ENGINEERING STANDARD

FOR

RAIN AND FOUL WATER DRAINAGE OF BUILDINGS

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PAGE No.

0. INTRODUCTION

This Engineering Standard prescribes the limits of drains and sanitary pipework versus sewer lines and sets out general design consideration for drainage of foul water of buildings and houses and recommends minimum requirement for sanitation in places of employment.

Due to distinct placement level of the drains (below ground) and the sanitary pipework (above ground), this Standard is presented in two Parts:

PART 1 **BUILDING DRAINAGE**

PART 2 **SANITARY PIPEWORK**

PART ONE
BUILDING DRAINAGE

1. SCOPE

This Standard sets out recommendations for the design and layout of foul sanitary wastes and surface water drainage systems constructed in the ground under and around buildings, and their connection to sewers and open ditches separately and/or their connection to cesspools, soakaways or watercourses.

The structural design criteria are limited to drains not generally exceeding DN 300, although the other criteria are of general application.

2. REFERENCES

In this Part of the Standard the following standards and publications are referred to and to the extent specified, form a part of this Standard.

BSI (BRITISH STANDARDS INSTITUTION)

BS 8301: 1985	"Building Drainage"
BS 6367: 1983	"Drainage of Roofs and Paved Areas"
BS 5572: 1978	"Sanitary Pipework"

IPS (IRANIAN PETROLEUM STANDARDS)

E-CE-380	"Sewerage and Surface Water Drainage System"
E-CE-400	"Sewage Treatment"
E-PI-160	"Plant Drainage System"

3. DEFINITIONS AND TERMINOLOGY

For the purposes of this Engineering Standard the definitions of drainage terms used in Iranian Petroleum Industries' Standards i.e. E-CE-380 and E-CE-400 are applicable here.

3.1 Drain

A pipe that takes foul sewage or surface water or both, from a single building or from any buildings or yards appurtenant to buildings within the same curtilage.

Note:

A drain becomes a sewer when it leaves the curtilage of the property and is connected to the public sewerage system or cesspool.

3.2 Blinding

Material that will fill the interstices and irregularities in the exposed trench bottom and, when adequately compacted will create a firm uniform formation on which to place the pipe bedding material.

Note:

Hoggin, sand, gravel, all-in-aggregate or lean concrete are commonly used.

3.3 Branch Drain

A line of pipes installed to discharge into a junction on another line or at a point of access, i.e. an access junction, inspection chamber or manhole.

3.4 Branch Vent

A ventilating pipe connected to one or more branch drains.

3.5 Discharge Unit

A unit of flow calculated for a drainage appliance so that the relative load-producing effect of its discharge can be expressed as a multiple of that unit.

Note:

The discharge unit load of an appliance depends on its rate and duration of discharge, the interval between discharges and the chosen criterion of satisfactory service. It is not a simple multiple of a rate of flow.

3.6 Inspection Chamber

A covered chamber constructed on a drain or sewer so as to provide access thereto for inspecting, testing or the clearance and removal of obstructions, and usually situated in areas subjected to light loading only.

3.7 Nominal Size (DN)

A numerical designation of the size of a pipe, bend or branch fitting, which is a convenient round number approximately equal to a manufactured dimension.

Note:

"Nominal bore" is the approximate internal diameter of a unit as declared by the manufacturer. This quantity is quoted with units (mm) whereas nominal size (DN) is quoted without units.

3.8 Gutter

A channel alongside a road, or around the eaves of a building to collect and carry away surface water of roads, carparks and roof of building.

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

5. GENERAL DESIGN PRINCIPLES

5.1 Introduction

A drainage system should be designed, installed and maintained so as to convey and discharge its contents without causing a nuisance or danger to health, arising from leakage, blockage or surcharge.

5.2 Separate Discharge of Rainwater and Foul Water

In accordance with Iranian Petroleum Industries' code of practice, rainwater and foul water shall be discharged separately. No rainwater from roof areas shall be admitted into foul water branch discharge pipes, stacks or sewers or waste pipes for foul water, nor shall foul water be discharged via rainwater pipes or storm water sewers.

5.3 Frost Precautions Inside Buildings

Drainage systems and flushing equipment inside buildings shall be designed and installed so that they are neither damaged nor their function impaired by frost, assuming that they are used in the manner intended. See also Clause 3.6 of Part 2.

5.4 Considerations in Preparation of Drainage Layouts and Working Drawings

Access should be provided at all bends and junctions. Where a bend external to an inspection chamber or manhole is unavoidable, it should be adjacent and should provide a deviation of not more than 45°.

Bends, particularly in the smaller diameter pipes, should have a long rather than a short radius and in any case this should be sufficiently long to enable access for cleaning by the usual methods.

Inspection chambers and manholes should be sited so as to avoid the need for acute changes in direction of flow from branch drains (see Clause 6.3).

The routes selected should make full use of the natural slopes of ground or any adjustments thereto, so as to achieve design gradients with minimum excavation.

Common trenches for foul and surface water drains may prove economical in excavation. However, care is needed to ensure the stability of the shallower pipes and the spacing of pipelines should be adequate for the connections, including those which may be needed in the future. When deciding on trench arrangements the primary consideration, as in every aspect of the design process, should be the hydraulic effectiveness of the system.

5.5 Pipe Sizes

A foul drain should be of nominal size not less than DN 100 (see clause 6). A surface water drain should be of nominal size not less than DN 75, (refer to E-CE-380, Part 1). In certain cases a connection to a drain may be of smaller nominal size to suit the nature and volume of flow from a single appliance.

There may be situations where, for hydraulic reasons, a discharge pipe, designed in accordance with Part 2 of this Standard may need to be continued below ground without increase in bore to a position in a drainage system where the flow will prevent undesirable deposition of solids. Such a pipe should be laid direct to an inspection chamber or manhole without change of line or gradient.

5.6 Pipe Gradients

The choice of gradient should be such as to maintain self-cleansing velocity under normal discharge conditions (see 6.2.4.4).

5.7 Drains Laid Outside Buildings

For housing and small structures it is preferable for drains to be laid outside where provision can be made for ready detection of blockages and their removal. Pipework laid under the buildings should then be limited to short branches. A drain trench should not impair the stability of a building. When drains are laid parallel to the foundation, care should be taken that the foundations are not undermined.

Where the horizontal distance between the drain trench and the foundation is less than the depth from the underside of the foundation to the invert of the trench, the sides of the trench should be shored with members of sufficient strength to resist any horizontal or vertical movement of the foundation.

Trenches adjacent to load bearing walls within 1 m of the foundation of the wall should be filled with concrete to at least the level of the underside of the foundation. For distances greater than 1 m the concrete fill should be to a level below the underside of the foundation equal to the distance from it to the nearside of the trench, less 150 mm.

5.8 Differential Movement

Differential settlement should be accommodated by means of flexible joints. The risk of shear fracture is considerably reduced by the provision of a flexible joint located as close as practicable to the face of the structure. The length of the next pipe should not exceed 0.6 m. Where considerable differential settlement is anticipated several "rocker" pipes should be laid, and the gradient should if necessary be increased locally to reduce the likelihood of a back fall developing.

Where it is not necessary for a pipe to be built into a structure, the effects of differential movement may be overcome by the provision of a lintel, relieving arch or sleeve leaving a gap of not less than 50 mm around the pipe. To prevent the entry of gravel, rodents or gas through such gaps, glasswool or bituminized jute can be adopted.

6. FOUL DRAINAGE

6.1 Drainage to a Sewerage System

The outfall of a foul water drainage system should discharge into a foul water, but where such a sewer is not conveniently available and cannot economically be extended to a site, other methods of foul waste disposal will be necessary, either to treatment or to cesspool. For treatment methods or cesspool refer to IPS-E-CE-400.

6.2 Hydraulic Design of Foul Drains

6.2.1 Minimum sanitation requirement

a) In individual unit houses with private yard and in family dwellings within a housing complex, the minimum sanitation requirement in terms of discharge units of w.c., lavatory, shower etc. should conform with the requirements of owner.

b) In the buildings, planned as places of employment, the minimum number of toilet facilities to be provided shall be in accordance with Tables 1 and 2.

TABLE 1 - MINIMUM NUMBER OF ASIATIC W.Cs

NUMBER OF EMPLOYEES	MINIMUM NUMBER OF W.Cs*
1 to 9	1
10 to 24	2
25 to 49	3
50 to 74	4
75 to 100	5
Over 100	1 for each additional 30 persons

*** In building of employment 10% of the total w.c. may be European if required and approved.**

TABLE 2 - MINIMUM NUMBER OF LAVATORIES

NUMBER OF EMPLOYEES	MINIMUM NUMBER OF LAVATORIES
1-50	1 For every 10 employees or portion thereof
51-100	10, Plus 1 for each additional 15 employees or portion thereof
Over 100	14, Plus 1 for each additional 20 employees or portion thereof

6.2.2 Basic design principles

For determining drain size and gradient, the discharge unit method based on probability theory should be used for estimating a realistic peak flow so that the assessed design flow will seldom be exceeded.

6.2.3 Determination of flow

The flow rates, probability of discharge factors and discharge unit ratings of different appliances are given in Table 3. The same values are used also in Part 2 of this Standard.

TABLE 3 - FLOW RATES, PROBABILITY OF DISCHARGE FACTORS AND DISCHARGE UNIT RATINGS

APPLIANCES	CAPACITY	DISCHARGE DATA		RECURRENCE USE INTERVAL (FREQUENCY OF USE) T	PROBABILITY OF DISCHARGE $P = \frac{t}{T}$	DISCHARGE UNITS
		Flow Rate	Duration, t			
	L	L/s	s	s*		
WC (9L, high level cistern)	9	2.3	5	1200 600 300	0.004 0.008 0.017	7♣ 14 28
Wash basin (32 mm branch discharge pipe)	6	0.6	10	1200 600 300	0.008 0.017 0.033	1♣ 3 6
Sink, double bowl (40 mm branch discharge pipe)	23	0.9	25	1200 600 300	0.021 0.042 0.083	6♦ 14 27
Mini tub (40 mm branch discharge pipe)	80	1.1	75	4500 (domestic) 1800	0.017 0.042	7♦ 18
Automatic washing machine	180	0.7	300	15000	0.020	4
Shower	—	0.1	—	—	—	Use flow rate
Spray tap	—	0.06	—	—	—	Use flow rate
Urinal (per stall, automatic flushing)	4.5	0.15	30	1200 900	0.025 0.033	0.3

*** A use interval or recurrent interval (frequency of use) of 1200 s, corresponds to domestic use; 600 s, to commercial use; 300 s, to congested use such as in public toilets, schools and factories.**

♣ In domestic installations, the highest loading occurs during the morning peak period and is made up of the discharges from WCs, basins, and sinks. For this reason, a dwelling, is usually allotted a fixed number of discharge units for a group consisting of one each of these appliances. In this Standard 14 discharge units per dwelling is assumed (see Part 2 of this Standard).

♦ Some proportion of the total number of appliances may be assumed to be in simultaneous operation if considered appropriate.

6.2.3.1 Calculation for groups of similar appliances

The probability of discharge factor ($P = \frac{t}{T}$) can be found from Table 3 and then from Fig. 1 the probable number of similar appliances that within a group might be used simultaneously can be calculated.

Note:

This method should not be used for mixed appliances to avoid unnecessary oversizing of pipes.

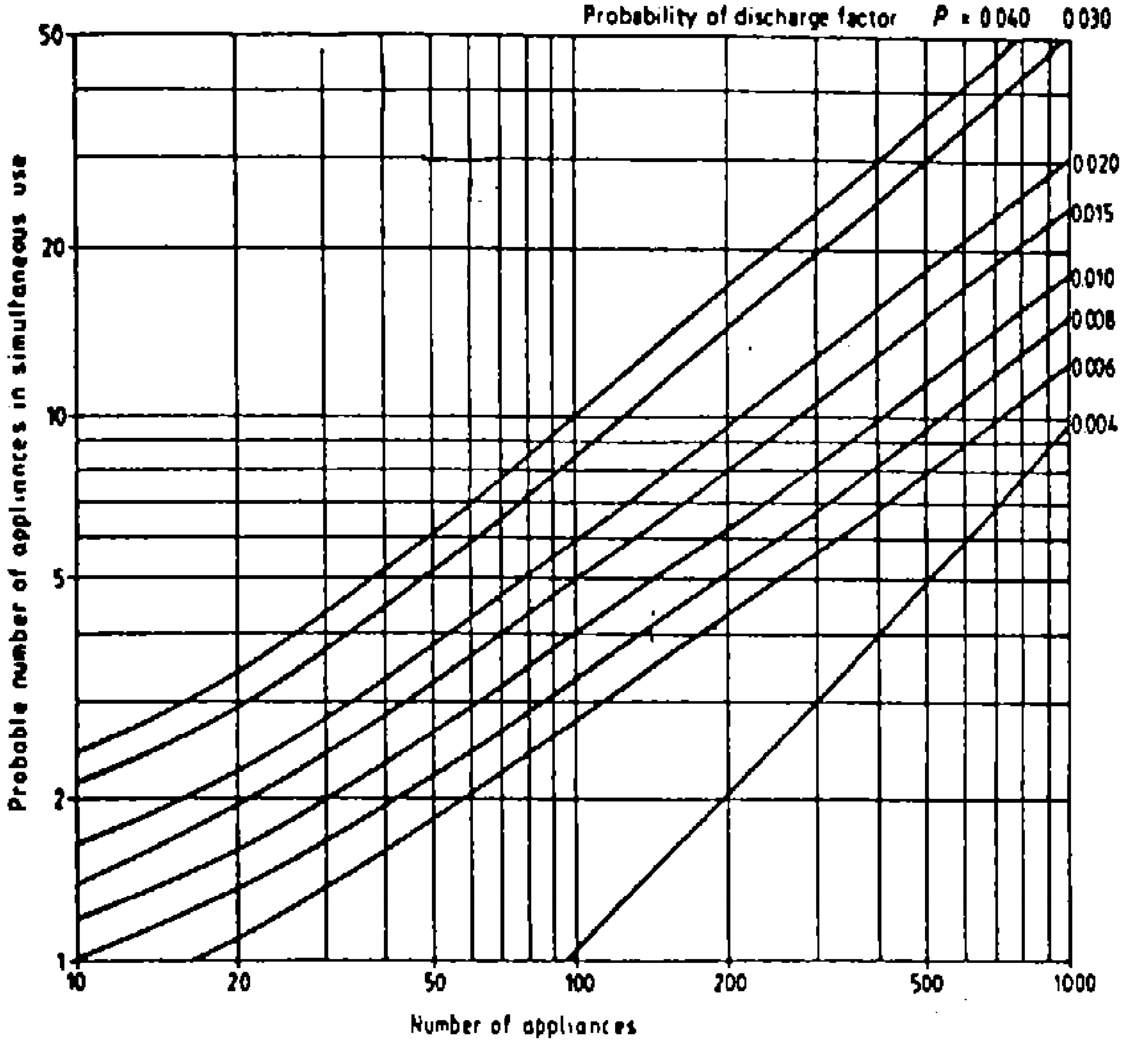
6.2.3.2 Calculation for groups of mixed appliances

For the calculations of flow in drains serving mixed appliances, discharge units are so chosen that the relative load-producing effect of appliances can be expressed as multiples of the units. The discharge unit rating of an appliance depends on its rate and duration of discharge, on the interval between discharges and on the chosen "criterion of satisfactory service"*.

