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MALAYSIAN STANDARD

MS 1402: PART 1:2006

CODE OF PRACTICE FOR SANITARY SYSTEM IN BUILDINGS – PART 1: DESIGN (FIRST REVISION)

ICS: 91.140.70

Descriptors: sanitary system, design, materials

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Association of Consulting Engineers Malaysia
Chartered Institute of Building Malaysia
Construction Industry Development Board Malaysia
Department of Standards Malaysia
Jabatan Bomba dan Penyelamat Malaysia
Jabatan Kerja Raya Malaysia
Jabatan Pengairan dan Saliran
Jabatan Perumahan Negara
Malaysian Timber Industry Board
Master Builders Association Malaysia
Ministry of International Trade and Industry
Pertubuhan Akitek Malaysia
Suruhanjaya Tenaga
The Institution of Engineers, Malaysia
Universiti Teknologi Malaysia

The Working Group on Sanitary System which developed this Malaysian Standard consists of representatives from the following organisations:

Association of Consulting Engineers Malaysia

Construction Industry Development Board Malaysia

Dewan Bandaraya Kuala Lumpur

DOE Industries Sdn Bhd

Indah Water Konsortium Sdn Bhd

Jabatan Kerajaan Tempatan

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FOREWORD

This Malaysian Standard was developed by the Working Group on Sanitary System under the authority of the Building and Civil Engineering Industry Standards Committee.

MS 1402 consists of the following parts, under the general title *Code of practice for sanitary system in buildings*:

Part 1: Design

Part 2: Installation

Part 3: Testing and commissioning

Part 4: Operation and maintenance

This Malaysian Standard is the first revision of MS 1402, *Code of practice for sanitary system in buildings.* In the revision of this standard, effort has been taken to divide sections of the former MS 1402 into four parts.

The major modifications are as follows:

a) the scope of work is from the discharge points of sanitary appliances to the last manhole within the building premise;

b) the requirements for rainwater system have been taken out; and

c) the requirements of pans, cistern, vitreous china and non-vitreous china used in sanitary appliances, vitreous china and stainless steel urinals, copper and copper alloy material and bathseats have been taken out.

This Malaysian Standard cancels and replaces MS 1402:1996, *Code of practice for sanitary system in buildings.*

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CODE OF PRACTICE FOR SANITARY SYSTEM IN BUILDINGS – PART 1: DESIGN (FIRST REVISION)

SECTION 1: GENERAL

1.1 Scope

This Malaysian Standard gives recommendation for planning, designing, installation and workmanship of sanitary systems in building, which includes water supply system, sanitary appliances, sanitary pipework, sanitary appurtenances and ventilation system including all other works necessary for non-pressure domestic, commercial and public buildings. This standard covers only from the fitting discharge to the final manhole.

This standard is intended to indicate what is considered to be the minimum requirements for the design of sanitary system and good practice, under normal conditions. However, it also covers any special requirements of building such as may be found in hospitals, research and similar laboratories, or trade waste discharge.

This standard's recommendations should be supplemented as required by skilled engineering advice based on knowledge of sanitary work practices and of local conditions.

1.2 Normative references

The following normative references are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

MS 29, *Specification for aggregates from natural sources for concrete*

MS 144, *Specification for cold reduced mild steel wire for the reinforcement of concrete*

MS 145, *Specification for steel welded fabric for the reinforcement on concrete*

MS 147, *Specification for quality of vitreous china sanitary appliances*

MS 523, *Specification for ready-mixed concrete*

MS 583, *Specification for cellulose wadding*

MS 922: Part 1, *Specification for concrete admixtures – Part 1: Accelerating admixtures, retarding admixtures and water reducing admixtures*

MS 1035, *Code of practice for unplasticised PVC pipework for the conveyance of liquid under pressure*

MS 1085, *Code of practice for the installation of buried unplasticised PVC pipework for gravity sewers*

MS 1522, *Specification for vitreous china water closet pans*

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BS 2598: Part 4, *Glass plant, pipeline and fittings – Part 4: Specification for glass plant components*

BS 4994, *Design and construction of vessels and tanks in reinforced plastics*

BS 5572, *Code of practice for sanitary pipework*

BS 8000: Part 13, *Workmanship on building sites – Part 13: Code of practice for above ground drainage and sanitary appliance*

AS 1449, *Wrought alloy steels – Stainless and heat-resisting steel plate, sheet and strip*

AS 1546, *Small septic tanks*

AS 1604, *Timber – Preservative-treated – Sawn and round*

AS 3571, *Glass filament reinforced thermosetting plastics (GRP) pipes - Polyester based - Water supply, sewerage and drainage applications*

AS 3600, *Concrete structure*

AS 3706, *Geotextiles*

AS/NZS 2878, *Timber – Classification into strength groups*

AS/NZS 1604, *Specification for preservative treatment*

AS/NZS 3500.2:2003, *Plumbing and drainage – Part 2: Sanitary plumbing and drainage*

1.3 Definitions

For the purposes of this Malaysian Standard the following definitions apply.

1.3.1 Access cover

A removable cover on pipes and fittings providing access to the interior of pipework for the purpose of inspection, testing and cleaning.

1.3.2 Branch discharge pipe

A discharge pipe connecting sanitary appliances to a discharge pipe.

1.3.3 Branch ventilating pipe

A ventilating pipe connected to a branch discharge pipe.

1.3.4 Criterion of satisfactory service

The percentage of time during which the design discharge flow loading will not be exceeded.

1.3.5 Discharge pipe

A pipe, which conveys the discharge from sanitary appliances.

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1.3.6 Discharge unit

A unit so chosen that the relative loading-producing effect of appliances can be expressed as multiples of that unit. The discharge unit rating on an appliance depends on its rate and duration of discharge, on the interval between discharge and on the chosen criterion of sanitary satisfactory service. It is to a simple multiple of a rate of flow.

1.3.7 Size

The term used in to indicate the nominal internal diameter of pipes regardless of specific materials and their classification in individual standard of MS 1402.

NOTE. The relationship between size (as used in this standard) and individual pipe standard.

1.3.8 Stack

A main vertical discharge or ventilating pipe.

1.3.9 Ventilating pipe

A pipe provided to limit the pressure fluctuations within the discharge pipe system.

SECTION 2: DESIGN CRITERIA

2.1 General

Consultation is essential between clients, architects and engineers at all stages of the design of buildings to ensure efficient and economic planning of the sanitary installations and the discharge system and the provision and positioning of ducts, in relation to the building as a whole.

Details of sewers and any precautions necessary to ensure satisfactory working of the discharge systems, e.g. information on the possibility of surcharging and details of Statutory Regulations should be obtained from the relevant authority. Specific requirements of the water authorities should be ascertained.

Alterations or extensions to existing work will probably need a survey and report, which should include the following:

a) the type of sanitary system in use and sewer loadings;

b) details and positions of sanitary wares and fittings connected to the system;

c) a description of the sanitary system and its condition;

d) particulars on ventilation of the sanitary system; and

e) the results of tests in accordance with MS 1402: Part 3.

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2.2 Statutory requirements

Attention is directed to Acts, By-laws, Regulations and any other statutory requirements relating to matters dealt with in this standard and related standards. Amongst others, these include the following:

a) *Street, Drainage and Building Act*, 1974;

b) *Uniform Building By-laws*, 1984;

c) *Sewerage Services Act*, 1993;

d) *Internal Sanitary Plumbing By-laws* (under preparation);

e) *Public Health Ordinance,* 1960 (Sabah No. 7 of 1960);

f) *Public Health Ordinance*, 1962 (Sarawak No. 24 of 1962); and

g) *Occupational Safety and Health Act*, 1994.

Users of this standard should ensure that they are referring to the latest editions of the statutory regulations mentioned above and elsewhere in this standard.

Local authorities are responsible for the enforcement of most of the above and information required by them may include the following:

a) information on the number, position and types of sanitary wares and fittings to be installed (see Annex A) and details of the proposed user of the premises;

b) notification on the appropriate forms and particulars of the proposed work; and

c) drawings and specification.

Before commencing the work, the contractor should possess of copies of the drawings as approved by the appropriate authorities, together with the specification and any further working drawings and information necessary to enable the work to be carried out.

2.3 Publication refereed to

Further information on certain subjects referred to in this standard is contained in the normative reference.

2.4 System planning criteria/Performance requirements

2.4.1 General

Discharge pipe systems should comprise the minimum of pipework necessary to carry away the discharges from sanitary appliances in the building quickly, quietly and with freedom from nuisance or risk of injury to health. It is essential that air from the discharge pipes or drainage system be prevented from entering the building.

2.4.2 Planning criteria and requirements

In the design of a sanitary system, the following criteria and requirements should be considered.

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2.4.2.1 Sanitary accommodations requirements

These requirements are specified in the Internal Sanitary Plumbing By-laws. Details are as given in Annex A.

2.4.2.2 Discharge

Requirements for the discharge rates from sanitary appliances should be a primary consideration of the designer. Typical discharge rates for Malaysia are listed in Table 1. The sizes of outlets, traps and pipework should be such that the discharge from sanitary appliances is not unduly restricted below such values. Pipes serving more than one appliance should be sized taking account of simultaneous discharge. Table 1 also gives information on the duration and frequency of use of sanitary appliances that may be used in calculations of simultaneous discharge. A value of 99 % is recommended as a minimum criterion of satisfactory service for such calculations.

Table 1. Flow and usage data of sanitary appliances

Sanitary appliances	Capacity	Discharge data		Frequency of use	Individual probability (p) of discharge
		Maximum flow rate $1s^{-1}$	Duration (t) S	(T) s	$p\frac{t}{T}$
Washdown Water Closet (WC)	9	2.3	5	1 200 600 300	0.004 1 0.008 3 0.016 7
Urinal (per person unit)	2.5	0.15	30	1 200 900	0.0167 0.033 3
Wash basin (32 mm branch)	6	0.6	10	1 200 600 300	0.008 3 0.016 7 0.008 3
Sink (40 mm branch)	23	0.9	25	1 200 600 300	0.020 8 0.041 7 0.083 4
Bath (40 mm branch)	80	1.1	75	4 500 1 800	0.016 7 0.041 7
Automatic washing machine	4 kg to 5 kg dry load	0.6	30	15 000	0.020 0
Shower	-	0.1	-	-	-
Spray tap basin	-	0.06	-	-	-

NOTE 1. A washing machine will discharge at various intervals during any selected programme. The maximum number of discharges will be 6 and the volume discharged each time will be in the order of 20 l. Hence:
- 240 s represents the minimum time between rinses;
- 900 s represents a mean discharge interval of 20 minute during the use of the machine; and
- 15 000 s represents a 4.2 h interval between uses of the machine.

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2.4.2.3 Exclusion of foul air

Conventional gravity discharge systems rely on water-filled traps at the appliances for the exclusion of foul air from buildings. The water seal depth should, therefore, be large enough to account for possible loss due to evaporation and pressure fluctuations to prevent foul air from the discharge pipe system or drain from entering the building. For water closets (WCs) there should be sufficient trap water for the containment of excreta. In this standard, trap seal depths of 75 mm are assumed for traps with diameters of up to and including 50 mm and for traps with diameters larger than 50 mm, a 50 mm depth is also assumed. Additional information on trap performance is given in Table 2.

Pressure fluctuations should be limited in order to retain these water seals and thereby prevent foul air from entering the building. Systems in this standard are designed so that pressure fluctuations do not exceed ± 38 mm water gauge and that at least 25 mm of water seal is retained in the traps. These limitations are based on the worst likely discharge conditions.

Table 2. Trap performance data

Typical seal loss [due to negative pressure (suction) of 325 N/m^2 (38 mm water gauge) in discharge systems]		Typical evaporation loss	
Trap detail	**Approximate seal loss**	**Trap detail**	**Accepted average figure per week**
Typical washdown WC, 50 mm seal depth	25 mm	Small and large before traps	2.5 mm (U.K. value)
Small diameter tubular trap, 75 mm seal depth	19 mm		

2.4.2.4 Limitation of noise

Noise generated by discharge systems should be limited so as to maintain environmental quality in buildings. The discharge from sanitary wares and fittings and pressure fluctuations in the pipework causing seal loss are important sources of noise, but pipework designed to limit pressure fluctuations as in 2.4.2.3 tends to be quiet. Another source of noise is the flow of water in discharge branches and stacks but this may be reduced by sound insulation of the pipework from the structure and of the containing ductwork.

2.4.2.5 Containment of water and air

The discharge pipework system should prevent the leakage of contaminated water and foul air into the building.

2.4.2.6 Resistance to blockage

The discharge pipework should be so designed as to minimise the risk of blockage. Since blockage can be caused by the accumulation of grease from waste water with high grease content such as discharges from a restaurant, the discharges from the kitchen of such a premise should be pre-treated by an efficient grease trap before it enters the building sanitary system.

2.4.2.7 Durability

The discharge system including materials, joints, supports and fixings should be durable under operating conditions.

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2.4.2.8 Access for maintenance

Discharge pipework should be easily accessible and traceable. Access covers and/or cleaning eyes should be positioned to allow cleaning and maintenance equipment to be easily inserted into the pipework and to permit cleaning or clearing of all parts of the system.

2.4.2.9 Replacement

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

2.4.2.10 Accessibility for testing

Systems should be capable of being tested to ensure that the required performance is attained. Adequate access should be provided to enable tests to be carried out

2.4.3 Type of discharge systems

2.4.3.1 Description of discharge systems

The discharge systems in this standard can conveniently be classified as follows:

a) Fully ventilated system (see Figure 1)
   A ventilated system is used in situations where there are large numbers of sanitary appliances in ranges or where they have to be widely dispersed and it is impracticable to provide discharge stack(s) in close proximity to the appliances. Trap seals are safeguarded by extending the discharge and ventilating stacks to atmosphere and providing individual branch ventilating pipes.

b) Ventilated stack system (see Figure 2)
   A ventilated stack system is used in situations where close grouping of appliances makes it practicable to provide branch discharge pipes without the need for branch ventilating pipes. Trap seals are safeguarded by extending the stack(s) to the atmosphere and by cross connecting the ventilating stack to the discharge stack.

c) Single stack system (see Figures 3 and 4)
   A single stack system is used in situations as described in a) but only where the discharge stack is large enough to limit pressure fluctuations without the need for a ventilating stack.

A modified single stack system providing ventilating pipework extended to the atmosphere or connected to a ventilating stack can be used where the positioning of appliances on a branch discharge pipe could cause loss of their trap seals. The ventilating stack need not be connected directly to the discharge stack and can be smaller in diameter than that required for a ventilated stack system.

For design purposes it is convenient to consider separately the effects of the flow in branch discharge pipes and in discharge stacks.

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2.4.3.2 Branch discharge pipe

Loss of water seal from the trap of a discharging appliance may occur by self-siphonage if the branch discharge pipe flows at full bore. Traps on appliances not discharging may also suffer seal loss by induced siphonage if the branch discharge pipe to which they are connected is following full bore or if conditions of flow in the vertical stack create negative pressure. These seal losses (see Figure 5) will be affected by the following:

a) the design of the appliances, e.g. funnel shaped appliances increase the chance of self-siphonage;

b) the length, slope and size of the pipe;

c) the type of trap and waste fittings, grid design and free cross-section at area at the outlet;

d) whether or not the appliances has an overflow which is connected into the waste fitting or to the trap;

e) the design of pipework fittings, particularly bends; and

f) the provision or not of a branch ventilating pipe.

2.4.3.3 Discharge stacks

Water flowing in discharge stacks will cause air pressure fluctuations. Suction can occur below discharging branch connections and offsets, causing water seal loss by induced siphonage from sanitary appliances connected to the stack. Back pressures or positive pressures can occur above offsets and bends in stacks causing foul air to be blown through the trap water seal and sometimes, seal loss. These seal losses (see Figure 6) will be affected by the following:

a) the flow load, depending on the total number and type of sanitary appliances connected to the stack, their distribution on each floor of the building and the frequency with which they are used;

b) the height and diameter of the stack, where excessive seal losses can be prevented by selecting the size of stack appropriate to the number of appliances connected to it and the height of the building;

c) the design of pipe fittings, particularly the shape and size of branch inlets and the radius of the bend at the base of the stack connecting K to the drain;

d) changes of direction in the wet portion of the discharge stack;

e) provision or not of a ventilating pipe;

f) surcharging of the drain; and

g) provision or not of an intercepting trap in the drain.

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2.4.3.4 Shape and size of branch inlets

Suction produced in the discharge stack below discharging branch inlets is affected by the radius or slope of the branch inlet. A large radius or a 45° entry will tends to minimise the amount of the suction but a near horizontal entry with a small radius tend to have the opposite effect. Branch inlets which are significantly smaller in diameter than the stack are not so critical in this respect (see 3.2.2.5).

2.4.3.5 Bends and offsets

Sharp bends at the base of a stack can cause large back pressures due to restriction of the stack air flow and similarly, offsets in the wet part of a stack can produce large pressure fluctuations. Changes in stack direction can also cause foaming of detergents and consequent pressure fluctuation.

2.4.3.6 Surcharging of the drain

If the drain to which the discharge stack is connected is surcharged, the normal flow of air down the stack during discharge is interrupted and high back pressures can occur. Under these conditions additional stack ventilation will be required.

2.4.3.7 Intercepting traps

In a situation where a single discharge stack is connected to a drain fitted with an intercepting trap in close proximity, large pressure fluctuations can occur. Additional stack ventilation will then be necessary.

2.4.3.8 Wind effects

Wind blowing across roofs can produce pressure fluctuations in the vicinity of parapets and corners of the building. If discharge or ventilation stacks are terminated in these areas unacceptable pressure fluctuations can be developed in the discharge system (see 3.2.3.6).

2.4.3.9 Effects of pumped or ejector discharge

Where it is necessary to pump, eject the waste water from the sanitary system into the building sewerage system. It should be carried out 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 sanitary system.

The exhaust compressed air from pneumatic ejectors should not be discharged into the ventilation system but should be discharged to atmosphere separately.

2.4.4 Local By-Laws requirement

Submitting person (architect/mechanical engineer) should submit necessary forms according to internal sanitary by-laws before commencement of the works to the approving by the authority.

2.4.5 Support for bends/joint

Proper support facilities should be provided at bends and joints along the stacks.

