in the direction of flow, can have a very detrimental effect on the performance of the branch pipe.

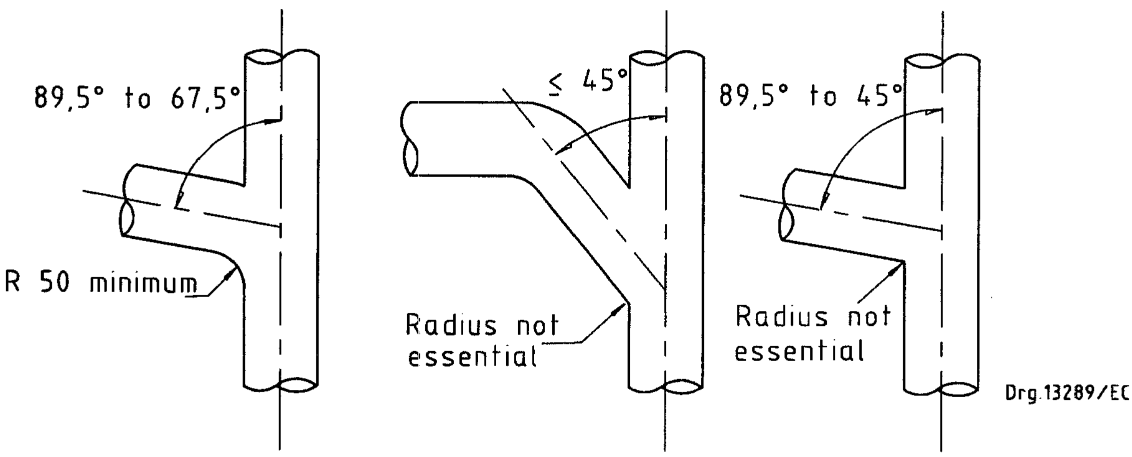
Opposed fixture branch discharge pipes that are connected to a branch in the horizontal plane should be so arranged that the risk of discharge from one fixture branch into the other is avoided, particularly if connections are made without swept entries. For the same reason, opposed branch connections to discharge stacks have to be made in accordance with 6.2.3.1(k) (see figure 16).



a) For branch discharge pipes of up to 65 mm in diameter
(except 32 mm branches serving wash-hand basins)

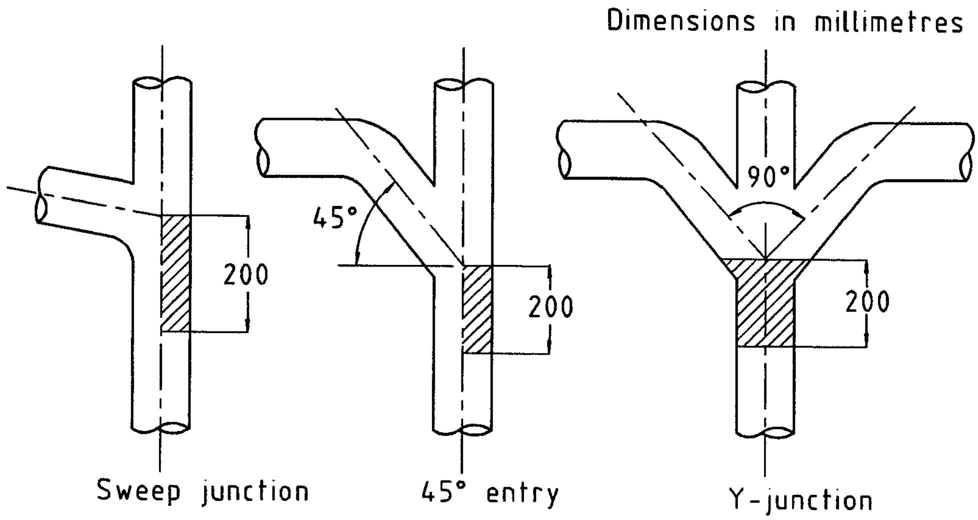


b) For branch discharge pipes of 32 mm diameter serving wash-hand basins



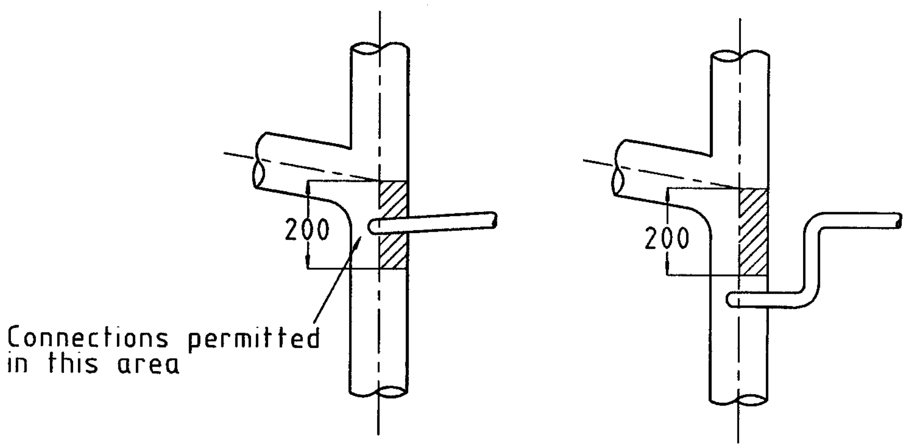
c) For branch discharge pipes of 75 mm to 150 mm diameter
(connected to stacks of up to 150 mm in diameter)

Figure A.11 — Branch discharge pipe connections

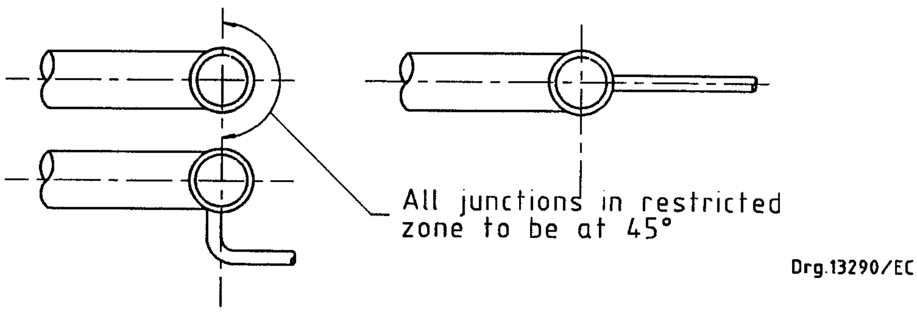


NOTE — No opposed connections permitted within hatched areas

a) Forms of opposed connections to stacks in restricted zone



NOTE — No connections permitted within hatched areas



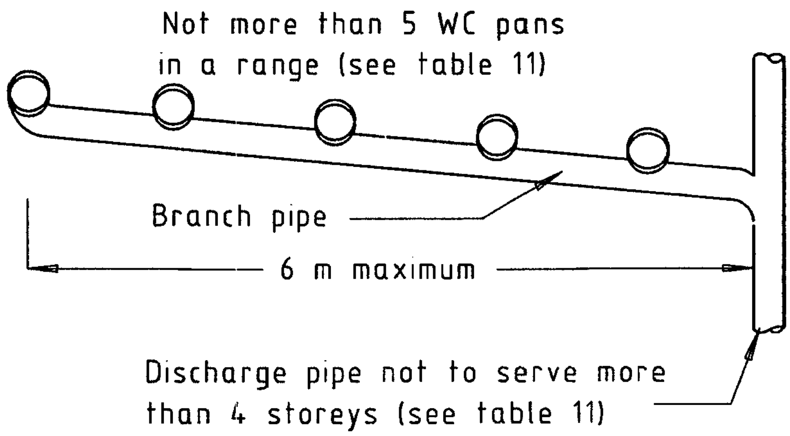
b) Connections in or near the restricted zone

Figure A.12 — Forms of connections to stacks

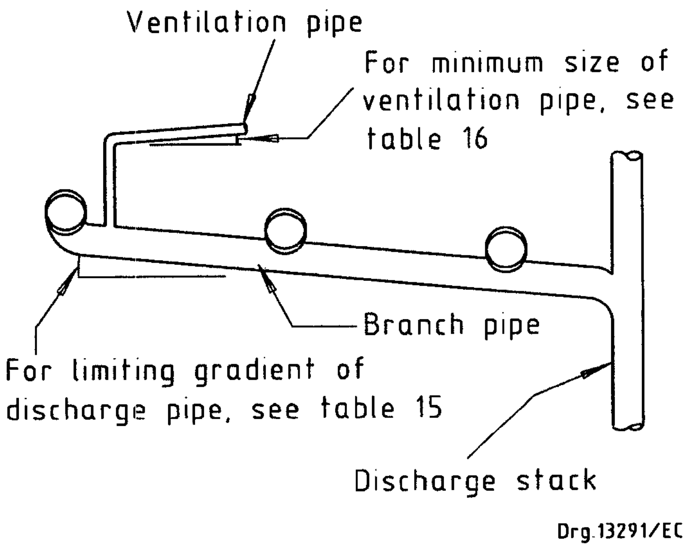
A.2 Commonly used pipework arrangements

A.2.1 Water closet pipework

Figure 19(a) illustrates the circumstances in which a trap vent to a single WC pan on the fully ventilated (one-pipe) system has to be provided (see 6.4.1.1). Any WC pan branch pipe that requires venting should be vented as shown in figure A.13(b), unless it is vented in accordance with 6.7.5.7. A branch that serves a range of not more than five WC pans that discharge to a discharge stack up to four storeys in height (see figure A.13(a)) does not normally require venting, provided that the length of the branch does not exceed 6 m. To reduce the risk of blockages, a WC pan discharge pipe or any common branch pipe should be installed with not more than two large radius bends and should be graded within a range of 5° and 14° (see table 15).



a) Branch not requiring venting



b) Branch requiring venting

Figure A.13 — Branch serving a range of WC pans

A.2.2 Urinal pipework

A stack that carries discharges from urinals only is likely to become rapidly encrusted with sediment, and special attention to access and regular cleaning is necessary. It is advantageous to connect other sanitary fixtures, such as WC pans and hot-water discharges, to a urinal stack to reduce this encrustation.

Branch pipes of diameter 40 mm that serve single urinal bowls are unlikely to run full bore but, should siphonage occur, the trail off at the end of the discharge will refill the trap, making venting unnecessary. Venting is normally not required, provided that not more than 4 urinals are provided in a range (see figure A.14) that is served by a common branch discharge to, for example, a stub stack and provided that the

a) length of the discharge pipework (that is, the length of the branch pipe plus that of the fixture discharge pipe), measured from the outlet of the trap of any one of the urinals to its connection to a discharge stack, does not exceed 6 m, and

b) height measured from the outlet of the trap of any one of the urinals to the invert of the bend at the foot of the stack does not exceed 2 m.

The urinal discharge pipe should not contain more than one bend and the common discharge pipe should be installed with not more than two bends. Because of build-up of sediment deposits, the length of urinal branches should preferably not exceed 2,5 m.

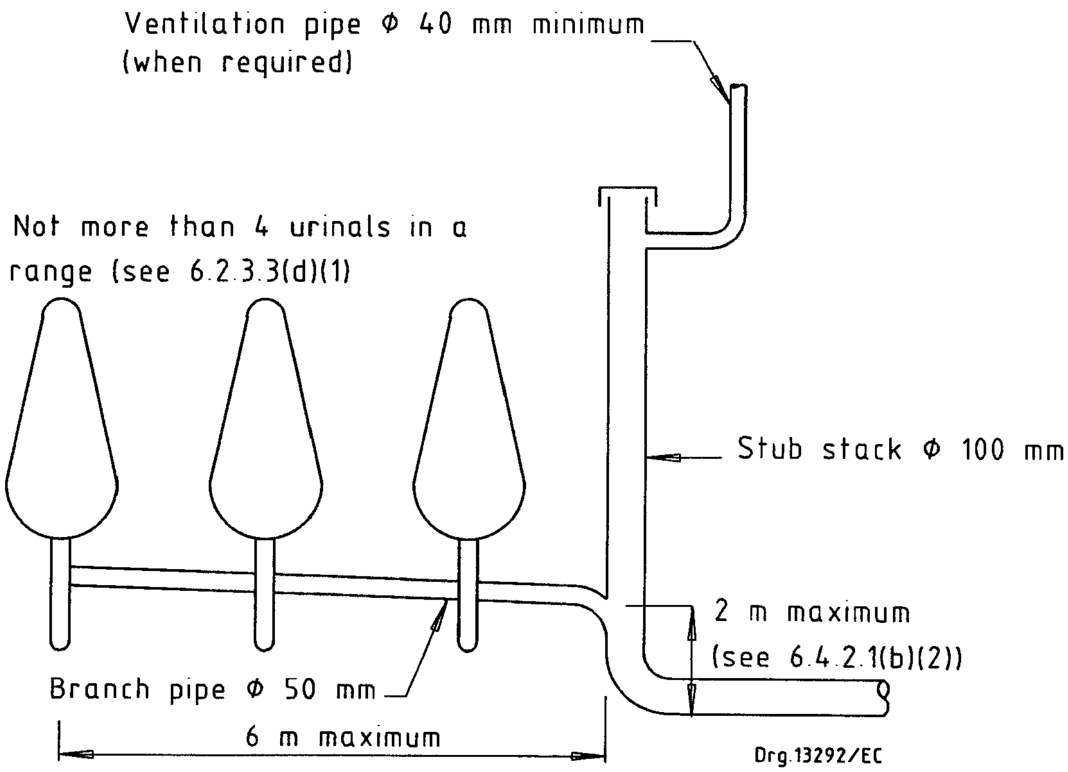


Figure A.14 — Urinal branch discharging to a stub stack

A.2.3 Discharge stacks that serve sinks and basins

In some layouts of multistorey flats, it may be convenient to connect the kitchen sinks to a separate stack. This arrangement can give rise to very heavy stack deposits (especially if the water is soft), which will require frequent removal if partial blockage is to be avoided. If such an arrangement cannot be avoided, ready access to the stack should be provided and regular maintenance arranged. Since a sink has to be fitted with a discharge pipe of diameter at least 40 mm (see 6.3.3.1(c)) and because a sink normally has a flat bottom, self-siphonage does not become a problem, since the trap seal is replenished at the end of the discharge. Therefore, the length and slope of a discharge pipe that serves a sink is not so critical. However, it is recommended that its length not exceed 3 m, in order to reduce the likelihood of blockage from deposits. The same criteria apply to a discharge pipe that serves a bath.

Branch discharge pipes that serve wash-hand basins have to have an inside diameter of at least 32 mm (see 6.3.3.1(c)). However, for installations in the single-stack system (see figure A.15 and figure A.16), the branch discharge pipes have to have an inside diameter of at least 40 mm (see 6.3.3.1(d)). The length and slope of the discharge pipe and the number of bends should be strictly controlled if venting is to be avoided. (For installations that discharge to stub stacks, see 6.2.3.2(b)(2)).