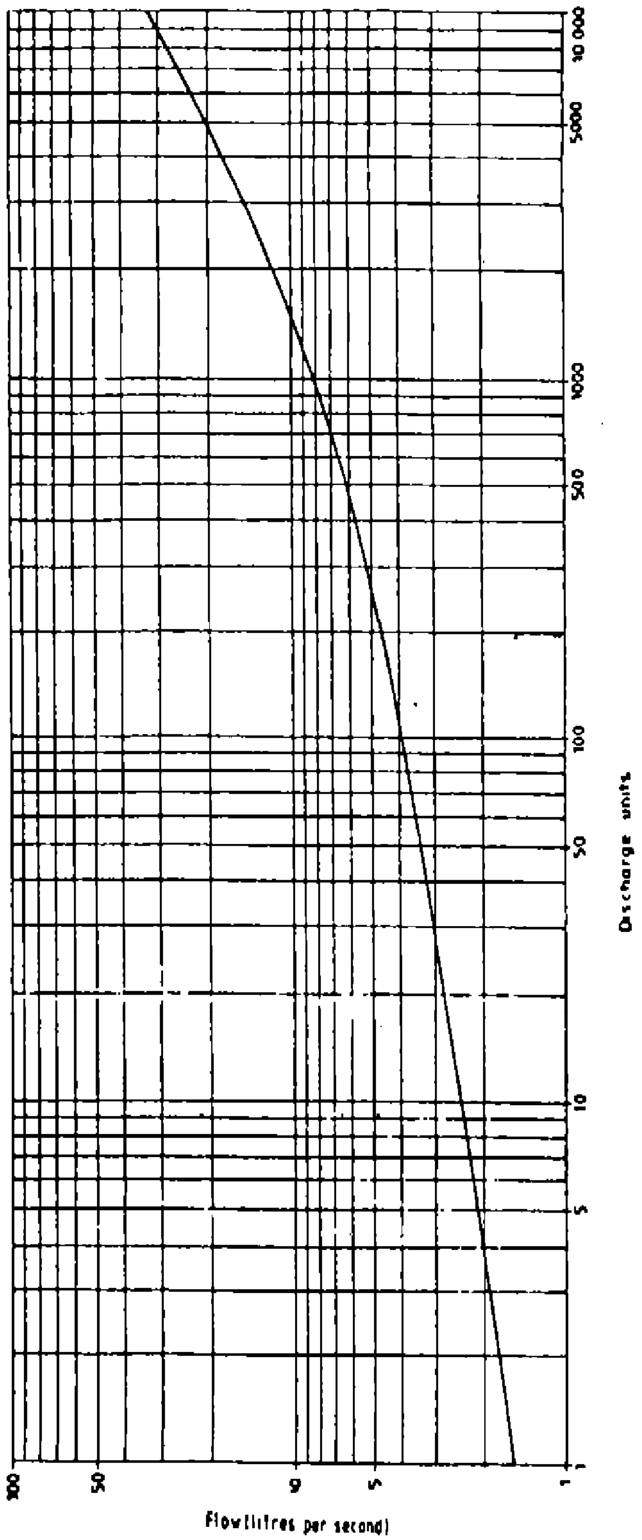
Discharge unit values for sanitary appliances in common use are given in Table 3. For other appliances the discharge unit value for each should be deduced from the data given in Table 3 for an appliance with the same trap diameter, and duration and rate of discharge.

The discharge unit values of all the appliances contributing to flow in the drain should be added, and the equivalent peak rate in L/s for this total obtained from Fig. 2. When the drain carries continuous flows from other sources, their rates can be added to the value obtained from Fig. 2.

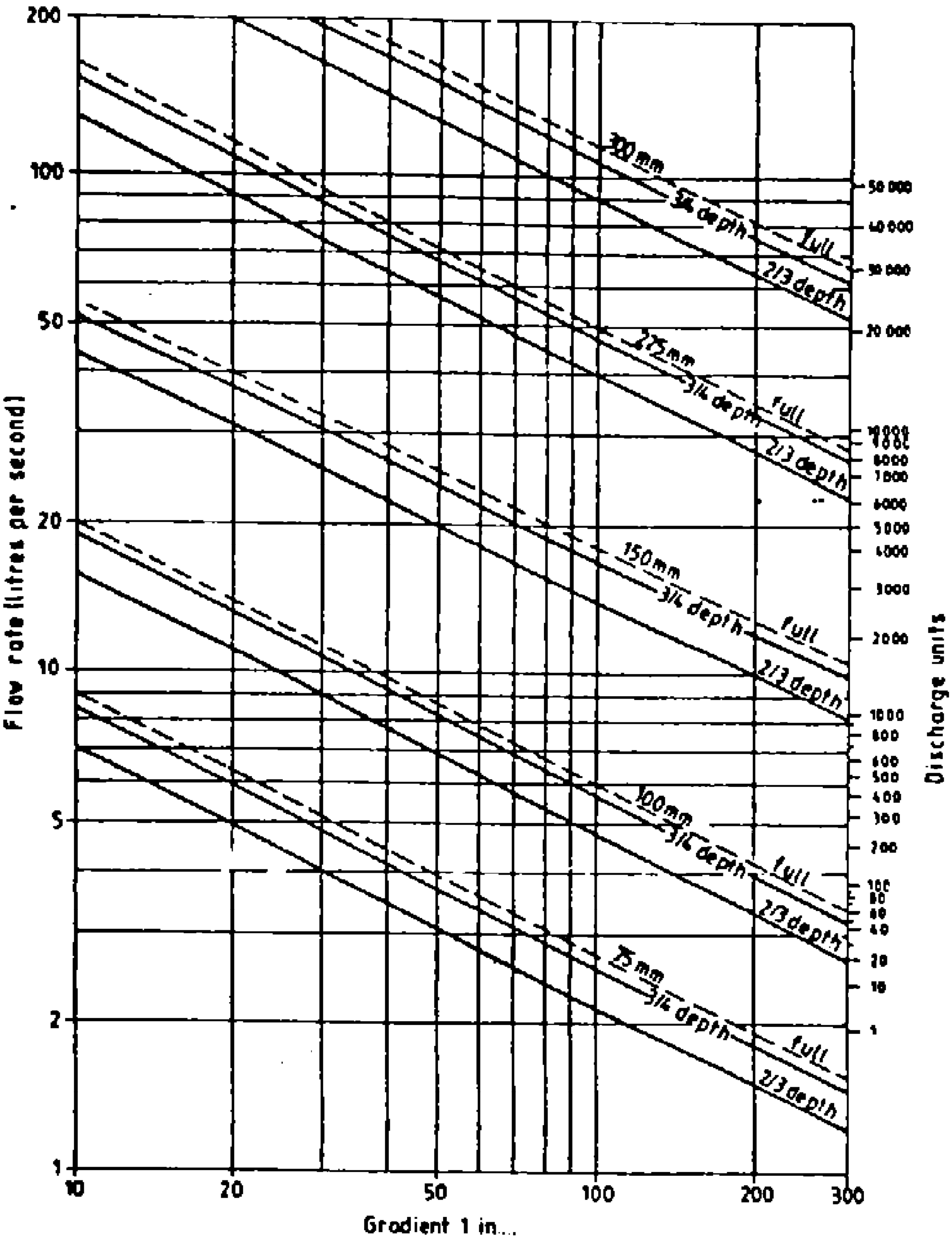
*** The criterion of satisfactory service referred to in this Standard is 99.5 % and is defined as the percentage of time that the design discharge flow loading will not be exceeded. A graph, based on this figure, showing the number of appliances likely to be in simultaneous use for a given total is shown in Fig. 1 for different values of appliance probability of discharge (P) figures.**



PROBABILITY GRAPH FOR NUMBER OF APPLIANCES DISCHARGING SIMULTANEOUSLY
Fig. 1



DESIGN FLOWS FOR FOUL DRAINS: CONVERSION OF DISCHARGE UNITS TO FLOW RATES
Fig. 2



DISCHARGE CAPACITIES OF DRAINS RUNNING FULL, 3/4 AND 2/3 PROPORTIONAL DEPTH: USED PIPES IN GOOD CONDITION (HYDRAULIC ROUGHNESS, k = 0.6 mm)

Fig. 3

6.2.4 Determination of Pipe Size and Gradient

6.2.4.1 General

Fig. 3 shows the discharge capacities of drains, from 75 mm to 300 mm diameter, when flowing full, and at 0.75 and 0.67 proportional depth. Using Fig. 3 and the likely peak flow rate, the designer should select a pipe diameter and gradient taking account of the factors in 6.2.4.2 and 6.2.4.3.

The design curves in Fig. 3 are based on a hydraulic roughness of 0.6 mm as defined for the Colebrook-White equation. This roughness should be suitable for intermittently used drains of all pipe materials.

Note:

For used pipes in poor condition refer to BS. 8301.

6.2.4.2 Design for minimum blockage

Blockages may occur because of misuse but the risk of recurring blockages during normal use can be minimized by ensuring a high standard of drain and manhole construction throughout the system and that pipes are not unacceptably oversized.

6.2.4.3 Choice of pipe size and depth of flow

Foul drains should be of minimum size DN 100, but where waste water only is conveyed DN 75 is considered acceptable. (Excepting special bore requirements, e.g. for hospitals min. size DN 150 is preferred).

For foul drains, the size of the pipe and the gradient (see 6.2.4.4) at which it is to be laid should be so chosen that at peak flow the risk of induced trap siphonage is minimized by ensuring adequate air movement in the drain. This is usually achieved by not exceeding a proportional depth of 0.75.

6.2.4.4 Choice of gradients

Choice of gradients should be such as to maintain self-cleansing velocity under normal discharge conditions.

To achieve a satisfactory installation, diameter and gradient should be adequate for the maximum flow and competent supervision should be provided to ensure a high standard of pipe quality, laying, jointing and workmanship. This is particularly important when pipes are laid to flat gradients.

The following guidelines on gradients should be observed.

a) For flows of less than 1 L/s, pipes not exceeding 100 mm nominal bore at gradients not flatter than 1:40 have proved satisfactory.

b) Where the peak flow is more than 1 L/s, a 100 mm nominal bore pipe may be laid at a gradient not flatter than 1:80, provided that at least one WC is connected.

c) 150 mm nominal bore pipe may be laid at a gradient not flatter than 1:150, provided that at least five WCs are connected.

d) Experience has shown that for gradients flatter than those given in items (a) to (c), a high standard of design and workmanship is necessary if blockages are to be minimized.

Where this has been achieved, gradients of 1:130 for 100 mm nominal bore pipes and 1:200 for 150 mm nominal bore pipes have been used successfully.

6.3 Connections to Foul Drains

6.3.1 General

A connection to a foul drain from a sanitary appliance, a discharge stack, a gully or branch drain should, where convenient and practicable, be made to an inspection chamber or manhole. However, provided that effective access to all pipe runs is achieved for maintenance, removal of blockages and testing, it may be made to a junction.

However made, it should be so arranged that the discharge is swept in the direction of flow at the point of connection. The length of a connection from an appliance should preferably not exceed 6 m and that from a group of appliances 15 m (see clause 10).

6.3.2 Connections

For all kind of connectional details to inspection chambers or manholes, to junctions, discharge stacks etc. refer to relevant Standard Drawings.

6.3.3 Connections to an existing drain

Where it is impracticable to construct an inspection chamber or manhole for a connection to an existing drain, a junction should be inserted. Where this is impracticable a saddle may be used providing the receiving drain is at least one size larger than the branch drain and the saddle connection is made so that the flow enters above the horizontal diameter.

6.4 Connections to Septic Tanks, Settlement Tanks or Cesspools

Where a drain or private sewer is connected to a septic or settlement tank, the entry velocity should be restricted so as to ensure that quiescent conditions within the tank are disturbed as little as possible. In the case of an incoming drain of up to 150 mm diameter this is usually achieved by adopting a gradient not steeper than 1:50 for a length of at least 12 m immediately upstream of the tank.

Provision should be made for effectively rodding the incoming drain and its connection to a septic tank.

Information on the design of small sewage treatment works and septic tanks is given in IPS-E-CE-400.

7. SURFACE WATER DRAINAGE OF PAVEMENTS

For design of surface water drainage system beyond the curtilage of building complex property, see Part One of IPS-E-CE-380.

8. THE STRUCTURAL DESIGN OF DRAINAGE

8.1 General

For design basis and methods of beddings for rigid and flexible pipes refer to IPS-E-CE-380.

9. PROVISION OF GULLIES AND GREASE TRAPS

For engineering and constructional details refer to standard drawings for gullies, IPS-D-CE-232 and for grease traps, IPS-D-CE-233.

10. ACCESS TO DRAINS

10.1 General

Access is required to drainage installations for testing, inspection, maintenance and removal of debris. Access to drains allowing rodding in both directions can be provided by inspection chambers and manholes, and by some access fittings whereas rodding eyes allow for rodding downstream only.

10.2 Provision of Access to Drains

The guiding principle is that every drain length should be accessible for maintenance and rodding without the need to enter buildings. Access should be provided at the head of each run of drain and at changes in direction, gradient or pipe diameter*.

Table 4 indicates the recommended maximum distance between rodding eyes, access fittings, inspection chambers and manholes. These are based on standard rodding techniques and the need for removing debris.

Where a branch drain joins another drain without the provision of an inspection chamber or manhole at the junction, access should be provided on the branch drain within 12 m of the junction.

*** For drains larger than DN 300 see IPS-E-CE-380.**

TABLE 4 - MAXIMUM SPACING OF ACCESS POINTS

DISTANCE TO	FROM ACCESS FITTING		FROM JUNCTION OR BRANCH	FROM INSPECTION CHAMBER	FROM MANHOLE
	1	2			
	m	m	m	m	m
Start of external drain**	12	12	—	22	45
Rodding eye	22	22	22	45	45
Access fitting (1) min. 150 mm × 100 mm or 150 mm Dia.	—	—	12	22	22
Access fitting (2) min. 225 mm × 100 mm	—	—	22	45	45
Inspection chamber	22	45	22	45	45
Manhole	22	45	45	45	90

**** See 6.3.1 for distance of first access point from start of drain, i.e. stack or ground floor appliance outlet.**

10.3 Rodding Eyes and Access Fittings

10.3.1 General

Rodding eyes and access fittings provide limited access and should be used in accordance with clause 10.2 and with the maximum spacing recommendations given in Table 4.

10.3.2 Rodding eyes

A rodding eye provides access at surface level for the clearance in one direction only of obstructions and debris using normally accepted manual rodding techniques. It should be constructed in pipework preferably of the same diameter as the drains it serves and should connect to the drain at an angle not steeper than 45° from the horizontal. It should preferably be carried up to ground level at the same angle to permit easy rodding and to reduce resistance to the passage of rods.

10.3.3 Access fittings

Access fittings provide for rodding in more than one direction and for testing. On a buried drain they are used in three ways:

a) as an opening in the top of the drain having a sealed cover and separate cover bedded at surface level;
b) with a raising piece terminating with a suitable cover at surface level;
c) with a sealed cover located within an inspection chamber or manhole, in which case spacings in Table 4 should be as for an access fitting.