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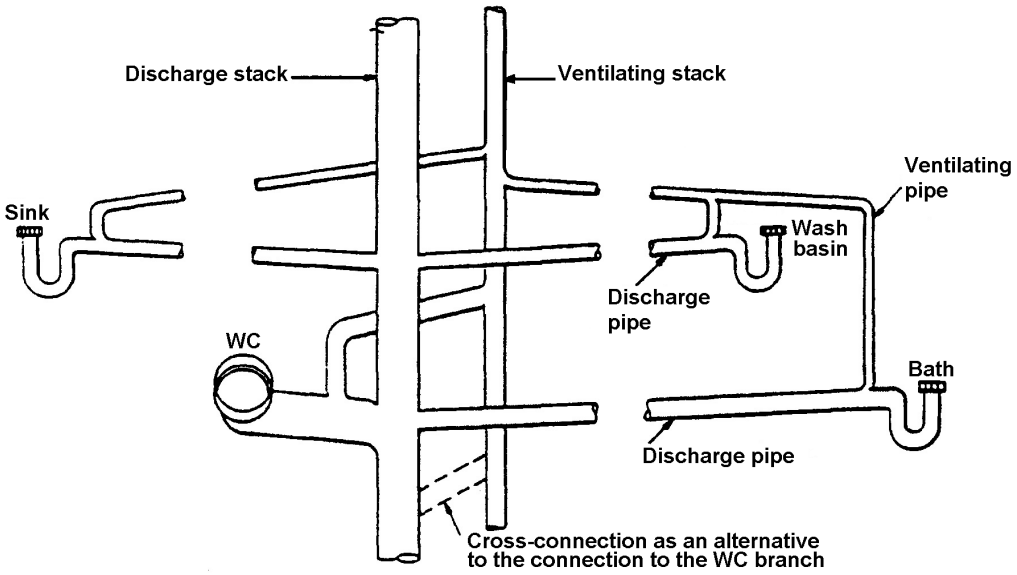
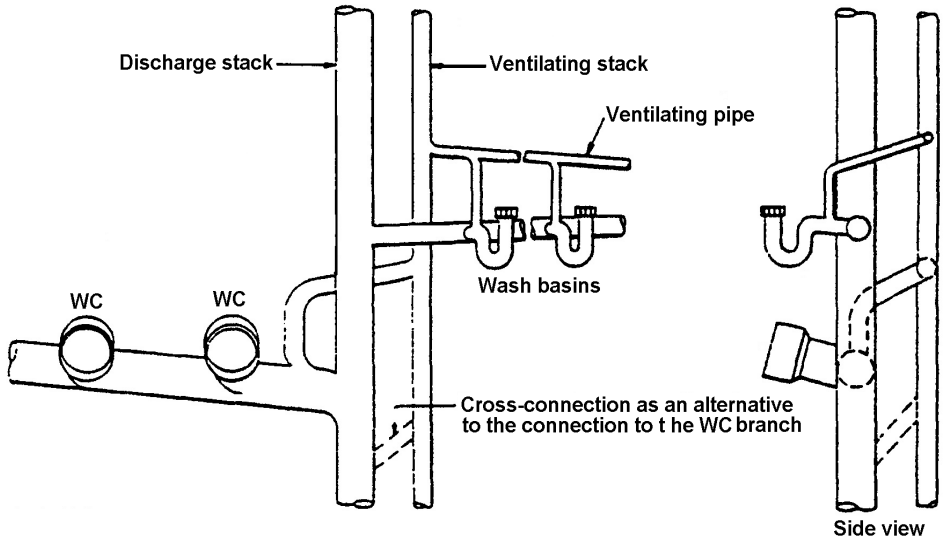


a) Single appliances



b) Multiple sanitary appliances

NOTE. These ventilated systems are use in situations where there are large numbers of sanitary appliances in ranges or where they have to be widely dispersed and it is impracticable to provide discharge stacks in close proximity to the appliances.

Figure 1. Ventilated system (diagrammatic)

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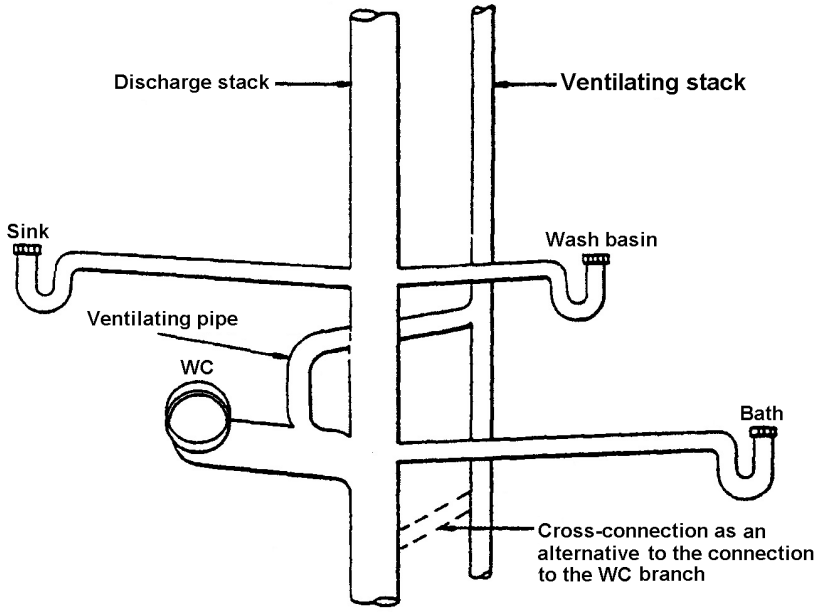
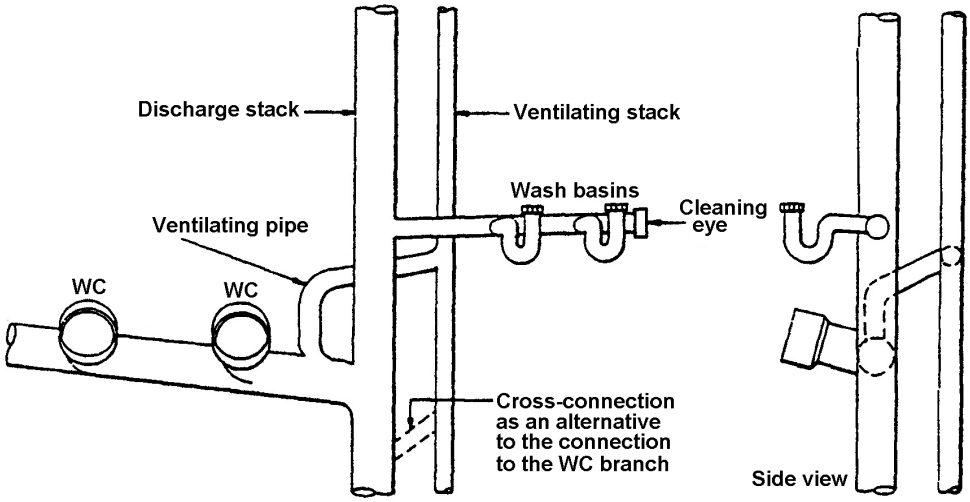


a) Single sanitary appliances



b) Multiple sanitary appliances

NOTE. These ventilated stack systems are use in situations where close grouping of sanitary appliances makes it practicable to provide branch discharge pipes without the need for branch ventilating pipes.

Figure 2. Ventilated stack system (diagrammatic)

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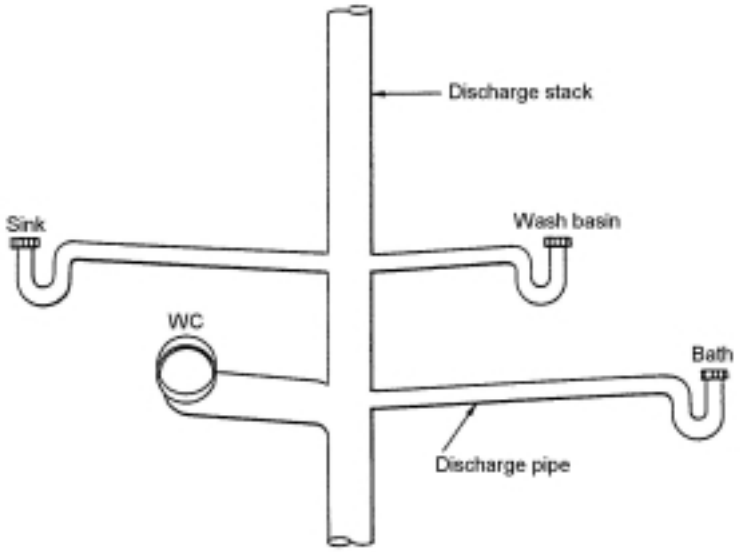
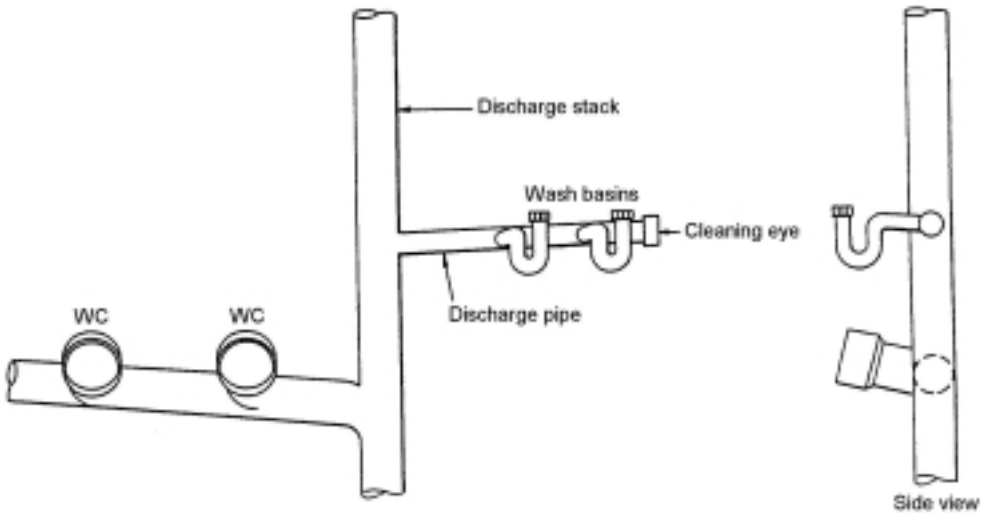


a) Single sanitary wares and fittings



b) Multiple sanitary wares and fittings

NOTE. These single stack systems are use in situations described in the note to Figure 2, but where the discharge stack is large enough to limit pressure fluctuations without the need for a ventilating stack.

Figure 3. Single stack system (diagrammatic)

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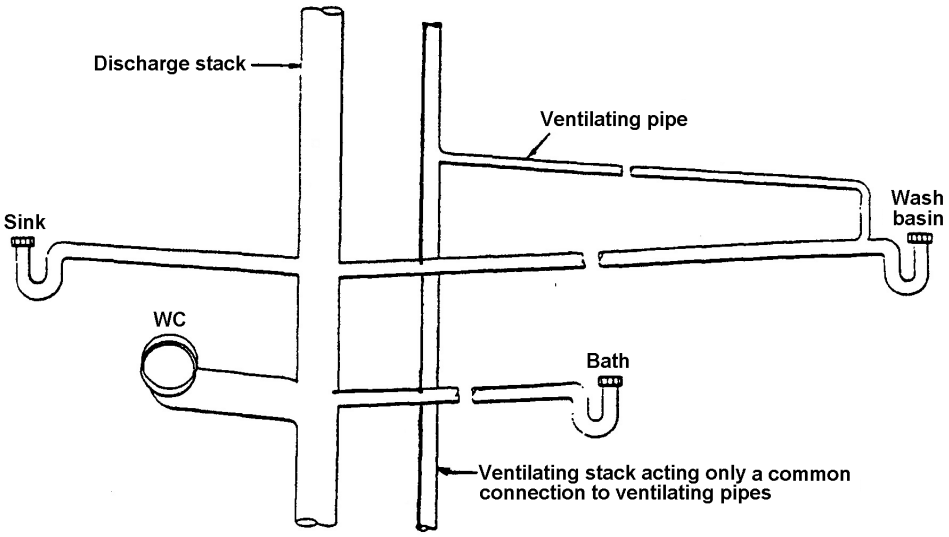
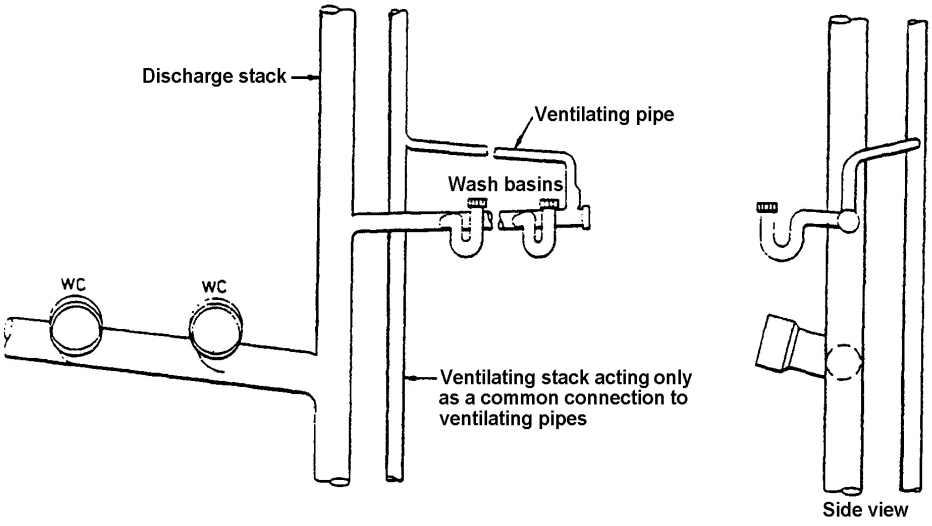


a) Single sanitary appliances



b) Multiple sanitary appliances

NOTE. These modified single stack systems are use in situations where the disposition of wares and fittings on a branch discharge pipe could cause loss of their trap seals (by the provision of ventilating pipework extended to the atmosphere or connected to a ventilating stack).

Figure 4. Modified single stack system (diagrammatic)

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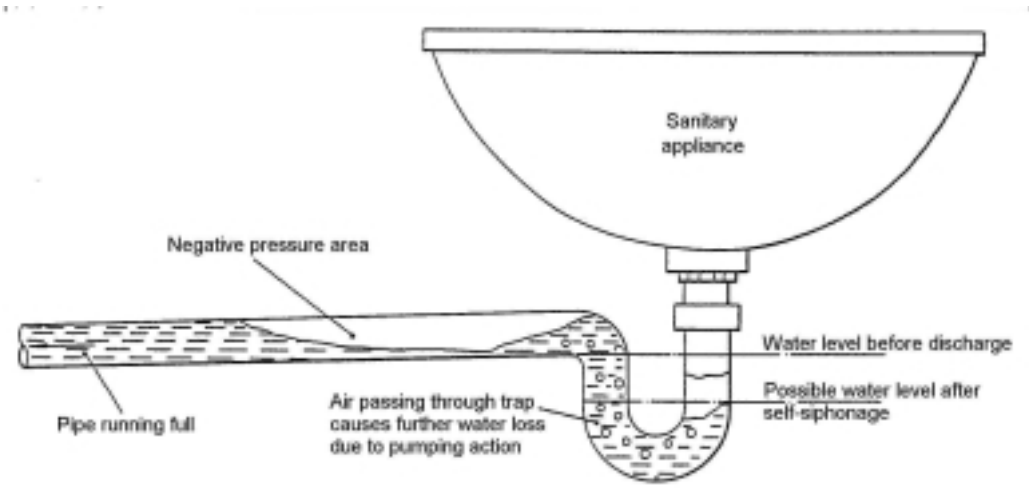
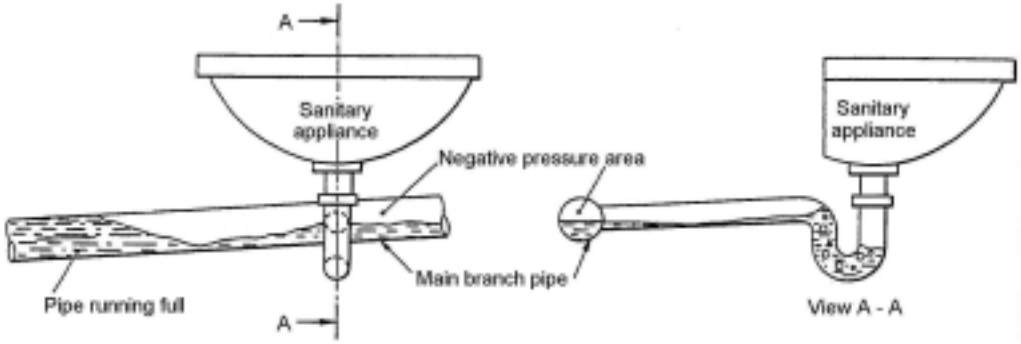


a) Self-siphonage, 1st the end as an appliance discharges



b) Induced siphonage (due to full bore flow in a main branch discharge pipe)

Figure 5. Seal loss due to flow branch pipes

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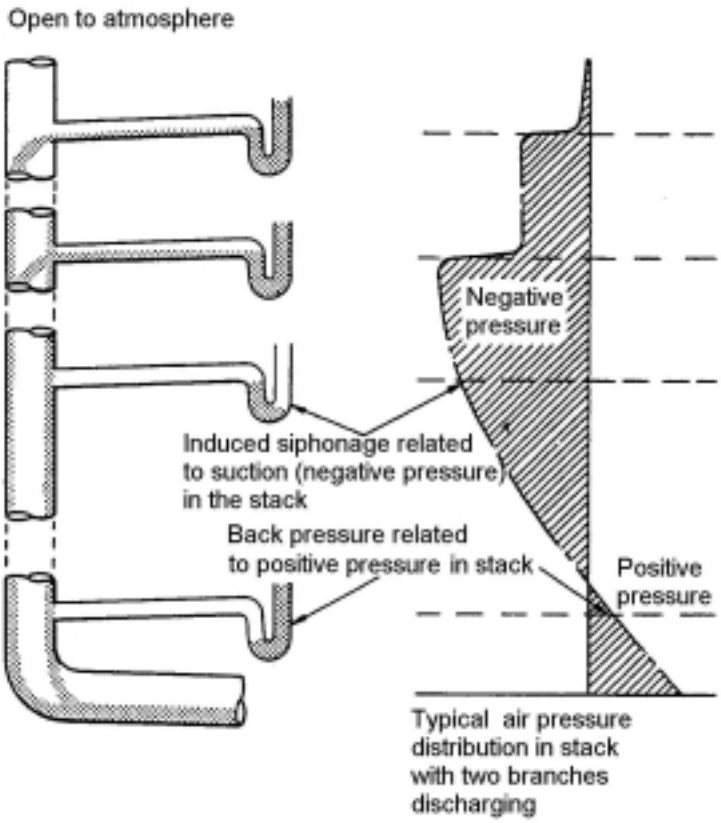

NOTE. Connection close to base of stack is not recommended but is shown here to illustrate pressure effects.

Figure 6. Pressure effects and seal losses due to water flow in a discharge stack

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SECTION 3: DESIGN

3.1 General

Recommendations in this standard are based, wherever possible, on sanitary appliances, pipes and fittings that comply with Malaysian Standards.

This clause gives detailed design data for the following:

a) Domestic buildings including bungalows, houses, multi-storey flats and halls of residence. Typical features of these installations are single appliances connected to, and often closely grouped through a discharge stack.

b) Non-domestic building such as offices, factories, schools and other types of public buildings. Typical features of these installations are ranges of sanitary appliances connected to the discharge stack by main branch discharge pipes. Generally, sanitary wares cannot be so closely grouped round the stack as in domestic buildings.

3.2 Discharge pipes and stacks

3.2.1 General

Because of their different performance characteristics, it is convenient to deal with branch discharge pipes and discharge stacks separately.

3.2.2 Branch discharge pipes

3.2.2.1 Diameter

Branch discharge pipes should not be reduced in diameter in the direction of flow. Sizes of branch discharge pipes are given in Table 3. Oversizing branch discharge pipes to avoid self-siphonage problems can be uneconomic and can lead to an increased rate of deposit accumulation.