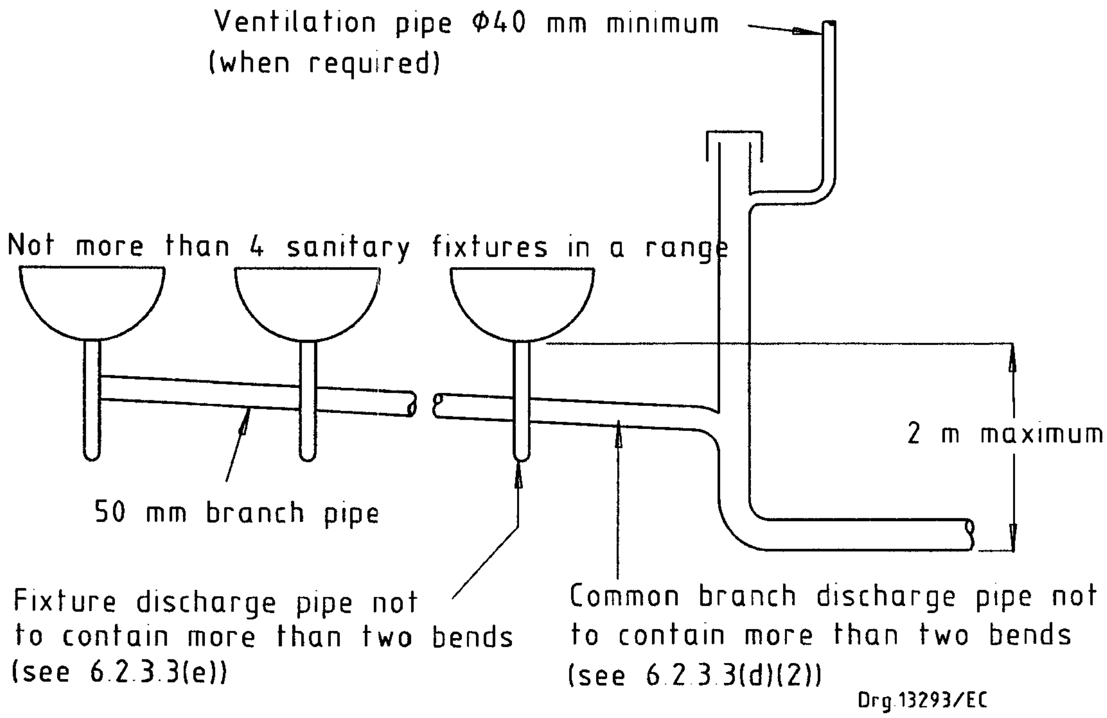
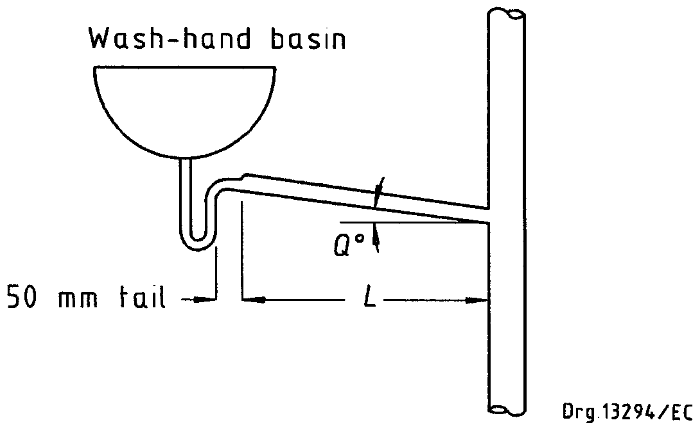


Figure A.15 — Range of wash-hand basins that discharge to a stub stack



NOTES
1 *Q* is between 1° and 2,5° (18 mm/m to 45 mm/m).
2 *L* is between 1,7 m and 3 m.
3 Trap of 75 mm depth and 32 mm diameter.
4 Recommendations are for wash-hand basins with overflow.
5 Up to two bends may be included in the branch pipe.
6 Branch pipe of 40 mm diameter.
7 The 32 mm to 40 mm reducer should be eccentric, its flat side facing downwards.

Figure A.16 — Single wash-hand basin that discharges to a stack

A.2.4 Food-waste macerators

Special precautions are necessary where food-waste macerators are connected to a discharge system, and if the manufacturers have provided any recommendations pertaining to the installation, these should be taken into consideration. A tubular (not a bottle or resealing) type trap, which is easily accessible for cleaning, should always be fitted. A discharge pipe from a food-waste macerator should be of diameter at least 40 mm for a household type and at least 50 mm for an industrial type, and should be as short as practicable, connecting direct to a drain or stack. The discharge pipe or stack should connect direct to a drain, without an intervening gully. The gradient of the discharge pipe should be at least 7,5° (135 mm/m) to the horizontal, although steeper gradients are advisable, and any bends should be of large radius. It is advantageous, especially in the case of industrial installations, if other sanitary fixtures can be connected to the discharge pipe upstream of the macerator connection, to assist with the discharge of the waste material.

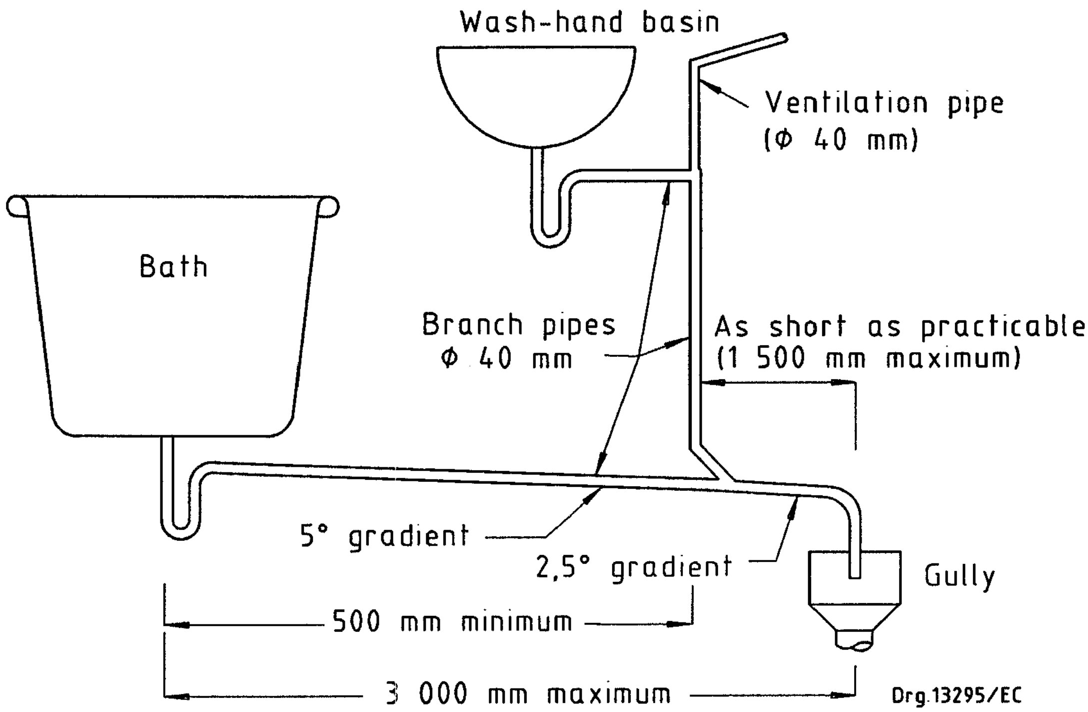
To avoid hot grease from being carried into discharge pipes and drains where it might build up and cause blockages, food-waste macerators should always be connected to a grease interceptor before the waste enters the drainage system. (See also 4.3.1 and 4.4.5.)

A.2.5 Sanitary-towel macerators

Special precautions are necessary where sanitary-towel macerators are connected to a discharge system, and if the manufacturers have provided any recommendations pertaining to the installation, these should be taken into consideration. A tubular (not a bottle or resealing) type trap, which is easily accessible for cleaning, should always be fitted. A discharge pipe from a sanitary-towel macerator should be of diameter at least 40 mm and should be as short as practicable, connecting direct to a main discharge pipe or stack. The discharge pipe or stack should connect direct to a drain, without an intervening gully. The gradient of the discharge pipe should be at least 3° (54 mm/m) to the horizontal, although steeper gradients are advisable, and any bends should be of large radius. It is advantageous if other sanitary fixtures can be connected to the discharge pipe upstream of the macerator connection, to assist with the discharge of the waste material.

A.2.6 Combined branches for bath and wash-hand basin

A common branch that serves a bath and wash-hand basin can be used, but self-siphonage and induced siphonage of the seals can occur, and water from the basin could back up into the bath if its arrangement is incorrectly designed. The use of such a common branch is therefore not recommended, since it is impossible to prescribe general design rules. The performance and behaviour of a particular layout or arrangement can only be determined from tests. However, the layout shown in figure A.17 has proved itself in practice to function satisfactorily.



NOTES

1 A bend in the horizontal plane can be included in the branch pipe that takes the discharge of the bath, provided that it has a minimum radius of 150 mm to its centre-line.

2 Any deviation from the dimensions (and limits) shown could cause self-siphonage or back flow into the bath.

3 Resealing traps can be used instead of venting, but noisy bath and wash-hand basin discharge could result.

Figure A.17 — Combined branch discharge pipe arrangement for a bath and wash-hand basin

A.2.7 Showers

Flow rates from showers are small, so the 40 mm discharge pipe that is usually fitted does not require venting. However, difficulties can arise in achieving a self-cleaning velocity, and adequate provision should be made for cleaning.

A.2.8 Domestic automatic washing machines and dishwashing machines

Requirements can vary slightly, but the arrangements shown in figure A.18 should suit most domestic automatic washing machines or dishwashing machines. A 40 mm diameter discharge pipe, which can be connected either direct to a discharge stack or gully, or to a sink branch pipe, is required. Normally a trap should either be fitted in the horizontal section of the discharge pipe, or a bottle type trap should be used, but this is not required for connections via the branch pipe, when made at the inlet of a sink trap and using a suitable fitting.

The arrangement in figure A.18(a) shows a loose connection between the machine drain hose and discharge pipe. In some machines, this air break is required to prevent the siphonage of water from the machine during operation. However, if the discharge pipe develops a blockage, water will overflow during the emptying cycle. This can also occur with the method shown in figure A.18(c). This disadvantage does not arise with the vented arrangement illustrated in figure A.18(b).

A.2.9 Floor drainage gullies

Branch pipes from floor gullies are normally of diameter at least 75 mm and do not generally run full. Consequently, venting is not normally required and the slope and length of the branch are not critical.

A.3 Access

A.3.1 General

A.3.1.1 Friction losses

Although specialist drain clearance firms use power-assisted drain clearance equipment that can cope with longer spacing between access points, the manual methods in common use determine the maximum allowable spacing between access points. Drain clearance rods are made from a variety of materials of different strengths and flexibility and it is important that the thrust on the rod result in sufficient force being transmitted to the blockage, to ensure clearance. The force exerted on the rod by the operator is subject to losses at the point of access where the rod buckles and rubs against the sides, and to similar losses along the length of the drain pipe itself.

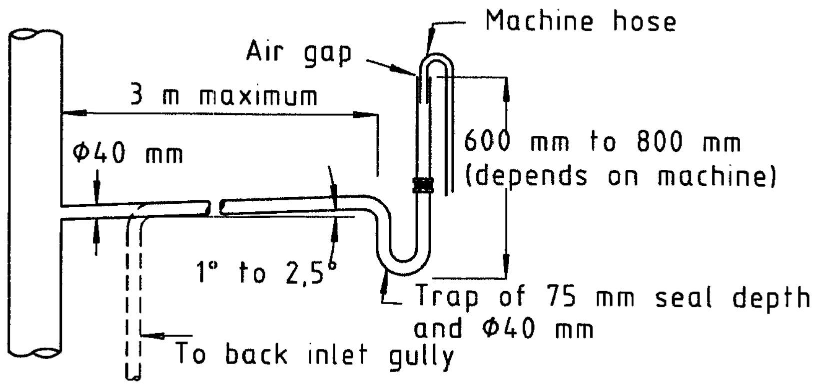
In general, the following apply:

a) rodding losses are about 1 % per metre of length in straight or in large-radius pipework of diameter 100 mm to 150 mm;

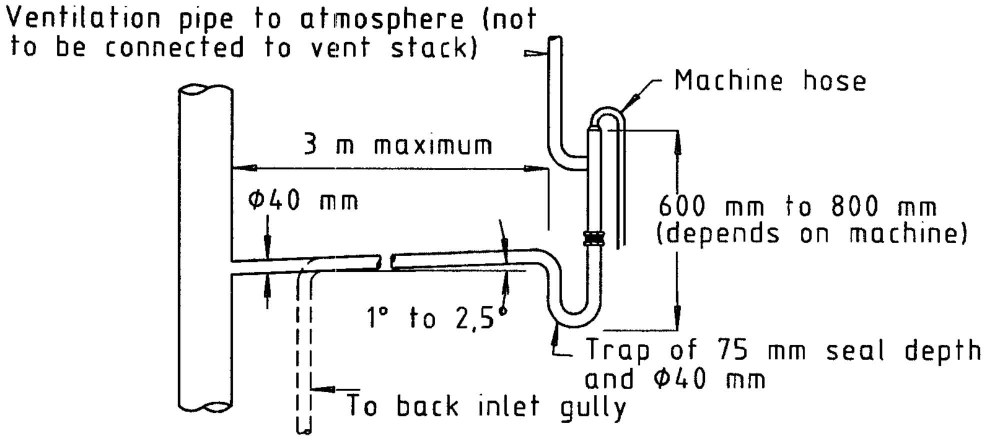
b) the pipe diameter does not have a large effect, nor does the rod material or its design; and

c) overall rodding losses in straight pipelines are similar to those in curved drain-lines of the same length and that are constructed of 150 mm diameter, plain-ended clayware in 5 m lengths, laid with a 1° deflection at each joint to produce a curved pipe run.

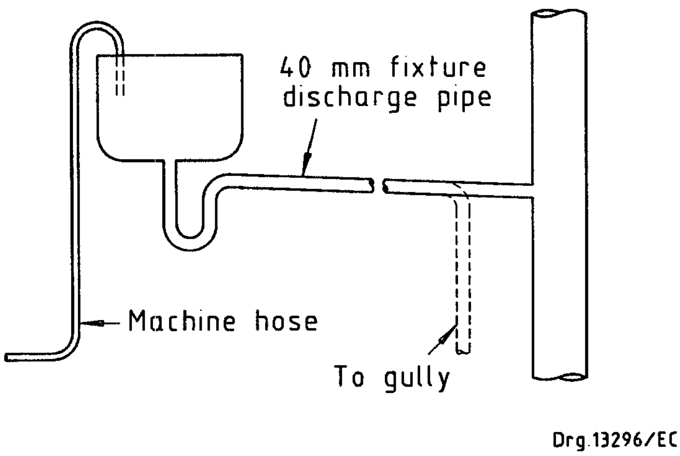
Rodding losses in inspection chambers and manholes increase as the depth and length of the chamber increase, probably owing to the changes in angular deflection of the rod within the chamber, and to frictional losses mainly on the invert of the channel and the vertical face of the chamber. In the case of an inspection chamber of depth 1 m and of length 0,45 m, for example, the rodding loss is about 25 % (when the operator is at ground level). In the case of a manhole of depth 1,5 m and of length 1,2 m, for example, the losses increase to about 45 % when the operator is at ground level, but are about zero when the operator is standing on the benching.



a) Without venting



b) With venting



c) Direct to sink

Figure A.18 — Branch pipes for washing machines and dishwashing machines

Losses in access fittings and rodding eyes are due to friction on the rods at the entry point to the fittings, and on the pipeline adjacent to the fitting. Losses at access fittings vary greatly with different types and sizes, from 10 % to over 50 %, with an average of about 40 %. However, rodding eyes at 45° to the drain run produce much lower losses (up to a maximum of about 25 %). Experience on site indicates that, generally, only a small residual force is required to break up a blockage.