10.4 Inspection Chambers and Manholes

10.4.1 General

Inspection chambers and manholes should be resistant to water penetration, be durable and be designed to minimize the risk of blockage. Provision to prevent flotation may be necessary.

Preformed and precast units should be installed strictly in accordance with manufacturer's instructions.

10.4.2 Dimensions

Dimensions depend on the size of the main drain and on the number, size and position of branch drains entering. The size of inspection chambers should be such that the drain can be cleaned from the surface. The design of manholes should permit entry without restricting operational space.

Subject to the minimal given in Table 5 internal dimensions for manholes with a number of branches may be estimated as follows:

a) Length

The length should be 300 mm for each DN 100 or DN 150 branch on the side having most branches plus an allowance at the downstream end for the angle of entry.

b) Width

The width should be the sum of the widths of the benching, plus 150 mm or the diameter of the main drain, whichever is the greater. The benching width should be 300 mm where there are branches or 150 mm where there is no branch.

Where manholes or inspection chambers with curved channels cannot be avoided, their dimensions should be based on the foregoing principles.

TABLE 5 - MINIMUM DIMENSIONS FOR RODDING EYES, ACCESS FITTINGS, INSPECTION CHAMBERS AND MANHOLES

TYPE OF ACCESS	DEPTH TO INVERT	Min. INTERNAL DIMENSIONS		Min. NOMINAL COVER SIZE		
		Rectangular length and width	Circular diameter	Rectangular length and width	Circular diameter	Remarks
	m	mm	mm	mm	mm	
Access fitting	0.6 or less except where situated in a chamber (see Clause 10.3)	(a) 150 × 100 (b) 225 × 100	150 —	150 × 100 225 × 100	150 —	The depth restriction is imposed because of the limited access afforded by these items and is based on the ability to manipulate a stopper at arm's length from the surface.
Inspection chamber *	0.6 or less	—	190 mm dia. for drains up to 150 mm dia.	—	190	The depth restriction is imposed as for the access fitting.
	1.0 or less	450 × 450	450	450 × 450	450♣	The extra internal size enables manipulation of a stopper from the surface at the increased depth.
Manhole♥	From 1.2 to 2.4	1200 × 750	1050	600 × 600	600	Larger size required for shallow manholes.
	Greater than 2.4	1200 × 750	1200	600 × 600	600	Generally in accordance with safe working in sewers and at sewage works'.
Manhole shaft (where applicable)	Greater than 2.7	900 × 840	900	600 × 600	600	Minimum chamber width 840 mm.
Rodding eye		Preferably same size as drain, but not less than 100 mm diameter		—	—	

*** A covered chamber constructed on a drain or sewer so as to provide access thereto, for inspecting, testing or the clearance and removal of obstructions, and usually situated in areas subjected to light loading only.**

♣ In the case of clayware and plastics inspection chambers the clear opening may be reduced to 430 mm in order to provide proper support for the cover and frame.

♥ A working chamber with cover constructed on a drain or sewer within which a person may inspect, test or clear and remove obstructions in safety.

Ø Minimum ¥ height of chamber in shafted manhole 2 m from crown of pipe to underside of reducing slab.

¥ The term "minimum" as used in this table refers to the smallest acceptable nominal dimension and does not exclude normal negative manufacturing tolerance below the nominal size.

11. SEWERAGE AND SURFACE WATER LIFTING INSTALLATION

Sewage lifting may become necessary where the levels of a building or site make it impracticable to provide a gravity connection to a suitable outfall or where a gravity drain would be subjected to unacceptable surcharge from the sewer. For sewage lifting installations in which the diameter of the delivery main does not exceed 150 mm refer to BS 8301:1985, Section three, but for large installations refer to IPS-E-CE-380.

APPENDICES

APPENDIX A
DRAINAGE OF ROOFS AND PAVED AREAS

A.1 SCOPE

This Appendix-A deals with the drainage of surface water from roofs, walls and paved areas like car park etc. and recommends acceptable methods of designing gutters, gutter outlets, rainwater pipes, and inlets to gullies and discharge stack, providing the climatological conditions of the project site such as the possibilities and frequency of frosting is taken into account by the designer in the choice of the type of the roof and its rainwater (including melted snow) drainage system.

A.2 METEOROLOGICAL ASPECTS OF DESIGN

The capacity of roof and paved area drainage systems should be adequate to dispose of intense seasonal rains that usually occur in thunderstorms. Allowance should be made, where necessary, for the effect on the drainage capacity of wind concurrent with rain.

A.2.1 Design Rates of Rainfall and Categories of Risk

For drainage design of paved areas such as paved roofs,car parks or playgrounds, on which ponding can be tolerated during a heavy storm and for a few minutes after the storm has ceased, except when overflow from them will present undue risk to persons or property a design rate of rainfall of 50 mm/h is recommended.

The probability, Pr, of exceeding the chosen rate of rainfall may be assigned a value between 0.0, representing assured safety, and 1.0, representing certainty that the rate will be exceeded. For values of the return period equal to or greater than 5 years, Pr and T are approximately related by the equation:

$$Pr = 1 - \left(1 - \frac{1}{T}\right) Ly \text{ (for } T \geq 5 \text{ years)}$$

where:

Pr is the probability of exceeding the chosen rate of rainfall;

T is the return period (in years) of the chosen event;

Ly is the anticipated life of the building or the period for which the contents need to be protected (in years),whichever is being used as the drainage design criterion.

For a given return period, the maximum rate of run-off will result from a storm whose duration is equal to the time of concentration, which is the minimum time for the whole area of the roof to contribute flow at the point of discharge. A time of concentration of 2 min. is considered typical for many roofs.

The designer should choose the rate of rainfall that at the chosen location has a return period equal to or greater than the recommended return period. For more design guidances refer to BS 6367:1983.

A.2.2 Wind

The recorded rates of rainfall on rain gages take no account of the driving effect of wind concurrent with the rain. Allowance for the effect of the wind is not required when designing drainage for horizontal surfaces, or for other surfaces protected from the wind by nearby objects, but such an allowance should be considered where sloping or vertical surfaces occur that are freely exposed to the wind. The angle of descent of wind-driven rain can safely be taken to be 26 to the vertical.

For method of determining the effect of wind on the run-off from pitched roofs and vertical surfaces refer to BS 6367:1983.

A.2.3 Snowfall

Although precautions are often required to prevent undue accumulation of snow on roofs, it is not necessary to allow for the removal of melted snow in sizing gutters and rainwater pipes as the maximum run-off resulting is less than the minimum recommended design rate of rainfall. Gutters and outlets may, however, become blocked by frozen snow but this can be avoided by the use of snowboards, the openings of which may be bridged by snow during heavy falls.

Snowguards may be fitted to the eaves of a pitched roof where sliding snow may cause damage to persons or structures below. Depending on what is at risk snowguards may be required for roof pitches up to 60 from the horizontal and need not be higher than 300 mm for most situations. The fixings should be strong enough to withstand a force per unit length Fs given by the equation:

$$F_s = kW \tan \alpha$$

Where:

Fs	is the horizontal force (in N) per meter length of snowguard acting half-way up the snowguard;
k	is the vertical pressure (in N/m2) exerted by an exceptional snowfall;
W	is the plan width (in m) of the roof perpendicular to the eaves;
α	is the slope of the roof from the horizontal.

Typical values of k are:

highlands with heavy snowfall	: 2000 N/m^2
humid coast* of caspian sea	: 1500 N/m^2
midlands	: 1000 N/m^2
lowlands	: 500 N/m^2

*** Shore lands of Caspian sea with return period of 50 years have seen snowfalls of 2 meters height.**

A.2.4 Thermal Movement for Gutters and Rainwater Pipes

Supports and fixings to gutters and rainwater pipes should allow thermal movement to take place without leakage and, in addition, expansion joints may be necessary. The spacing of expansion joints depends upon the flexibility of the jointing material used, the method of jointing and supporting, and the coefficient of expansion of the material of which the gutter is made. For further design guidances refer to BS 6367:1983.

A.2.5 Effective Catchment Area of Run-off

The effective catchment area of a sloping or vertical surface depends upon the angle of descent of the rain. It may normally be assumed for purposes of design that the rain falls at an angle of one unit horizontal to two units vertical (26° to the vertical), and that its direction is such as to produce the maximum rate of run-off to each length of gutter.

A.2.5.1 Flat roofs and paved areas

The effective catchment area, Ae, of a freely exposed horizontal surface is equal to the plan area of the surface (see Fig. 4 (a)). Where sloping or vertical surfaces drain to a flat roof or paved area, the additional area of catchment should be calculated as described in A.2.5.2 and A.2.5.3.

A.2.5.2 Sloping roofs

The effective catchment area, Ae, of a freely exposed roof draining to an eaves or parapet wall gutter is equal to the plan area of the roof, plus half its maximum area in elevation (see Fig. 4(b)).

In a valley gutter, one side of the roof will tend to be exposed to the wind and the other side will tend to be sheltered; the method of calculating the effective catchment area is illustrated in Fig. 4(c).

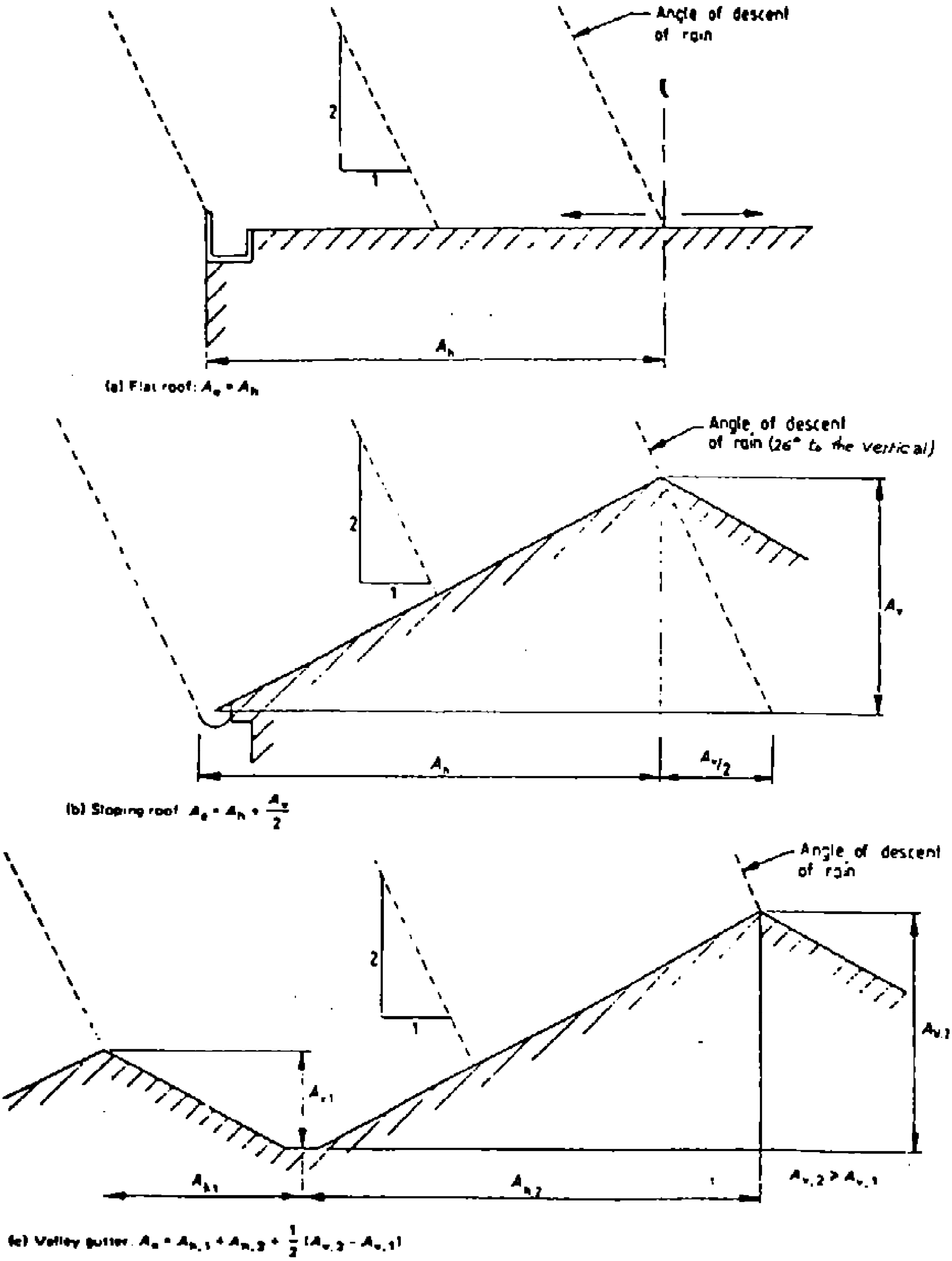
Run-off from any vertical walls should be allowed for (see A.2.5.3).

A.2.5.3 Vertical surfaces

Wind-driven rain will cause run-off from walls and other vertical surfaces that are freely exposed to the wind to reach a paved area. Such run-off from vertical surfaces will only need to be considered where flooding of the paved area cannot be tolerated.

Although not all the rain approaching a wall will reach a paved area however.

In designing wall-drainage the total rain approaching the wall may be used, bearing in mind that the resulting figure will normally have a large margin of safety. For the method of calculating Ae see the illustration in Fig. 5.



CALCULATION OF EFFECTIVE CATCHMENT AREA, Ae, FOR ROOFS

Fig. 4

A.2.6 Rate of Run-Off

Run-off from roofs, paved areas and vertical surfaces should be calculated assuming that the surfaces are impermeable. The rate of run-off, Q (in L/s), is given by the equation:

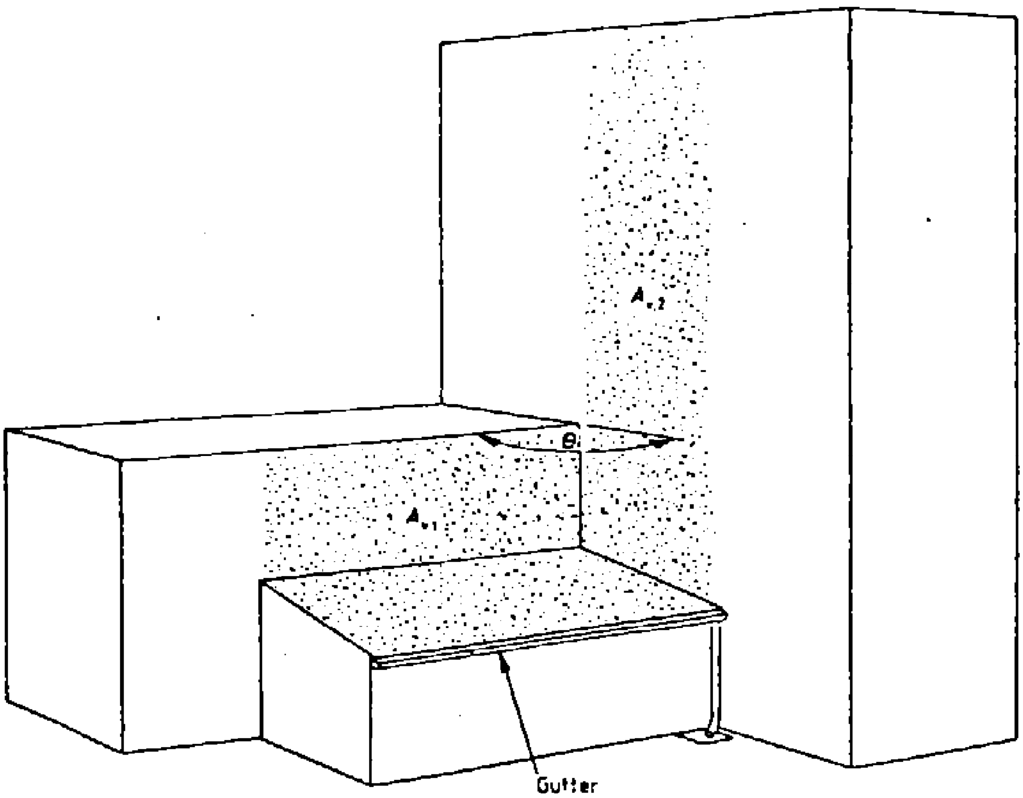
$$Q = \frac{Ae\ l}{3600}$$

Where:

Ae is the effective catchment area (in m^2) (see Clause A.2.5);

l is the design rate of rainfall (in mm/h) (see Clause A.2.1).