Table 3. Maximum fixture unit loadings for graded discharge pipes

Graded %	Nominal size of pipe							
	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150	DN 225
5.00	6	15	51	65	376	953	1 959	7 098
3.35	5	10	29	39	248	686	1 445	5 583
2.50	4	8	21	27	182	509	1 148	4 513
2.00	X	X	X	20	142	410	953	3 739
1.65	X	X	X	16	115	342	813	3 258
1.25	X	X	X	X	X	254	627	2 656
1.00	X	X	X	X	X	X	509	2 272

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3.2.2.2 Gradients

The gradient of a branch discharge pipe should be uniform and adequate to drain the pipe efficiently. Practical considerations usually limit the minimum gradient to 1° or 1¼° (18 mm/m or 22 mm/m). This can be undesirable and adequate self-cleansing of such an arrangement is only possible with high flow rates (e.g. of not less than 2.5 l/s) and workmanship of a high standard.
Pipe sizes, gradients and pipe capacities are inter-related as shown in this section and this relationship is vital for the 32 mm branches normally connected to wash basins. Vertical 32 mm branch pipe to wash basins with 's' traps often run full bore and ventilating pipework may be needed to prevent self-siphonage and noisy discharge.

3.2.2.3 Lengths

Branch discharge pipes, especially those serving wash basins and urinals, should be kept as short as practicable to reduce both self-siphonage effects and the accumulation of deposits. Large diameter branches serving WCs present fewer problems in these respects.

3.2.2.4 Branch pipe bends and junctions

Bends in branch discharge pipes should be avoided, especially for single, ranges of wash basins, as they can cause blockages and increase self-siphonage effects. When they are unavoidable they should be of large radius.

Junctions between branch discharge pipes of about the same diameter should be swept in the direction of flow using swept entry branches with a 25 mm minimum root radius, otherwise 45° branches should be used. To minimise the risk of blockage, branches up to 40 mm size joining larger diameter horizontal branches of 100 mm or over should, if practicable, connect to the upper part of the pipe wall of the larger branch. For the same reason, opposed branch connections in the horizontal plane to a main branch discharge pipe should be avoided.

For a combined branch to which a wash basin is connected, the shape of a tee junction fitting can have an especially significant effect on performance, unless swept in the direction of flow.

3.2.2.5 Branch pipe connections to discharge stacks (see Figure 7)

Small diameter branch discharge pipes of up to 65 mm size may be connected to stacks of 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 87½° branch boss. However, for 32 mm pipes serving wash basins the sweep radius should be not greater than 25 mm [see Figure 7 b)] and the change in gradient should be within 250 mm from the stack.

A branch inlet of 75 mm to 150 mm size joining a discharge stack of equal diameter should be swept in the direction of flow with a radius of not less than 50 mm for angles of 87½° to 67½° [see Figure 7 c) i)].

Branch pipe connections at 45° or less do not need swept inlets [see Figure 7 c) ii)].

Branch inlets of 75 mm size joining 100 mm or 150 mm discharge stacks and branch inlets of 100 mm joining 150 mm stacks may be swept or unswept [see Figure 7 c) iii)].

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3.2.2.6 Prevention of cross flow (see Figure 8)

Opposed small diameter branch discharge pipes without swept entries should be arranged so that the risk of the discharge from one branch into the other is avoided.

To prevent the discharge from a large diameter branch (e.g. a WC branch) backing up a smaller diameter branch (e.g. a bath branch) the latter should be connected to the stack so that its centre line meets the centre line of the stack at or above the level at which the centre line of the large branch meets the centre line of the stack, or at least 200 mm below it. Similar rules apply to opposed small diameter branches (see Figure 8).

3.2.2.7 Direct connections to an underground drain

3.2.2.7.1 Gullies

It is often convenient in low-rise houses, bungalows and ground floor flats or maisonettes, to discharge the waste water from some sanitary appliances e.g. baths, wash basins and sinks, into an external gully. The sanitary appliances should be fitted with suitable traps and the discharge pipes should terminate below the grating but above the water level in the gully.

This arrangement usually requires a certain length of vertical or near vertical discharge pipe, which can cause self-siphonage of the trap seals and some noise. The former is not so likely with baths and sinks because trail off at the end of discharges will refill the traps sufficiently but wash basin branches may require venting. However, in suitable circumstances a resealing trap may be fitted. Noisy discharges can only be prevented by venting.

3.2.2.7.2 WC connections

WCs can be connected directly to a drain, without individual venting, provided that the vertical distance from the crown of the trap to the invert of the drain is not more than 1.5 m.

3.2.2.7.3 Stub stacks

For single storey buildings a short, straight, 100 mm discharge stack with the top closed, preferably with an access fitting, can be used to connect one set of domestic sanitary appliances, e.g. bath, wash basin, sink, washing machine and WC, directly to the drain provided that the crown of the WC trap is not more than 1.5 m from the invert of the branch drain and that the distance between the topmost connection to the stub stack and the invert of the branch drain is not more than 2 m. The method can also be used for ground floor sanitary appliances of other buildings where it may be considered undesirable to connect them to the main discharge stack because of the effects of positive pressure at the base of the stack.

NOTE. Direct connections to a drain for individual sanitary appliances or for stub stacks should only be made when the drain is adequately ventilated to safeguard trap scale.

3.2.3 Discharge stacks

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3.2.3.1 Diameter

The internal diameter of a discharge stack should be not less than that of the largest trap or branch discharge pipe connected to it. The discharge stack above the topmost sanitary appliance connection should be continued without any reduction of diameter to the point of termination (see 3.2.3.6), except for one and two storey housing where, in certain cases, economies can be made by using a 75 mm vent pipe without detriment to the performance of the system. Sizes of discharge stacks are given in Table 4.

3.2.3.2 Bends and branches at the base of stacks (see Figure 9)

Bends at the base of a discharge stack should be of large radius, at least a 200 mm radius to the centre line, but preferably, two 450 large radius bends should be used. Increasing the size at the base of a 100 mm stack and bend to 150 mm is an alternative but this may oversize the drain and be uneconomic.

Generally, for systems up to five storeys the distance between the lowest branch connections and the invert of the drain should be at least 750 mm, but for low rise single dwellings 450 mm is adequate. For larger multi-storey systems, it is better to connect the ground floor sanitary appliances into the horizontal drain and not directly to the stack. For buildings over 20 storeys high, it may be necessary for both the ground and first floor sanitary appliances to be so connected.

Table 4. Maximum loading on stacks in fixture units

a) Four or more floor levels

Size of stack	Maximum loading per floor level	Maximum loading per stack
DN 40	4	16
DN 50	9	36
DN 65	14	56
DN 80	20	80
DN 100	125	500
DN 125	250	1 000
DN 150	600	2 400
DN 225	1750	7 000

b) Three or fewer floor levels

Size of stack	Maximum loading per floor level	Maximum loading per stack
DN 40	2	6
DN 50	5	15
DN 65	6	18
DN 80	13	40
DN100	65	195
DN 125	150	450
DN 150	250	750
DN 225	950	2 850

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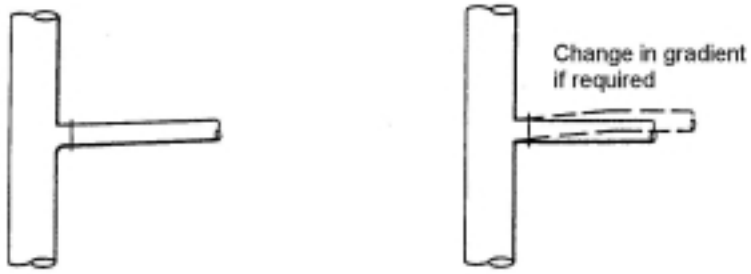
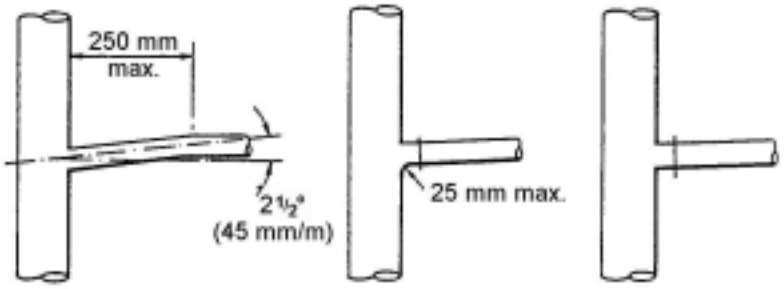


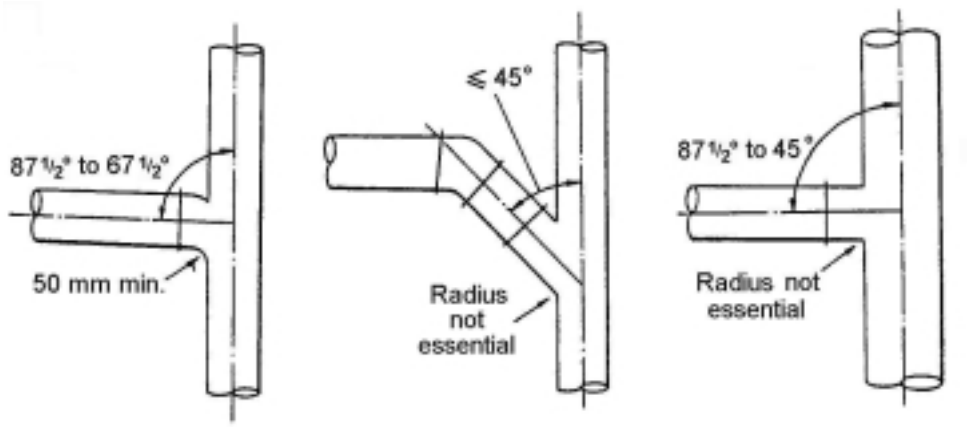
i) With radius ii) Without radius

a) For branch discharge pipes of up to 65 mm diameter (except 32 mm branches serving wash basins)



i) Using 87½° boss when pipe gradient has to be less than 2½° (45 mm/m) ii) With small radius iii) Without radius

b) For branch discharge pipes of 32 mm diameter serving wash basins



i) Equal branch ii) Equal branch iii) Unequal branch

c) For branch discharge pipes of 75 mm to 150 mm diameter (connected to stacks of up to 150 mm diameter)

Figure 7. Branch discharge pipe connections to discharge stacks

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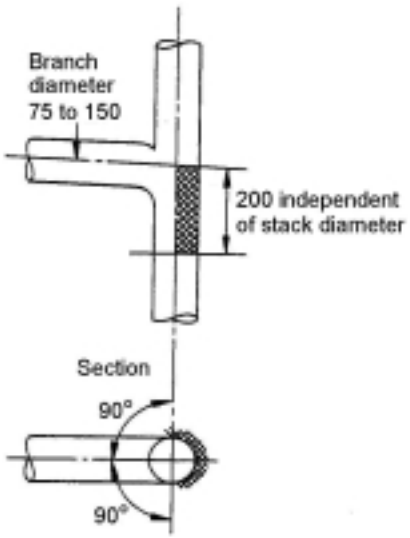
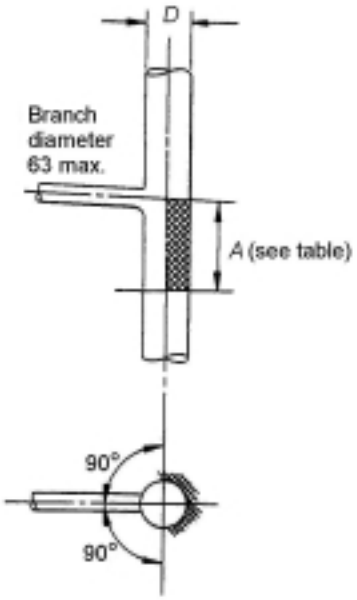
Dimensions in millimetres



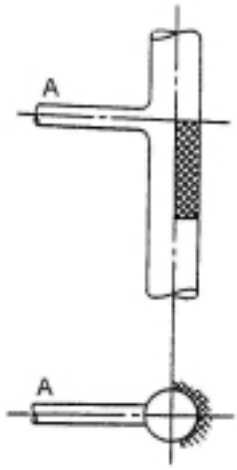


i) No connection zone opposite a large branch.

ii) No connection zone opposite a small branch

a) Opposed connection or large and small branch discharge pipes

Dimensions in millimetres



i) Consider a stack with branch A and its no connection zone, shown shaded.

Figure 8. Opposed branch connections to stack; prevention of cross flow
(see 3.2.2.6)

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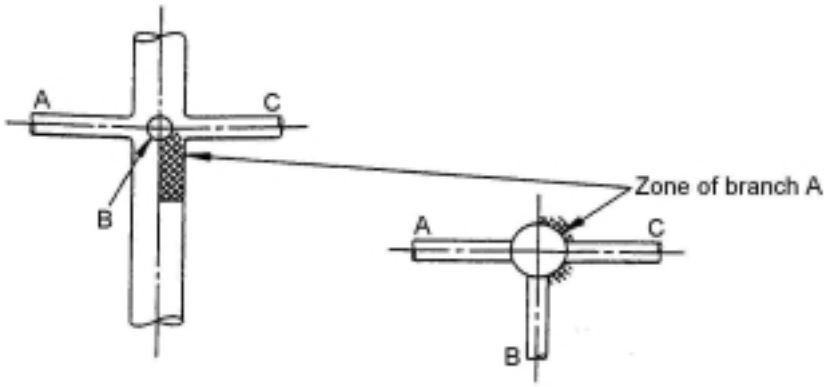
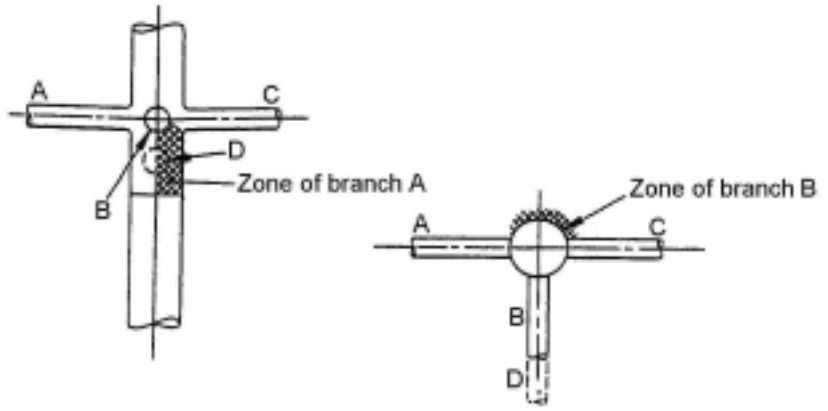


ii) Other branches may be fitted at the same level as A, as shown at B and C. Each branch creates its own no connection zone. Only that of branch A is shown in this diagram.



iii) A branch may also be fitted at D, or elsewhere on the same vertical centre line. Although this would be on the boundaries of the no connection zones of branches A and C its centre line would not be inside either of them. But as branch B has no connection zone on the far side of the stack it. Would not be possible to fit a branch opposite branch D.

Stack diameter (mm)	Distance *A* (mm)
75	90
100	110
125	210
150	250

b) Opposed connections of small diameter branch discharge pipes

Figure 8. Opposed branch connections to stack; prevention of cross flow
(see 3.2.2.6) *(concluded)*

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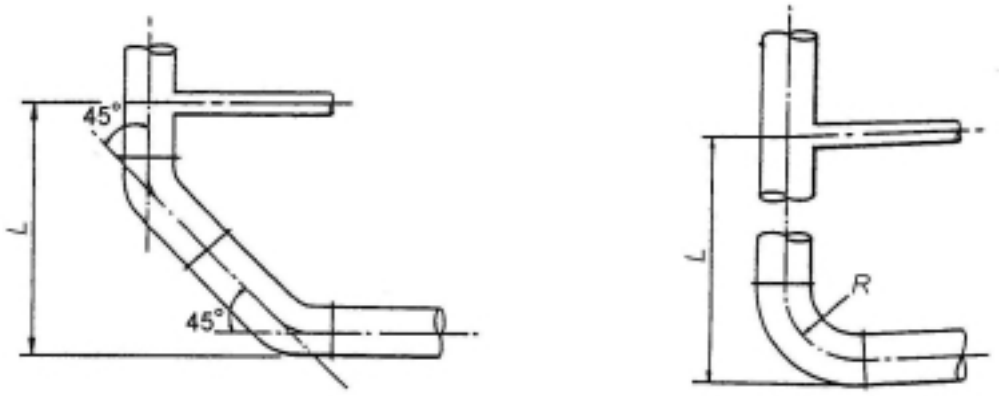

i) Preferable arrangement
Alternative arrangement ii)

L ≥ 450 mm (for single houses up to three storey high)

or *L* ≥ 740 mm (for multi-storey systems up to five storeys high)

or *L* ≥ one storey height (for multi-storey systems higher than five storeys) i.e. no connections on ground floor level

R is as large as possible (twice internal diameter (*ID* X 2)

Figure 9. Bend and branch connections at base of discharge stack

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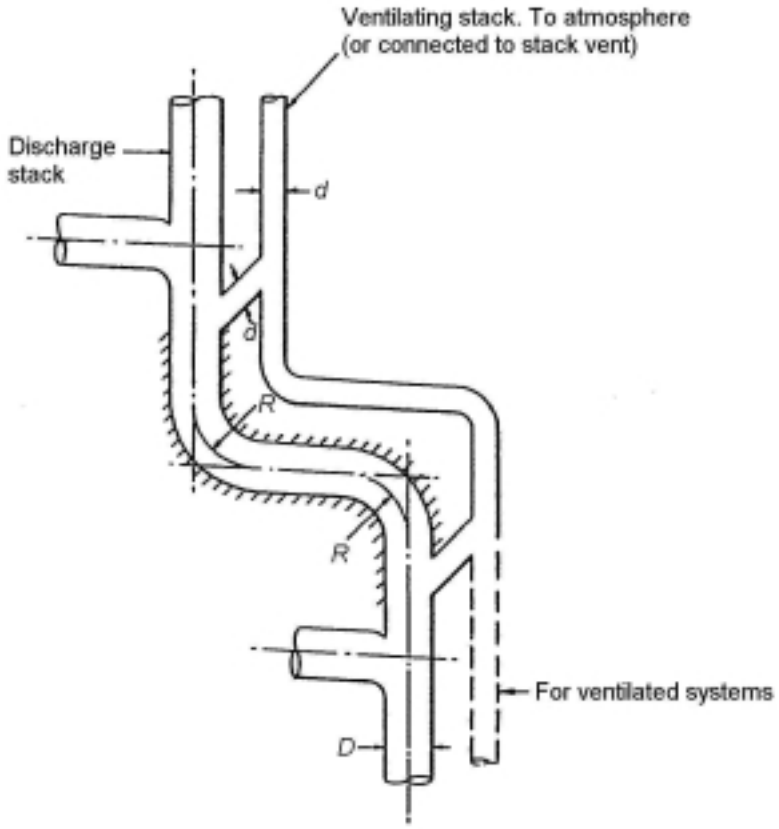

a) Direct connection to ventilation stack

Figure 10. Offsets in discharge stacks

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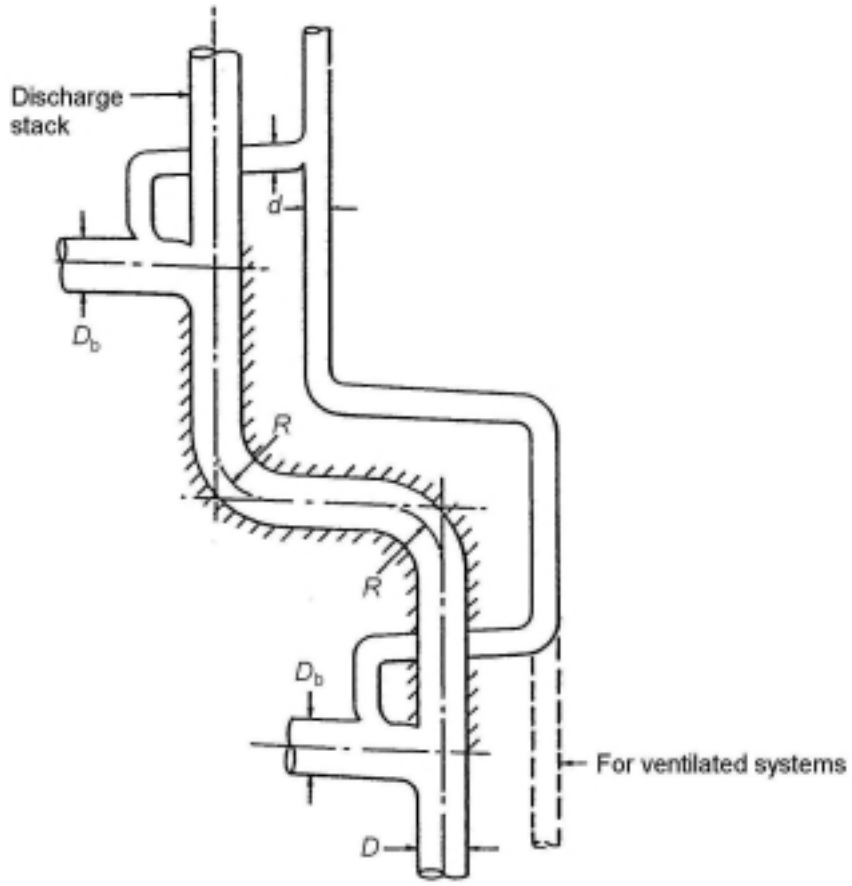

b) Indirect connection to ventilation stack

R is as large possible (200 mm minimum)

d D12, or for ventilated systems as required in Table 6 if larger than *D/2*

D_b > 75 mm (see Note 2)