A.3.1.2 Basic requirements

Easy access to pipes, particularly junctions and cleaning eyes, will result in reduced maintenance costs and minimum interference with the occupants and function of the building. However, poor design, poor construction and poor positioning of the access points are common causes of blockages. Whatever the form of access, a number of basic requirements should be met:

a) the access points should provide entry into the drains, for the release of blockages. The access points should be so positioned that no part of the drain is inaccessible to rodding equipment, even though various forms of water-jetting methods are widely used. Most blockages can be broken up by rodding and some of the debris is then usually carried away by the flow of the water trapped behind the blockage. Except for the very short lengths of drain adjacent to buildings where the water discharged from sanitary fixtures is usually sufficient for complete clearance, access should allow rodding in a downstream direction to facilitate the movement of the material lying in the invert of the drain to an access point;

b) there should be facilities along the drain for the physical removal of the debris that has not been carried away by the flow of water in the drain and that could become the cause of another blockage elsewhere. Such access should either allow someone to reach down into the drain from ground level, to remove debris or, for deeper systems, should allow actual entry into the drain;

c) the access should provide a means for occasional inspection of the functioning of a drain, so that complete blockage can be forestalled, or, should one occur, to establish the approximate position of the blockage. Such access also provides a means of inspection and testing of a drain during and after construction. At least one of the access points should be sufficiently large to insert and remove drain plugs for testing purposes; and

d) the access should not be the cause of any health hazard, either to the occupants of the building, or to anyone maintaining the drains. Covers should be close fitting and, where possible, airtight.

Generally, access within a building should be avoided, since drain clearance through such internal fittings leads to contamination of surrounding areas and to possibly objectionable, although not necessarily dangerous, odours. The possibility of removing a WC pan to gain access for the clearing of difficult blockages should only be relied on as a last resort.

A.3.2 Type of access

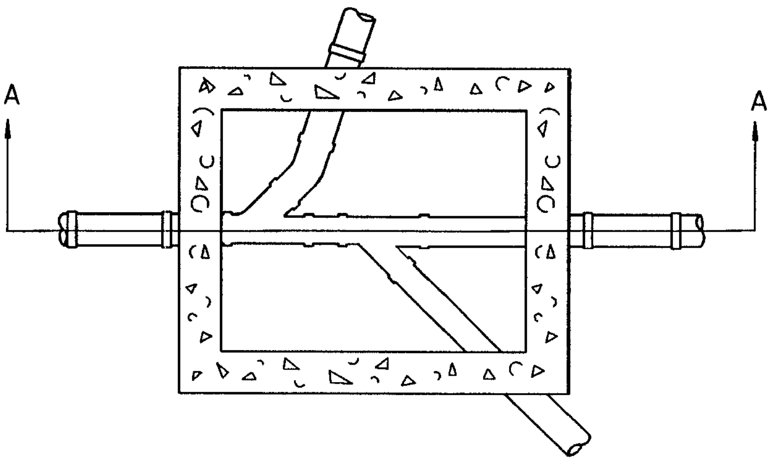
A.3.2.1 Rodding eyes

A rodding eye is a pipe fitting that is accessible from surface level, and that has a removable, sealed cover, to enable the clearance of obstructions in one direction by rodding along the drain. Typical arrangements of rodding eyes are illustrated in figure 27.

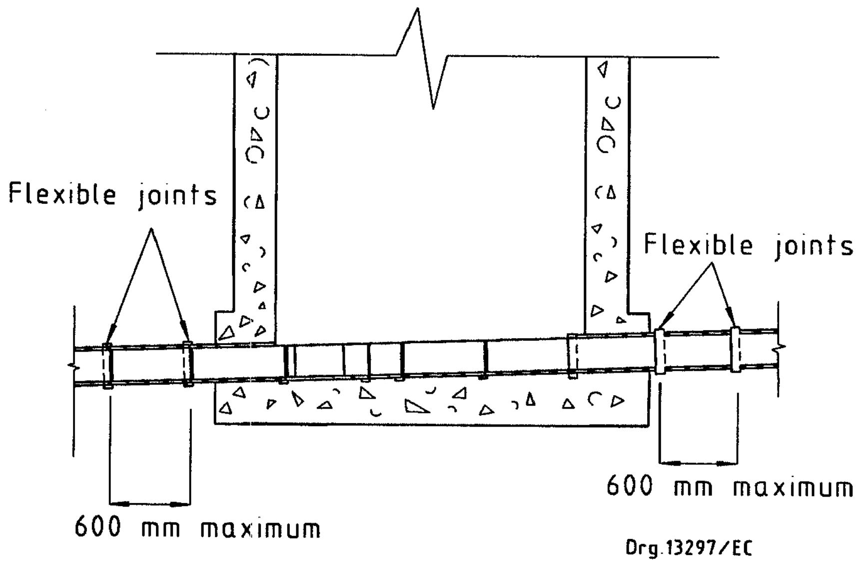
Rodding eyes are essentially extensions of the pipework system but they are used only for the insertion of cleaning equipment. They can be fitted to relatively deep drains. Rodding eyes, though part of the pipework and thus of limited dimensions, do provide additional facilities for the insertion of drain plugs for testing purposes, and can be used for the removal of some debris, although the small size of the opening is not ideal for this purpose. A buried depth of up to 0,6 m (approximately an arm's length) is the maximum depth at which these operations can be performed. Rodding eyes are sometimes used instead of open channels in inspection chambers or manholes where a sealed drainage installation is required.

A.3.2.2 Inspection chambers

Inspection chambers on a drain or sewer are normally constructed to provide access for inspection, testing, maintenance and clearance of obstructions, as well as for the removal of debris, in all instances operating from surface level. A typical inspection chamber is shown in figure A.19.



a) Plan

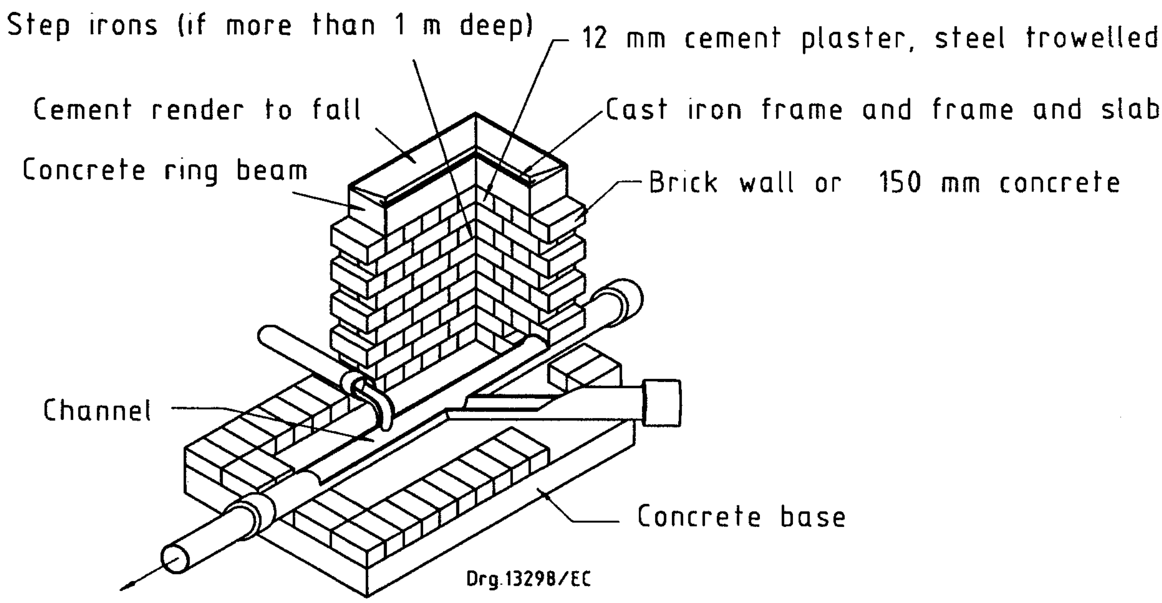


b) Section A-A

Figure A.19 — A typical inspection chamber

A.3.2.3 Manholes

Manholes that have removable covers permit the entry of a person for inspection, testing and maintenance, as well as the clearance of obstructions and removal of debris from drains. A typical manhole is shown in figure A.20. Manholes should be designed in accordance with SABS 1200-LD.



NOTE - Minimum dimensions are given in table 18.

Figure A.20 — Typical manhole

A.3.3 Siting of access

A.3.3.1 General

It is not always possible to prescribe definite rules on the positioning of access because so many factors affect the positioning, such as

a) the number of branch drains,

b) the drain layout,

c) the drain length,

d) the type of drainage installation, and

e) possible limitations on the use and positioning of some types of access.

A.3.3.2 Access sited close to the building

Traditionally, the two-pipe system is used in single-storey buildings. Soil-water fixtures connect direct to the drain by means of bends (see figure A.21), while waste-water fixtures discharge over a trapped gully (see figure A.22). Houses often have a discharge stack that serves the bathroom fixtures, while the kitchen fixtures discharge over a trapped gully. Points of access sited close to a building are largely governed by the position of sanitary fixtures.

Access fittings such as traps, elbows and T-pieces can normally meet all the necessary requirements close to the dwelling. Where possible, the installation should permit the removal or opening of all fixture traps. The bends of branch discharge pipes should be fitted with access eyes at strategic points. Elsewhere, large-radius bends without access eyes should be used. In the case of installations in a closed-drainage system, the cleaning eyes of stub stacks provide the normal means of access for the maintenance of drains.

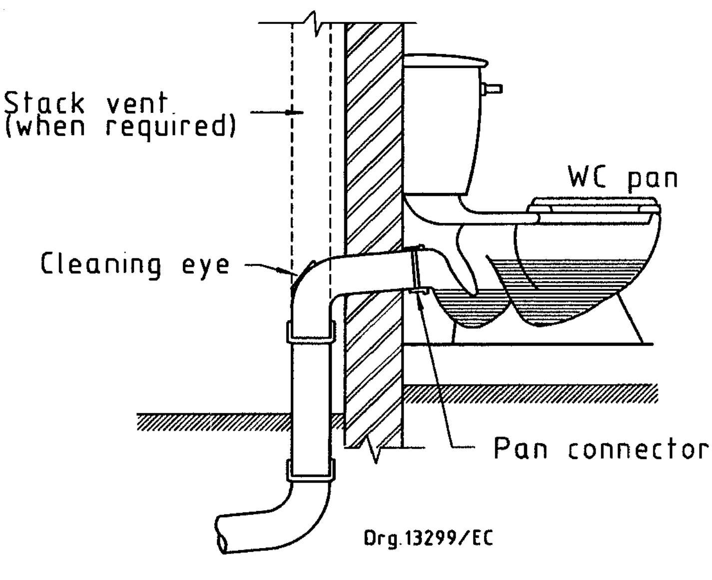


Figure A.21 — Typical ground floor soil fixture connected to a drain

A.3.3.3 Access at drain junctions

It is not always necessary to provide access at junctions, provided that all the pipes can be easily rodded from elsewhere. Where changes in direction of flow occur, any form of access in itself can be a cause of blockage. However, where access is required at junctions, it can be provided by means of access fittings, inspection chambers or manholes.

In the case of installations in a closed-drainage system, branch drains should be joined to the main drain with 45° plain junctions without inspection eyes. Where a branch drain and a drain meet at an angle of 90°, a connection as illustrated in figure A.23 should be used.

A.3.3.4 Access at changes in direction

It should not be necessary to provide access at all changes in direction, provided that the conditions prescribed in 6.5.1.3(a)) are met. At changes in drain direction, large-radius bends should be used as far as possible. When a short-radius 90° bend is required, access should be provided. Such access should be fitted with an integral access fitting, or a manhole/inspection chamber should be provided.

A.3.3.5 Access at the head of a drain

In terms of 6.5.1.3(e), a rodding eye has to be provided at the highest point of the drain not connected to a stub stack. Such access is normally adequate, since no provision is required for the removal of debris at this point. However, there should always be some form of access provided sufficiently close downstream to enable the rodded material to be removed.

A.3.3.6 Spacing of access

In terms of 6.5.1.3(c), rodding eyes have to be provided at such intervals along any drain that no rodding distance is more than 25 m, measured along the line of a drain from a rodding eye or other permanent means of access to such drain. The spacing recommendations given in table 17 generally assure that at least 50 % of the applied force used for rodding is available for breaking up of blockages, assuming rodding is performed from both ends of the drain. Where an inspection chamber or manhole is constructed with access fittings, the spacing requirements applicable are those that apply to the access fittings themselves.

Some guidance on the positioning of access in a closed-drainage installation is given in figure A.24 and general access requirements for drains below ground are given in figure A.25.