Any run-off occurring from unpaved areas, should be prevented from draining on to paved areas.



$$A_e = \frac{1}{2}\sqrt{(A_{v,1}^2 + A_{v,2}^2 - 2A_{v,1} \cdot A_{v,2} \cos\theta)}$$

where $A_{v,1}$ and $A_{v,2}$ are areas of the vertical walls, as shown, contributing to the flow of the gutter.

CALCULATION OF EFFECTIVE CATCHMENT AREA, Ae, FOR VERTICAL SURFACES
Fig. 5

A.3 HYDRAULIC DESIGN OF ROOF DRAINAGE

A.3.1 General Principles

A roof drainage system, whether flat or pitched generally comprises of three parts:

a) the gutter or channel that collects the flow from the roof;
b) the outlet into which the flow from the gutter or channel discharges;
c) the pipework that conveys the flow from the outlet to the below-ground drainage system.

Note:

In the design practice of flat roof drainage systems, adoption of gutter can be omitted for catchment areas of up to approximately 1000 m^2, by provision of more outlets and rain water down-pipes that are installed inside the building perimeter.

The three parts of the drainage system can be designed separately if the outlet and the pipework are made large enough for the flow to discharge freely from the gutter.

Gutters and downpipes may be omitted from a roof at any height provided that it has an area of 6 m^2 or less and provided that no roof or other surface drains on to it.

A.3.2 Method of Design of Gutters

The method of design adopted in this Standard is based on the following assumptions:

a) the gutter slope is not steeper than 1 in 350 (i.e. it is nominally level);
b) the gutter has a uniform cross-sectional shape;
c) the outlets are large enough to allow the gutter to discharge freely;
d) the distance between a stop end and an outlet is less than 50 times the upstream water depth, or the distance between two outlets is less than 100 times the water depth.

Eaves gutters should wherever possible be designed to discharge freely. For the method of calculation of flow in gutters and its other design aspects refer to BS 6367:1983.

A.3.3 Rainwater Pipes

The vertical rainwater pipes for standard eaves gutters or valley and parapet wall gutters, should have the same nominal bore as the gutter outlets to which they are connected. The horizontal lengths of rainwater pipe should where possible be given a small fall to prevent the ponding of water. Long runs of pipework need to be designed according to standard hydraulics principles for steady flow in pipes. For further details refer to BS 6367:1983.

A.3.3.1 Warming of rainwater pipes

Where the temperature of the air falls and remains below zero for appreciable times during winter season, it is recommended to warm-up the rainwater pipes and gutters by circulating hot air along its length and or to run hot water return pipes adjacent to rainwater pipes to avoid frosting and blockage of rainwater drainage system.

Note:

As far as possible use of exposed rain water down pipes should be avoided in such areas.

A.3.4 Flat Roofs

A.3.4.1 General

For the purposes of this Standard, a flat roof is defined as one having a pitch of 10 or less to the horizontal. Flat roofs should be so designed that pools of water do not remain on the roof after rainstorms.

A.3.4.2 Layout of roof

Flat roofs may be drained in two ways:

a) Towards the outer edges of the roof with falls provided by the construction of the roof.
b) Towards channels or towards several outlets within the perimeter of the roof with falls provided by screeding.

Falls are required in both cases, and minimum values should not be less than 1 in 70 in the case of (a) and 1 in 80 in the case of (b).

A.3.4.3 Location of outlets

The location of outlets of rainwater in flat roofs, preferably should be at the sunny side in order to avoid frosting of melted snow at the mouth of outlets.

In general an economic scheme will include few outlets, but the number needed may often be determined by the plan shape of the roof rather than by the area to be drained.

A.3.4.4 Rate of run-off

If recorded rainfall intensities are not available, the recommended design rate of rainfall for such a roof is 75 mm/h, but adoption of higher rates may be required by owner if it is necessary to reduce the risk of flooding in very sensitive buildings.

The design rate of run-off from a roof should be calculated assuming that the roof is impermeable .

Allowance should be made for water that drains from adjacent roofs and vertical surfaces.

A.3.4.5 Discharge at edge of roof

Run-off from a flat roof may be discharged into:

a) An eaves gutter (see Fig. 6 (a)).
b) A chute connected to a hopper head (see Fig. 6 (b)).

The eaves gutter should be designed according to the method described in A.3.2. The entrance to a chute acts as a weir and the width that is required can be estimated from Table 6.

TABLE 6 - CAPACITY OF OUTLET WEIRS FOR FLAT ROOFS

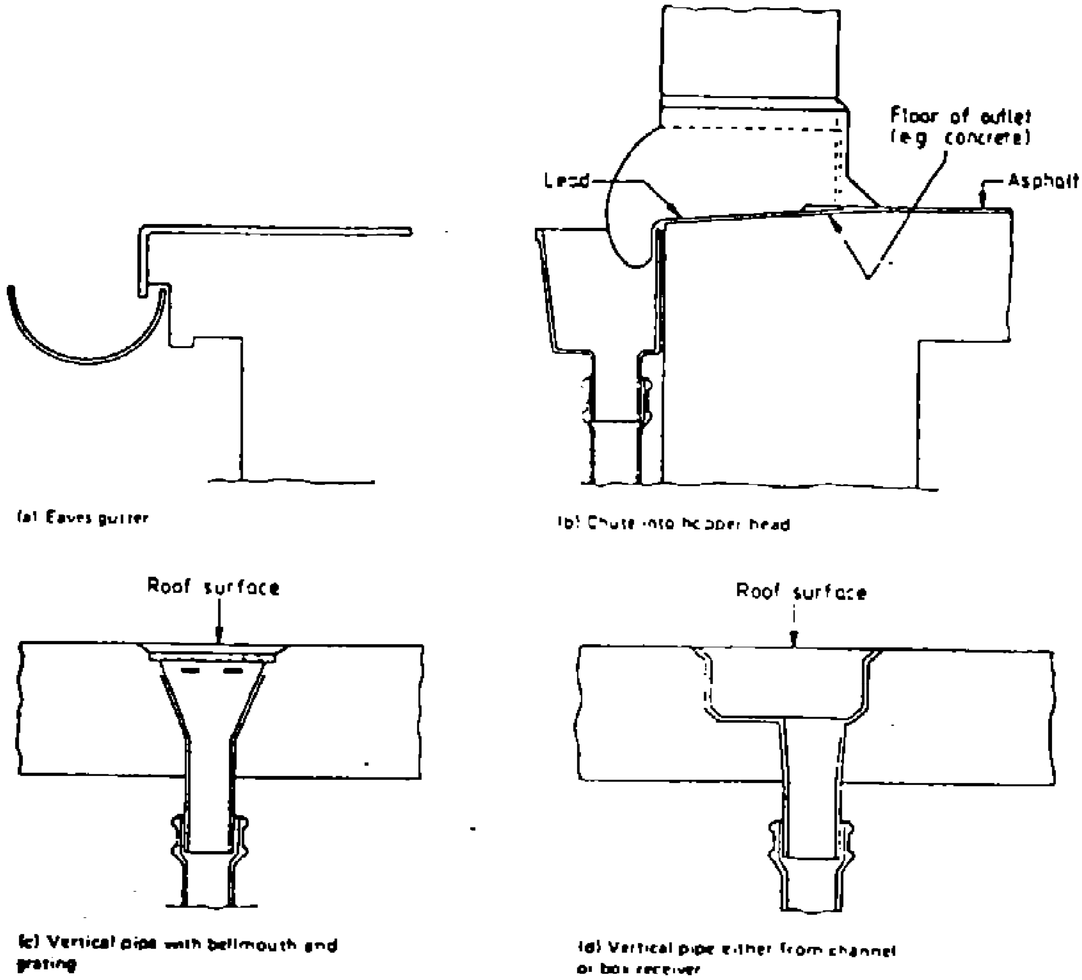
DEPTH OF FLOW ABOVE INVERT OF WEIR	DISCHARGE PER MILLIMETER LENGTH OF WEIR Qx	AREA DRAINED PER MILLIMETER LENGTH OF WEIR AT DESIGN RATE OF RAINFALL OF 75 mm/h
mm	L/s	m^2
5	4.66×10^{-4}	2.24×10^{-2}
10	1.32×10^{-3}	6.32×10^{-2}
15	2.42×10^{-3}	11.6×10^{-2}
20	3.73×10^{-3}	17.9×10^{-2}
25	5.21×10^{-3}	25.0×10^{-2}
30	6.85×10^{-3}	32.9×10^{-2}

A.3.4.6 Discharge within perimeter of roof

Run-off from a flat roof may discharge to:

a) a channel formed within or by the roof (see Fig. 6 (d));
b) a sump containing an outlet;
c) an outlet draining the roof directly (see Fig. 6 (c)).

Roof channels and their outlets should be designed in the same way as valley gutters. Sumps and roof outlets normally act as weirs, and should be sized so as to limit the depth of water on the roof to 30 mm or less. The depth of a sump is determined by the capacity of the outlet that drains it, and should be not less than h+25 mm where h is the depth of water above the outlet. Design procedures for sumps and roof outlets are given in BS 6367:1983.



DRAINAGE FROM FLAT ROOFS: TYPES OF OUTLET
Fig. 6

A.3.4.7 Design of roof outlets

Some types of outlets that are suitable for asphalt roofs are illustrated in related IPS-D-CE-217. Approximate areas that can be drained by these outlets at a rainfall intensity of 75 mm/h are given in Table 7.

TABLE 7 - ESTIMATED CAPACITIES OF OUTLETS FOR FLAT ROOFS

OUTLET TYPE	TABLE IN BS 416 : 1973	PIPE SIZE	AREA DRAINED AT RAINFALL INTENSITY OF 75 mm/h AT DEPTH OF WATER ABOVE OUTLET:					
			5 mm	10 mm	15 mm	20 mm	25 mm	30 mm
		mm	m^2	m^2	m^2	m^2	m^2	m^2
Square flat grating	17 A	100	17	49	90	135	190	250
Circular flat grating	17 B	50, 65	4.5	12	23	36	51	67
	17 B	75, 90, 100	9.6	27	50	77	105	140
Circular flat grating with	17 D	50	4.5	12	23	36	51	67
horizontal pipe	17 D	75, 100	7.1	20	37	57	80	105

A.4 DRAINAGE OF PAVED AREAS

A.4.1 Layout of Drainage System

For design of drainage system consisting of series of channels that collect the run-off from the paved area and the gullies situated at intermediate points along the channels and at their downstream ends that convey the flow to the below-ground drainage system, refer to Clause 9 of BS 6367:1983.

A.4.2 Gradients

Gradients should be designed to permit quick drainage to collecting channels or gullies. Recommended gradient limits are given in Table 8.

TABLE 8 - TYPICAL GRADIENT LIMITS FOR PAVED AREAS

DRAINED AREA	GRADIENTS		
	ACCESS ROADS	PAVED AREAS	FOOTPATHS
Longitudinal gradient or fall	1 in 15 max.*	—	—
Crossfall or average camber	1 in 40 normal	1 in 60 min.	1 in 30 max. 1 in 30 min.
Kerb channels (no channel blocks)	1 in 150 min.	1 in 150 min.	—
Kerb channels (with channel blocks or high class surfacing)	1 in 200 min.	1 in 200 min.	—
Super elevation: road curves not exceeding 100 m radius	1 in 25 max.	—	—

*** The first 10 m of an access road from its junction with a major road or public highway should have a gradient of not more than 1 in 30.**

A.4.3 Hydraulic Design

For hydraulic design of collecting channels, intermediate and terminal gullies of paved areas, refer to Clause 9.4 of BS 6367:1983.

Note:

For hydraulic design of surface water drainage in catchment areas refer to IPS-E-CE-380.

PART TWO
SANITARY PIPEWORK

1. SCOPE

This Part of the Standard gives guidance for the design of above ground non-pressure sanitary pipework for domestic, commercial and public buildings. The term "above ground" includes all such pipework within or on the building including any basement (s), but excluding any pipework which has entered the ground, either externally or as the result of penetrating the lowest floor level or an outer wall of the building.

2. REFERENCES

In this Part of the Standard the following standards and/or publications are referred to and to the extent specified from a part of this Standard:

BSI (BRITISH STANDARDS INSTITUTION)

BS 5572:1978 "Sanitary Pipework"

MHUD (MINISTRY OF HOUSING AND URBAN DEVELOPMENT)

Research Center "Plumbing Systems in Building"
Report No. 122:1992

3. DEFINITIONS AND TERMINOLOGY

The following definitions together with definitions of Part One apply:

3.1 Criterion of Satisfactory Service

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

3.2 Crown of Trap

The topmost point of the inside of a trap outlet.

3.3 Depth of Water Seal

The depth of water which would have to be removed from a fully charged trap before air could pass freely through the trap.

3.4 Ventilating Pipe

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

3.5 Ventilating Pipes and Stacks

a) Single stack system

System in which a single stack or a number of discharge stacks is extended to the atmosphere.

b) Ventilated stack system

- Ventilated stack

Discharge stack that is vented by a ventilating stack cross-connected to the discharge stack in each storey.

- Branch ventilating pipes

Ventilating pipes that vent the branch discharge pipes and connect to ventilating stack or are extended to the atmosphere.

- Relief venting

Venting of a branch or bypass pipe by connecting it to the associated stack or to a vented building drain.

- Secondary venting

Additional venting of each branch pipe by connecting its trap to a separate ventilation system.

3.6 Frost-free Depth

The frost-free depth is a variable based on the local climatic conditions and is specified as the distance between ground level and the water level in the trap or the soffit of the building drain.

3.7 Access Cover

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

3.8 Branch Discharge Pipe

A discharge pipe connecting sanitary appliances to a discharge stack.

3.9 Discharge Pipe

A pipe which conveys the discharges from sanitary appliances.