NOTES:

1. No branch connections in shaded area unless vented.

2. Arrangement b) is only possible if D_b is 75 mm or larger.

3. No offset venting is required in lightly loaded systems of up to three storeys in height.

4. Offsets above highest branch connections do not require venting.

Figure 10. Offsets in discharge stacks *(concluded)*

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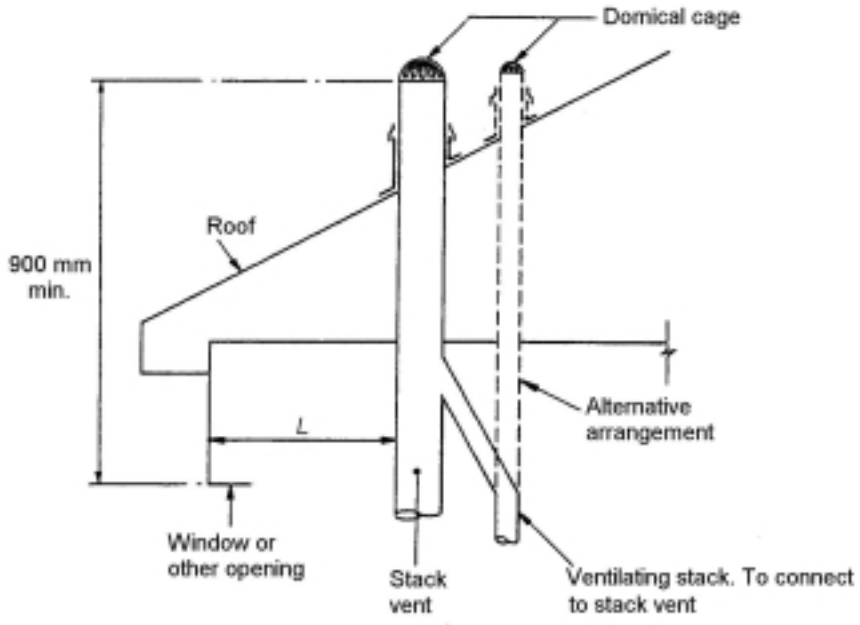
3.2.3.3 **Offsets** (see Figure 10)

Offsets in the wet portion of a discharge stack should be avoided. When they have to be fitted, large radius bends should be used as described in 3.2.3.2 but a ventilation stack may still be necessary with connection to the discharge stack above and below the offset. Offsets above the topmost sanitary appliance or branch connection do not require venting.

3.2.3.4 **Surcharging of the drain**

If the drain to which the discharge stack is connected is likely to be surcharged a ventilating pipe or stack should be connected to the base of the stack above the likely flood level. Ventilated systems may require larger ventilating stacks.



Requirement of *L* is less than 3 m.

Figure 11. Termination of discharge and ventilating stacks (diagrammatic)

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3.2.3.5 Intercepting traps

Intercepting traps are generally no longer used but if a stack is to be connected to an existing drain in which an intercepting trap is fitted, the size of ventilating stack should be as for a surcharged drainage system (see 3.2.3.4).

3.2.3.6 Termination of discharge stacks (see Figure 11)

The outlet of every discharge stack to the open air should be at such a height and position that foul air does not cause a nuisance or health hazard. In general this is achieved if the stack is not less than 900 mm above the head of any window or other opening into a building and within a horizontal distance of 3 m. Outlets should also be positioned away from parapets and corners of buildings.

3.2.3.7 Discharge stacks serving only urinals

A stack carrying only discharges from urinals is likely to become rapidly encrusted with sediment and special attention to access and regular cleaning is necessary. It is an advantage to connect other sanitary appliances, such as WCs and hot water discharges to a urinal stack to reduce this encrustation.

3.2.3.8 Discharge stacks serving only sinks

In some multi-storey flat layouts it may be convenient to connect the kitchen sinks to a separate stack. This arrangement can give rise to very heavy stack deposits especially with soft water, 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.

3.3 Design of fully and ventilated system

3.3.1 Fully ventilated systems

A fully ventilated system should comprise a system of sanitary plumbing with provision for the individual venting of every fixture trap by means of a trap vent air admittance valve (except for any traps permitted to discharge to a floor waste gully) and in which a relief vent is normally installed.

3.3.2 Fully ventilated modified system

A fully ventilated modified system should comprise a system of sanitary plumbing differing from the fully ventilated system in that each branch or discharge pipe connected to the stack is ventilated and some individual fixture trap vents or air admittance valves are omitted, and in which groups of two or more fixtures that discharge to the same graded pipe or branch are ventilated by means of one or more group vents or air admittance valves.

3.3.3 Single stack systems

Single stack systems are also designed on the principle that the air within the discharge pipes from fixtures, the stack and the stack vent allow the permitted type and number of fixtures to be connected to the stack without the need for individual trap vents or, in the case of ranges of fixtures, venting of the common discharge pipe.

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In domestic or residential buildings, fixtures should be connected to the stack individually or through floor waste gullies.

In commercial or industrial buildings, fixtures may be connected to the stack individually, through floor waste gullies or in ranges of the same type of fixtures.

3.3.4 Single stack modified system

The single stack modified system permits tacks to receive a higher discharge loading or to be extended to serve a greater number of floor levels by introducing a relief vent and cross-vents. The cross-vents are installed between the relief vent and stack. The single stack modified system allows these increases in loading or height without increasing the nominal size of the stack.

3.3.5 Branch ventilating pipes. (see Figure 12)

3.3.5.1 Size

The size of ventilating pipes to branches from individual appliances can be 25 mm but, if they are longer than 15 m or contain more than five bends, a 32 mm pipe should be used. If the connection of the ventilating pipe is liable to blockage due to repeated splashing or submergence on a WC branch (see Figure 1) it should be larger, but it can be reduced when it is above the spill-over level of the appliances.

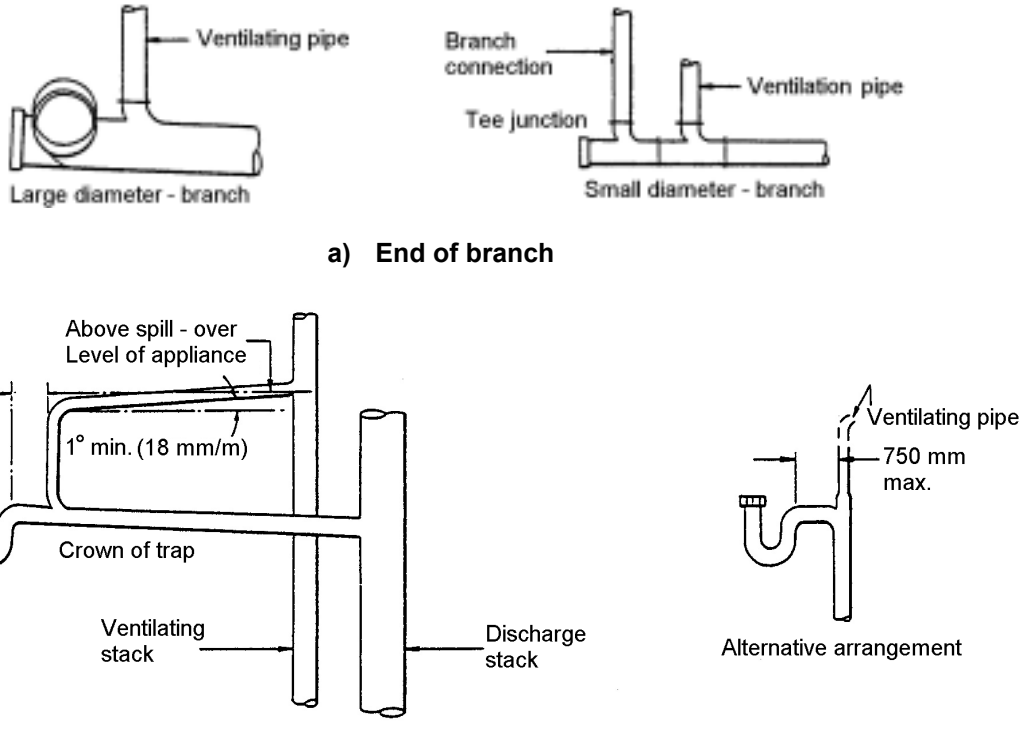

Figure 12. Ventilating pipes to branches

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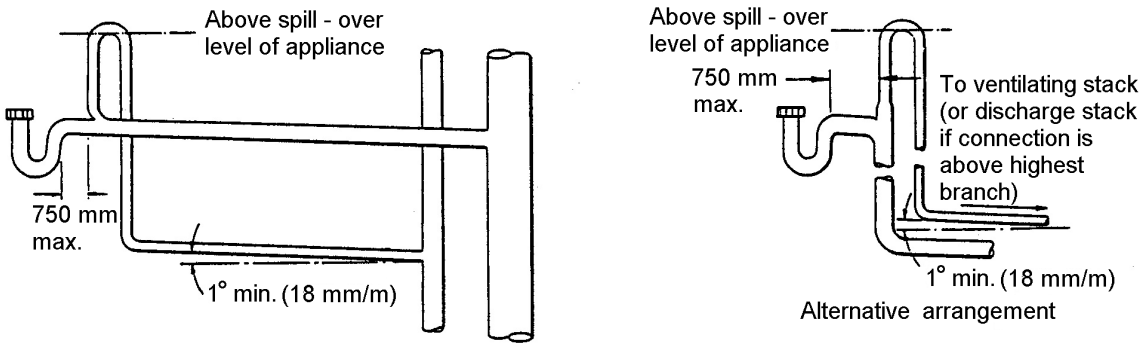
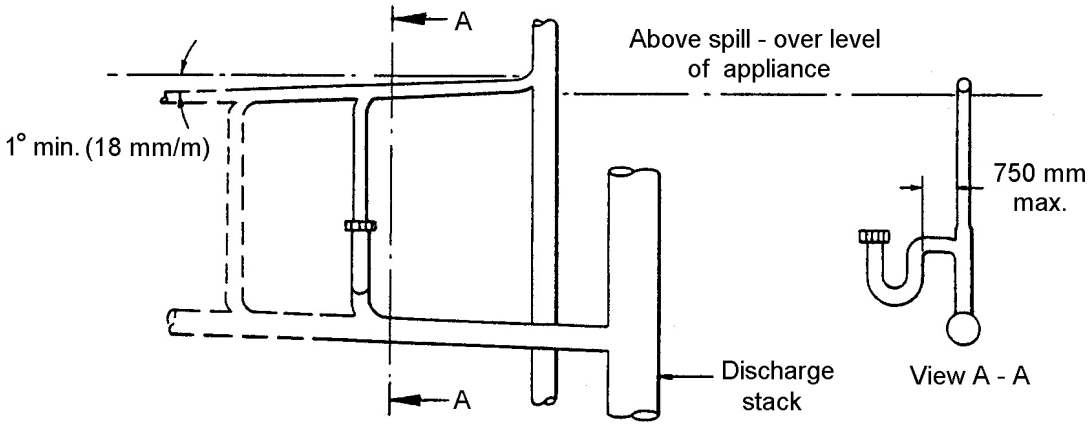


c) Avoiding unsightly pipes to single appliances



d) Ranges of appliances

Figure 12. Ventilating pipes to branches *(concluded)*

3.3.5.2 Connections to stacks

For branch discharge pipes requiring relief venting the ventilating pipes can be connected to the ventilation stack in a ventilated system. For a modified single stack system where the discharge stack does not need a ventilating stack, the ventilating pipes can be run to the open air either directly or, in multi-storey systems, via a common connecting ventilating stack. Connections between the branch ventilating pipes and any vertical stack should normally be above the spill-over level of the highest fitting served. An alternative solution for situations where such a pipe run would be unsightly is also shown in Figure 12 c).

3.3.5.3 Connections to discharge pipes

Connections to the sanitary appliance discharge pipe should normally be as close to the crown of the trap as practicable but within 150 mm. Connections to the end of branch runs, i.e. end venting, should be to the top of the branch pipe, away from any likely backflow which could cause blockage.

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3.3.5.4 Installation

Ventilating pipes should be installed so that there is a continuous fall back into the branch discharge pipe system as a safeguard against the possibility of a condensation waterlock preventing the movement of air through the ventilating system and to minimise the risk of internal corrosion. An exception is the venting method shown in Figure 12 c) in which the fall is towards the vent stack.

3.3.6 **Ventilating** stacks (see Figure 13)

3.3.6.1 Size

Sizes of ventilating stacks are as follows:

a) The trap connecting directly to a discharge pipe should be provided with a branch-ventilating pipe of not less than 50 mm in diameter.

b) For multi-storey buildings of seven-stories or higher, the discharge pipe serving the second storey should be connected to a secondary discharge stack of diameter not less than 100 mm. This stack should be extended to a serve as ventilating stack but may be reduced to 75 mm diameter.

3.3.6.2 Connections

In ventilated and ventilated stack systems (see Figures 1 and 2) the ventilating stack can be joined to the discharge stack by cross-connections, usually on each floor. These cross-connections should slope upwards from the discharge stack (67½ maximum) to prevent discharge water from entering the vent system and should be of the same diameter as the ventilating stack. Another method of connection is via large size (minimum 75 mm) branches at each floor level. These connections should be the same size as the ventilating stack and should be made to the branch discharge pipe as close to the stack as practicable. The latter method is preferable for ventilating stacks smaller than 50 mm.

The lowest end of the ventilating stack should normally be connected to the discharge stack at or below the lowest branch connection; the upper end can be connected to the discharge stack above the spill-over level of the topmost sanitary appliance or pass through the roof to the atmosphere.

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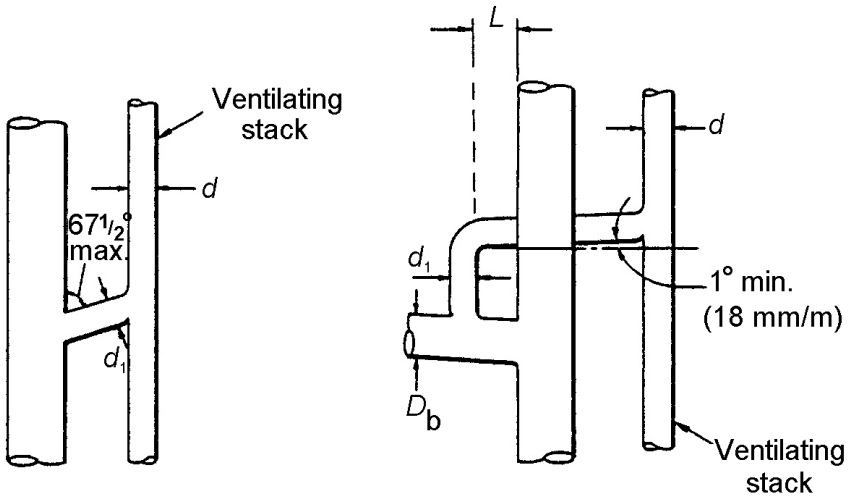
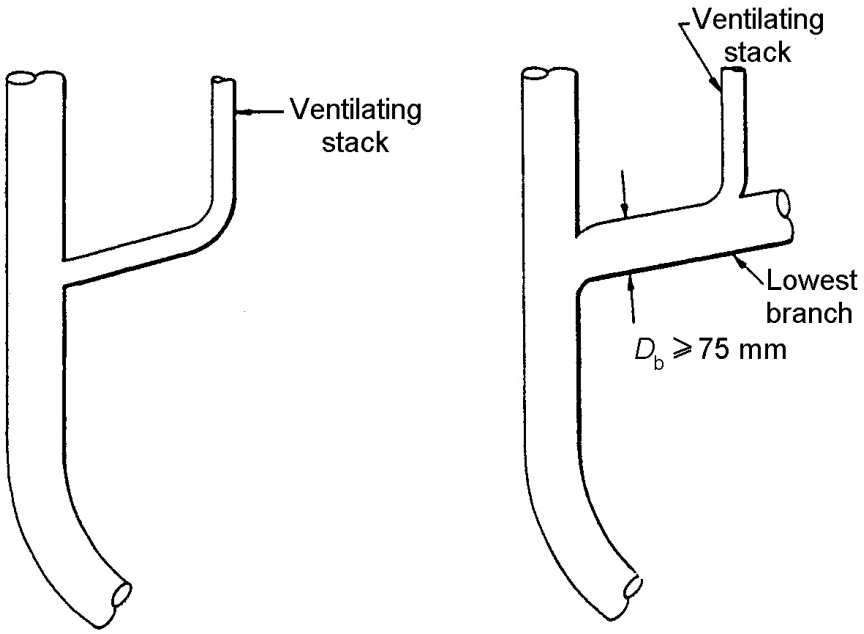


d_1 is same as ventilating stack

D_b ≥ 75 mm (if d is smaller than 50 mm, the method shown in the right-hand figure is preferable)

L is a small as practicable

a) Cross –connections for discharge stack ventilation



b) Bottom of stack

Figure 13. Ventilating stacks

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3.3.6.3 Installation

Bends and offsets in ventilating pipes do not normally affect performance, but they should be of large radius.

3.3.7 Termination of ventilating pipes and stacks (see Figure 11)

Ventilating pipe and stack outlets should be positioned as described for discharge pipe outlets (see 3.2.3.6) and should be fitted with a guard or domical cage of durable material or other cover which does not unduly restrict the flow of air.

3.3.8 Relief vents

3.3.8.1 General

A relief vent should be provided on any stack if one or more floors separate the floor levels of the highest and lowest branch pipe connected to the stack (see Figure 14).

3.3.8.2 At offset of stack

Where at any stack is offset at less than 45° to the horizontal, a relief vent should be provided:

a) on the stack, below the offset, if disregarding the offset one or more floors separate the floor levels of the highest and lowest branch pipe connected to the stack; and

b) on the stack, above the offset, if one or more floors separate the floor levels of the highest and the lowest branch pipe connected to the section of the stack above the offset (see Figure 15).

The lower relief vent may interconnect with the upper relief vent above the flood level rim of the lowest fixture served by the upper relief vent.