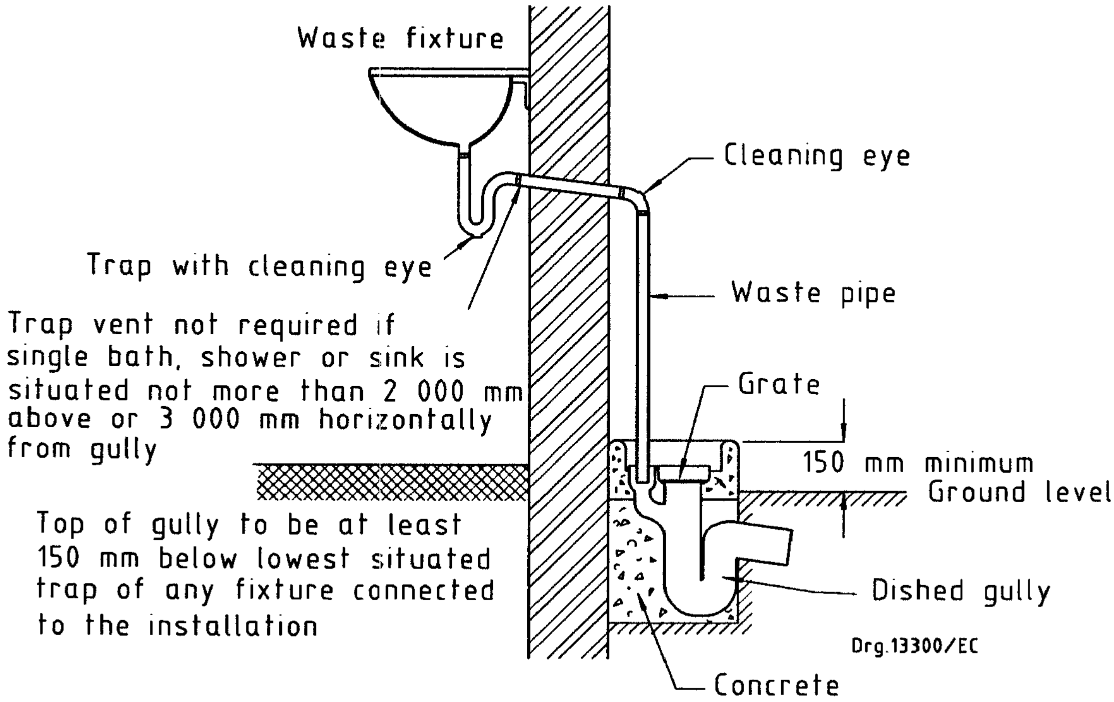


Figure A.22 — Typical discharge over a trapped gully

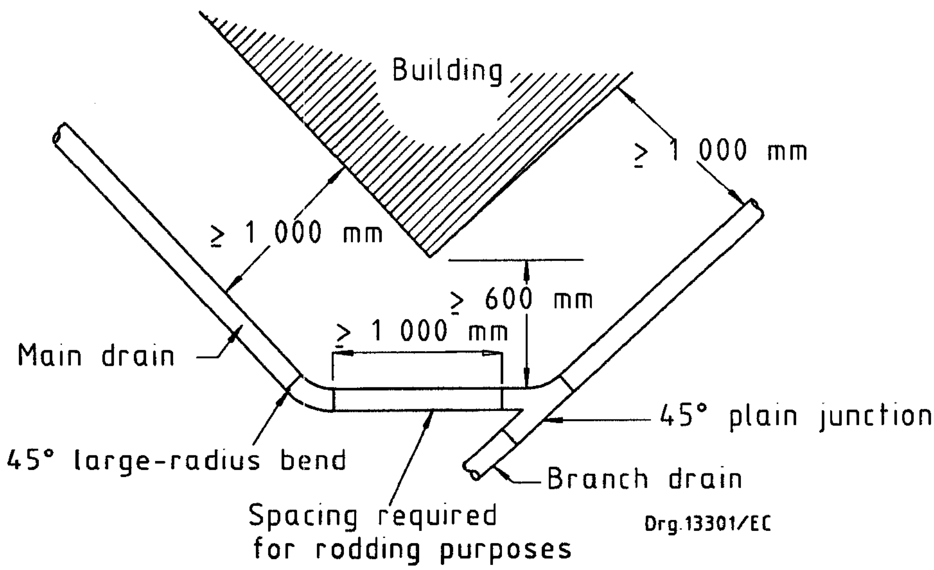
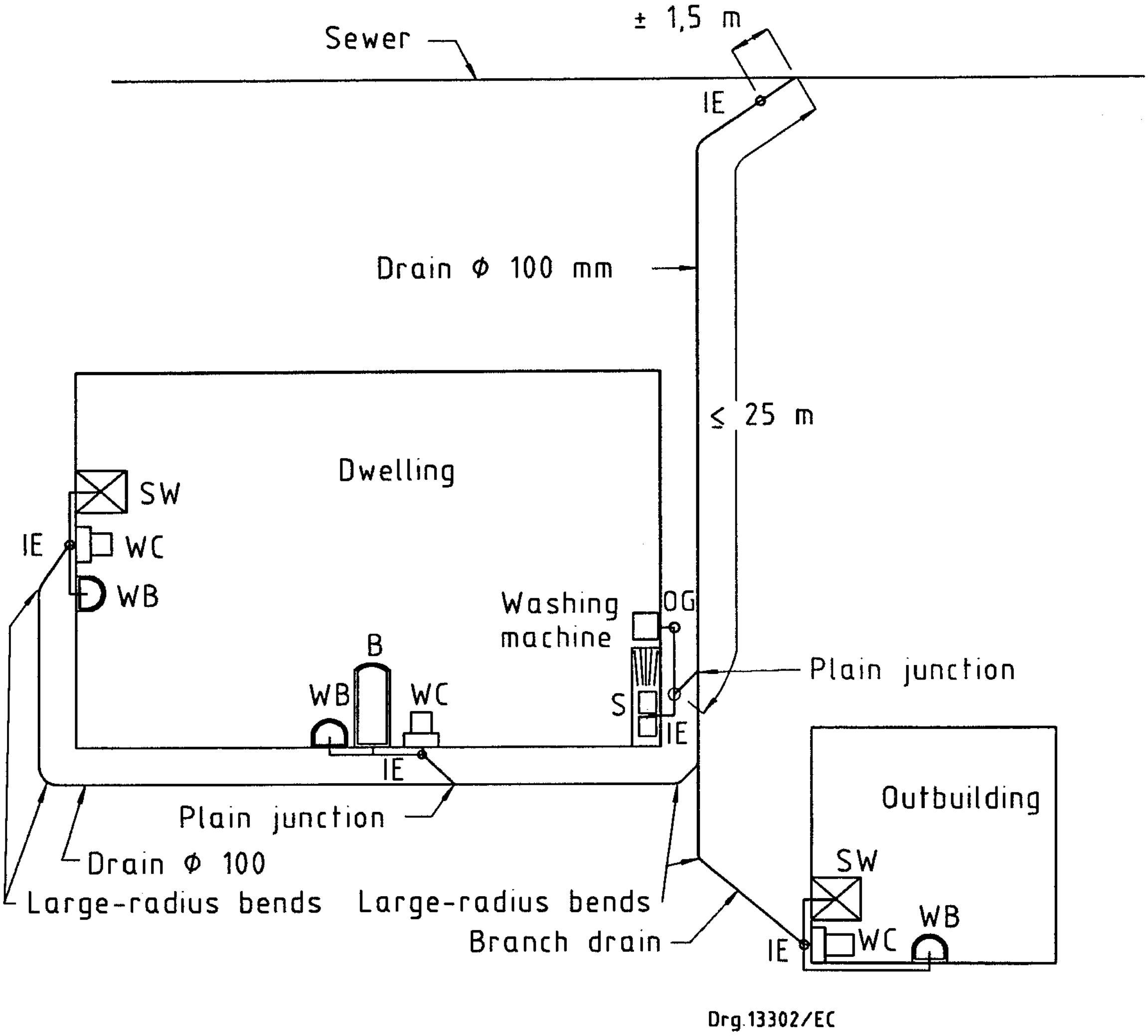
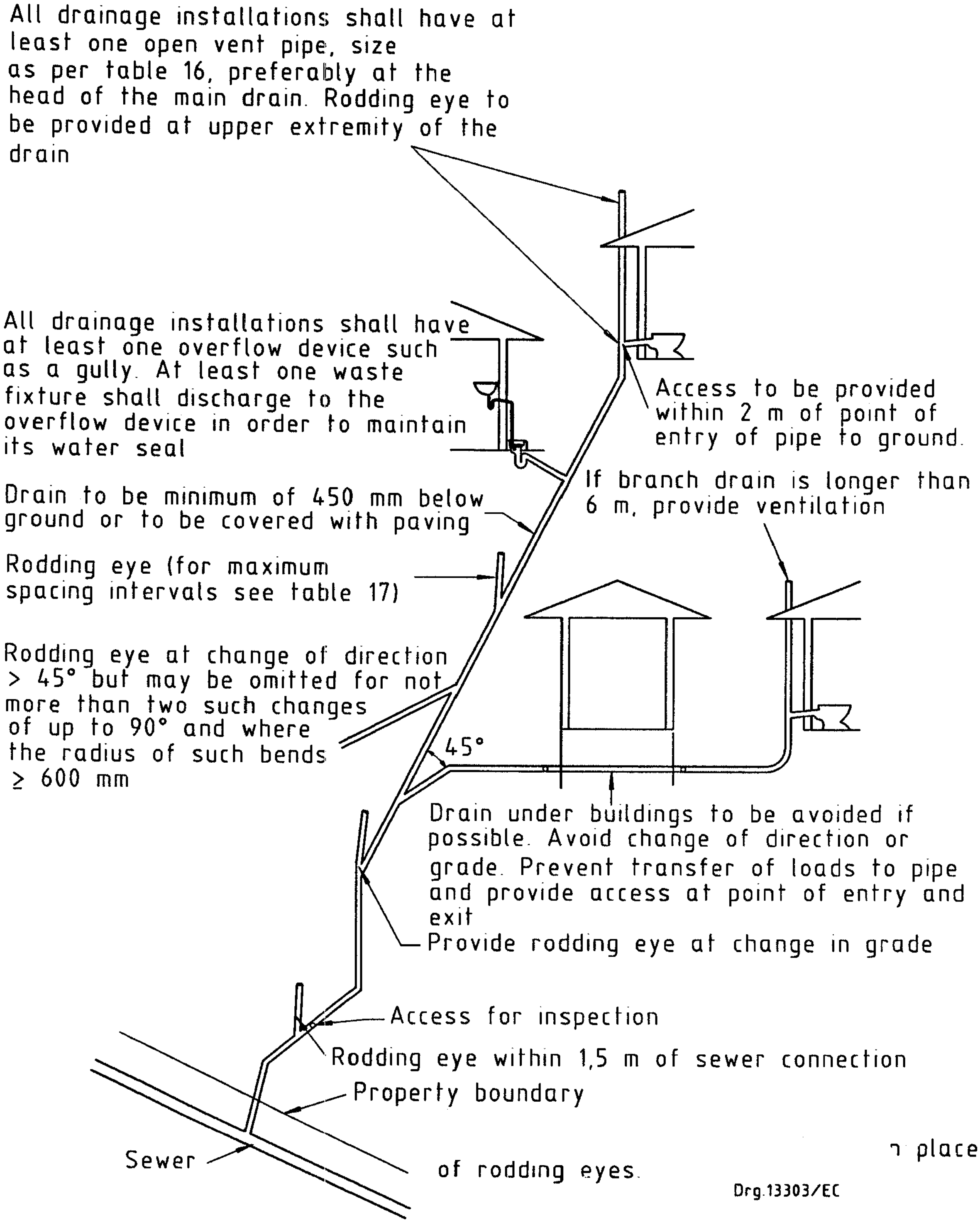


Figure A.23 — 90° connection between branch drain and drain



NOTE - Large radius bends are with radius at least 600 mm.

Figure A.24 — Recommendations for access to installations in the closed-drainage installation at a domestic dwelling



NOTE - Manholes may be provided in place of rodding eyes.

Figure A.25 — General access requirements for drains below ground

A.3.4 Design and construction

A.3.4.1 General

Access should not only be sited and spaced correctly, but should also be of adequate size, of a practical depth, of a design suitable for its purpose and suitably constructed to withstand the flow of water. Generally accepted dimensions and maximum depths for the various forms of access are given in table 18. Pipe bends and junctions with access eyes are available in three patterns, left-hand, right-hand and straight. Inspection eyes situated in false ceilings should be avoided or, at the least, catered for by the provision of waterproof ceiling panels.

A.3.4.2 Rodding eyes

Rodding eyes are usually constructed from the same pipework and fittings as the drain. They should be of diameter at least 100 mm, so that rodding can be carried out as efficiently as possible with minimum loss in effort. For the same reason, the rodding eye should connect to the drain at an angle of at least 45° in the direction of flow (see 6.5.2.2). Rodding losses are reduced if access is extended to ground level at the same angle. As the access fitting is used only for rodding, there are no restrictions on the depth of the drain to which it is connected.

A.3.4.3 Access fittings

To facilitate rodding, access fittings should have an opening of at least 150 mm x 100 mm. They should have a maximum depth of 0,6 m, to ensure that the invert of the drain is within arm's length of a person who is lying on the ground and intends to clear the debris from a drain. Access fittings can either be in the form of a simple access cover boxed to the drain and positioned in a small concrete or brick chamber with a cover, or with a raised piece of pipework extended to ground level. Since small fittings can provide great resistance to rodding, this is reflected in the spacing recommendations given in table 17. When access fittings are used in inspection chambers or manholes, it is recommended that the spacing of such chambers be reduced to the distances given for the fittings concerned.

A.3.4.4 Inspection chambers

Inspection chambers are not large enough to allow the entry of a person, but they should allow a person who is lying on the ground to reach the drain, to clear debris from it. Chambers with dimensions as prescribed in table 18 allow both the arm and shoulder of a person to reach into the drain invert, provided that the depth to the invert of the drain does not exceed 1 m. Inspection chambers, ready for installation and connection to the pipework and complete with benching and channels, are available as factory units. However, when brick and concrete chambers are constructed, the following design factors should be observed:

a) to prevent flow from one branch to an opposite one, the invert levels of the branch connections in chambers with channels should be above the invert level of the main drainage channel. A further precaution is to stagger branch entries. Chambers equipped with pipework and access fittings should always have staggered junctions to prevent flow from one branch to another, especially if one branch is more frequently used than the opposite one; and

b) where channels are used to connect a branch from the downstream side of an inspection chamber, a change in direction of more than 90° is required, and this is difficult to achieve without the risk of flooding the benching. Three-quarter section channel bends can be used, but they tend to make the drain difficult to rod. The most practical solution is to change the direction of the branch flow by means of a bend external to the chamber, provided that the bend is suitable for rodding.

A.3.4.5 Manholes

Any manhole provided has to comply with 6.5.2.6. The dimensions for manholes given in table 18 make provision for the entry of a person and allow for rodding and clearance while he is standing on the benching. The dimensions are such that the person will also be able to carry breathing apparatus, if necessary.

A.4 Installation of flexible pipes underground

A.4.1 General

Flexible pipe laid in the ground is subject to deformation by the load of the backfill, which tends to increase the horizontal diameter and decrease the vertical diameter. If this action is not resisted, the crown of the pipe will eventually buckle inwards. However, the outward movement of the sides of the pipe produces a reaction in the fill at the sides of the pipe, and this reaction will restrain the outward deflection of the pipe walls to a degree that depends on the condition of the sidefill. This restraint on the outward deflection has a corresponding effect on the inward deflection in the vertical direction. It can be shown that tamping the fill at the sides of the pipe will produce elongation of the vertical diameter, which is later overcome by the load of the fill on top of the pipe. Careful installation of the pipe can therefore result in negligible deflection in both vertical and horizontal directions. Careless backfilling or the use of unsuitable backfilling materials, on the other hand, can easily result in collapse of the pipe.

A.4.2 uPVC pipes

A.4.2.1 General

Normal duty (SDR 51) uPVC pipes that comply with SABS 791 are acceptable for use in underground drainage systems. However, where a pipe runs under a public road or under other areas carrying heavy traffic, the normal duty pipe should be buried to a depth of at least 1 m above the crown of the pipe, and special attention should be paid to bedding and sidefilling. If shallower depths have to be used,

a) heavier walled pipe should be used, or

b) the load should be carried by a sleeve of a rigid material, or

c) the load should be spread in some other suitable manner.

A.4.2.2 Selection of backfilling materials

The first consideration when backfilling materials are being selected is the identification and selection of stable materials. A soil is considered stable if it provides dependable support and undergoes only slight volume change with variation in its moisture content. The ability of soil to provide support depends on its resistance to consolidation and its shear strength. In general, sand and fine gravels are the best materials. Material from trench excavation can be used for bedding and backfilling when suitable. Manufacturers of uPVC pipes that comply with SABS 791 generally recommend that the tests given in A.4.2.3 and A.4.2.4 be carried out to determine the suitability of in-situ materials for bedding and backfilling purposes.

A.4.2.3 Maximum particle size

The maximum particle size should generally not exceed 19 mm. The presence of an occasional particle between 38 mm and 19 mm is acceptable, provided that the total quantity of such particles is only a very small fraction of the whole. Material that contains particles of size exceeding 38 mm should be rejected. When in doubt, take a representative sample by taking about 50 kg of the proposed material, which should then be heaped on a clean surface and divided with a spade down the middle into two halves. One of these should then be similarly divided with a spade down the middle, into two halves. One of these should then be similarly divided, and so on, until the required sample weight, about 2,27 kg, remains.

The sample is then sieved, using 38 mm and 19 mm BS sieves, and if any particles are retained on the 38 mm sieve, or more than 5 % by mass of the sample is retained on the 19 mm sieve, the material is not acceptable, unless it is first screened so as to comply with this requirement.

A.4.2.4 Compaction factor

Once it has been established that the particle size is satisfactory, a representative sample of the material should again be obtained. This should be more than sufficient to fill an open-ended cylinder of length 254 mm and of internal diameter 152 mm (± 6,3 mm). The moisture content of the sample should be substantially the same as that of the bedding material at the time of its use in the trench. Then

a) place the cylinder on a flat firm surface and gently pour the sample material into it, loosely and without tamping,

b) strike off the surface, level with the top of the cylinder, and remove all surface material,

c) move the full cylinder to a clear flat area and empty it out,

d) place about one-quarter of the material back in the cylinder and tamp vigorously with a metal rammer (of mass 0,91 kg to 1,13 kg and with a striking face of diameter 38 mm) until no further compaction can be obtained. Repeat with the second quarter, tamping as before, and so on for the third and fourth quarters, tamping the final surface as level as possible,

e) use a rule to measure down from the top of the cylinder to the surface of the compacted material,

f) calculate the compaction fraction by dividing the height of the cylinder by the distance measured in (e) above, and

g) if the compaction fraction is

   1) over 0,3, the material is unsuitable,

   2) between 0,1 to 0,3, the material is suitable only for pipes that will not be subjected to water-logged conditions after having been laid, and

   3) 0,1 or less, the material is suitable.

A.5 Jointing of pipework

Guidance for the jointing of pipes is given in tables A.1 to A.3.