3.10 Trap

A fitting or part of an appliance or pipe arranged to retain water or fluid so as to prevent the passage of foul air.

3.11 Stack

A main vertical discharge or ventilating pipe.

4. PERFORMANCE CRITERIA

4.1 Discharge

Requirements for the discharge rates from appliances should be a primary consideration of the designer. Typical discharge rates are listed in Table 3 of Part one. 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. A value of 99% is recommended as a minimum criterior of satisfactory service for such calculations.

4.2 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, after possible loss due to evaporation and pressure fluctuations, to prevent foul air from the discharge pipe system or drain from entering the building.

For WCs there should be sufficient trap water for the containment of excreta. In this Standard trap seal depths of 75 mm are recommended for traps with diameters of up to and including 50 mm and for traps with diameters larger than 50 mm, trap seal depths of 50 mm can be acceptable. Additional information on trap performance is given in Table 9. Pressure fluctuations should be limited in order to retain these water seals and thereby prevent foul air from entering the building. The discharge pipe systems should be so designed that positive and negative pressures do not exceed 38 mm water gage and that at least 25 mm of water seal is retained in the traps. These limitations are based on the worst likely discharge conditions.

Note:

For some situations where the pressure and loss criteria are likely to be exceeded resealing traps are given as a design solution.

TABLE 9 - TRAP PERFORMANCE DATA

TYPICAL SEAL LOSS (due to negative pressure (suction) of 375 N/m^2 (38 mm water gage) in discharge system)		TYPICAL EVAPORATION LOSS	
Trap details	Approximate seal loss	Trap detail	Accepted average figure per week
Typical washdown WC, 50 mm seal depth	25 mm	Small and large bore traps	2.5 mm
Small diameter tubular trap, 75 mm seal depth	19 mm		

4.3 Limitation of Noise

The discharge from sanitary appliances and pressure fluctuations in the pipework causing seal loss, are important sources of noise . The pipework designed to limit pressure fluctuations, as per Clause 4.2 will tend to be quiet. Another source of noise is the flow of water in discharge branches and stacks. This can be reduced by sound insulation of the pipework from the structure and of the containing ductwork.

4.4 Hydraulics and Pneumatics of Discharge Systems

The sanitary discharge systems comprising of branch discharge pipes,discharge stacks and the ventilated stack system should be designed as per design guidances and properly executed in accordance with standard drawings referred in Clauses 5 and 6.

4.5 Classification of Discharge Systems

The discharge systems in this Standard is classified as follows and adoption of any one of them depending on particular arrangement of sanitary appliances is acceptable. See Std. Drg. No. IPS-D-CE-500.

a) Ventilated system

A ventilated system can be used in situations where there are large numbers of sanitary appliances in ranges or where 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 for each and all appliances.

b) Ventilated stack system

The ventilated stack system can be 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

The single stack system can be used in situations as described in (b) but only where the discharge stack is large enough to limit pressure fluctuations without the need for a ventilating stack.

5. DESIGN OF SANITARY PIPEWORK

5.1 General

In this Standard design guidances are given for the domestic and non-domestic buildings:

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

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

5.2 Traps (See Fig. 7)

5.2.1 General

A trap which is not an integral part of an appliance should be attached to, and be immediately beneath its outlets and be self-cleansing. The internal surface of the trap should be smooth throughout.

All traps should be accessible and capable of being readily removed or dismantled.

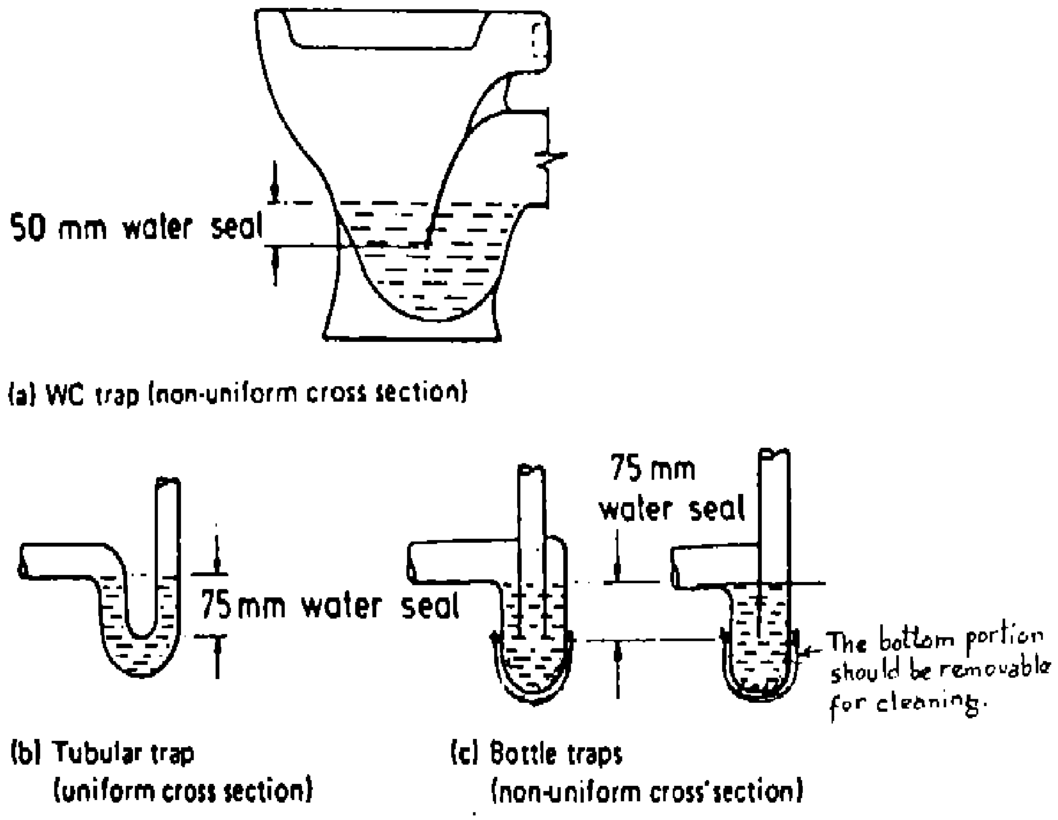
5.2.2 Depth of seals

a) Traps with outlets for pipes up to and including 50 mm size should have a minimum water seal of 75 mm (see Clause 4.2).

b) Traps with outlets for pipes over 50 mm size should have a minimum water seal of 50 mm (see Clause 4.2).

5.2.3 Diameters of tubular traps

The size of tubular traps should be not less than those given in Table (10).



TRAP TYPES (DIAGRAMMATIC)
Fig. 7

TABLE 10 - MINIMUM SIZES OF TUBULAR TRAPS

TYPE OF APPLIANCE	SIZE OF TRAP, mm	TYPE OF APPLIANCE	SIZE OF TRAP, mm
Wash basin	32	Drinking fountain	32
Bidet	32	Barwell-Beverages	32
Sink	40	Hotel or restaurant kitchen sink	40
Bath	40	Urinal (bowl)	40
Shower bath tray	40	Urinal (stall, 1 TO 6)*	65
Wash tub	50	Food-Waste disposal unit (industrial type)	50
Food-Waste disposal unit (domestic)	40	Sanitary towel macerator	40

*** Where there are more than six stalls in one range, more than one outlet should be provided.**

5.2.4 Bottle traps

This type of trap in which the division between the inlet and outlet legs is formed by a dip tube or vane within the body of the trap , should meet the requirements of 5.2.1 and 5.2.2. The size of inlet and outlet should be as given in 5.2.3 and there should be no reduction in flow area through the trap. This type of bottle traps are often used in conjunction with wash basins where the trap is exposed, or where there may be difficulty in fitting a tubular trap.

5.2.5 Resealing traps

These are specially designed traps for unventilated small size discharge pipes fitted to appliances where, because of the arrangement of the pipework, siphonage would otherwise occur.

5.2.6 Floor drainage gullies

Trapped floor drainage gullies are normally connected to branch pipes of 75 mm size or larger and are therefore not subject to seal loss due to self-siphonage. Infrequent use can however lead to total loss of seal due to evaporation. consequently, these traps should only be specified for areas where the usage will ensure that the trap seal is maintained (Clause 4.2).

5.3 Discharge Pipes and Stacks

5.3.1 General

Because of their different performance characteristics the branch discharge pipes and discharge stacks are dealt with separately.

5.3.2 Branch discharge pipes

5.3.2.1 Diameter

Sizes are given in clauses 6 and 7. Oversizing branch pipes to avoid self-siphonage problems can be uneconomic and can lead to an increased rate of deposit accumulation.

5.3.2.2 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), but flatter gradients down to ½" (9 mm/m), when space is restricted, may be imposed on long runs of pipes with 100 mm and 150 mm diameter. Self-cleansing of pipes laid in flat gradients is only possible with high flow rates (e.g. of not less than 2.5 1/s).

Pipe sizes, gradients and pipe capacities are inter-related as discussed in Clause 6 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 (Clause 4.2 and 4.3).

5.3.2.3 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.

5.3.2.4 Branch pipe bends and junctions

Bends in branch discharge pipes should be avoided, especially for single and 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, see Std. Drg.: IPS-D-CE-503; otherwise 45° branches should be used.

5.3.2.5 Branch pipe connections to discharge stacks

For swept or unswept branch discharge pipe connections to discharge stacks of different permissible sizes and gradients refer to standard drawing No. IPS-D-CE-500, sheet 1 of 2.

5.3.2.6 Prevention of cross flow

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. For restricted and permitted connections refer to Std. Drg. IPS-D-CE-501, sheet 2 of 2.

5.3.2.7 Direct connections to an underground drain

a) Gullies

It is often convenient in low rise houses, bungalows and ground floor flats, to discharge the waste water from some appliances, e.g. baths, wash basins and sinks, into an external gully. The appliances should be fitted with suitable traps and the discharge pipes should terminate below the grating but above the water level in the gully. To avoid self-siphonage of the trap seals and noisy discharges, provision of venting is recommended.

b) 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 (Clause 4.2).

c) Stub stacks

A stub stack consists of a short, straight, 100 mm discharge stack with the top closed, preferably with an access fitting. It can be used for single storey buildings to connect one each of 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 appliances of 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 (Clause 4.2).

Note:

Direct connection to a drain for individual appliances or for stub stacks should only be made when the drain is adequately ventilated to safeguard trap seals.

5.3.3 Discharge stacks

5.3.3.1 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 appliance connection should be continued without any reduction of diameter to the point of termination (see 5.3.3.5).

5.3.3.2 Bends and branches at the base of stacks

For recommended bend connections at the base of a discharge stack refer to Std. Drg. No. IPS-D-CE-503.

5.3.3.3 Offsets (see Std. Drg. IPS-D-CE-501)

Offsets in the wet portion of a discharge stack should be avoided. When they have to be fitted, large radius bends should be used.

5.3.3.4 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. Sizes are given in Clause 6 .

5.3.3.5 Termination of discharge stacks

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. For diagrammatic details refer to Std. Drg. IPS-D-CE--501.

5.4 Ventilating Pipes and Stacks

5.4.1 Branch ventilating pipes (see Std. Drg. IPS-D-CE-502)

5.4.1.1 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 it should be 50 mm, but it can be reduced when above the spill-over level of the appliance.

5.4.1.2 Connections to stacks

For branch discharge pipes requiring relief venting the ventilating pipes can be connected to the ventilation stack in a ventilated system.

5.4.1.3 Connections to discharge pipes

Connections of ventilating pipes to the appliance discharge pipe should normally be as close to the crown of the trap as practicable but within 300 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.

5.4.1.4 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 minimize the risk of internal corrosion.

5.4.2 Ventilating stacks (see Std. Drg. IPS-D-CE-502)

5.4.2.1 Size

Sizes of ventilating stacks are given in Clause 6.3 and Table 11.

5.4.2.2 Connections

In ventilated and ventilated stack systems (Clauses 4.5a 4.5b)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.

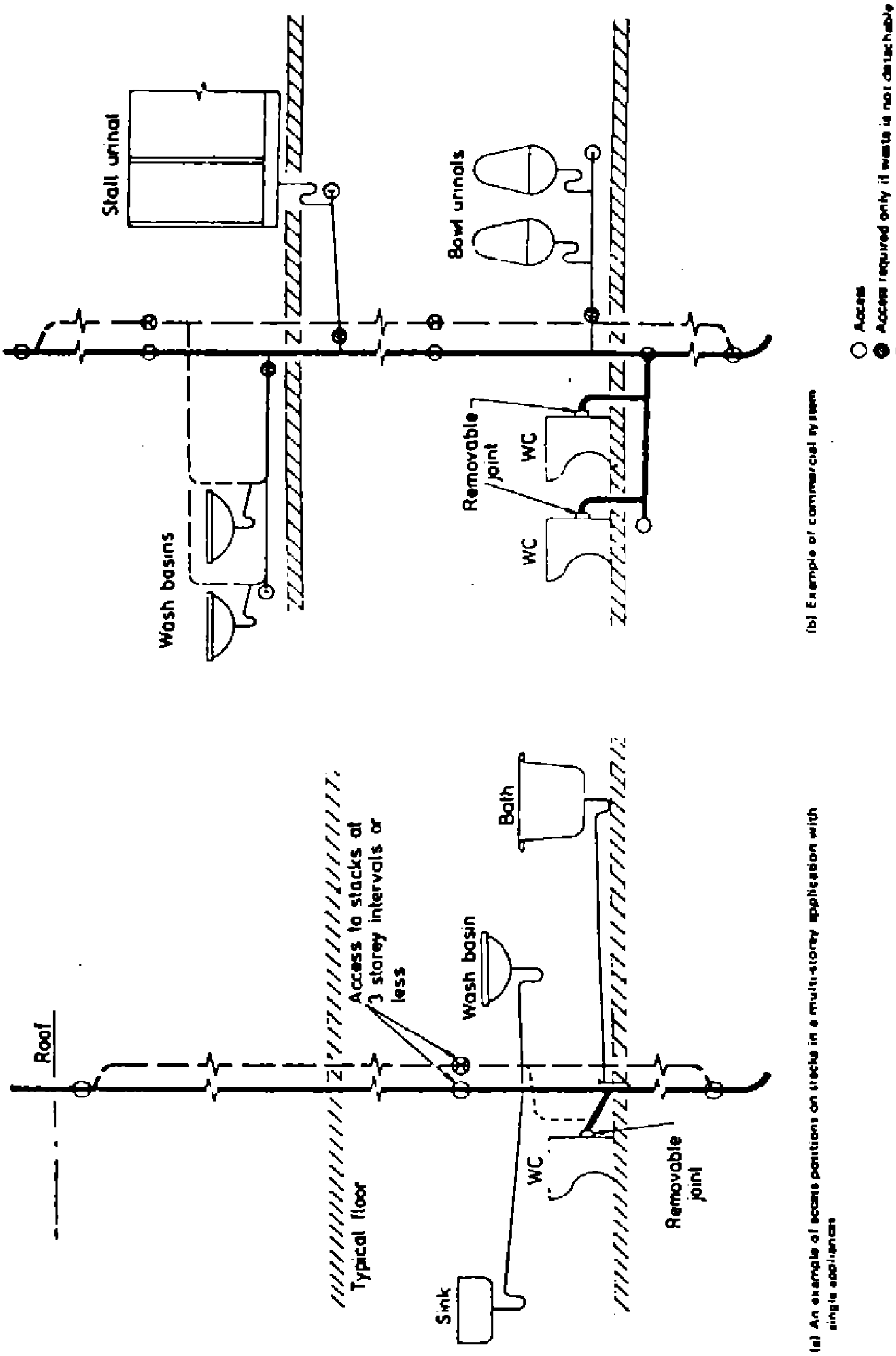
The lowest end of the ventilating stack should normally be connected to the discharge stack at or below the lowest branch connection; the upper end can be connected to the discharge stack above the spillover level of the topmost appliance, or pass through the roof to the atmosphere.