3.3.8.3 Relief vents should connect to stacks, below the lowest connection at an angle of 45° (see Figure 14).

3.3.8.4 Relief vents should either:

a) extended upwards at a minimum grade of 1.25 % and interconnect with the stack vent, a header vent or another relief vent; or

b) extended upwards to the open air.

3.3.8.5 Size

The size of any relief vent should be in accordance with Table 5, having regard to the size of the stack, the sum of the rating of all fixture connected and the developed length of the vent measured along the pipework from its lowest connection to the stack to its upper termination point.

A relief vent need not be larger than the stack to which it is connected.

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3.3.9 Stack vents

3.3.9.1 Extension

The stack vent may extend separately to the atmosphere or interconnect with the relief vent above the overflow level of the highest fixture connected to the stack, and should be size in accordance with Table 5, except that the stack vent need not be larger than the stack.

Table 5. Size of relief vents and stack vents

Size of stack	Maximum appliance units connected	Maximum developed length of vents (m)							
		Required vent size							
		DN 32	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150
DN 40	16	6	15						
DN 50	20	8	15	46					
DN 50	36	6	10	30					
DN 65	20		12	40	110				
DN 65	56		7	24	80				
DN 80	20		8	27	70	170			
DN 80	80			12	20	110			
DN 100	150			9	25	70	280		
DN 100	300			8	22	60	216		
DN 100	500			6	19	50	197		
DN 125	300				9	22	95	280	
DN 125	750				7	19	72	230	
DN 125	1 100				6	14	62	190	
DN 150	700				4	9	37	155	300
DN 150	1 300					7	30	130	250
DN 150	2 400					6	24	100	200
DN 225	1 700							16	62
DN 225	4 000							14	43
DN 225	7 000							6	31

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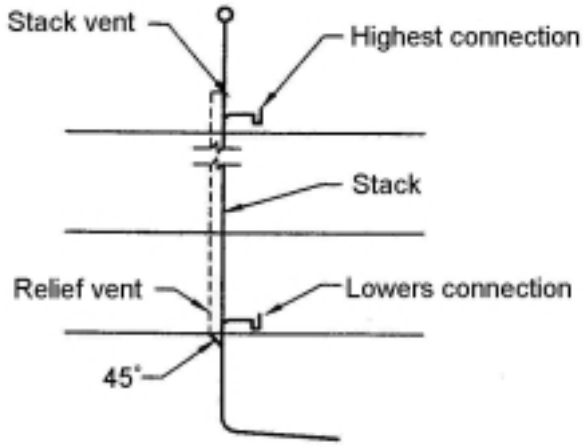

Figure 14. Typical relief vent requirements

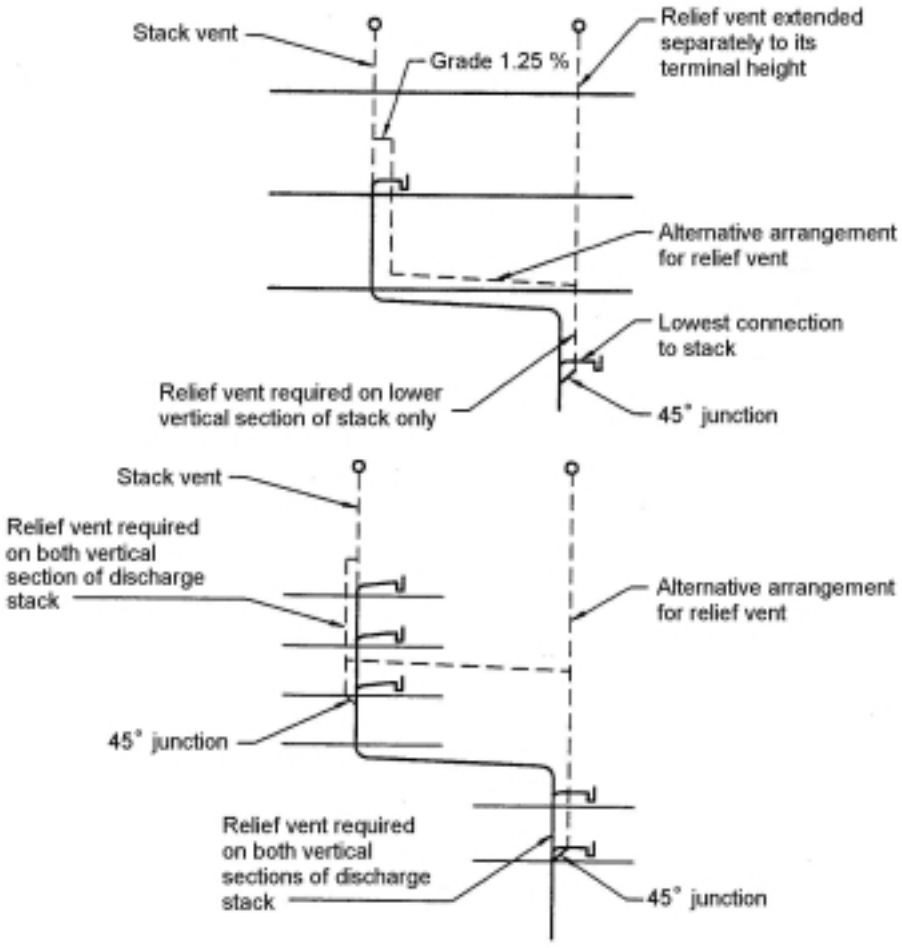

Figure 15. Typical relief vent requirements at stack offsets

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3.3.9.2 Developed length

The developed length of the stack vent should be:

a) for stacks with relief vents, the length of the relief vent; or

b) for stacks without relief vents, the length of stack vent and stack to the point of connection of the lowest branch.

3.3.9.3 Cross relief vents

Cross relief vents should be installed in accordance with the following:

a) Vertical section stacks 20 floor levels or more in height, measured between the highest graded pipe or branch connected and point of connection of any relief vent should be cross-relief vented to the relief vent at intervals of no more than ten floor levels.

b) The size of cross relief vent should be the size of the main relief-vent or the size of the stack, whichever is smaller.

c) Cross-relief vents should connect into the stack at an angle of 45°.

d) Cross-relief vents should commence from below the lowest branch connection to the stack from the floor level concerned and join into the main relief-vent above the flood level rim of the lowest fixture, discharging into the stack at that floor (see Figure 16).

e) In the case of stack with a steep offset, such stack should be deemed to be straight with only one vertical section.

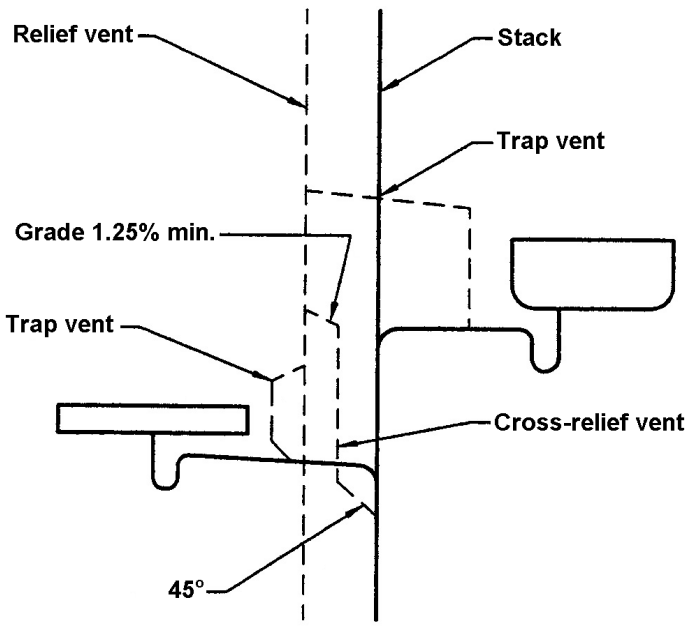

Figure 16. Typical installation of cross relief vents

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3.3.10 Offsets in stacks

3.3.10.1 Steep offsets

3.3.10.1.1 General

A steep offset is any offset made at an angle of more than 45° to the horizontal.

3.3.10.1.2 Sizing of stack

The size of the steep offset stack should be in accordance with 3.3.10.7.2 and the maximum fixture unit loading should comply with Table 4.

3.3.10.1.3 Venting

Venting for the steep offset stack should be in accordance with the following:

a) Where the installation of a relief vent at the base of the stack is to be installed as specified in 3.3.8.1, additional relief vents in close proximity to the bends of the offset, as specified in 3.3.8.2, should not be required.

b) Cross-relief vents should be installed in accordance with 3.3.9.3.

c) Stack vents should be installed in accordance with 3.3.9.

3.3.10.2 Graded offsets

3.3.10.2.1 General

A graded offset is any offset made at an angle of less than 45° to the horizontal.

3.3.10.2.2 Minimum grade

The minimum grade of a graded offset should be in accordance with Table 6.

Table 6. Minimum grade of offsets

Size grade section	Minimum gradient (%)
< DN 80	2.50
DN 100	1.65
DN 125	1.25
DN 150	1.25
DN 225	0.60
DN 300	0.40

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3.3.10.2.3 Restricted connection zones above the graded offset (see Figure 17)

For graded offsets, no connection should be made within:

a) 600 mm of the bend when the stack extends not more than five floor levels above the offset; or

b) 1 m of the bend when the stack extends more than five floor levels above the offset.

3.3.10.2.4 Restricted connection zone below the graded offset

No connection should be made within 600 mm of the bend.

3.3.10.2.5 Restricted connection zone within the graded offset (see Figure 18)

No connection should be made within:

a) 2.5 m of the upper bend; or

b) 450 mm of the lower bend.

3.3.10.2.6 Sizing of stack

The size of the graded offset stack should be in accordance with 3.3.10.7.2 and the maximum fixture unit loading on the graded section should comply with Table 4.

3.3.10.2.7 Venting

Venting for the graded offset stack should be in accordance with the following:

a) Relief vents should be installed in accordance with the relevant sub-clauses of 3.3.8 (see Figure 15).

b) Cross-relief vents should be installed in accordance with 3.3.9.3.

c) Stack vents should be installed in accordance with 3.3.9.

d) No laundry trough or clothes-washing machine should be connected to the stack.

e) Each fixture should discharge into the stack by means of an individual fixture discharge pipe.

f) The stack should be straight between the discharge pipe of the highest fixture connected and the drain, and have no offset or other deviation from the vertical.

g) The graded section of the drain to which the base of the stack connects should not be smaller than DN 100.

h) Offsets should only be permitted in the stack vent above the highest branch connection to the stack. The offsets should preferably be more than 45° (steep offsets). However, offsets less than 45° are permitted.

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3.3.10.3 DN 80 stack with the top section graded installed in a domestic or residential building

A stack of DN 80 serving not more than two floor levels with the top section graded nominally horizontal may receive the discharge from fixtures without vents on the fixture discharge pipes, provided that the installation complies with the following (see Figure 19):

a) Fixtures should discharge to the graded section by means of an individual fixture discharge pipe.

b) Not more than one of each of the following fixtures should discharge to the graded section:

   i) bath;

   ii) basin;

   iii) dishwashing machines;

   iv) kitchen sink; or

   vi) water closet pan.

c) No laundry trough or clothes-washing machine should be connected to the stack.

d) No fixtures should be connected to the lower vertical section of the stack.

e) The connection of a fixture discharge pipe to the graded section of a stack.

f) The graded section of the stack may be reduced in size along its length towards the vent, according to the size of individual fixture discharge pipes connected to it but in no case should the graded section or vent be smaller than DN 50.

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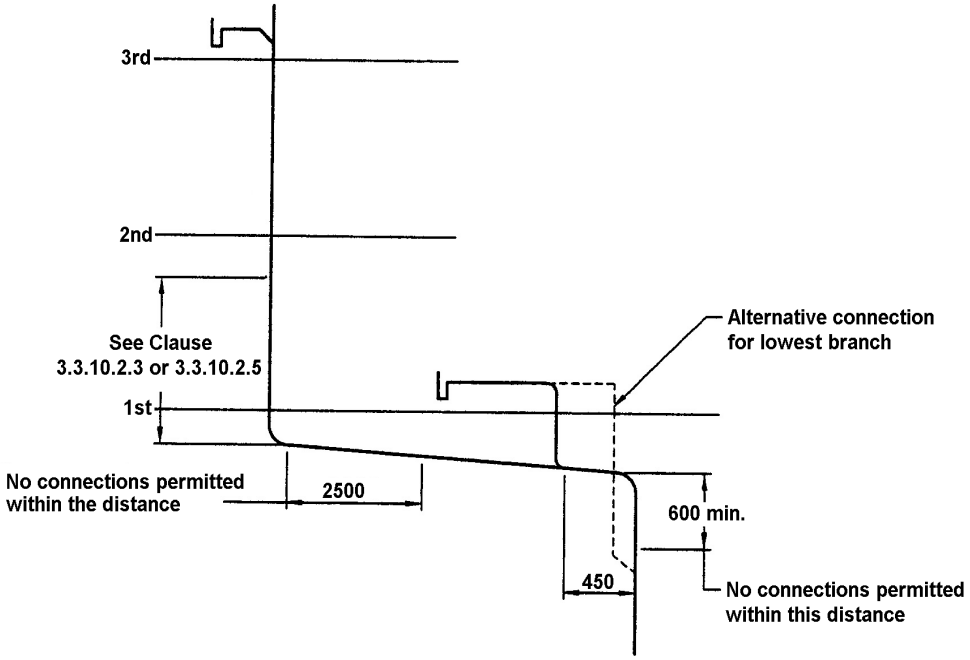

Figure 17. Prohibited connections at graded offset

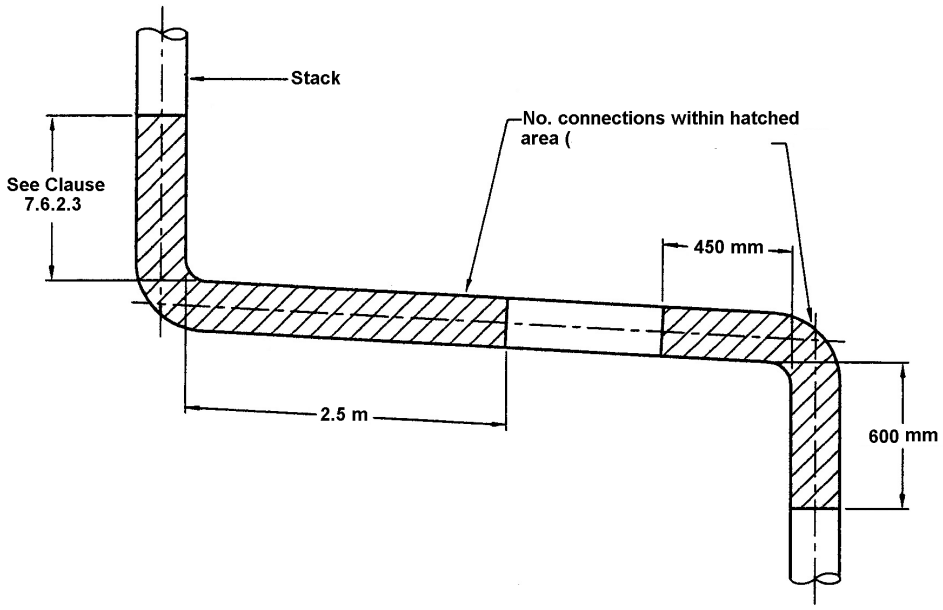

Figure 18. Connections at offset of stack

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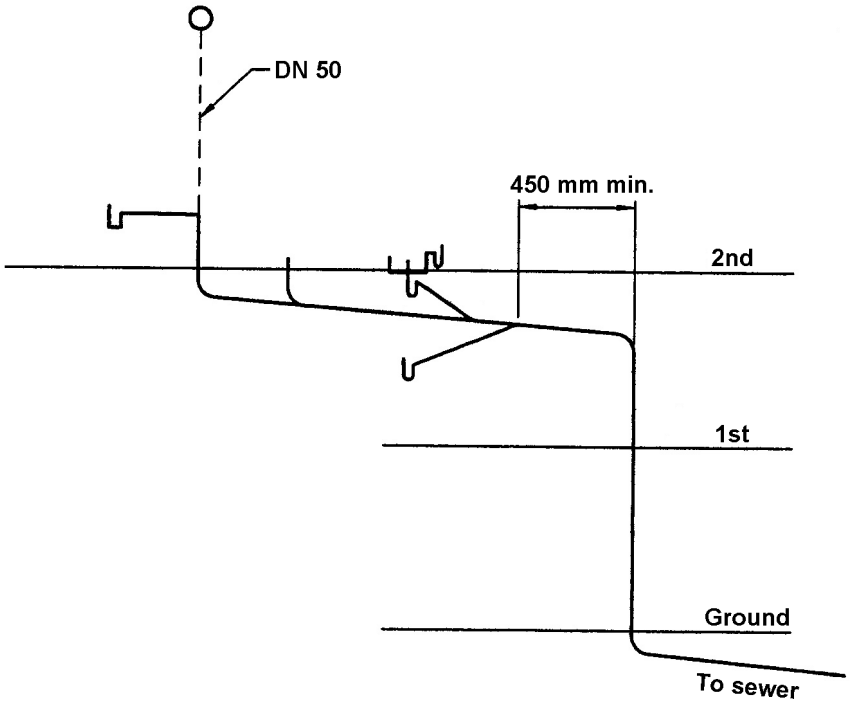

Figure 19. Typical DN 80 stack up to two floors with topmost section nominally horizontal

3.3.10.4 DN 100 stack up to three floors with the top section graded installed in a domestic or residential building receiving 30 fixture units

A stack of DN 100 serving not more than three floor levels with the top section graded nominally horizontal in a domestic or residential building may receive the discharge from fixtures without vents on the fixture discharge pipes provided that the installation complies with the following (see Figure 20):

a) Fixtures should discharge to the graded section by means of individual fixture discharge pipes.

b) The stack should not exceed three floor levels in height and the stack loading should not exceed 30 fixture units.

c) The connection of a fixture discharge pipe to the graded section of the stack should not be less than 450 mm from the lower vertical section of the stack, measured from the inlet of the lower bend commencing the graded section.

d) The graded section of the stack may be reduced in size along its length towards the vent according to the size of the individual fixture discharge pipe connected to it, but in no case should the graded section or vent be smaller than DN 50.