NOTES

1 For abbreviations, see 3.2.

2 In tables A.2 and A.3, horizontal headings represent the upstream portion of the stack and vertical headings the downstream portion, e.g. PF to GMS - "CCCJ to GMS caulking socket" (see table A.3) but GMS to PF - "CCCJ to special PF socket" (see table A.2).

3 Special adaptors with flexible seals are available for connections between WC outlets and discharge pipes.

Table A.1 — Joints between pipes of different materials for small branch pipes to vertical stacks

1	2	3	4	5	6
Branch	**Type of joint**				
	Vertical stack				
	CI (plain ended)	**COP**	**GMS**	**PF**	**uPVC**
ABS		Push-fit ring-seal joint to copper spigot at stack or ABS/MI fitting to BSPT socket	ABS/MI adaptor to BSPT boss welded to stack or CCCJ in metal socket	ABS/MI adaptor to BSPT socket or special push-fit or compression type joint	Push-fit ring-seal joint to uPVC boss on stack or solvent-weld joint to uPVC socket
COP	Sizes smaller than 40 mm outside diameter: Step pipe up with reducers to minimum of 40 mm outside diameter and use SSN coupling and CI reducing junction to connect to CI stack	Silver-soldered, bronze-welded joint connection, push-fit ring-seal joint to spigot at stack or compression joint	Special adaptor to prevent corrosion at boss, then a compression joint to copper. Normally a BSPT plastics insert at stack in socket	Compression joint to copper-alloy fitting bolted to stack or other special adaptor	Push-fit ring-seal joint to uPVC boss or compression joint at boss connection on stack
GMS		BSPT screwed joint to FI copper-alloy fitting at boss connection to stack or LCJ to copper-alloy thimble on branch	BSPT screwed joint to welded FI boss on stack	BSPT screwed joint to FI socket on special adaptor on stack or other special adaptor	MI/uPVC adaptor screwed in FI socket on GS pipe, not normally used with uPVC but if so, GMS should not stress uPVC boss on stack
HDPE	Sizes 40 mm to 100 mm outside diameter: Use SSN couplings and reducing junctions to connect to CI stack	Push-fit ring-seal joint to copper spigot or HDPE/MI fitting to BSPT socket	HDPE/MI adaptor to BSPT/FI boss welded to stack or other special fitting to metal socket	HDPE/MI adaptor to BSPT boss on special adaptor bolted to stack or other special fitting to PF socket	Push-fit adaptor ring-seal joint on boss at uPVC stack (cannot be solvent-welded to uPVC)
Lead		Soldered or lead-welded joint to copper-alloy adaptor with compression joint at stack or soldered or lead-welded joint to copper spigot at stack	Soldered or lead-welded joint to copper-alloy adaptor with compression joint to BSPT/MI adaptor screwed to welded boss on stack or LCJ to L/CA adaptor in GMS socket	Soldered or lead-welded joint to copper-alloy adaptor then a compression joint to stack or L/CA adaptor in special socket	Soldered or lead-welded joint to copper-alloy adaptor or copper tube, then either push-fit or compression joint to boss on uPVC stack
MuPVC		MuPVC/MI adaptor to copper-alloy boss on stack or push-fit ring-seal joint to copper spigot at stack	MuPVC/MI adaptor to BSPT boss welded to stack or CCCJ with special adaptor in GMS socket	MuPVC/MI adaptor to BSPT boss on special adaptor bolted to stack or other special joints	Push-fit ring-seal joint or solvent-welded joint to boss on stack or to other branch fittings
PP		PP/MI adaptor to copper-alloy boss or stack or push-fit ring-seal joint to copper spigot at stack	PP/MI adaptor to BSPT boss welded to stack CCCJ with special adaptor in GMS socket	PP/MI adaptor to COP BSPT boss on special adaptor bolted to stack or other special joints	Push-fit ring-seal joint to boss on stack (cannot be solvent-welded to uPVC)

Table A.2 — Joints between pipes of different materials of the same size

1	2	3	4	5	6
Down-stream portion	**Type of joint**				
	Upstream portion				
	ABS	**CI (plain ended)**	**COP**	**GMS**	**HDPE**
ABS	(a) Solvent cement (b) Ring seal	SSN coupling	(a) ABS/COP adaptor with ring-seal joint to COP (b) ABS/BSPT adaptor to CA fitting	ABS/BSPT adaptor	(a) Special ring-seal adaptor (b) Compression type joint (c) BSPT coup-lings
CI	(a) Special CB with CCCJ to CI socket (b) CI plug with FI thread to ABS/MI adaptor	SSN coupling	CA/CB bronze-welded or silver-soldered joint to COP then LCJ or CCCJ to CI socket	(a) LCJ or CCCJ to CI socket (b) GI/BSP MI thread to FI thread in CI plug	(a) Special CB with CCCJ to CI socket (b) CI plug with FI thread to HDPE/MI adaptor
COP	(a) ABS/copper adaptor with ring-seal joint to COP spigot (b) ABS/BSPT adaptor to CA fitting	SSN coupling	(a) Bronze-welded or silver-soldered joint (b) Soldered capillary joint (c) Ring-seal joint	(a) LCJ or CCCJ to CA welded or silver-soldered joint to COP (b) GMS/BSPT to CA COP/ BSPT adaptor. There is a risk of corrosion at these joints	(a) HDPE COP ring-seal adaptor (b) HDPE/BSPT adaptor to CA fitting (c) Special screwed coupling
GMS	(a) ABS/BSPT adaptor (b) Special CB with CCCJ to GMS caulking socket	SSN coupling	(a) CA/CB bronze-welded or silver-soldered joint to copper then LCJ or CCCJ to GMS caulking socket (b) GMS/BSPT to CA copper/BSPT adaptor Note the risk of corrosion at joints	(a) BSPT screwed joints (b) Bolted flanged with synthetic rubber rings or other washers (c) CCCJ to GMS caulking socket	(a) HDPE/BSPT adaptor (b) Special CB with CCCJ to GMS caulking socket
HDPE	(a) Special ring-seal adaptor (b) Compression type joint (c) BSPT coup-lings	SSN coupling	(a) HDPE/copper ring-seal adaptor (b) HDPE/BSPT adaptor to CA fitting (c) Special screwed coupling	HDPE/BSPT adaptor	(a) Ring-seal joint (b) Compression couplings
Lead	Either (a) ABS/copper ring-seal adaptor, or (b) ABS/BSPT adaptor to CA fitting then soldered or lead-welded joint of COP or CA fitting to lead	SSN coupling	Soldered or lead-welded joint direct to copper or CA fitting	(a) LCJ or CCCJ to CA socket, soldered or lead-welded to lead (b) CA/BSPT adaptor with soldered or lead-welded joint to lead and GMS/ BSPT adaptor	Either (a) HDPE/copper ring-seal adaptor, or (b) HDPE/BSPT adaptor to CA fitting then soldered or lead-welded joint of COP or CA fitting to lead

Table A.2 *(concluded)*

1	2	3	4	5	6
Down-stream portion	**Type of joint**				
	Upstream portion				
	ABS	**CI (plain ended)**	**COP**	**GMS**	**HDPE**
MuPVC	(a) ABS/MuPVC ring-seal adaptor (b) ABS/MuPVC solvent-cement adaptor where solvent cement and adaptor are specifically intended for this	SSN coupling	(a) MuPVC/COP ring-seal adaptor (b) MuPVC/COP adaptor to CA fitting (c) MuPVC/COP compression adaptor	MuPVC/BSPT adaptor	MuPVC/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)
PF	(a) Ring-seal adaptor to special PP setting (b) Special CB with CCCJ to PF caulking socket	CI to VC connector	CA/CB with CCCJ to special PF socket and bronze- welded or silver-soldered joint to COP	CCCJ to special PF socket	(a) Ring-seal adaptor to special PP fitting (b) Special CB with CCCJ to PF caulking socket
PP	ABS/PP ring-seal adaptor (These materials cannot be solvent-cemented together)	SSN coupling	(a) PP/COP ring-seal adaptor (b) PP/COP adaptor to CA fitting (c) PP/COP compression adaptor	PP/BSPT adaptor	PP/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)
uPVC	(a) ABS/uPVC ring-seal adaptor (b) ABS/uPVC solvent-cement adaptor where solvent cement and adaptor are specifically intended for this purpose	SSN coupling	(a) uPVC/COP ring-seal adaptor (b) uPVC/BSPT adaptor to CA fitting (c) uPVC/COP compression adaptor (d) CA/CB bronze-welded or silver-soldered joint to COP and CCCJ to special uPVC socket or special uPVC socket heat-shrunk over synthetic gasket onto COP spigot	(a) uPVC/BSPT adaptor (b) Joint GMS spigot to special uPVC socket with CCCJ (c) Special uPVC socket heat-shrunk over synthetic rubber gasket onto GMS spigot	uPVC/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)
VC[1)]	(a) Special CB with CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to ABS and VC spigots	CI to VC connector	CA/CB bronze-welded or silver-soldered joint to COP then CCCJ or CMJ to VC socket	CCCJ or CMJ between GMS spigot and VC socket	(a) Special CB with CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to HDPE and VC spigot
1) Vitrified clay pipes are not used for above-ground drainage but this information provides some guidance where vertical discharge pipes connect to the buried drains at ground floor level.					

Table A.3 — Joints between pipes of different materials of the same size

1	2	3	4	5	6
Down-stream portion	**Type of joint**				
	Upstream portion				
	Lead	**MuPVC**	**PF**	**PP**	**uPVC**
ABS	Either: (a) ABS/COP ring-seal adaptor; or (b) ABS/BSPT adaptor to CA fitting, then soldered or lead-welded joint of COP or CA fitting to lead	(a) ABS/MuPVC ring-seal adaptor (b) ABS/MuPVC solvent-cement adaptor where solvent cement and adaptor are specifically intended for this purpose	Ring-seal adaptor to special PP pitch fibre fitting	ABS/PP ring-seal adaptor (These materials cannot be solvent-cemented together)	(a) ABD/uPVC ring-seal adaptor (b) ABS/uPVC solvent-cement adaptor where solvent cement and adaptor are specifically intended for this purpose
CI	SSN coupling	SSN coupling	CI to VC connector	SSN coupling	SSN coupling
COP	Soldered or lead-welded joint direct to COP or CA fitting	(a) MuPVC/COP ring-seal adaptor (b) MuPVC/COP adaptor to CA fitting (c) MuPVC/COP compression adaptor	CCCJ to CA socket bronze-welded or silver-soldered joint to COP	(a) PP/COP ring-seal adaptor (b) PP/COP adaptor to CA fitting (c) PP/COP com-pression adaptor	(a) uPVC/COP ring-seal adaptor (b) uPVC/COP to CA fitting (c) uPVC/COP compression adaptor (d) Special CB with CCCJ
GMS	(a) CA/CB with soldered or lead-welded joint to lead and LCJ or CCCJ between CB and GMS caulking socket (b) CA/BSPT adaptor to CA fitting, then soldered or lead-welded joint of COP or CA fitting to lead	(a) MuPVC/BSPT adaptor (b) Special CB with CCCJ to GMS caulking socket	CCCJ to GMS caulking socket	(a) PP/BSPT adaptor (b) Special CB with CCCJ to GMS caulking socket	(a) uPVC/BSPT adaptor (b) Special CB with CCCJ to GMS caulking socket
HDPE	Either (a) HDPE/COP ring-seal adaptor; or (b) HDPE/BSPT adaptor to CA fitting then soldered or lead-welded joint of COP or CA fitting to lead	MuPVC/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)	Ring-seal adaptor to special PP pitch	PP/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)	uPVC/HDPE ring-seal adaptor (These materials cannot be solvent-cemented together)
Lead	a) Soldered joint b) Lead-welded joint	Either (a) MuPVC/COP ring-seal adaptor; or (b) MuPVC/BSPT adaptor to CA fitting then soldered or lead-welded joint of COP or CA fitting to lead	CCCJ to CA socket soldered or lead-welded to lead	Either (a) PP/COP ring-seal adaptor (b) PP/BSPT adaptor to CA fitting, then soldered or lead-welded joint of COP or CA fitting to lead	Either (a) uPVC/COP ring-seal adaptor or (b) uPVC/BSPT adaptor to CA fitting or (c) Special CB with CCCJ to CA socket then soldered or lead-welded joint of COP or CA fitting to lead

Table A.3 *(concluded)*

1	2	3	4	5	6
Down-stream portion	**Type of joint**				
	Upstream portion				
	Lead	**MuPVC**	**PF**	**PP**	**uPVC**
MuPVC	Either (a) MuPVC/COP ring-seal adaptor; or (b) MuPVC/BSPT adaptor to CA fitting then soldered or lead-welded joint of COP or CA fitting to lead	(a) Solvent cement (b) Ring seal	PF/MuPVC ring-seal special adaptor	PP/MuPVC ring-seal adaptor (These materials cannot be solvent-cemented together)	(a) Solvent cement (b) Ring seal
PF	CA/CB with CCCJ to special PF socket and soldered or lead-welded joint to lead	(a) PF/MuPVC ring-seal special adaptor (b) Special CB with CCCJ to PF caulking socket	(a) Ring seal (b) Drive tape coupling	(a) Ring-seal adaptor to special PP fitting (b) Special CB with CCCJ to PF caulking socket	(a) Ring-seal adaptor to special PP fitting (b) Special CB with CCCJ to PF caulking socket
PP	(a) PP/COP ring-seal adaptor (b) PP/COP adaptor to CA fitting (c) PP/COP compression adaptor (The COP or CA fitting is soldered or lead-welded joint to lead)	PP/MuPVC ring-seal adaptor (These materials cannot be solvent-cemented)	Ring-seal adaptor to special PP fitting	(a) Ring seal (b) Compression type joint	uPVC/PP ring-seal adaptor (These materials cannot be solvent-cemented together)
uPVC	(a) uPVC/COP ring-seal adaptor (b) uPVC/BSPT adaptor to CA fitting (c) CA/CB jointed to lead by soldered or lead-welded joint, and jointed to special uPVC socket with CCCJ or special uPVC socket heat-shrunk over synthetic rubber gasket onto CB	(a) Solvent-cemented (b) Ring seal	Special adaptor ring-seal joints	uPVC ring-seal adaptor (These materials cannot be solvent-cemented together)	(a) Solvent-cement (b) Ring seal
VC[1)]	CA/CB with CCCJ or CMJ to VC socket and jointed to lead by soldered or lead-welded joint	(a) Special CB with CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to MuPVC and VC spigots	(a) CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to PP and VC spigots	(a) Special CB with CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to PP and VC spigots	(a) Special CB with CCCJ or CMJ to VC socket (b) Special adaptor with ring seals to uPVC and VC spigots

1) Vitrified clay pipes are not used for above-ground drainage but this information provides some guidance where vertical discharge pipes connect to the buried drains at ground floor level.

A.6 Maintenance

A.6.1 Types of blockage or deposit and method of removal

A.6.1.1 Deposits due to misuse of the discharge system

Complete or partial blockages due to large objects or compacted masses, such as toilet paper and sanitary towels, can usually be loosened by rodding. All such material should be removed from the system at the nearest access point.

A.6.1.2 Lime scale

In hard-water districts where heavy lime scale accumulations are observed on the surface of sanitary fixtures, similar lime scale deposits may form in the discharge stacks and pipes. The worst condition will be found in the stacks and pipes from urinals, where precipitation of lime generated by the reaction of urine in contact with the hard water accelerates the process of scale formation. In these situations, conditions can be further aggravated by the residue from abrasive cleaning powders that are used in the cleaning of sanitary fixtures and that can combine with the lime precipitate, resulting in complete blockage of the pipe.