5.4.3 Termination of ventilating pipes and stacks

Ventilating pipe and stack outlets should be positioned as described for discharge pipe outlets (see Sub-Clause 5.3.3.5).
5.5 Access (see Fig. 8)

5.5.1 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.



ACCESS FOR CLEANING AND TESTING PURPOSES (DIAGRAMMATIC)

Fig. 8

5.5.2 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.

For multi-storey domestic buildings, access to the ventilating and discharge stacks should be provided at about 3 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.

5.5.3 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 appliances have been installed .

5.6 Materials

The choice of material depends on the size and function of the pipe- work, the temperature and constituents of the discharge and the ambient conditions including temperature. Other considerations are the weight, physical strength, ease of assembly and maintenance requirements of the pipework.

5.7 Special Design Requirements

5.7.1 Restaurant kitchens

The peak rate of waste discharge normally would occur during washing up periods rather than in food preparation phase. Crockery wash machines vary in size and according to the capacity of the machine may use water from 125 litres/h with a peak flow rate in the order of 80 litres/min to in excess of 600 litres/h with a peak of 180 litres/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 appliances.

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 mandatory.

5.7.2 Specific design requirements

For specific design requirements of sanitary pipework concerning restaurant kitchens and hairdressing salons refer to clause 8.7 of BS 5572:1978.

6. COMMONLY USED PIPEWORK ARRANGEMENTS; LAYOUT AND SIZING DATA

6.1 General

This clause contains data on the sizing of discharge and ventilating pipework and shows commonly used pipework arrangements for buildings within the scope of this Standard. All sizes assume a reasonable degree of maintenance. The information in this clause is based on the design limits given in Clause 4 and in particular on the flow and usage data in Table 3 of Part 1.

For typical examples of pipe sizing procedures refer to Appendix B of BS 5572.

6.2 Commonly Used Arrangements of Branch Discharge Pipes

6.2.1 General

The information given below should be used in conjunction with the figures referred to in the text and the general design recommendations in Clause 5.

6.2.2 Branch discharge pipes to single appliances

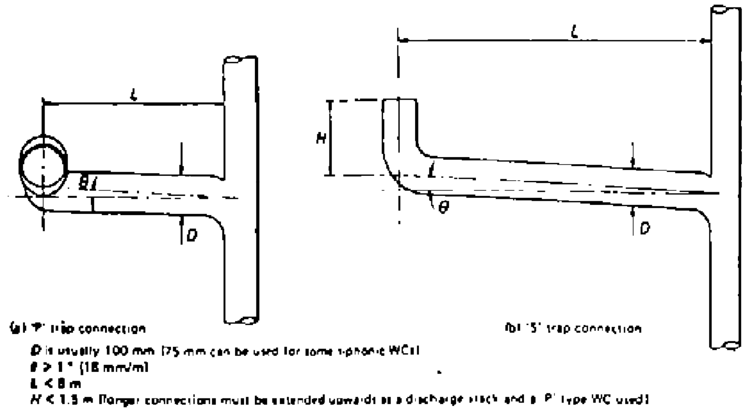
6.2.2.1 Water closets (see Fig. 9)

WC branches of 75 mm or 100 mm size do not normally require venting whatever the length or the number of bends included in the run. Bends, however, should have as large a radius as possible to prevent blockage.

6.2.2.2 Urinal (see Fig. 17 of BS 5572)

The large diameter branch pipes to stall urinals do not require venting. Branch pipes of 40 mm size serving single urinal bowls are unlikely to run full bore but, should siphonage occur, the trail off at the end of the cistern discharge will refill the trap, making venting unnecessary (Clause 4.2).

Because of the build-up of deposits all urinal branches should be as short as possible and should not exceed 3 m.



BRANCH DISCHARGE PIPES FOR SINGLE WCs

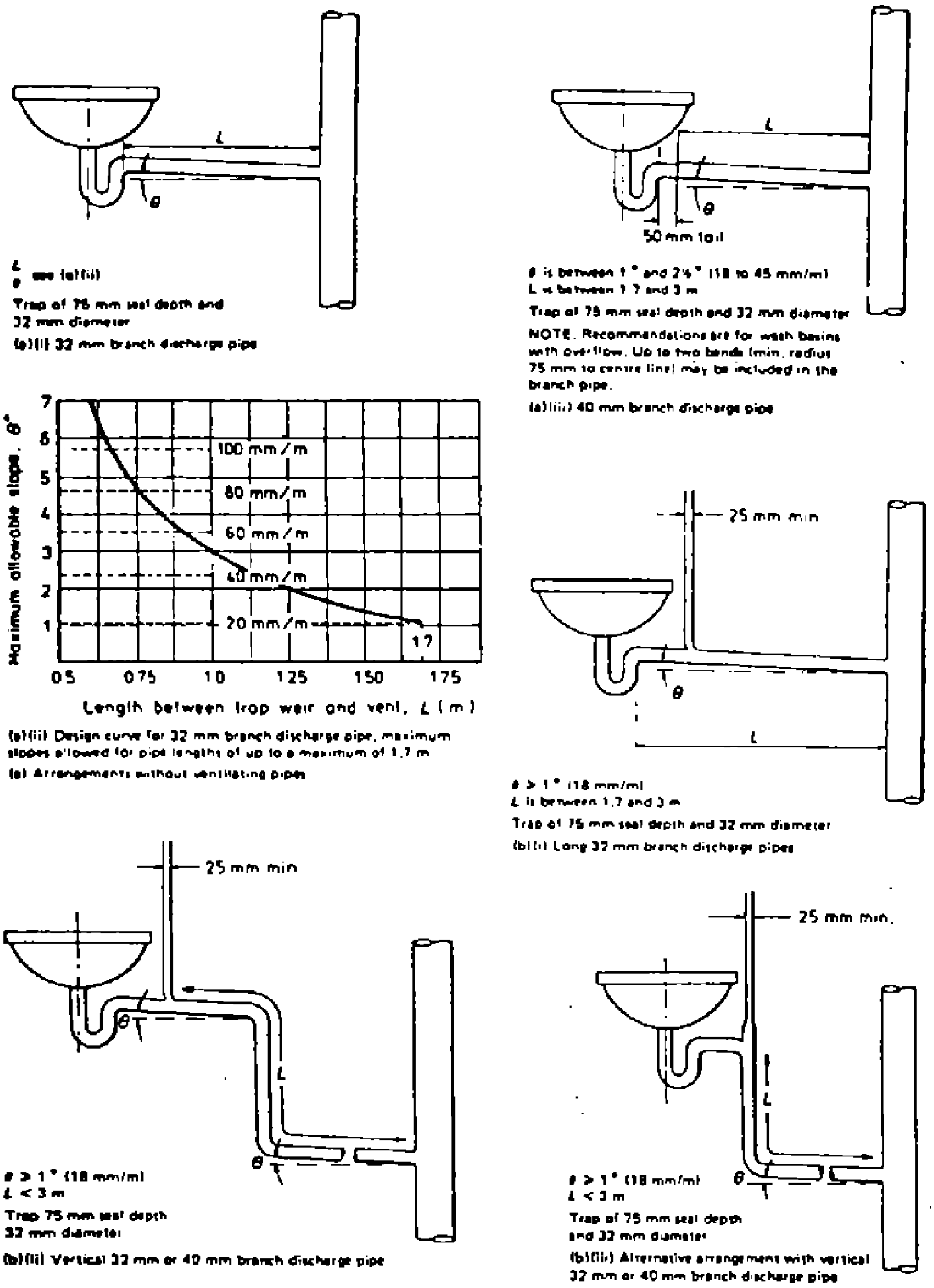
Fig. 9

Note:

Any additional bends should be of large radius and the WC trap should have a 50 mm seal depth (see also Clause 5.3.2.5 for branch connection to stack).

6.2.2.3 Wash basin, with plug waste (see Fig. 10)

Wash basins are normally fitted with 32 mm discharge pipes. The length and slope of the discharge pipes and the number and design of bends, should be strictly controlled if venting is to be avoided. Detailed information is given in Fig. 10(a)(i) and (ii). Arrangements outside these strict design limits should be vented or a larger diameter pipe used (see Fig. 10 (a)(iii) and 10 (b). In situations where it is impracticable to comply with these conditions a suitable resealing trap may be fitted. If a vertical 32 mm discharge pipe is used with a "P" or "S" trap, venting or a resealing trap will probably be necessary.



BRANCH DISCHARGE PIPES FOR SINGLE WASH BASINS
Fig. 10

Notes:

1) Venting also required for more than two bends in the horizontal plane in the branch pipes shown in (a).

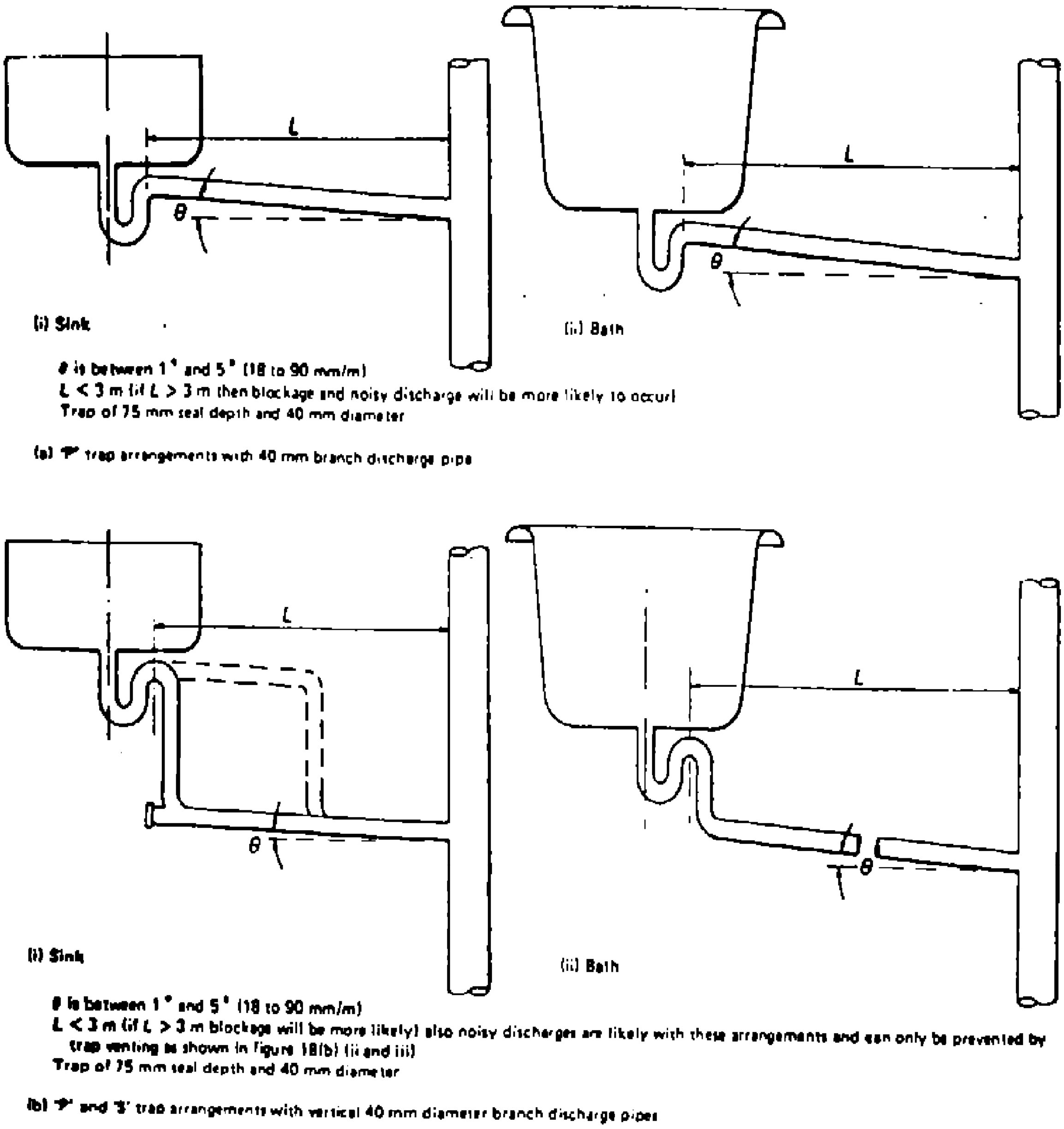
2) In all the arrangements shown in (a) and (b) above the traps may be mounted in a plane at 90 to that shown; for 'P' traps a bend may then be required (75 mm min. radius to center line for arrangements in (a)).

6.2.2.4 Bidets

Branch discharge pipes to bidets should be designed to the recommendations as given for wash basins with plug wastes (sub-Clause 6.2.2.3).

6.2.2.5 Sinks and baths (see Fig. 11)

These appliances are normally fitted with 40 mm discharge pipes. Self-siphonage is not a problem because of the trap seal replenishment which occurs at the end of the discharge due to the flat bottom of the sink or bath. Therefore length and slope of the discharge pipe are not so critical and venting is not normally required although the maximum length should be restricted to 3 m to reduce the likelihood of blockage from deposits.



BRANCH DISCHARGE PIPES FOR SINGLE BATHS AND SINKS
Fig. 11

Note:

Traps may be mounted in a plane at 90° to that shown; for "P" traps a bend (75 mm min. radius to center line) may then be required.

6.2.2.6 Showers

Flow rates from showers are small so that the 40 mm discharge pipe usually fitted does not require venting. However difficulties may arise in achieving a self-cleansing velocity and adequate provision should be made for cleaning (Clause 4.2).

6.2.2.7 Domestic automatic washing machines and dish washing machines (see Fig. 12)

Requirements may vary slightly but the arrangements shown in Fig. 12 should suit most machines. A 40 mm size discharge pipe is necessary, which can be connected either directly to a discharge stack or gully, or to a sink branch pipe. Normally a trap should be fitted in the horizontal section of the discharge pipe but this is not required for connections via a sink branch pipe, when made at the inlet of a sink trap using a suitable fitting (Clause 4.2).

Note:

Some of the arrangements in Fig. 12 show loose connections between the machine drain hose and discharge pipe. Some machines require this air break to prevent siphonage of water from the machine during operation. However, if the discharge pipe develops a blockage, water will overflow during the emptying cycle. This can also occur with the method in which the sink discharge pipe is used. The vented arrangement for machines in dwellings not exceeding four storeys avoids this disadvantage.