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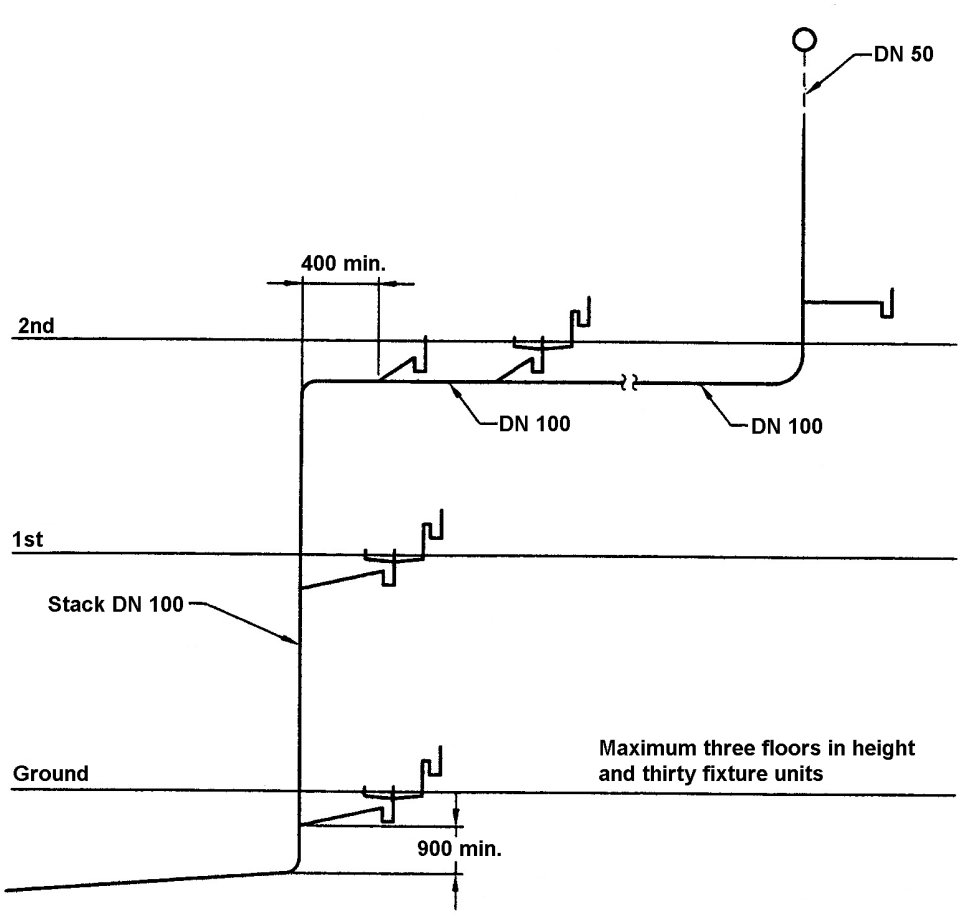

NOTE. Size of graded section can vary to a minimum of DN 50.

Figure 20. Typical DN 100 stack with topmost section nominally horizontal

3.3.10.5 DN 100 stack of one floor with top section graded

A stack of DN 100 serving the first floor above ground level in a domestic or residential building may receive the discharge from fixtures without vents on the fixture discharge pipes provided the installation complies with the following (see Figure 21):

a) Fixtures should discharge to the graded section by means of individual fixture discharge pipes (see Table 7).

b) The stack loading should not exceeding 90 fixture units.

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c) The connection of a fixture discharge pipe to the graded section of the stack should not be less than 450 mm from the lower vertical section of the stack measured from the inlet of the lower bend commencing the graded section.

d) The graded section of the stack may be reduced in size along its length towards the vent according to the size of individual fixture discharge pipes connected to it, but in no case should the graded section or vent be smaller than DN 50.

e) Branches should not connect to the vertical sections of the stack within 600 mm below the lower bend forming part of the offset.

Table 7. Fixture discharge pipes without trap vents to stacks

Fixture	Maximum length (m)	Permitted grade (%)
Waste fixture	2.5	2.50 to 5.00
Water closet pans		
DN 100	6.0	1.65 to 5.00
DN 80	2.5	1.65 to 5.00
Urinals		
DN 50 to DN 80	2.5	2.50 to 5.00
DN 100	6.0	1.65 to 5.00

Table 8. Waste stacks – Loading permitted through graded offsets

Size of graded section of offsets	Maximum fixture unit loading permitted through the offsets
DN 40	1
DN 50	3
DN 65	8
DN 80	24
DN 100	60

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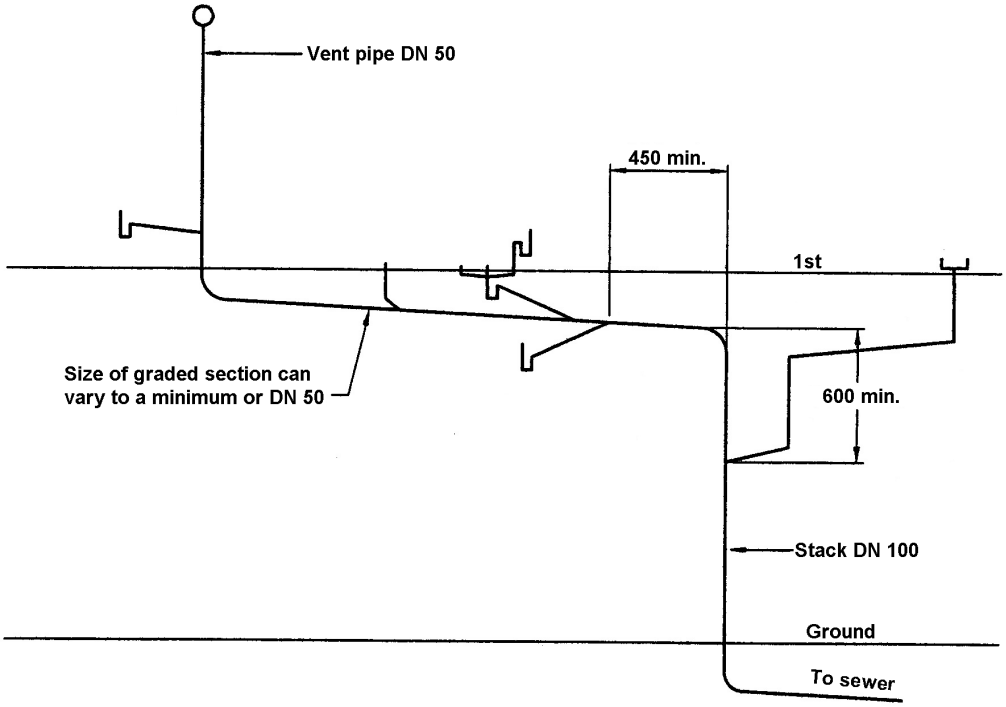

Figure 21. Typical DN 100 stack with topmost section nominally horizontal for one floor – 90 fixture units

3.3.10.6 Connection for multiple fixtures into or below a graded offset DN 100 stacks (see Figure 22)

Multiple fixtures located on the floor above a graded offset may be connected by means of a common discharge pipe into or below the graded section of the offset in accordance with 3.3.10.2, provided that the stack to which the branch pipe connects does not exceed:

i) five floors above the graded offset with a maximum loading of 90 fixture units; or

ii) three floors above the graded offset with a maximum loading of 45 fixture units.

3.3.10.7 Waste stack up to DN 100 with either graded or steep offset between the highest and lowest connections

3.3.10.7.1 Graded offsets

A waste stack up to DN 100 may have graded offsets installed between the highest and lowest graded pipes in accordance with the following (see Figure 23):

a) The maximum fixture unit loading permitted to discharge through the graded section of the offset shall be as in Table 8.

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b) The distance between the centrelines of the vertical sections of a stack, each side of the graded offset should be not less than 1 m.

c) For stacks of DN 80 or smaller, no branch should connect to the stack within 900 mm above the upper offset bend. However, DN 80 stack with offset may have the minimum vertical distance of 900 mm reduced to 600 mm provided that the height between the highest connection to the stack and the upper offset bend does not exceed three floor levels.

d) In the case of DN 100 stacks only the connection near the upper offset bend should be in accordance with Table 9.

e) Where connections are made to the stack below the offset, the size of the offset and the stack above the offset and up to the vent cowl should be as determined from Table 8. The fixture unit loading for the complete stack should be determined from Table 10. The stack size should be the greater value determined from Table 8 and Table 10.

f) Branches should not connect to the vertical sections of the stack within 600 mm below the lower bend forming part of the offset.

g) Where no connections are made to the stack below the offset, the maximum fixture unit loading permitted to discharge through the offset, should be as given in Table 10. The upper vertical section and the offset should be increased to the next larger size.

h) The connection of multiple fixtures into the offset should be in accordance with 3.3.10.6.

i) Where unvented fixtures are connected into the graded section, the fixture discharge pipe should comply with Table 7.

j) Where a common discharge pipe is connected into the stack and a relief vent and cross vents are installed, the fixture loading permitted to discharge to the stack should be as in Table 3.

Table 9. Offsets requirements for DN 100 waste stacks

Maximum height in consecutive floor levels above upper offsets bend	**Minimum distance between upper offset bend and connection of fixture discharge pipe (mm)**	**Maximum fixture unit loading** (see also Table 12)
5	450	60
10	600	60

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Table 10. Size of waste stack

Stack size	Maximum fixture unit loading
DN 40	2
DN 50	6
DN 65	15
DN 80	30
DN 100	120

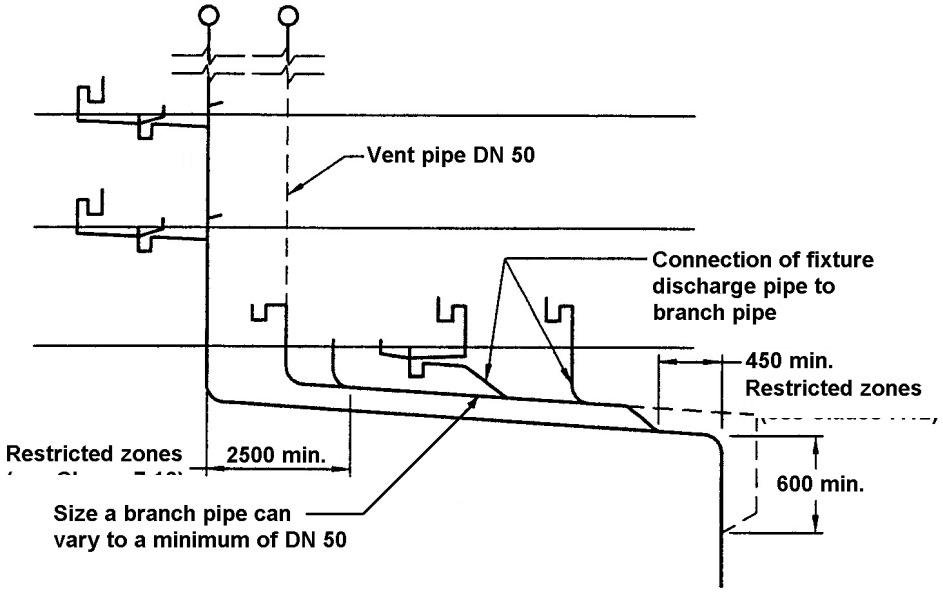

Figure 22. Multiple fixture branch

3.3.10.7.2 Steep offsets

A waste stack of up to DN 100 may have steep offsets between the highest and lowest graded pipes connected, in accordance with the following:

a) Where the fixtures are unvented in accordance with g), the maximum fixture unit loading permitted to discharge to the stack should not exceed 120 fixture units.

b) Steep offsets of 60° or more to the horizontal should have no connections made above the offset within:

   i) 450 mm of the upper bend when the stack extends through five floors or less above the offset; or

   ii) 600 mm of the upper bend when the stack extends through more than five floors above the offset.

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Steep offsets of less than 60° to the horizontal should have no connections made above the offset within 150 mm of the upper bend for stacks of any height.

c) Steep offsets of less than 60° to the horizontal should have no connections made into the offset within:

   i) 2.5 m of the upper bend; or

   ii) 450 mm of the lower bend.

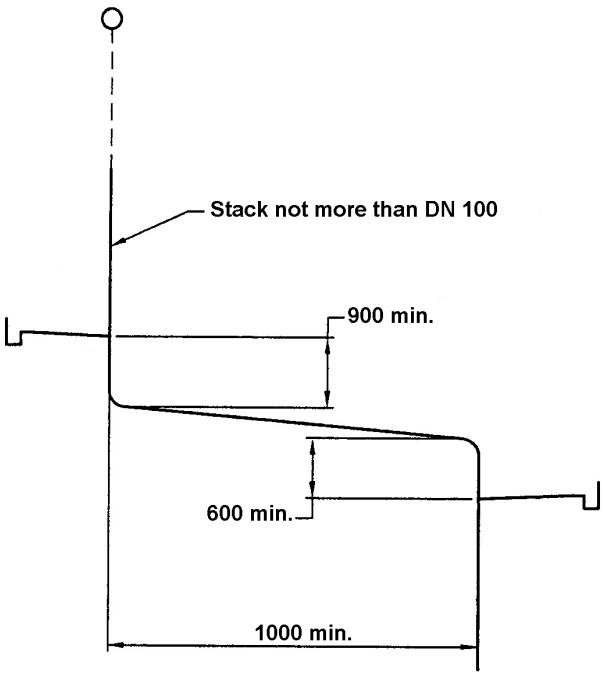
d) Steep offsets of 60° or more to the horizontal, should have no restrictions within the offset, provided that any such connection is made using a 150 mm degree or sweep junction.

e) Steep offsets should have no connections made below the offset within 600 mm of the lower bend.

f) Where unvented single waste fixture discharge pipes are connected into the stack, the pipes should be sized in accordance with Table 7.

g) Where a common discharge pipe is connected into the stack and a relief vent is installed, the fixture unit loading permitted to discharge to the stack should be in accordance with Table 3.

Dimensions in millimetres



NOTE. See Table 10 for fixture units discharging through graded section.

Figure 23. Typical waste stack up to DN 100 with graded offset between the highest and lowest connections

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3.3.10.8 DN 65 waste stack

A waste stack of DN 65 may receive the discharge from kitchen sinks and laundry troughs provided that:

a) the stack does not exceed two floor levels in height measured between the base of the stack and the highest floor level upon which a fixture is connected; and

b) not more than two kitchen sinks or one kitchen sink and one laundry trough are separately connected at each floor level.

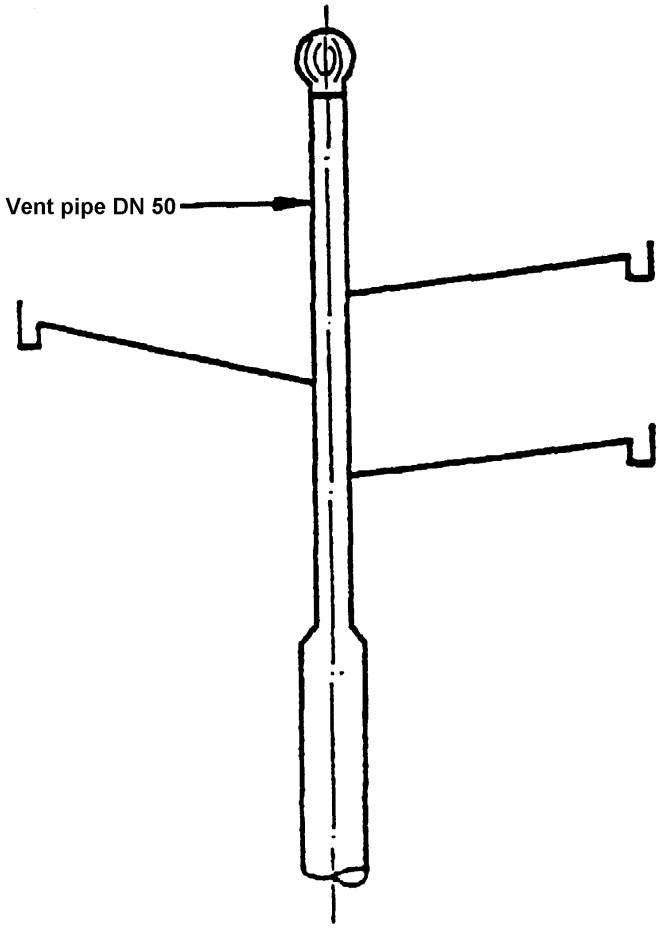

Figure 24. Typical connection of waste fixtures to a DN 50 vertical section of stack

3.3.10.9 DN 50 vertical section of stack

Three waste fixtures only, being basins, showers or kitchen sinks, may be connected to the top DN 50 vertical section of a stack not more than three floor levels in height with a maximum loading of 30 fixture units (see Figure 24).

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3.3.10.10 Connection at the change of direction in stack with top section graded

Where a DN 80 or DN 100 stack has the top section nominally horizontal, a trap vent should be required on a fixture discharge pipe that connects to the stack at the point at which the top graded section joins the vertical section of the stack (see Figure 25).

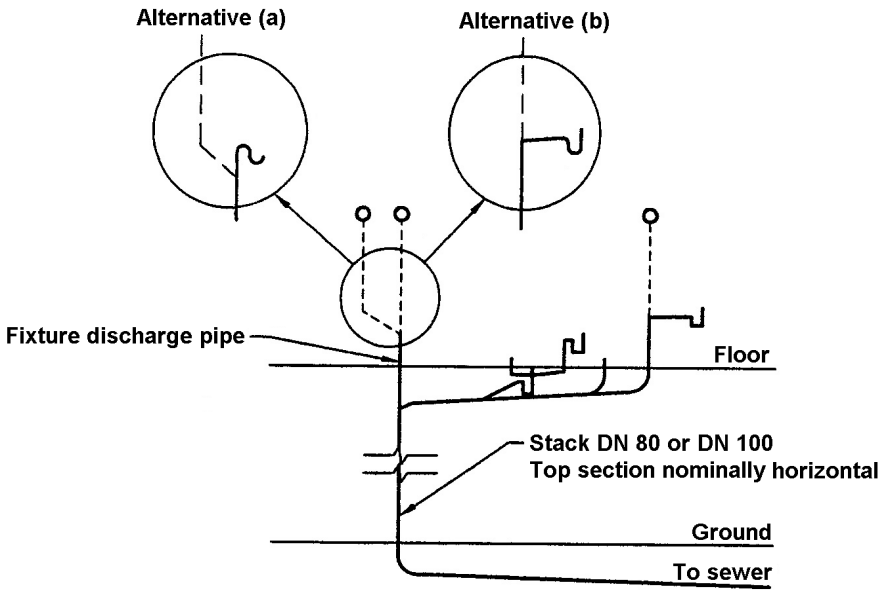

Figure 25. Venting requirements for fixture connected at change of direction in DN 80 or DN 100 stacks

3.4 Design of single stack system

3.4.1 General

Offsets are permitted in single stack design and may be either:

a) a steep offset made at an angle of more than 45° to the horizontal; or

b) a graded offset made at an angle of less than 45° to the horizontal. The minimum grade for a graded offset should be 2.5 % for waste stacks of DN 80 or smaller and 1.65 % for stacks of DN 100 or larger.

3.4.2 Offsets in single stack system

DN 100 stacks may be offset between the base of the stack and the highest connection (see Figure 26) in accordance with the following:

a) The height of the stack should not exceed ten consecutive floor levels.

b) Laundry troughs should only be connected to the stack as specified in 3.4.3, except as provided in 3.4.4.

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c) Connections near the upper and lower offset bends and the maximum fixture unit loading to the stack should be in accordance with Table 11 except as provided in 3.4.4.

d) The minimum distance between the connection of any fixture discharge pipe and the upper offset bend should not be less than 100 mm (see Figure 27).

e) The single stack system may be used for residential buildings up to six storeys high where there are single sanitary appliances connected to a discharge stack or where the sanitary appliances are closely grouped round a discharge stack which is large enough to limit pressure fluctuations without the need for a ventilating stack.

f) The main discharge stack should have a uniform diameter of not less than 150 mm without offset throughout its entire length. However, for conventional housing, a main discharge stack of 100 mm diameter may be provided.

g) The length of the discharge pipe connecting to the discharge stack should not be more than 2.5 m and there should be not more than two connections made to the discharge pipe.

3.4.3 Connection of laundry trough to DN 100 stacks

Laundry trough:

a) may be connected into either the upper or lower vertical section of a steep offset stack; and

b) should only be connected to the upper section of a DN 100 stack in accordance with Table 12.