Recurring scale formations of this type are best dealt with by periodic descaling of the system, using suitably inhibited acid-based cleaners (see A.6.2.5). The discharge stacks and pipes should be inspected periodically and the rate of scale formation noted. The required frequency of treatment and the strength of acid required to soften the scale can then be established and included in a planned maintenance schedule. It should not be necessary to repeat the treatment more than three of four times a year.

Where lime scale encrustation in a urinal discharge pipe is so heavy that the point of almost total blockage has been reached, the obstruction can sometimes be softened and removed by the application of an acid drip feed method. In severe cases it may be necessary to repeat the process, to ensure that all deposits are removed.

A.6.1.3 Accumulation of grease and soap residues

Obstructions in discharge pipes and traps caused by accumulations of grease and soap residues can often be partially removed by the use of a plunger, but a more effective treatment is by flushing the system with a solution of caustic soda dissolved in hot water. The process is easy to carry out but needs extreme safety precautions (see A.6.2.5) when it is carried out. Blockages of this type are mostly found in long discharge pipes from sinks or wash-hand basins, especially in soft-water areas and where the rate of flow in the pipe falls below that required to sustain a self-cleansing velocity. Where mirrors are fixed over basins, hair combings washed into the waste pipes will combine with the grease and soap residues and considerably increase the risk of blockage.

A.6.2 Cleaning and descaling

A.6.2.1 Plunger

Only slight blockages in fixture branch pipes or fixture traps can be cleared by means of a plunger.

A.6.2.2 Rods

The traditional way of clearing blockages is by means of rods. Clearing devices are available that can be fitted to the end of the rod, for example, scrapers, plungers and brushes. Rods can be used for the clearing of blockages in pipes of diameter 75 mm and larger, where only moderate flexibility is required to introduce the rods into the pipework. Mechanically rotated versions are also available.

A.6.2.3 Kinetic ram gun

The kinetic ram gun can remove obstructions in branch pipes, provided that its function and its limitations are properly understood. The operation of the gun is based on the principle that the impact of compressed air against a column of water behind a blockage will create a shock wave that is transmitted to the obstruction to dislodge and remove it. A stubborn blockage can, however, produce a "blow-back" of the gun and injure the operator, or damage pipework and fixtures that are not designed to withstand the pressure applied. The same also applies to machines that discharge water, or air, at high velocities into pipework. Where there are open branches on the system, waste matter can be forced out of any openings such as ventilation pipes and fixture traps, and damage wall and ceiling decorations. The use of ram guns should be restricted to the removal of blockages that consist of compacted soft material, e.g. grease, soap residue and saturated paper.

A.6.2.4 Coring and scraping

Coring of the pipe can be considered in pipes of diameter 100 mm and larger, where the pipe bore is severely restricted or even completely blocked with hard lime scale or similar material. However, the pipe material should first be checked to ensure that damage will not result.

The process involves the use of a purpose-made rotating steel cutter on a flexible drive, which can be pushed into the pipe to cut through the obstructions. Peripheral accumulations of grease and other gelatinous formations in pipes of these sizes can generally be removed satisfactorily by the periodic use of profile scrapers attached to ropes and pulled through the pipe.

A.6.2.5 Chemical cleaning

Details of chemical cleaning methods are given in table A.4. Attention to safety precautions is vital if injury to the operator or damage to pipework and fixtures is to be avoided. Acid-based cleaners in contact with chlorine bleach will produce chlorine gas. Discharge systems have to be thoroughly flushed to remove all traces of chlorine bleach residues as far as possible before acid-based cleaners are used. All windows should be opened in the areas where acid-based cleaners are being used.

The work involved in the removal of scale and grease from sanitary fixtures and pipework requires an understanding of the problem and skill in the handling and application of chemicals and tools. Great care should be taken to ensure that all the necessary precautions are taken to minimize the risk of personal injury to the cleaning operators or damage to the fixtures and the system. Protective clothing, including gloves and eye-shields, should be provided for operators handling and using chemicals, and, on completion of the work, all exposed surfaces of sanitary fixtures should be thoroughly washed, using a detergent cleanser to remove any acid or other chemical that might otherwise come into contact with a person using the fixture. Adjoining finishes and decorations may need to be protected while the work is in progress.

Table A.4 — Chemical cleaning of discharge pipes and sanitary fixtures

1	2	3
Application	**Method**	**Notes**
The removal of lime scale accumulations in discharge stacks and branch pipes	Apply diluted, inhibited, acid-based descaling fluid direct to the scale. This can be done either by pouring small measured quantities of fluid into the pipes at predetermined points on the pipe line, or by using a drip feed method (acid strength approx. 15 % inhibited hydrochloric acid, 20 % orthophosphoric acid).	Acid-based descaling fluid will attack linseed oil bound putty. Care must be taken to avoid unnecessary and/or prolonged contact of scaling fluid with the jointing of the outlet fittings on wash-hand basins and urinals.
	For heavy lime scale encrustations, undiluted descaling fluid can be used (30 % inhibited hydrochloric acid, 40 % orthophosphoric acid). The softened scale can be removed by thorough flushing, and, where practicable, by the use of drain rods and scrapers. On completion of the work, the system should be thoroughly flushed with clean water. Particular care should be given to the traps of fixtures to ensure that all traces of acid are removed from the trap water seals when the work is finished.	Drip feed method: the acid-based descaling fluid is allowed to drip slowly into the discharge pipe, at a rate of about 4 L over a period of 20 min. Repeat, after flushing with clean water, if necessary, for very heavy deposits.
The removal of grease and soap residues from the discharge pipes from wash-hand basins and sinks	Fill the wash-hand basin or sink with very hot water and add caustic soda at the rate of 1 kg of caustic soda crystals to 10 L of hot water. When the crystals have dissolved, release basin or sink plug to flush trap and discharge pipe. For basins in ranges, fill all of the basins with soda solution, and release plugs simultaneously. Clean overflows, using a solution of soda crystals in hot water and a wire-core bottle brush.	For cases where grease and soap residue formation in the discharge pipes is frequent, this process can be applied periodically with satisfactory results. Caustic soda is a strong oxidizing agent that needs extreme safety precautions (see A.6.2.5) when it is used.

Annex B
(informative)

Septic tank systems

B.1 Septic tanks

B.1.1 Design principles

B.1.1.1 Compartmentation

The inflow to a septic tank from residential and from non-residential buildings can vary greatly. During peak flow, higher concentrations of solids are likely to be discharged from the septic tank and this can have a detrimental effect on the absorption field (french drains and evapotranspiration beds). Well designed double-compartment septic tanks reduce the effect of peak flows. It is therefore better to use double-compartment tanks, although single-compartment septic tanks function satisfactorily under average conditions. Any further advantage derived from dividing septic tanks into more than two compartments is usually insignificant.

B.1.1.2 Geometry of the septic tank

The geometry of the septic tank has an influence on the velocity at which the sewage flows through it, on the sludge accumulation and on the possible presence of stagnant pockets of liquid inside the tank. When the tank is too deep in relation to its surface area, the plan dimensions will be too small and a direct flow of sewage (short-circuiting) can take place between the inlet and outlet, resulting in a reduced retention time for the liquid.

Where the septic tank has too large a liquid surface area in relation to its volume, the clear space between sludge and scum will become small, resulting in too high a liquid flow rate for sedimentation and flotation.

Septic tanks (see figure B.1) should be designed to have

a) a liquid depth (L) of between 1 m and 1,8 m,

b) a rectangular shape, the length of the septic tank being three times its width (W), and

c) a first compartment of twice the size of the second compartment.

The following equation can be used to calculate septic tank dimensions:

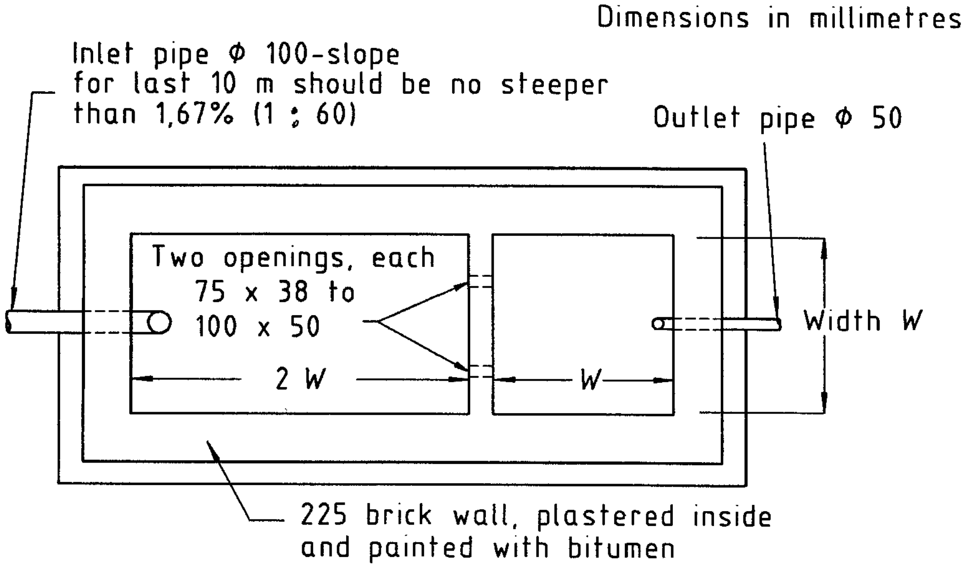
$$W^2 = \frac{C}{3 \times D}$$

where

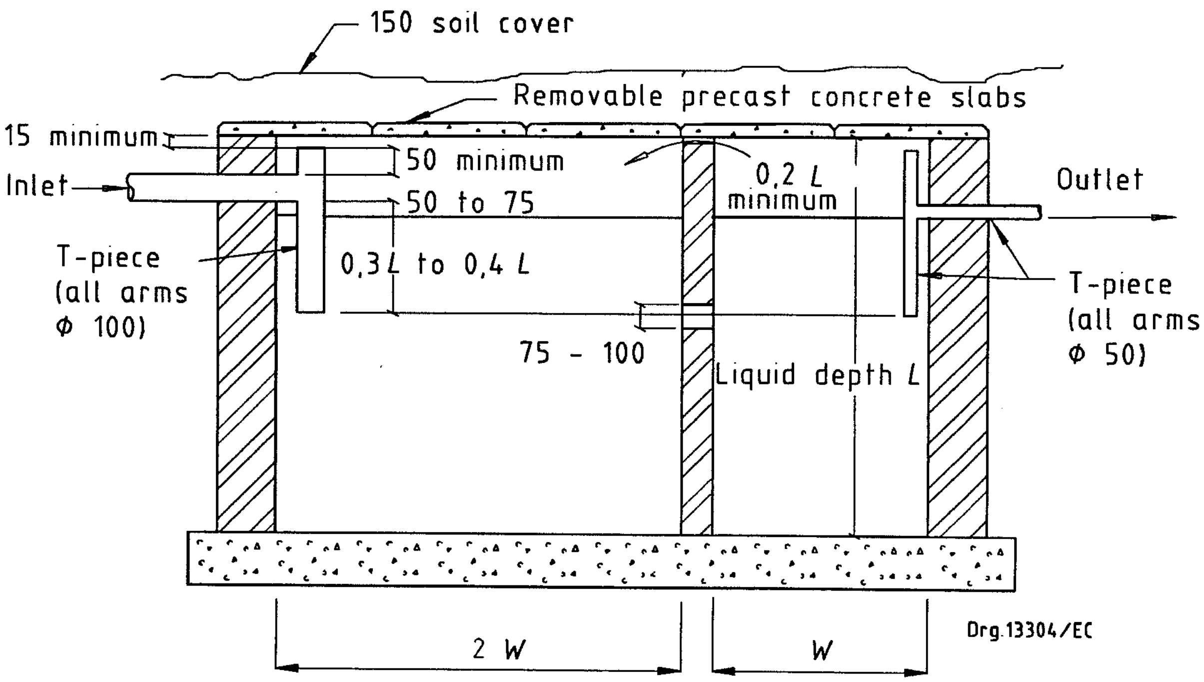
W is the width of the tank, in metres;

C is the required capacity, in cubic metres; and

D is the selected depth, in metres.



a) Plan of septic tank



b) Longitudinal section through septic tank

Figure B.1 — A typical septic tank

B.1.1.3 Inlet and outlet arrangements

B.1.1.3.1 Inlet to first compartment

The inlet to the first compartment should preferably be a sanitary T-piece. The vertical portion of the T (see figure B.1) should extend below the surface of the liquid, to minimize incoming turbulence. The lower vertical arm of the inlet should be submerged to between 30 % and 40 % of the liquid depth. The upper vertical arm should extend at least 50 mm above the crown of the inlet and should end 15 mm below the cover of the septic tank. The invert of the inlet pipe should be between 50 mm and 75 mm above the surface of the liquid.

B.1.1.3.2 Opening between compartments

Flow of liquid between compartments is best through vertical slots. Two or more slots, 75 mm to 100 mm deep and half as wide, should be provided at a depth of between 30 % and 40 % of the liquid depth from the surface of the liquid.

B.1.1.3.3 Outlet from second compartment

The outlet should also be a sanitary T-junction. All arms of the T-junction should have an inside diameter of half to three-quarters of that of the inlet pipe. Reducing the size of the outlet has the advantage of damping peak flows through the septic tank. The invert of the outlet pipe should be 50 mm to 75 mm below that of the inlet pipe. The lower vertical arm of the T-junction should also be submerged to between 30 % and 40 % of the liquid depth. The upper vertical arm of the T-junction should project above the layer of floating scum.

B.1.1.4 Access

All compartments and fittings should be readily accessible for inspection and cleaning. If manholes are to be provided, they should give access to both inlet and outlet pipes (where blockages can occur). Alternatively, access can be provided through removable cover slabs.

B.1.2 Septic tank capacity

B.1.2.1 General

Apart from the provisions of 7.2.2, the capacity of the septic tank should be adequate to store sludge and scum, as well as to retain liquid for at least 24 h just before the tank needs desludging. The flow of residential sewage is often directly related to the level of the water supply to the building. Therefore, the level of water supply to the building can be used to determine, as follows, the capacity required:

a) for non-residential systems, estimate the average daily flow from the establishment. The capacity of the septic tank has to be 3 times the estimated average daily flow;

b) for dwellings or dwelling units with full in-house water reticulation, relate the capacity of the septic tank required to the number of (bed)rooms (see B.1.2.2.1); and

c) for special residential systems such as multi-home systems or dwelling units without full in-house water reticulation, relate the capacity of the septic tank to the number of persons to be served by the system (see B.1.2.2.2).

Septic tanks for multi-homes should be able to handle a variable sewage flow because approximately 45 % of the total sewage flow takes place within a peak of four hours. Multiple-compartment septic tanks are therefore a necessity. A multicompartment effect could also be accomplished by the use of two or more septic tanks in series. Design features for these tanks are generally the same as those for tanks that serve single dwellings.

B.1.2.2 Recommended methods of calculating septic tank capacity

B.1.2.2.1 Method 1

This method, where the capacity of the septic tank required is related to the number of bedrooms, is applicable mainly to middle-income and higher-income areas because there is often a relationship between the number of occupants in a house and the number of bedrooms. Each servant's room should be counted as an additional bedroom. When this method is used to establish the capacity of a septic tank required for dwellings in lower-income areas, it is recommended that each room in the dwelling be regarded as a bedroom. From figure B.2, determine the size of the septic tank required. The graph provides for a 24 h liquid retention time and the septic tank capacities indicated should prevent any appreciable discharge of scum and sludge.