6.2.2.8 Floor drainage gullies

Branch pipes to floor drainage gullies are normally 75 mm size or larger and do not generally run full. Consequently, venting is not normally required and the slope and length of the branch is not critical (Clause 4.2).

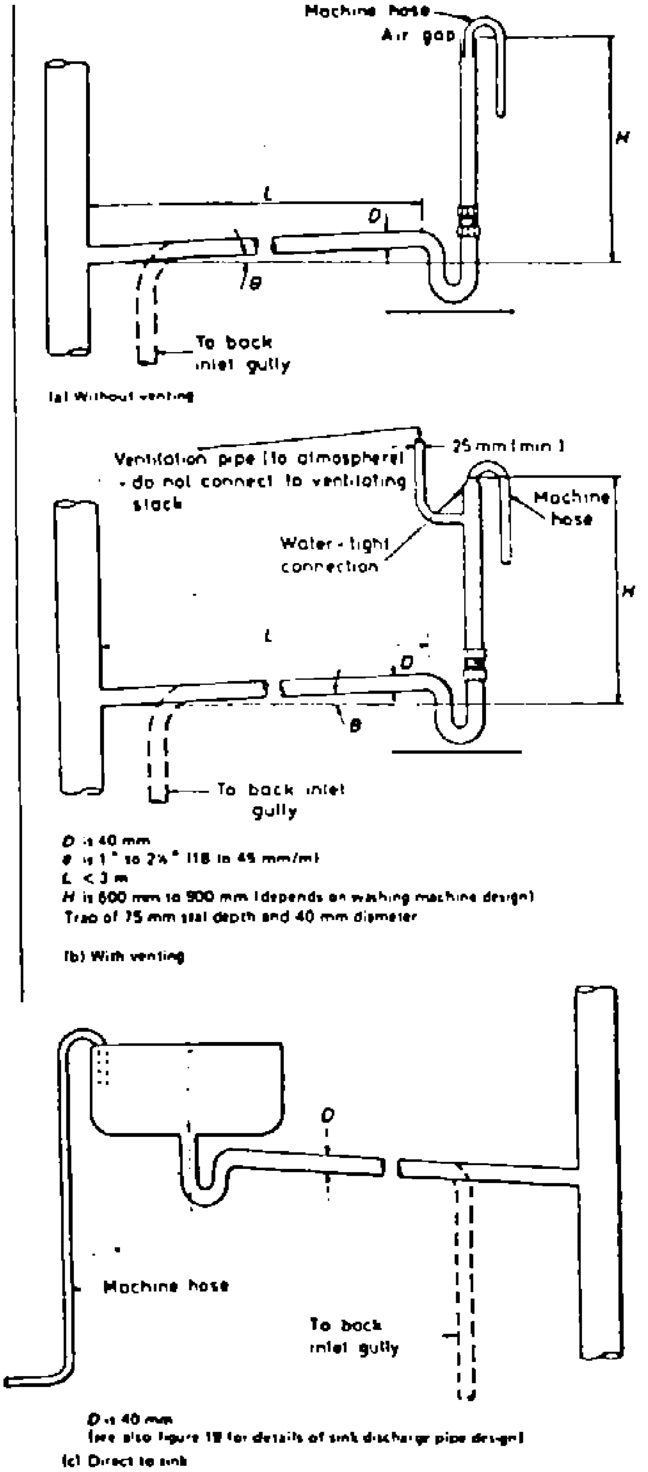
6.2.3 Branch discharge pipes to ranges of appliances

6.2.3.1 Ranges of WCs (see Std. Drg. IPS-D-CE-503)

Branch pipes serving ranges of WCs are normally 100 mm size and there is usually no need for branch venting. Length and slope are not critical but venting may be necessary where there are several bends in the branch pipe or more than eight WCs are connected (Clause 4.2).

6.2.3.2 Ranges of urinals (see Fig. 23 of BS 5572)

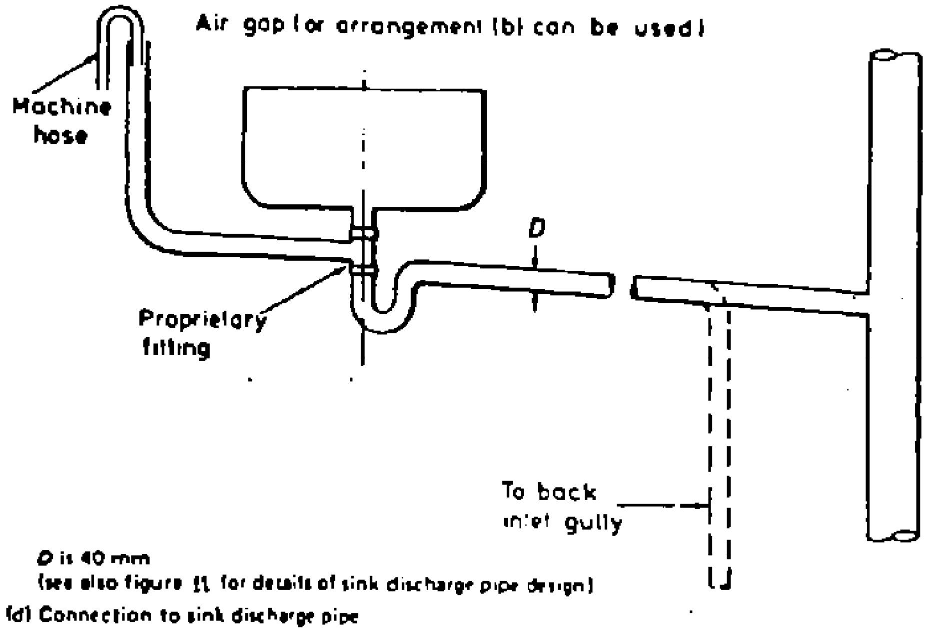
Because of the large size main branch pipes (50 mm to 75 mm) normally used with ranges of stall and bowl urinals, no venting is needed. However, the 40 mm branch joining a bowl urinal to the main branch pipe (50 mm size min.) should be kept as short as possible (Clause 4.2).

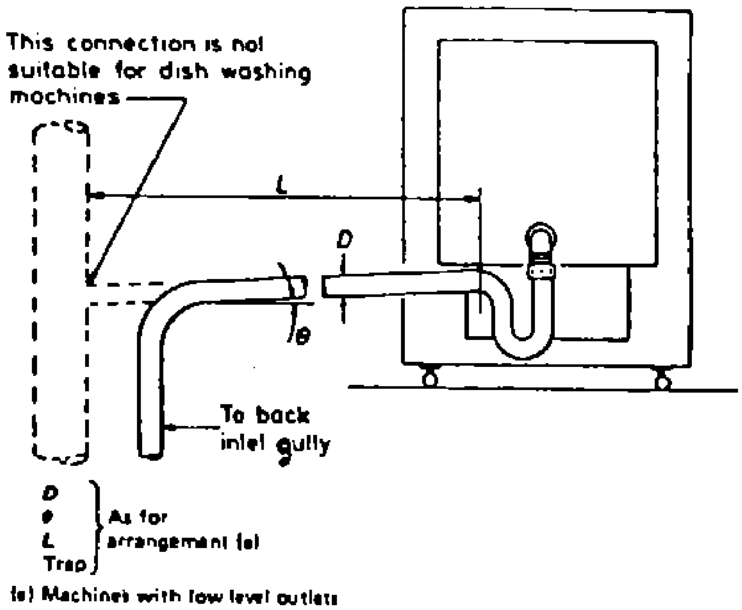


BRANCH DISCHARGE PIPES FOR WASHING AND DISH WASHING MACHINES
Fig. 12

(to be continued)

(continued)





BRANCH DISCHARGE PIPES FOR WASHING AND DISH WASHING MACHINES (concluded)
Fig. 12

Note:

In arrangement (a), blockage in branch or trap will cause overflow through air gap. In arrangement (b) blockage in branch or trap will cause water to be discharged through the ventilating pipe. Hence terminate ventilating pipe outside building or over another appliance. In arrangement (d), blockage in branch or trap will cause machine water to back up into the sink.

6.2.3.3 Ranges of wash basins

Venting is often needed with ranges of wash basins but some arrangements requiring no venting are also shown in the Std. Drg. IPS-D-CE-503.

6.3 Commonly Used Arrangements of Discharge Stacks and Branches

6.3.1 Stack sizing table

Table 11 gives sizes of discharge and ventilating pipes and stacks for various appliance arrangements. These arrangements,lettered from A to E, are shown in Fig. 13.

Note:

The ventilation stack requirements are affected not only by the number of appliances but sometimes also by the branch pipe design detail (e.g. whether 'S' or 'P' traps are used).

6.3.1.1 Assumptions

The following assumptions apply together with those given in 6.1 and 6.2.1:

a) A criterion of satisfactory service of 99 %;

b) there are no offsets in the discharge stack below the topmost appliance connection and the stack is truly vertical; the additional ventilating pipework needed with offsets is given in Clause 6.3.2;

c) WCs with 9 litres cisterns are used;

d) the drain serving the base of the stack is not likely to be surcharged and an intercepting trap is not fitted;

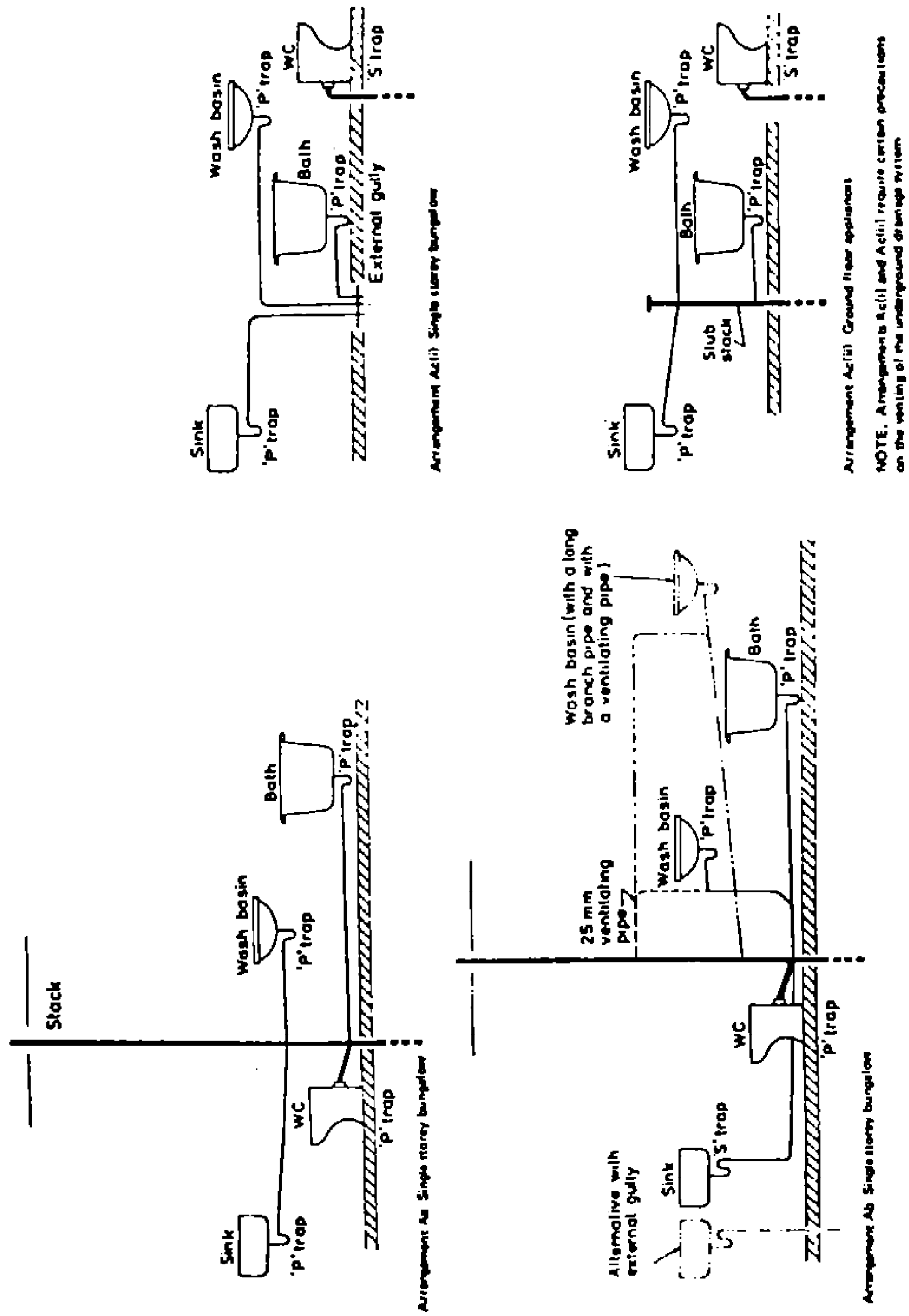
e) the branch discharge pipe sizes are as given in Clause 6.2.

A 'Group of appliances' is as follows:

1) In a domestic building, one WC, one wash basin,
one sink and one bath (and/or shower);
also one washing machine in buildings up to three floors;

2) in a hall of residence, one WC, one wash basin and one shower;

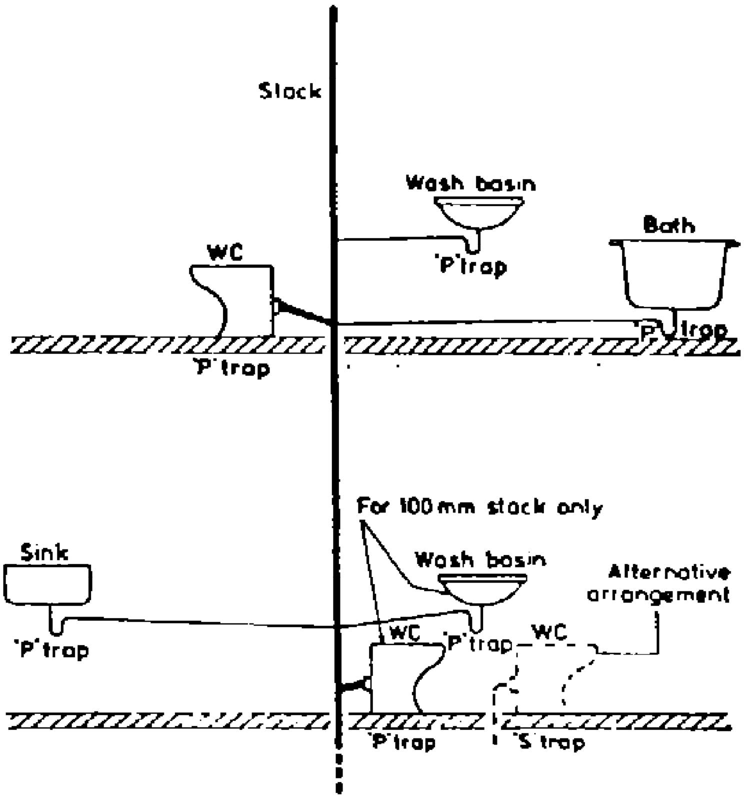
3) in a commercial building, one WC, one wash basin (see conversion table for urinals).