Table 11. Offset requirements

Maximum height in consecutive floor levels above upper offset bend	Minimum distance between upper offset bend and connection of fixture discharge pipe (mm)	Minimum distance between lower offset bend and connection of fixture discharge pipe (mm)	Maximum fixture unit loading
5	450	600	90
10	600	600	150
10	900	600	260

Table 12. Offset requirements for laundry troughs

Maximum height in consecutive floor levels above upper offset bend	Minimum distance between upper offset bend and connection of fixture discharge pipe (mm)	Maximum fixture unit loading
5	450	50
10	600	50

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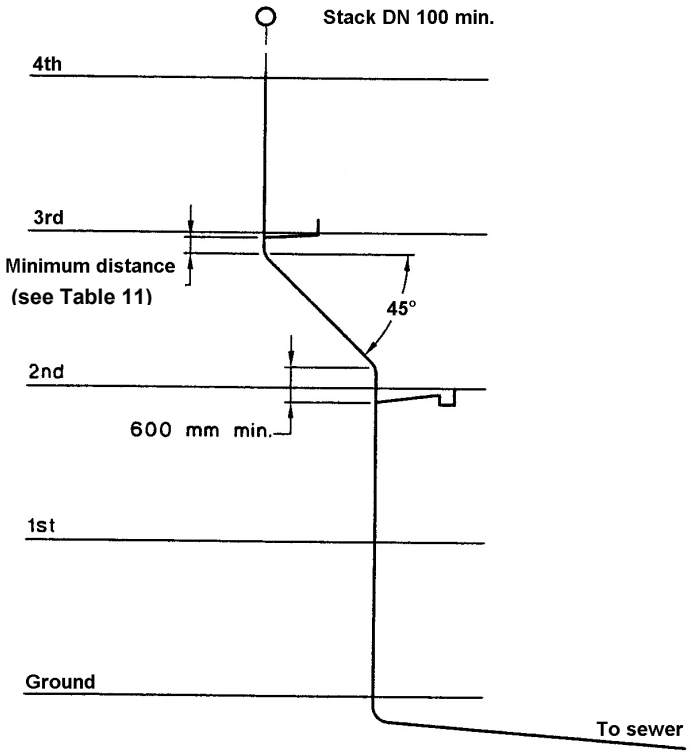
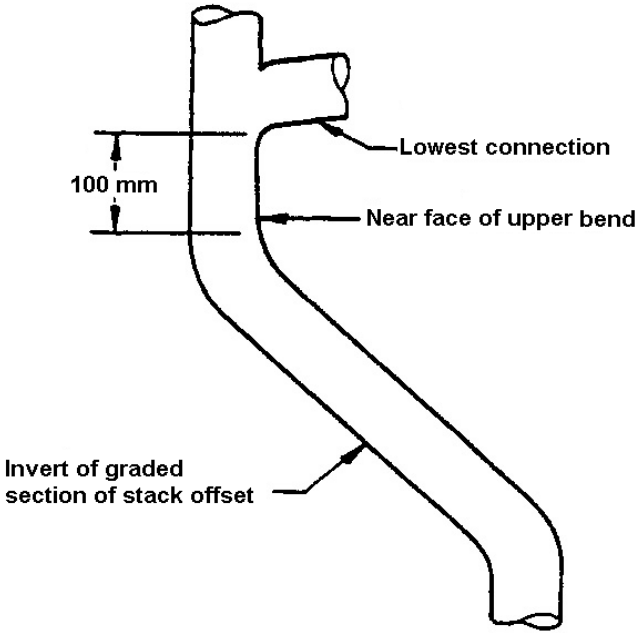


Figure 26. Typical steep offset



NOTE. Measurement increases with height of stack above offset and fixture unit loading.

Figure 27. Typical near face measurement

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3.4.4 Steep offsets below the lowest connection

Where a steep offset is installed below the lowest connection to a stack of not less than DN 100, the minimum distance between the fixture connection and the upper offset bend should be in accordance with Table 11. This distance may be reduced to 100 mm provided the following conditions are met (see Figure 28):

a) The number of consecutive floor levels above the upper offset bend served by fixtures is three or less.

b) The maximum loading should not exceed 30 fixture units through the offset section.

c) No laundry trough should be connected.

3.4.5 Graded offsets

DN 100 stacks may be offset between the base of the stack and the highest connection (see Figure 29) in accordance with the following:

a) Only one graded offset should be permitted in any stack.

b) The height of the stack should not exceed ten consecutive floor levels.

c) The fixtures may be connected either into:

   i) the upper vertical section in accordance with 3.3.10.2; or

   ii) the graded or lower vertical section in accordance with 3.3.10.2.

d) The minimum distance between the centrelines of the vertical sections of the stack should be 2 m.

3.4.6 Connections above the offset

Where fixtures are connected into the upper vertical section, the following conditions should apply:

a) The height of the vertical section of the stack above the upper offset bend should not exceed five consecutive floor levels.

b) The maximum loading should not exceed 90 fixture units.

c) No connection should be made to the vertical section within 900 mm of the upper offset bend.

The distance may be reduced to 600 mm where a water closet pan is the lowest fixture connected, provided the fixture discharge pipe from the water closet pan is fitted with a DN 40 trap vent (see Figure 29).

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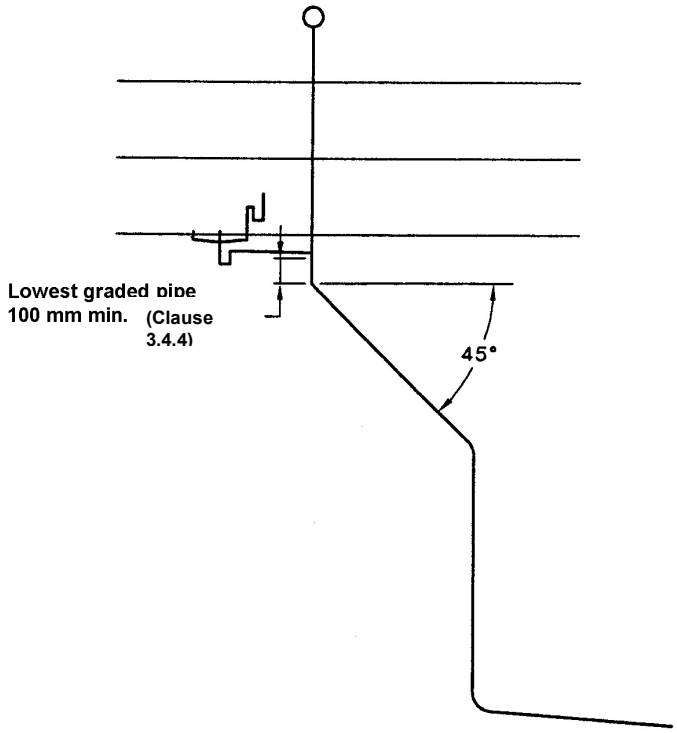

Figure 28. Steep offsets below lowest connection

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Dimension in millimetres

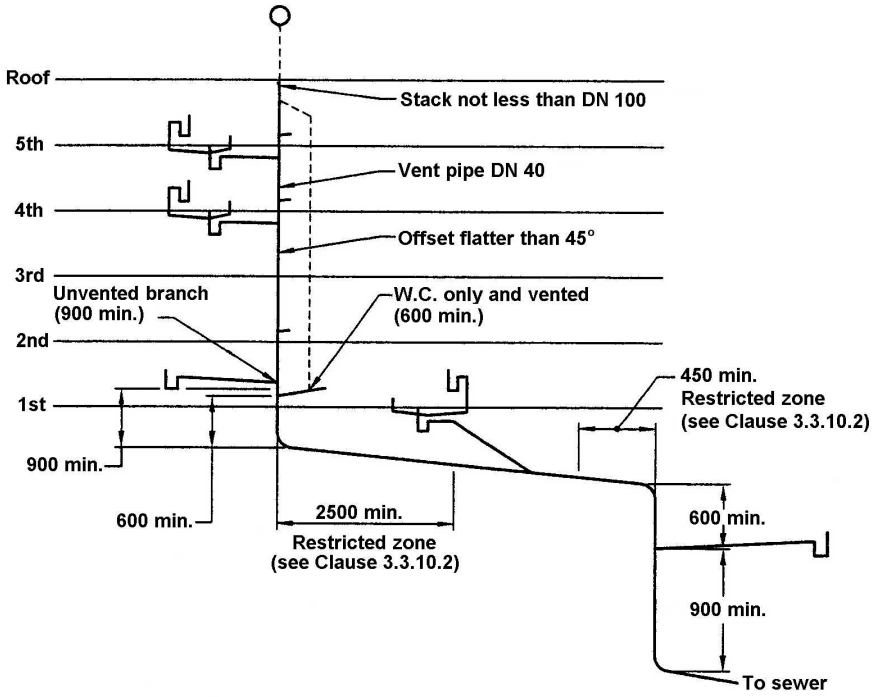

Figure 29. Graded offset

3.5 Access (see Figure 30)

3.5.1 General

Sufficient and suitable access should be provided to enable all pipework to be tested and maintained effectively. The access covers, plugs or caps should be sited so as to facilitate the insertion of testing apparatus and the use of equipment for cleaning and/or for the removal of blockages. Their use should not be impeded by the structure or other services.

Access points should not be located where their use may give rise to nuisance or danger if spillage occurs. This can be mitigated if they are above the spill-over level of the pipework likely to be affected by a blockage and/or are extended to suitable positions at the face of a duct or casing or at floor level.

3.5.2 Pipe ducts

Pipework enclosures, e.g. ducts, casings, etc., should be suitable in size and provide ready access for maintenance, testing and cleaning. They should be constructed appropriately for fire resistance, sound insulation and to limit the spread of vermin.

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3.5.3 Water closets

WCs are particularly prone to obstruction in or near the trap through misuse. There are advantages in using a joint or jointing material to a WC pan, which will allow the easy removal and replacement of the pan.

3.5.4 Urinals

The discharge from urinals can give rise to heavy deposits especially with hard waters. Special attention is therefore necessary to the provision of access so that all parts of the stack, branch and trap can be readily cleaned.

3.5.5 Wash basins, sinks and baths

Where access is required this may be conveniently provided for by the use of traps and joints that are easily disconnected. Additional access is needed only under exceptional circumstances, such as where the discharge pipe is longer than normal or where several bends occur in the pipework.

With soft water, branches from spray tap wash basins are likely to become blocked and particular attention should be paid to access. Stacks serving sinks only, especially where the water is soft may require access on each floor.

3.5.6 Discharge and ventilating stacks

Where the vertical discharge pipe has a relatively long connection to a manhole, access for rodding and testing should be provided at or near the foot of the stack. Where the horizontal discharges pipe are relatively long, access should be provided at 15 m intervals.

For multi-storey domestic buildings, access to the ventilating and discharge stacks should be provided at about three storey intervals or less to facilitate cleaning and to enable pressure tests to be carried out. For the same reasons access to the ventilating and discharge stacks in multi-storey offices and similar more complex systems should be provided on each floor.

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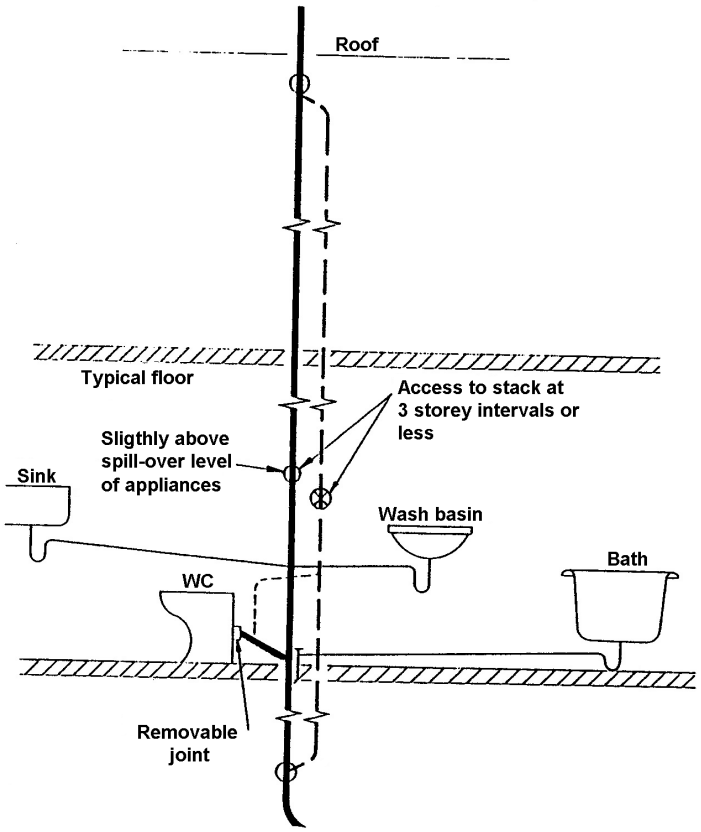

a) Example of access positions on stacks in a multi-storey application with single appliances

Figure 30. Access for cleaning and testing purpose (diagrammatic)

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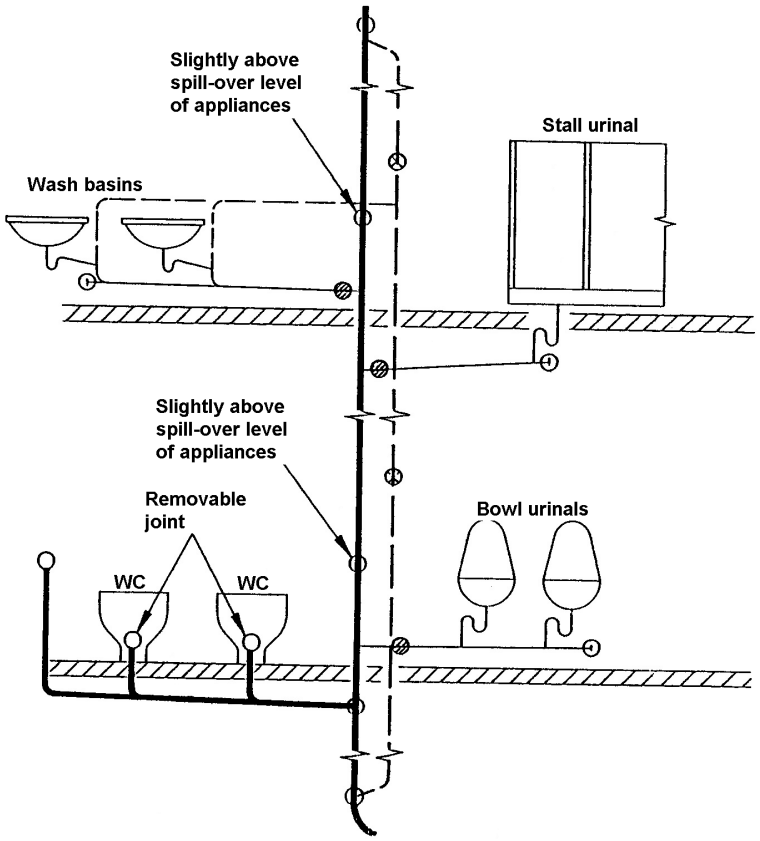

b) Example of commercial system

Figure 30. Access for cleaning and testing purpose (diagrammatic) *(continued)*

3.6 Special design requirements

3.6.1 Restaurant kitchens

In restaurant kitchens the risk of pipe blockage is increased by the higher proportion of grease and suspended solids in the waste water. In addition to the normal provision of access points on the discharge stack above the spill-over level of the appliances and at the high end of the branch discharge pipes, access should be provided close to appliances such as food waste macerators and vegetable paring machines where there is a high risk of blockage.

It is also necessary to ensure that access points are located in positions, which will be accessible, after the sanitary wares and fittings have been installed.

3.6.1.1 General

For the purpose of considering the waste discharge from a restaurant kitchen the work process can be divided into two main operations:

a) food preparation and cooking, involving the use of vegetable preparation sinks, general purpose sinks, vegetable paring machines and waste disposal macerators; and

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b) washing up, involving the use of waste disposal macerators, crockery wash machines, pot wash sinks, sterilising sinks and general purpose sinks.

The time scale during which the operations may be carried out will not conform to a set pattern, but will vary from kitchen to kitchen according to its size, the number of meals served and the period over which the meal service is provided.

The peak rate of waste discharge will probably occur during washing up periods when crockery washing machines are in use. Crockery wash machines vary in size and according to the capacity of the machine may use water from 125 l/h with a peak flow rate in the order of 80 l/min to in excess of 600 l/h with a peak of 180 l/min. The flow rate of waste discharge from kitchen appliances should, therefore, be calculated on the basis of the capacity and peak usage of the sanitary appliances.

Kitchens are of necessity designed to ensure a natural flow of work and seldom permit the grouping of the sanitary wares to give the best conditions of drainage. As it is of primary importance that there should be no loss of water seal in the traps on kitchen appliances an adequate ventilated system of drainage is necessary.

Table 13. Physical properties and normal application of commonly used materials for pipework

Material	Relative density	Vicat softening point (°C)	Coefficient of linear expansion per °C	Normal application
Iron, cast, spun and ductile	7.4	Not applicable	1.0×10^{-5}	Discharge and ventilating pipes 50 mm size and over
Galvanised steel	7.8	Not applicable	1.0×10^{-5}	Discharge and ventilating pipes of all sizes. Suitable for prefabricated welded assemblies (galvanised after assembly).
Copper	8.9	Not applicable	10×10^{-5}	Discharge and ventilating pipes and traps of all sizes. Suitable for prefabricated assemblies.
Lead	11.3	Not applicable	1.0×10^{-5}	
ABS	1.04 to 1.07	93 to 105	1.0×10^{-5}	
High density polyethylene	0.93 to 0.96	110 to 130	1.0×10^{-5}	
Modified PVC	1.35 to 1.46	78 to 83	1.0×10^{-5}	
Unplasticised PVC	1.35 to 1.46	75 to 82	1.0×10^{-5}	
Pitch fibre	1.26 to 1.30	Not applicable	1.0×10^{-5}	

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3.6.1.2 Specific requirements

'Drain-off' valves on food containers should be of the full way plug-cock type with quick release bodies for easy cleaning. These valves should not be connected to a discharge pipe or drain without an intervening air break.

Floor channels and gratings to open gullies in kitchens, food preparation and wash-up rooms, harbour dirt and grease and if the gratings are not properly fitted they can be hazardous to pedestrian traffic. This form of drainage is unhygienic and should be avoided.

Sinks and washing up machines should be individually trapped and connected directly to the discharge/drainage system.

Vegetable paring machines should be fitted with a waste dilution unit and the discharge pipe should be trapped and connected directly to the discharge/drainage system.

The pipes from appliances which discharge waste water containing heavy concentrations of solid matter, e.g. vegetable paring machines and waste disposal macerators, should not be connected to the head of long runs of horizontal discharge pipes. They should be connected as close as is practicable to the main vertical discharge stack or drain to gain the maximum flushing advantage from appliances with high waste water discharge rates.

Where practicable items of kitchen equipment such as steaming ovens, bains marie, boilers and cafe sets should discharge over a drip tray or a fixed tundish having a trapped outlet connected to the discharge system.

Boiling pans should be drained separately over removable tundishes into trapped gullies. The trapped gully should be fitted with a solid hinged flap flush with the floor, the flap kept closed when not in use.

3.6.1.3 Grease traps

The use of grease traps should be avoided if practicable. Where used, they should be designed and located to promote cooling, coagulation, and retention of the grease within the trap.

They should be sized to achieve maximum efficiency. The temperature and velocity of flow of the waste water should allow the grease to separate and collect on the surface of the water in the trap reservoir. In the standard type of grease trap the process of separation will be impaired or even prevented by the use of detergents, which emulsify the grease.