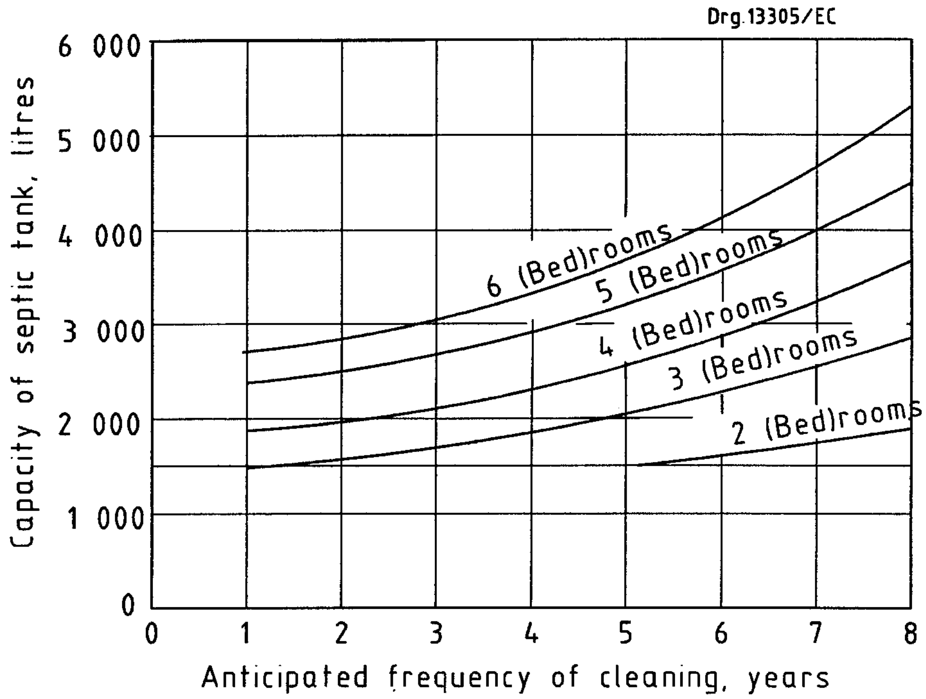


Figure B.2 — Septic tank capacity related to size of dwelling

B.1.2.2.2 Method 2

This method, where the capacity of a septic tank is determined from the number of persons served, should be used when materials other than water or paper are used for anal cleaning, or for dwellings without multiple sanitary fixtures, or for multiple residential systems. The rate of sludge and scum accumulation will depend on various factors such as ambient temperature, living standards, diets, the health of the occupants, etc. The rate of sludge and scum accumulation is therefore very variable (see table B.1 and table B.2 for guidance).

Table B.1 — Rate of sludge and scum accumulation for dwellings without multiple sanitary fixtures

1	2
Materials used for anal cleansing	**Rate of accumulation** L/person/day
Sand, stone, etc.	
Toilet wastes only	55
Additional household sewage	70
Hard paper, leaves and grass	
Toilet wastes only	40
Additional household sewage	50
Water and soft paper	
Toilet wastes only	25
Additional household sewage	40

Table B.2 — Rate of sludge and scum accumulation for dwellings with multiple sanitary fixtures

1	2	3	4
Years of service	**Rate of collection** L/person/year		
	Sludge	**Scum**	**Total**
1	65	20	85
2	105	35	135
3	125	50	175
4	145	65	210
5	170	85	255
6	195	95	290
8	240	120	360
10	295	145	440

The required capacity of the septic tank required can be determined as follows:

a) estimate the expected average daily sewage flow;

b) establish the capacity needed for sludge and scum accumulation in the first compartment (see B.1.2.2.1);

c) calculate the total capacity of the septic tank as follows:

$$A = Q + P$$

where

A is the required capacity of the septic tank, but not less than 3 x Q or 1 700 L;

Q is the estimated daily sewage flow, in litres; and

P is the capacity required to store sludge and scum between septic tank cleanings, in litres.

B.1.3 Starting up

A newly built septic tank should be tested for watertightness. It should be filled with water prior to use and tested over a period of 24 h for watertightness. If watertight, the tank should be left full. No special chemicals are needed to start the digestion process and it will take only a few weeks for the normal operational conditions to be established. However, operational conditions can be accelerated if a few buckets of digested material from another septic tank are introduced to the new tank.

B.1.4 Operation and maintenance

No chemical additives are needed to assist the digestion processes in a septic tank and normal amounts of domestic bleach, caustic materials, soaps, detergents and drain cleaners do not impede the process. Materials such as sanitary towels, facial tissues, coffee grounds, cooking oil and cigarette butts should not be flushed into the tank because they do not degrade and may clog the system.

The tank needs very little routine maintenance and should last for many years. The main cause of problems is failure to desludge the tank periodically because, as the volume of sludge and scum increases, the efficiency of treatment decreases and the result is failure of the absorption field. Tanks should be inspected once every year to establish whether desludging is necessary. Sludge and scum measurements should be carried out in the first (sewage receiving) compartment of multiple-compartment septic tanks.

When being cleaned, septic tanks should not be washed, scrubbed or disinfected. It is not necessary to leave any solid matter inside to restart the digestive process.

B.2 Absorption fields

B.2.1 Site suitability

The septic tank only partially treats sewage and it is the function of an absorption field to provide final treatment and disposal of the effluent in a safe and inoffensive way. However, it is always very difficult, if not impossible, to lay down rigid criteria for deciding whether a site is suitable for a subsurface absorption system or not. Either the percolative capacity of the soil or the pollution of the ground water can be the determining factor for such systems and the success of the system thus depends on the ability of the soil to treat and dispose of effluent.

A proper in-depth site evaluation is fundamental to the design of a subsurface absorption system such as an absorption field. The most suitable area(s) for the placement of an absorption field on a site should be identified. Since in-depth site evaluation costs can be quite high, the above area(s) should be identified by means of a preliminary site evaluation.

B.2.1.1 Preliminary site evaluation

A visual survey of the site should be made and all features that might affect the proposed system should be noted and marked on the site plan. Such features include those given in B.2.1.1.1 to B.2.1.1.5.

B.2.1.1.1 General topography and flood plains

The location of any depressions, gullies, boulders or rock outcrops, water courses and other distinct land and surface features should be noted, including areas with a flood hazard.

B.2.1.1.2 Land slopes

The slope of a site should be noted. Concave slopes cause surface runoff to converge, while convex slopes disperse it. Shallow bedrock that can cause inadequately treated liquids to surface is often present at steep slopes. A steep slope usually counters the successful operation of an absorption field. Sites that have a slope of 9 % to 18 % are usually more manageable than level sites because the slope can be used to direct effluent away from the point of introduction.

B.2.1.1.3 Land setting

The setting and shape of the land of the site should be noted, since they can indicate surface and subsurface drainage patterns. For example, hill tops and upper slopes can be expected to have better drainage than depressions and foot slopes.

B.2.1.1.4 Vegetation

The type of vegetation can give some indication of the drainage characteristics of the site. Some plants prefer poorly drained soils and others not.

B.2.1.1.5 Soil texture

Permeability, whether termed hydraulic conductivity or percolation, is a crucial factor affecting the ability of soil to dispose of and treat effluent. Under most circumstances, soil texture governs the permeability of the soil. The higher the proportion of clay and silt, the lower the permeability of the soil. The texture of the soil can be determined in the field by its feel and appearance, and by reference to table B.3.

Table B.3 — Textural properties of mineral soils

1	2	3
Soil class	**Feel and appearance**	
	Dry soil	**Moist soil**
Sand	Loose, single grains that feel gritty. If squeezed in hand, the soil mass falls apart when the pressure is released.	If squeezed in the hand, it forms a cast that crumbles when touched. Does not form a ribbon between the thumb and forefinger.
Sandy loam	Clods can be easily crushed; when pulverized, the soil initially has a slight velvety touch, but becomes gritty with continued rubbing; the gritty feel of sand soon predominates.	Forms a cast that withstands careful handling, without breaking. Does not form a ribbon between the thumb and forefinger.
Loam	Clods are crushed under moderate pressure, but can be quite firm. Pulverized loam feels velvety but becomes gritty with continued rubbing. Casts withstand careful handling.	Casts can be handled quite freely without breaking. Very slight tendency to ribbon between the thumb and forefinger. Rubbed surface is rough.
Silt/loam	Clods are firm to hard, but may be crushed under moderate pressure. Feels flour-like when pulverized.	Casts can be freely handled without breaking. Slight tendency to ribbon between the thumb and forefinger. Rubbed surface has a broken or rippled appearance.
Clay/loam	Very firm and hard clods that strongly resist crushing by hand. When pulverized, the soil feels somewhat gritty owing to the very hard particles that persist.	Casts can bear much handling without breaking. Pinched between the thumb and forefinger, the soil forms a ribbon with a surface that feels slightly gritty when dampened and rubbed. The soil is plastic, sticky and "puddles" easily.
Clay	Clods are extremely hard and strongly resist crushing by hand. When pulverized, clay has a gritty texture owing to the many very small, hard particles that persist.	Casts can bear considerable handling without breaking. Clay forms a flexible ribbon between the thumb and forefinger and retains its plasticity when elongated. The rubbed surface has a very smooth satin-like feel. Sticky when wet and "puddles" easily.

B.2.1.2 In-depth site evaluation

An in-depth site evaluation is essential to determine whether an absorption field is viable on a site. The in-depth evaluation comprises the steps given in B.2.1.2.1 to B.2.1.2.3.

B.2.1.2.1 Soil profile investigation

At least four sample holes should be dug around the perimeter of the proposed absorption field, to a depth of at least 1 m below the base of the proposed absorption field. Samples should be taken of all the soil layers so that the characteristics of each layer can be determined, and the following should be noted:

a) the depth of, and the type of soil layers; and

b) the presence of a seasonal ground-water table.

The depth to the highest seasonal ground-water table is indicative of the likelihood of ground-water pollution and it can affect the rate of flow of effluent from the absorption field - particularly the vertical flow. An unsaturated soil depth of 0,6 m or more is needed for the effective purification of effluent. Under saturated conditions, greater depths are necessary to achieve purification. The presence of a seasonal ground-water table is often suggested if soil mottling (that is, a mixture or variation of colours) can be identified. In soils with restricted internal drainage, grey, yellow, red and brown colours often are intermingled, giving the soil a multicoloured effect. Sometimes, however, organic matter can also cause soil colours to appear mottled. Soils with poor drainage can usually be easily identified by a thick and very dark or black layer of surface soil, and by an accompanying dark-grey subsoil that is nearly uniform in colour. In soils with average to good drainage, the surface soil is often dark while the subsoil has a uniformly bright colour.

B.2.1.2.2 Soil texture investigation

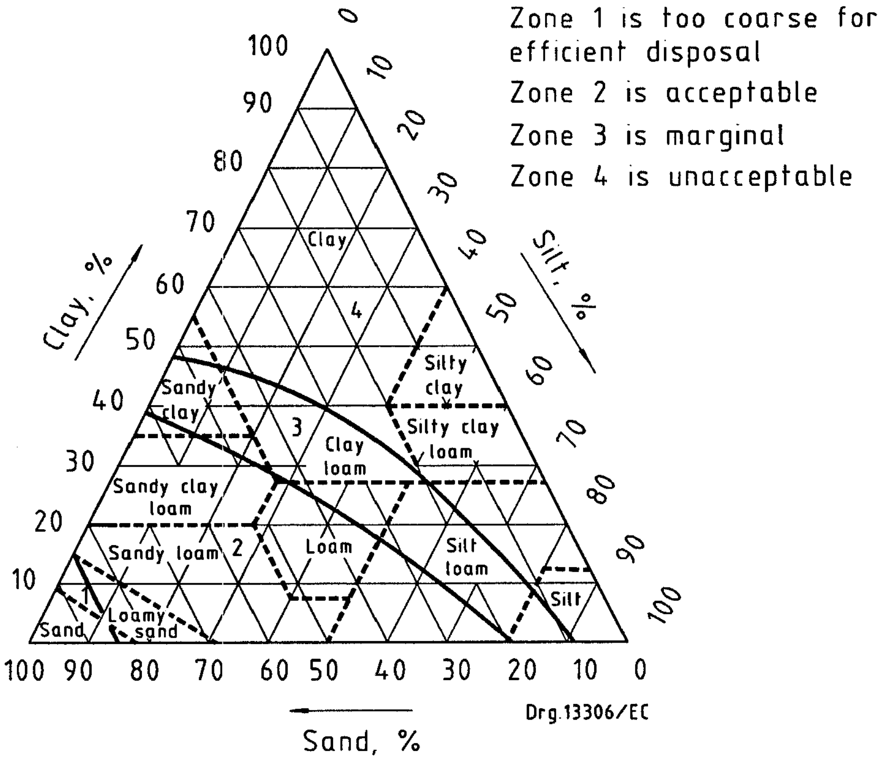
The texture of the soil (that is, the solid particles that are smaller than 2 mm in diameter and in three size fractions, namely sand, silt and clay) below the base of the proposed absorption field drain should be determined from a sieve analysis. The size limits for each soil particle fraction are given in table B.4. The results obtained from the sieve analysis should be plotted on the chart given in figure B.3 and adjustments should be made for bulk density and coarse fragments, as prescribed. Any soil particle larger than 2 mm should be regarded as coarse. The suitability of the permeability zones defined in figure B.3 is commented upon in table B.5.

B.2.1.2.3 Percolation test

Finally, the rate at which water moves into the soil should be quantified by means of a percolation test as prescribed in 7.3.2.

Table B.4 — Size limits for soil texture fractions

1	2	3
Fraction	**Size range** mm	**Tyler standard sieve number**
Sand:	2 - 0,05	10 to 270 mesh
Very coarse	2 - 1	10 to 16 mesh
Coarse	1 - 0,5	16 to 35 mesh
Medium	0,5 - 0,25	35 to 60 mesh
Fine	0,25 - 0,10	60 to 140 mesh
Very fine	0,10 - 0,05	140 to 270 mesh
Silt	0,25 - 0,002	-
Clay	< 0,002	-



Instructions:

1 Plot texture on triangle, based on percentage sand, silt and clay (USDA classification) as determined by hydrometer analyses.

2 Adjust for coarse fragments by moving plotted point an additional 2 % in the direction for each 10 % (by volume) of fragments exceeding 2 mm in diameter.

3 Adjust for compactness of the soil by moving the plotted point an additional 15 % in the clay direction for soils that have a bulk density in excess of 1,7 g/mL.

Figure B.3 — Soil texture/percolation chart

B.2.1.3 Design considerations

B.2.1.3.1 General

The object of an absorption field design should be to maximize the use of soil surface that is expected to provide the highest infiltration rate. In somewhat permeable and homogeneous soils and in humid regions where percolating rainwater reduces the matrix potential along the side wall, the bottom surface is usually the main infiltrative surface. In less humid areas and on sloping sites with shallow restrictive horizons (such as high ground-water table, bedrock, etc.), the side wall area may become the main absorption surface. However, absorption fields will often be oversized if it is assumed that all flow takes place only either through the bottom, or through the side wall surfaces.

B.2.1.3.2 Types of conventional absorption fields (french drains)

The two types of conventional absorption fields to be considered are pits and trenches.

B.2.1.3.2.1 Pits

A pit is a deep, covered excavation used for the disposal of effluent. It is cheaper to construct and easier to check and maintain than conventional trench systems (see figure B.4). Effluent enters the chamber, where it is stored until it seeps out through the base and side walls.

This system is recommended where impervious soils are underlaid with porous soils. Pits should have a diameter of between 1,8 m and 3,6 m and a depth of up to 6 m. When more than one pit is needed, the distance between the side wall of one pit and the next should be three times the diameter of the largest pit.