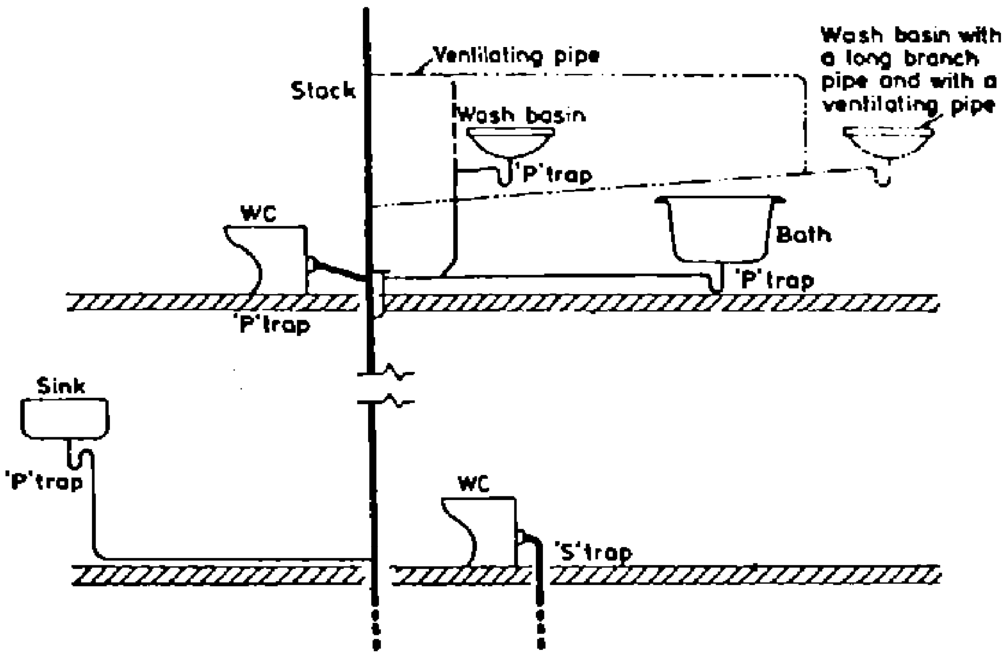
COMMON ARRANGEMENTS OF DISCHARGE STACKS AND BRANCHES (DIAGRAMMATIC)
Fig. 13

(to be continued)

(continuation)



Arrangement 8a

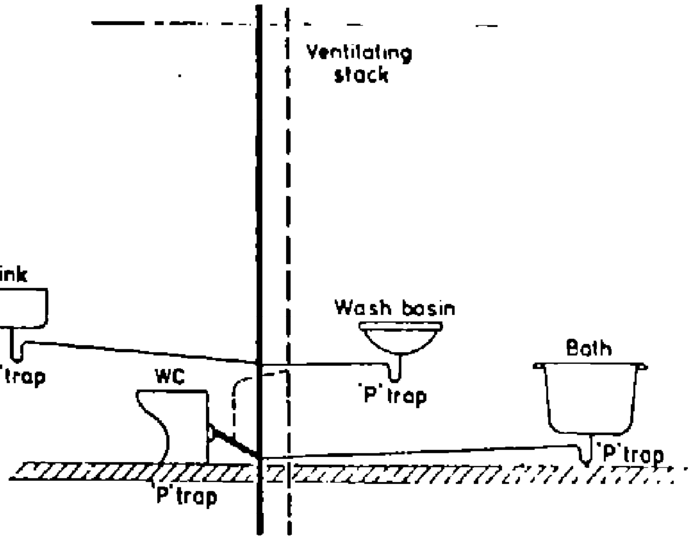


Arrangement 8b

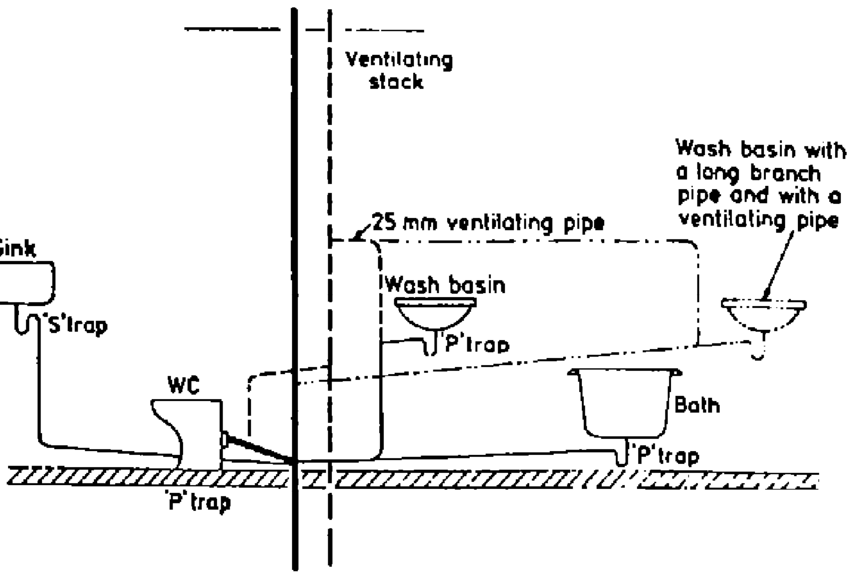
Fig. 13

(to be continued)

(continuation)



Arrangement Ca



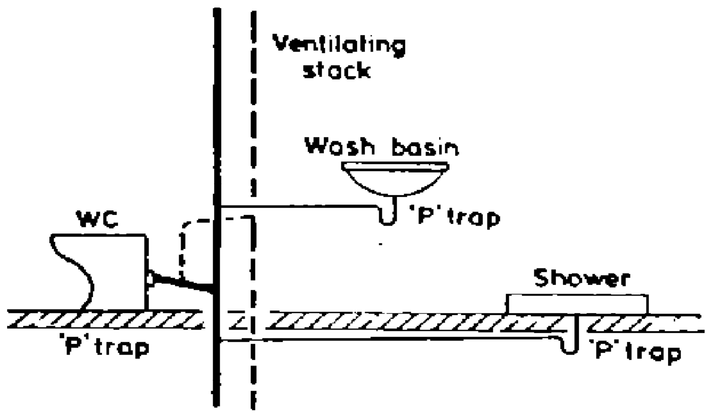
Arrangement Cb

Multi-storey flats

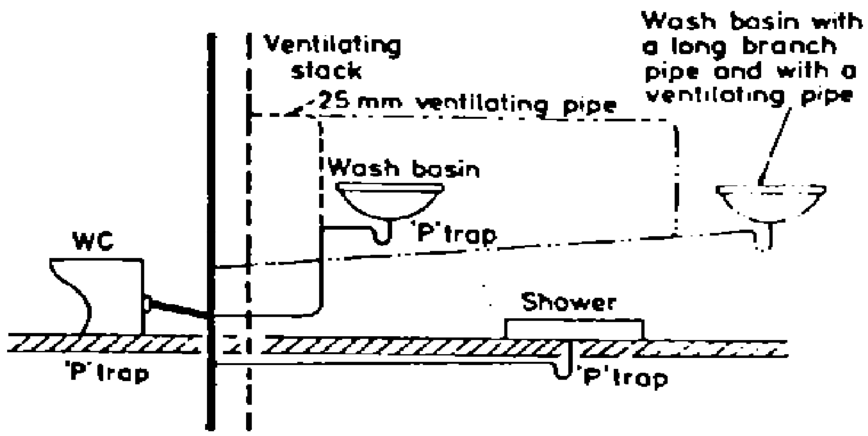
Fig. 13

(to be continued)

(continuation)



Arrangement Da



Arrangement Db

Multi-storey halls of residence

Fig. 13

(to be continued)

(continuation)

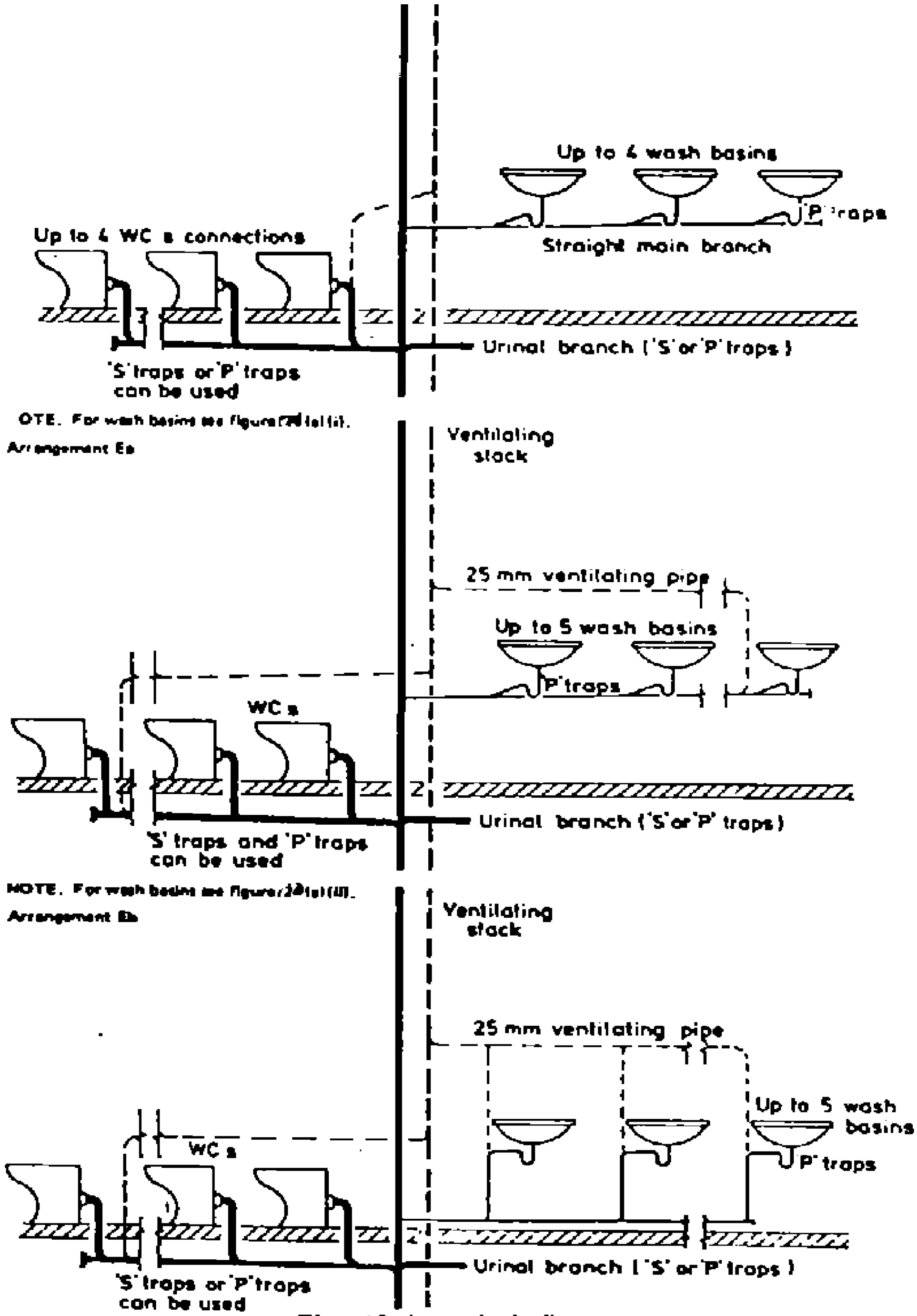


Fig. 13 (concluded)

Note:

1) Only 5 WCs and 5 wash basins per floor are referred to in table 4 on ventilating stack sizes.
Arrangement Ec Commercial and public buildings

TABLE 11 - VENTILATING STACK SIZES (in mm) FOR COMMONLY USED ARRANGEMENTS OF DISCHARGE STACKS AND SWEPT ENTRY BRANCHES

Discharge stack size		75 mm	100 mm																						150 mm													
Frequency of use		20 min	20 min					10 min										5 min							20 mm		10 min						5 mm					
Usage description		Domestic	Domestic					Hall of residence				Commercial						Congested							Domestic		Hall of residence		Commercial				Congested					
Number of floors		1 to 2	1 to 3	1 to 10		11 to 15		1 to 8		9 to 12		1 to 4		5 to 8		9 to 12		1 to 4		5 to 8		9 to 12			1 to 30		1 to 30		1 to 8		9 to 24		1 to 8		9 to 16		17 to 24	
Arrangements (see figure 28)		Aa Ab Ba Bb	Aa Ab Ac Ba Bb	Ca	Cb	Ca	Cb	Da	Db	Da	Db	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec		Ca	Cb	Da	Db	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec	Ea	Eb Ec
Number of appliance groups (per floor)	1	0	0	0	32*	50	50	0	32*	32	32	0	32*	0	32*	32	32	0	32*	0	32*	32	32		0	32*	0	32*	0	32*	0	32*	0	32*	0	32*	0	32*
	2		0	0	32*	50	50	0	32*	32	32	0	32*	0	32*	32	32	0	32*	50	50	50	50		0	32*	0	32*	0	32*	0	32*	0	32*	0	32*	0	32*
	3											0	32*	32	32	40	40	0	32*	50	50								0	32*	0	32*	0	32*	0	32*	65	65
	4											0	32*	40	40	40	40	32	32*										0	32*	75	75*	0	32	75	75	75	75
	5											0	32*	40	40				32*										0	32*	75	75	0	32	75	75	75	75

*Modified single stack arrangement

NOTE 1. Connections from the ventilating stack to the discharge stack required on each floor level except where indicated by "*"

NOTE 2. With non-swept WC branch connections to a stack, a single stack system can be used for appliance layouts Aa, Ab, Ba, Bb, Ca and Cb when restricted to not more than two groups of appliances per floor in the following situations:

up to 4 floors with 100 mm discharge stack;

up to 15 floors with 150 mm discharge stack.

NOTE 3. The following are conversions to be used with the above table

WC		Urinal		Wash basin		WC		Wash basin
2	+	1	+	2	Equivalent to	2	+	2
2	+	2	+	3		3	+	3
3	+	3	+	4		4	+	4
4	+	4	+	5		5	+	5

6.3.1.2 Conversion table for stacks serving WCs, basins and urinals

Table 11 includes a conversion table to enable systems serving wash basins, WCs and urinals to be sized for commercial or congested usage. It gives four examples of WC/urinal/wash basin combinations that may be taken as hydraulically equivalent to WC/wash basin combinations in Table 11.

6.3.2 Ventilating stack sizes for offsets in discharge stacks (see Sub-Clause 5.3.3.3)

Offsets in the "wet portion" of a discharge stack generally require the connection of a ventilating stack, the diameter of which should be half the diameter of the discharge stack. The distance between the center lines of the nearest branch connections and the offset should be at least 750 mm.

6.3.3 Ventilating pipe sizes for systems subjected to drain surcharging

Discharge stacks connected to drains which are likely to surcharge, generally require large diameter ventilating pipes, at least 75 mm size for a 100 mm discharge stack and 100 mm size for a 150 mm discharge stack (Clause 4.2).

7. PIPE SIZING USING DISCHARGE UNIT METHOD

7.1 General

This method can be used for special installations, e.g. systems for very tall or large buildings, not covered by the data in Clause 6.3.

For engineering guidances refer to clause 10 of BS 5572:1978.