Consideration should also be given to the general nature of the waste matter discharged, since the reduced flow velocity through the trap will allow solid waste matter in suspension to settle and collect in the trap reservoir.

Provision should be made to facilitate the hygienic removal and disposal of the grease. Provision should also be made for the trap to be completely emptied and cleaned periodically to prevent the development of septic conditions in the trap reservoir.

To avoid the risk of food contamination grease traps should not be located in food rooms.

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3.6.2 Hairdressing salons

Special fittings should be provided at the outlet of basins to prevent the ingress of hair into the discharge system.

3.6.3 Pipe support

3.6.3.1 Brackets, clips and hangers

Brackets, clips and hangers should be installed at the spacings given in Table 14 and should be:

a) formed of a suitable materials;

b) securely attached to the building structure and not to any other service;

c) designed to withstand the applied loads;

d) protected against corrosion where exposed to a corrosive environment;

e) made from compatible materials;

f) clamped securely to prevent movement, unless designed to allow for thermal movement;

g) restrained to retract lateral movement; and

h) designed so that pipes and fittings are supported with minimal load being taken by the joints.

Table 14. Maximum spacing of brackets, clips and hangers

Pipework material	Maximum spacing of supports (m)	
	Vertical pipes	Graded pipes
Cast iron	3	3
PVC-U DN 40 – 50	2	1
PVC-U DN 65 – 150	2.5	1.2
PP	2	1
PE	2	1
NOTE. For all pipe materials maximum spacings should be in accordance with manufacturer's recommendations.		

3.6.3.2 Prohibited supports

The method of supporting or spacing of pipes by means of brazing or welding a short section of any material to the surface of each pipe should not be permitted.

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SECTION 4: MATERIALS

4.1 General

This section specifies requirements for materials and products to be used in sanitary plumbing system.

4.2 Authorisation

Materials and products used in the installation should comply with the relevant statutory requirements for authorisation.

a) Materials and products requiring assurance for fitness for purpose are required to have certification mark.

b) Materials and products requiring authorisation for connection to the authority's network system are required to have the watermark.

c) In certain circumstances a local regulatory authority may authorise a material or product to be used in the local authority's area only.

4.3 Selection and use

The materials and products used should be selected to ensure satisfactory service for life of installation. Factors to be taken into account in the selection should include but not be limited to the following:

a) the type of usage likely to occur and the nature of the liquids to be conveyed;

b) the nature of the ground and the possibility of chemical attack therefrom;

c) the physical and chemical characteristics of the materials and products; and

d) the possibility of abrasion by solids in the flow, or of chemical attack.

4.4 Pipes and fittings for non-pressure applications

4.4.1 Ductile iron

Ductile iron pipes and fittings should not be cement-lined when used for sanitary gravity lines.

4.4.2 Galvanised steel

The following limitations should apply to the use of galvanised steel pipes and fittings, which should:

a) not be used for the conveyance of discharge from soil fixtures;

b) not be cement-lined;

c) not be bent; and

d) only be installed in accessible locations.

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4.4.3 Glass

Glass pipes and fittings should be made from grade, low thermal expansion, and borosilicate glass to BS 2598: Part 4.

4.4.4 Glass-filament-reinforced thermosetting plastics (GRP) pipes

4.4.4.1 Specifications

GRP pipes should comply with AS 3571.

4.4.4.2 Limitations on use

The following limitations should apply to the use of GRP pipes, which should:

a) be resistant to ultra-violet light when used above ground; and

b) have a minimum pipe stiffness of 5 000 kN/m deflection per metre length when installed below ground.

4.4.5 Polypropylene fittings

Polypropylene fittings should only be used within buildings in locations not exposed to direct sunlight.

4.4.6 Unplasticised polyvinyl chloride (uPVC)

Pipes and fittings complying with MS 1085 should be used for sanitary drainage above ground, where subject to direct sunlight.

4.4.7 Vitrified clay pipe

Vitrified clay pipes and fittings should not be used above ground, except where installed as a riser connected to a fixture or as a drain under buildings.

4.5 Pipes and fittings for pressure applications

Pipes and fittings for pressure applications should comply with MS 1035.

4.6 Sheets

4.6.1 Stainless steel

Stainless steel sheet should be alloy 304 complying with AS 1449, and should not be less than 1.2 mm thick.

4.7 Jointing components

4.7.1 Rubber rings

Rubber rings should be of dimensions, composition and hardness appropriate to the material being joined and for the particular complication.

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4.7.2 Rubber gaskets

The properties of gasket materials should comply with AS 1546, as appropriate.

4.7.3 Silver brazing alloy

Silver brazing alloys used for jointing copper and copper alloy pipes and fittings should have a silver content of not less than 1.8 %.

4.7.4 Solvent cement and priming fluid

Solvent cement and priming fluid used for jointing UPVC pipes and fittings should be appropriate to the material being joined and for the particular application.

4.8 Concrete and mortar

4.8.1 Cement

Cement should be Portland cement complying with MS 522 .In inspection chambers with an open channel, sulphate-resistant cement should be used.

4.8.2 Fine aggregate (sand)

Fine aggregate should comply with MS 29.

4.8.3 Coarse aggregate (metal)

Coarse aggregate should comply with MS 29 and should not exceed 20 mm nominal size.

4.8.4 Concrete mix

Ready-mixed concrete should comply with MS 523 and should have a minimum characteristic compressive strength (F^1_c) as specified in AS 3600, of 20 Mpa.

Site-mixed concrete should consist of cement, fine aggregate, coarse aggregate all measured by volume, should have sufficient water added to make the mix workable, and should have a minimum F^1_c of 20 Mpa.

4.8.5 Cement mortar

Cement mortar should consist of one part cement and two parts of fine aggregate measured by volume properly mixed the minimum amount of water necessary to render the mix workable.

For bedding pipes, a mixture consisting of one part of cement to four parts of fine aggregate may be used.

Cement mortar that has been mixed and left standing for more than 1 h should not be used.

4.8.6 Chemical admixtures

Chemical admixtures used in concrete should comply with MS 922: Part 1.

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4.8.7 Water for concrete and mortar

Water used for mixing concrete and cement mortar should be free from amounts of matter that are harmful to the mixture the reinforcement, or any other items embedded within the concrete or mortar.

4.8.8 Steel reinforcement

Steel reinforcing bars used in concrete structures should comply with MS 144.

Steel welded mesh reinforcing fabric used in concrete structures should comply with MS 145.

4.9 Miscellaneous

4.9.1 Timber

Timber exposed to the weather should be of durability Class 2 complying with AS 2878 or should be treated in accordance with AS 1604.

4.9.2 Epoxy resins

Epoxy resins should be compatible with the material being joined.

4.9.3 Pipe bedding

Pipe bedding materials should comply with 3.2.3.2.

4.9.4 Backfill

Backfill material should comply with 4.8.

4.9.5 External protective coatings

External coatings used for the protection of drains installed in corrosive are should:

a) be impervious to the passage of moisture;

b) be resistant to the external corrosive environment;

c) be resistant to abrasion by the surrounding fill; and

d) not contain any material that could cause corrosion to the underlying pipes or fittings.

NOTE. Polyethylene sleeving used to protect underground drains may require additional protection if installed in rock or in stony ground.

4.9.6 Glass-fibre-reinforced plastic tanks

Glass-fibre-reinforced plastics tanks should be manufactured in accordance with BS 4994 and should:

a) be not less than 5 mm in thickness; and

b) have tank surfaces with less than a 1 mm thick, resin rich, layered finish.

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4.9.7 Geotextiles

Geotextiles should comply with the requirements of the regulatory authority.

NOTE. The methods of test for the determination of the properties of geotextiles are specified in AS 3706.

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Annex A
(normative)

Sanitary accommodation requirements

A1. Separate WCs and bathrooms with separate entrances for male and female are to be provided where applicable. Toilet floors should be graded towards floor traps.

A2. Where toilets are provided for the public they should be in the following ratio:

No. of WCs	Squatting	Pedestal
1	1	-
2	1	1
3	2	1
4	3	1
5	3	2
6	4	2
7	4	3
8	5	3
9	6	3
10 and above	70 %	30 %

Modifications of these ratios may be considered on individual merits.

A3. Every dwelling unit with three or less bedrooms should have at least one WC and one bathroom. Additional toilet facilities should be provided in the ratio of one WC and bathroom for every three bedrooms or less.

A4. Offices, shopping complexes and factories should have a space provided with sinks and should be 25 % of the total number of wash basin for the floor with a minimum of two units.

A5. For computation, the floor area should be:

$$\frac{\text{Gross built-up areas}}{1.3}$$

A6. All WC's and urinals should be so as to enable both facilities to be used concurrently.

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A7. Premises should be provided with toilets as tabulated. These toilets are to be made accessible to the public for their use.

Table A1. Number of sanitary facilities

	Staff					Public				
	Female		Male			Female		Male		
	WC	Wb	WC	Ur	Wb	WC	Wb	WC	Ur	Wb
i) Office (each floor)										
Not more than 500 m^2	1	1	1	2	1					
501 m^2 to 1 000 m^2	2	1	2	4	2					
1 001 sq m to 2 000 m^2	3	2	3	5	3					
Every additional 1 000 m^2 or less in excess of 1 000 m^2	1	1	1	1	1					
ii) Shopping places (each floor)										
Not more than 250 m^2	-	-	-	-	-	1[a]	1[a]	-	1	-
501 m^2 to 1 000 m^2	-	-	-	-	-	2	1	1	2	1
1 000 m^2 to 2 000 m^2	2	1	1	2	1	1	1	1	2	1
2 001 m^2 to 3 000 m^2	3	2	2	3	2	2	1	1	2	2
Every additional 1 000 m^2	4	3	3	4	3	3	2	2	4	3
or less in excess of 3 000 m^2	1	1	1	1	1					
iii) Eating establishments including bars and nightclubs (each floor)										
Not more than 150 m^2		-	-	-	-	-	1[a]	1[a]	-	1
151 m^2 to 250 m^2	-	-	-	-	-	1	1	1	2	1
251 m^2 to 500 m^2	1	1	1	1	1	1	1	1	2	1
501 m^2 to 750 m^2	2	1	1	1	1	2	1	1	2	1
751 m^2 to 1 000 m^2	2	1	1	2	1	2	1	2	3	2
1 001 m^2 to 1 500 m^2	3	2	2	3	2	4	2	2	4	2
1 501 m^2 to 2,000 m^2	3	2	2	4	3	5	3	3	5	3
Every additional 1 000 m^2 or less excess of 2 000 m^2	-	-	-	-	-	1	1	1	2	1
iv) Conferences halls, clubs, assemblies: Based on seating capacity as follows:										
Not more than 150 persons	-	-	-	-	-	1	1	1	2	1
150 persons to 300 persons	-	-	-	-	-	2	2	2	3	2
301 persons to 450 persons	-	-	-	-	-	3	2	2	5	3
451 persons to 600 persons	-	-	-	-	-	4	2	3	5	4
601 persons to 900 persons	-	-	-	-	-	5	3	4	7	5
Every additional 300 persons or less in excess of 900 persons	-	-	-	-	-	1	1	1	2	1
v) Places of worship:										
a) for every 200 males or less										
b) for every 100 females or less	-	-	-	-	1	1	1	2	1	
vi) Parks, tourist sites, public resort piers	-	-	-	-	-	2	2	2	2	2

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Table A1. Number of sanitary facilities *(continued)*

	Staff					Public				
	Female		Male			Female		Male		
	WC	Wb	WC	Ur	Wb	WC	Wb	WC	Ur	Wb
vii) Factories, workshop, garages, vehicles, depots and printing presses: The sanitary requirements should be provided in accordance to the number of workers or the floor area, whichever is greater.										
By areas:										
a) Not more than 500 m^2	1	2	1	2	2	-	-	-	-	-
501 m^2 to 1 000 m^2	2	3	2	4	3	-	-	-	-	-
1 001 m^2 to 2 000 m^2	3	5	3	6	5	-	-	-	-	-
Every additional 1 000 m^2 or less in excess of 2 000 m^2	1	2	1	2	2	-	-	-	-	-
b) By number of workers:										
Male workers up to 25	-	-	1	2	2	-	-	-	-	-
26 workers to 50 workers	-	-	2	3	3	-	-	-	-	-
51 workers to 100 workers	-	-	3	5	5	-	-	-	-	-
Every 50 workers in excess of 100 workers	-	-	1	2	1	-	-	-	-	-
Female workers up to 20	1	1	-	-	-	-	-	-	-	-
21 workers to 40 workers	2	2	-	-	-	-	-	-	-	-
41 workers to 70 workers	3	3	-	-	-	-	-	-	-	-
71 workers to 100 workers	4	4	-	-	-	-	-	-	-	-
101 workers to 140 workers	5	5	-	-	-	-	-	-	-	-
141 workers to 180 workers	6	6	-	-	-	-	-	-	-	-
Every 40 in excess of 180 workers	1	1	-	-	-	-	-	-	-	-
c) Showers - if required for every 25 workers (of each sex) or less - 1 shower										

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Table A1. Number of sanitary facilities *(continued)*

		Female			Male			
		WC	WC	Br	WC	Ur	Wb	Br
viii) Hotels, guest houses boarding houses, (use whichever is greater)								
a) Public sanitary facilities								
No. of bedrooms	No. of beds							
Not more than 5	Not more than 10	1	1	1	1	2	1	-
6 to 10	11 to 20	2	2	2	2	2	3	2
Every additional 5 in excess thereof	Every additional in excess thereof	1	1	1	1	1	1	1
b) Staff sanitary facilities								
No. of bedrooms	No. of beds							
Not more than 100	Not more than 200	1	1	1	1	1	1	1
101 to 500	201 to 1 000	2	2	2	2	2	2	2
in excess of 500	in excess of 1000	3	3	3	3	4	3	3
ix) Hostels, dormitories, nursing homes:								
a) No. of beds (Male)		-	-	-	1	1	2	1
		-	-	-	2	2	3	2
Not more than 5 beds		-	-	-	1	1	1	1
6 beds to 15 beds								
		1	1	1	-	-	-	-
Every additional 10 beds in excess thereof		2	3	2	-	-	-	-
		1	1	1	-	-	-	-
b) No. of beds (Female)								
Not more than 5 beds								
6 beds to 15 beds								
Every additional 10 beds in excess thereof								
		-	-	-	1	1	2	1
x) Hospitals, maternity homes: (each floor)		-	-	-	2	2	2	1
		-	-	-	1	2	1	1
a) Male patients:								
Not more than 10								
11 to 20		1	1	1	-	-	-	-
Every additional 20 in excess thereof		2	2	1	-	-	-	-
		1	1	1	-	-	-	-
b) Female patients:								
Not more than 7								
8 to 15								
Every additional 15 in excess thereof								

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Table A1. Number of sanitary facilities *(continued)*

	Female			Male			
	WC	Wb	Br	WC	Ur	Wb	Br
xi) Schools, colleges, universities, educational and commercial institutions							
a) Male students:							
Up to 40 students in excess thereof	-	-	-	1	2	1	-
Every additional 40 students in excess thereof	-	-	-	1	2	1	-
b) Female students:							
Up to 40 students	2	1	-	-	-	-	-
Every additional 40 students in excess thereof	2	1	-	-	-	-	-
xii) Creshes							
a) Children Every 40	4[a]	4[a]	2[a]	-	-	-	-
b) Staff Every 20	1[a]	1[a]	1[a]	-	-	-	-
xiii) Massage parlours Every 5 rooms	1	1	1	1	1	1	1
xiv) Lock-up shops	1[a]	1[a]	-	-	-	-	-
xv) Petrol stations	1	1	1	1	1	1	1
xvi) Cinemas Based on seating capacity as follows:							
Not more than 150 persons	1	1	-	1	2	1	-
151 persons to 300 persons	2	2	-	2	3	2	-
301 persons to 450 persons	3	2	-	2	5	3	-
451 persons to 600 persons	4	2	-	3	5	4	-
601 persons to 900 persons	5	3	-	4	7	5	-
Every additional 300 persons or less in excess of 900 persons	1	1	-	1	2	1	-
xvii) Bus terminal							
Not more than 20 bus bays	1	1	-	1	2	1	-
21 to 50	2	2	-	2	4	2	-
51 to 100	2	2	-	3	6	3	-
More than 100	3	2	-	4	7	5	-
xviii) Car parks The sanitary requirements are based on the size of parking area as follows:							
Not more than 500 m^2	-	-	-	-	-	-	-
501 m^2 to 1 000 m^2	1[a]	1[a]	-	-	1	-	-
1 001 m^2 to 2 000 m^2	1	1	-	1	1	1	-
2 001 m^2 to 4 000 m^2	2	2	-	2	2	2	-
For every additional 2 000 m^2 or less in excess thereof	1	1	-	1	1	1	-
Provisions of sanitary facilities on alternate floors acceptable							

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Table A1. Number of sanitary facilities *(continued)*

		Female			Male			
		WC	Wb	Br	WC	Ur	Wb	Br
xix) Supports fields								
Up to 5 acres:								
a) for players		1	1	2	2	4	3	2
b) for spectators		1	1	-	1	5	1	-
xx) Markets, food centres (each floor) The greater number of sanitary facilities based on either calculations is to be used								
No. of stalls	Gross floor area (m^2)	2	1	-	2	2	2	-
Not more than	Not more than 1 000	2	2	-	2	3	2	-
51 to 100	1 001 to 2 000	3	2	-	3	4	3	-
101 to 200	2 001 to 4 000	4	3	-	4	4	4	-
201 to 300	4 001 to 6 000							
Every additional	Every additional							
100 in excess thereof	2 000 in excess thereof	1	1	-	1	1	1	-
xxi) Stadiums								
a) Spectators		5	3	-	4	9	5	-
Not more than 2 000 persons		8	4	-	7	15	8	-
2 001 persons to 5 000 persons		13	6	-	11	25	13	-
5 001 persons to 10 000 persons		20	10	-	18	40	20	-
10 001 persons to 20 000 persons		33	16	-	30	72	33	-
20 001 persons to 50 000 persons		50	25	-	45	100	50	-
50 001 persons to 100 000 persons								
b) Player & Athletes Sanitary facilities within the stadium should be uniformly distributed around the stadium to ensure that no spectator would have to walk more than 50 m to reach any toilet.		4	6	10	2	2	9	10
xxii) Warehouses (each floor)		-	-	-	18	1	18	-
xxiii) Construction sites								
Every 25 male workers or less		-	-	-	1	1	1	1
Every 25 female workers or less		1	1	-	-	-	-	-
xxiv) Crematoria								
Each cremator		1	1	-	1	2	1	-
xxv) Bowling alley/skating rink		3	2	2	2	4	3	3
xxvi) Funeral parlour								
For each unit		1	1	-	1	2	1	-

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Table A1. Number of sanitary facilities (*continued*)

	Female				Male				
	WC	**Wb**	**Br**	**Bh**	**WC**	**Wb**	**Ur**	**Br**	**Bh**
Xxvii) Public swimming pools									
Up to 150 m^2	1	1	1	1	1	1	1	1	1
151 $m^2$to 300 m^2	2	2	3	3	2	2	2	3	3
301 m^2 to 900 m^2	3	3	4	4	3	4	4	5	5
Exceeding 900 m^2	3	4	5	6	6	5	5	8	10

Notations: WC - Water closet
Wb - Wash basin
Ur - Urinal (1 Ur = 6 - mm)
Br - Bathroom with shower
Bh - Bench and hanger - 600 mm

NOTES:

1. In hotels where toilets are provided for public use in common areas all of the water closets should be of the pedestal type.

2. [a] To be used by both male and female

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