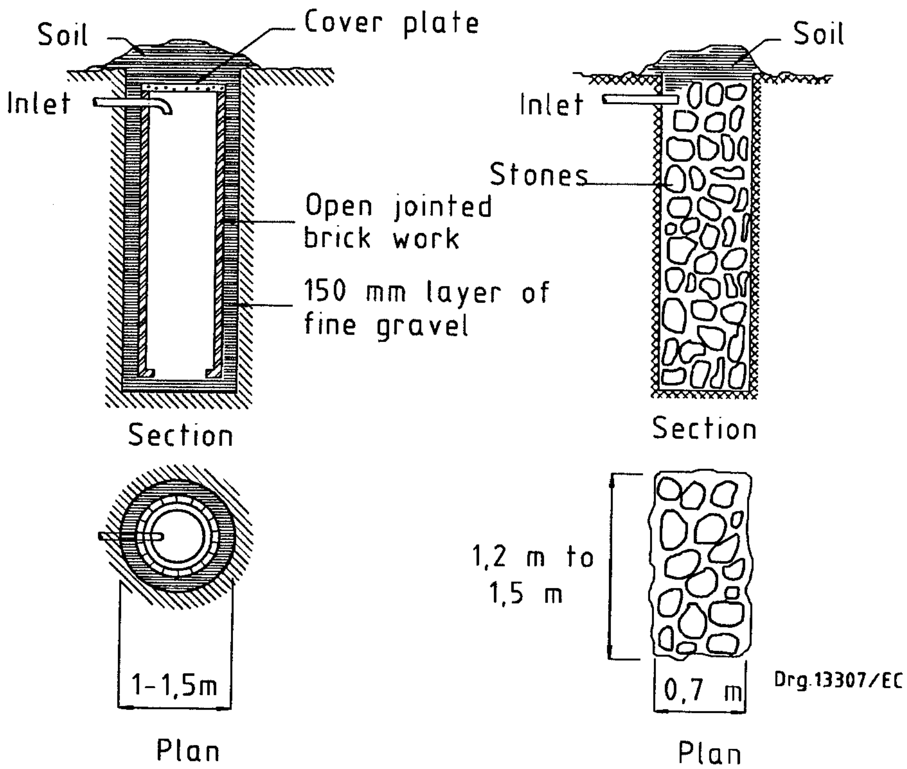


Figure B.4 — Detail of pit construction

B.2.1.3.2.2 Trenches

The soil and climatic conditions should be taken into account when trench dimensions are being selected. In the wetter parts of South Africa, shallower, wider trenches should be used, sized on the basis of the trench-bed infiltration area, while in the drier parts, narrower, deeper trenches should be used, sized on the basis of side wall infiltration. The following are recommended when trenches are constructed (see figure B.5):

a) trenches should be constructed along the contour of the soil surface. The average widths of trenches are usually between 300 mm and 450 mm, while an average depth is approximately 600 mm. Since the sizing of an absorption field depends on approximations, it is advisable to provide for possible extensions later;

b) where two or more trenches are constructed adjacent to one another, they should be located at a distance of not less than twice their depth from one another;

c) after excavation, trench surfaces should be roughened to restore their natural infiltration surface;

d) the infiltrative surfaces of the side walls of the trenches should be protected by means of a suitable polyester filter fabric, or alternatively, by a layer of fine gravel or coarse sand;

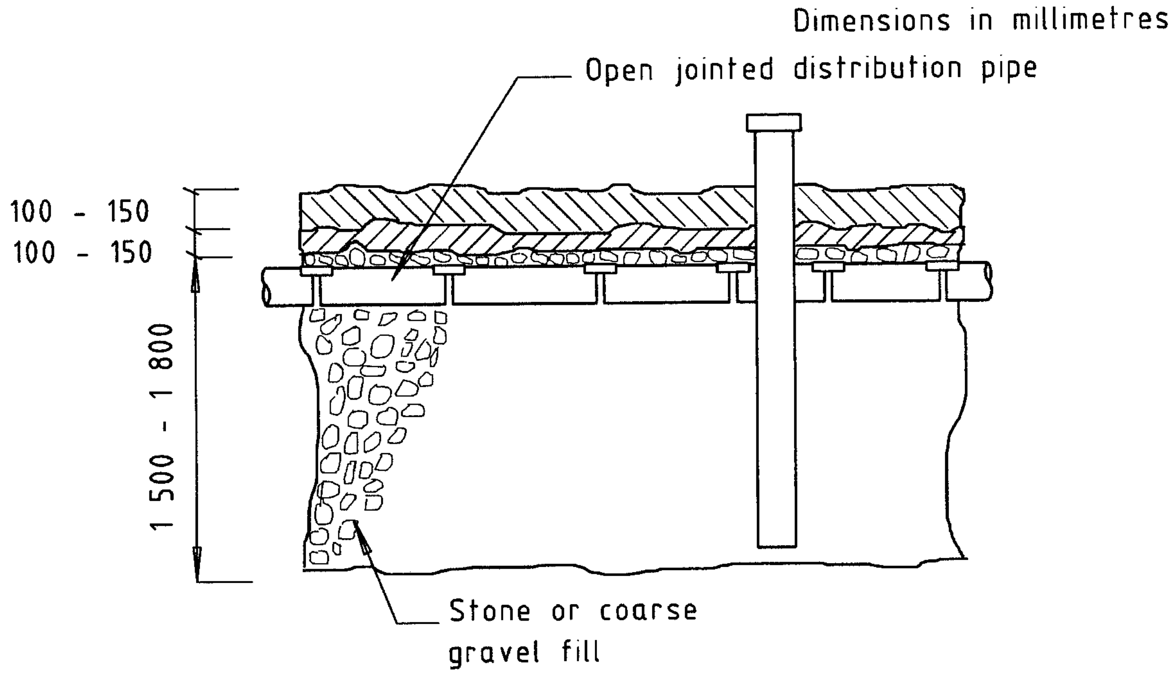
e) the gravel filling material should be clean and should range from 20 mm to 100 mm in diameter. Builder's rubble is not acceptable;

f) effluent should be distributed evenly over the surfaces of trenches by means of suitable pipes laid near the top of the gravel fillings; and

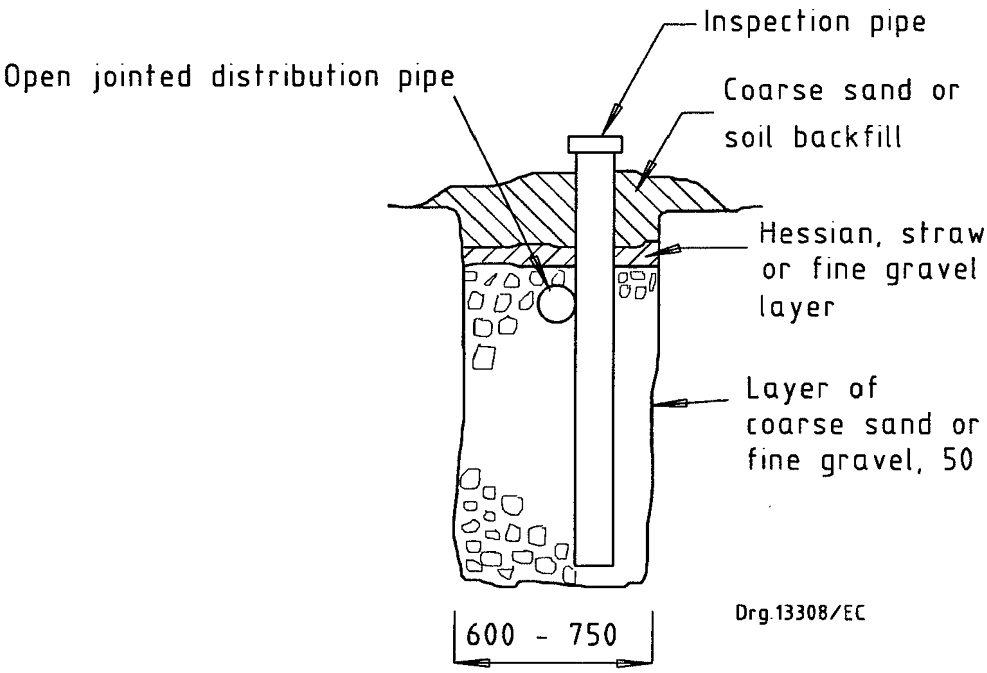
g) a layer of polyester filter fabric should be placed on top of the filling material, in order to prevent soil from entering the filling material. A topsoil layer of between 100 mm and 150 mm should be placed on top of the filter fabric.

Table B.5 — Soil suitability for french drains

1	2
Zone and soil permeability class	**Comments**
Zone 1: (Too coarse) Very rapid to rapid	Soils in this zone have a very high sand content. They readily accept effluent but, because of low percentages of silt and clay particles, they generally provide minimal treatment. Distances separating the french drain from a point of ground-water abstraction should be increased and special measures should be introduced to ensure treatment of effluent.
Zone 2: (Acceptable) Moderately rapid to moderate	Soils in this zone are expected to provide adequate percolation and treatment. They are considered acceptable for conventional absorption fields, without further testing.
Zone 3: (Marginal) Moderately slow	Soils in this zone are expected to provide good treatment of effluent, but their ability to accept and transmit effluent at a suitable rate is questionable.
Zone 4: (Unacceptable) Slow to very slow	Soils in this zone are considered unsuitable for french drains because of their impermeability.



a) Longitudinal section



b) Cross section

Figure B.5 — Detail of trench construction

B.2.2 Rehabilitation of absorption field absorptivity

The absorptivity of a malfunctioning system can often be restored by complete resting for 10 to 12 months (while another absorption field is being used), if failure has resulted from the development of a biological clogging layer at the infiltrative surface under anaerobic conditions.

Alternatively, the system can be rejuvenated by treating it with hydrogen peroxide (H_2O_2), which is a strong oxidizing agent that needs extreme safety precautions when it is used. Sandy soils require lower concentrations of H_2O_2 than silty soils, and can be successfully rejuvenated with a solution of 7,5 % or 15 % at application rates of 0,5 L/m^2 or 1,25 L/m^2, respectively. However, for silty soils, an application of at least 2,44 L/m^2 is needed. Unfortunately, H_2O_2 treatment can be expensive and the decision on whether to construct a new absorption field or to use H_2O_2 is purely a balance between economics and convenience.

B.2.3 Pollution

The primary objective of the absorption field is the destruction of excreted pathogens. A secondary objective is the disposal of effluent in a suitable and inoffensive way. Since the effluent to be disposed of still contains vast numbers of pathogens, it is necessary to consider and evaluate the possible impact the effluent may have on the environment. There are two basic ways in which a french drain can fail to purify effluent.

B.2.3.1 The first type of failure is when partly treated or untreated effluent emerges on the surface. To avoid this, the absorption fields should be properly designed, sited, constructed and maintained. Where the following are ensured, surfacing of liquids should not become a problem:

a) sites should not have an impermeable soil layer or a shallow restricting layer such as a high ground-water table. Such sites are not at all suitable for subsurface absorption systems because of their poor permeability;

b) sites that have very steep slopes, especially when underlain by a somewhat impermeable layer, should be avoided;

c) absorption fields should be properly constructed, e.g. it should not be possible for trenches to cave in, or for fine materials to ingress into gravel backfilling; and

d) effluent application rates should not be too high and the septic tank itself should be properly maintained to reduce the chance of the infiltrative surfaces of absorption fields from becoming clogged.

B.2.3.2 The second type of failure is the downward passage of pollutants to the ground water, in which they are carried to a point of abstraction. The possible downward passage of pathogens and contaminants to the ground water is the failure that is the most often encountered and unfortunately is not readily identifiable. It is also difficult to qualify or quantify the possible extent and severity of the failure and the only way in which the associated health risk can be reduced, is to increase the contact time between the effluent and the unsaturated soil. This type of failure is therefore most likely where an absorption field is located on porous bedrock, coarse sand or creviced bedrock, or where the unsaturated soil layer between the absorption field and the ground water is shallow. The following factors should be recognized in order to reduce the susceptibility of the ground water on a site to pollution:

a) soils with a lower permeability remove microbial organisms best because of their improved surface absorption;

b) the saturation of a soil layer does not affect the removal of viruses – they are removed equally effectively both in saturated and unsaturated soil layers;

c) bacteria are removed more effectively in an unsaturated soil layer; and

d) a clogging layer in an absorption field assists in the removal of bacteria and viruses.

Sometimes it may become necessary to assess the degree of the risk taken should pollutants be carried to a point of ground-water abstraction. In such instances, the severity of the contaminants and the sensitivity of the site to the pollutants become the two main issues that require assessment. The severity of the contaminants is determined by the type and the extent of the pollutants that are present in the effluent. However, for ordinary dwelling houses, this factor does not need special investigation, since the quality of domestic effluent does not vary greatly and can therefore be readily identified from a literature survey. (See the references in annex C.) The sensitivity of a site to ground-water pollution thus becomes the only factor that normally requires a special investigation and in this regard, the following aspects, among others, should be investigated:

1) the depth to, and gradient of, the ground-water flow;

2) the types of soils and their permeability;

3) the use of ground water (numbers of users and usage); and

4) the distances between a french drain and any ground-water sources.

Annex C
(informative)

Bibliography

C.1 Standards

BS 8313, *Code of practice for accommodation of building services in ducts*.

DIN 1999-1, *Separators for light liquids - petrol separators, fuel-oil separators - Part 1: Construction principles.*

DIN 1999-2, *Separators for light liquids - petrol separators, fuel-oil separators - Part 2: Design, installation and operation.*

DIN 1999-3, *Separators for light liquids - petrol separators, fuel-oil separators - Part 3: Testings.*

DIN 4040-1, *Grease interceptor systems - Part 1: Concepts, nominal sizes, requirements, testing.*

DIN 4040-2, *Grease interceptor systems - Part 2: Design, installation and operation.*

DIN 4043, *Traps for light liquids (fuel-oil traps), principles of construction, installation and operation, testing.*

SABS 22, *Glazed ceramic wall tiles and fittings*.

SABS 993, *Modular co-ordination in building*.

SABS 0107, *The fixing of glazed wall tiles*.

SABS 0143, *Building drawing practice*.

SABS 0400, *The application of the National Building Regulations*.

SABS 0401, *The construction of dwelling houses in accordance with the National Building Regulations*.

C.2 References

1. Botha, J. *Design of the closed drainage system.* NBRI Information Sheet X/BOU 2-65, CSIR, Pretoria.

2. Building Research Establishment. 1984. *Access to domestic underground drainage systems.* Building Research Establishment Digest 292, BRE, London, UK.

3. Department of Community Development. 1983. *Guidelines for the provision of engineering services in residential townships.* Department of Community Development, Pretoria.

4. Department of Development Aid. 1987. *Interim guidelines for services and amenities in developing communities.* Department of Development Aid, Pretoria.

5. De Villiers D.C. 1984. *Sanitation Systems.* NBRI Information Sheet X/BOU 2-67, CSIR, Pretoria.

6. De Villiers D.C. 1987. *Evaluation of sites for on-site sanitation systems.* The Civil Engineer in South Africa, August 1987, SAICE, Marshalltown, Johannesburg.

7. De Villiers D.C. 1987(b). *Septic tank systems.* NBRI Special Report X/BOU 93. CSIR, Pretoria.

8. Heap, M.A. 1984. *The ventilated improved pit latrine.* NBRI Information Sheet X/BOU 2-71, CSIR, Pretoria.

9. Feachem, R.G, D.J. Bradley, H. Garelick and D.D. Mara. 1981. *Appropriate technology for water supply and sanitation: Health aspects of excreta and sullage management – a state-of-the-art review.* The World Bank, Transportation, Water and Telecommunications Department, Washington D.C., USA.

10. Massey, H.C. 1985. *Plumber's handbook revised.* Craftsman Book Co, Carlsbad, California, USA.

11. National Building Research Institute. 1987. *Low-cost housing.* NBRI Special Report BRR 642, CSIR, Pretoria.

sabs pta
(pdf)