# CONSTRUCTION STANDARD

# FOR

# WATER SUPPLY AND SEWERAGE SYSTEMS

## CONTENTS :

PAGE No.



## APPENDICES:

## 1. SCOPE

This Standard provides general guidance on the construction of water and sewage networks and installation of internal pipes and fittings at buildings, including inspection of both services.

## 2. REFERENCES

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

### 2.1 IPS (IRANIAN PETROLEUM STANDARDS)

| | |
|---|---|
| I-AR-115 | "Testing, Adjusting, Balancing and Start-Up Procedures of HVAC & Refrigerators" |
| E-AR-100 | "Building Heating System" |
| E-CE-110 | "Soil Engineering" |
| C-AR-110 | "Installation, Testing, Adjusting & Commissioning of HVAC & R Systems" |
| C-CE-112 | "Earthworks" |
| E-TP-270 | "Coatings" |
| E-CE-340 | "Water Resources & Distribution" |
| M-CE-345 | "Water Supply & Sewerage Equipment" |
| E-CE-360 | "Building Piping (Hot and Cold)" |
| E-CE-380 | "Sewerage & Surface Water Drainage System" |
| M-PI-190 | "Material and Equipment Standard for Line Pipes" |

### 2.2 National Standards

### BSI (BRITISH STANDARDS INSTITUTION)

| | |
|---|---|
| BS 1387:1985 | "Specification for Screwed and Socketed Steel Tubes and Tubulars..." |
| BS 1972:1967 | "Specification for Polythene Pipe (Type 32) for above Ground Use for Cold Water Services" |
| BS 2035: 1966 (1981) | "Specification for Cast Iron Flanged Pipes and Flanged Fittings" |
| BS 2494: 1986 | "Specification for Elastomeric Joint Rings for Pipework and Pipelines" |
| BS 2779: 1986 | "Specification for Pipe Threads for Tubes and Fittings" (Metric Dimensions) |
| BS 3505: 1986 | "Specification for Unplasticized Polyvinyl Chloride (PVC-U) Pressure Pipes for Cold Potable Water" |
| BS 4346: Part 1, 2 & 3 | "Joints and Fittings for Use with Unplasticized PVC Pressure Pipes" |
| BS 4772: 1988 | "Specification for Ductile Iron Pipes and Fittings" |
| BS 5572: 1978 (1984) | "Code of Practice for Sanitary Pipework" |
| BS 6164: 1990 | "Code of Practice for Safety in Tunneling in the Construction Industry" |
| BS 6700: 1987 | "Specification for Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use Within Buildings and Their Curtilages" |
| BS 8005: Part 1:1987 | "Guide to New Sewerage Construction" |

| | |
|---|---|
| BS 8010: Part 1: 1989 | "Pipelines on Land: General" |
| BS 8010: Part 2: 1989 | "Pipelines on Land: Design, Construction and Installation" |
| BS 8301: 1985 | "Code of Practice for Building Drainage" |
| BS CP 312: Part 2 | "Unplasticized PVC Pipework for the Conveyance of Liquids Under Pressure" |

**DIN (DEUTSCHES INSTITUTE FOR NORMUNG)**

| | |
|---|---|
| DIN 1988 Part 2: 1988 | "Drinking Water Supply Systems; Materials, Components Appliances, Design and Installations" |
| DIN 4033: 1979 | "Sewers and Sewage Pipelines" |
| DIN 4035: 1976 | "Stahlbetonrohre, Stahlbetonderuckrohre and Zugehörige Formstucke aus Stahlbetion" |
| DIN 4279: Parts 1 to 10: 1975 | "Testing of Pressure Pipelines for Water" |
| DIN 19630: 1982 | "Guidelines for the Construction of Water Pipelines" |
| DIN 19800: Part 2: 1973 | "Asbestos Cement Pipes and Fittings for Pressure Pipelines" |

## 3. DEFINITIONS AND TERMINOLOGY

Definitions and terminology given in IPS Standards E-CE-340, E-CE-360, E-CE-380 and E-CE-390, together with relevant clauses of BS 8005 and DIN 19630 also apply to this Standard.

## 4. UNITS

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

## 5. CONSTRUCTION OF WATER MAINS

### 5.1 Transport and Storage of Pipeline Components

#### 5.1.1 Loading and unloading

Pipeline components must be protected against damage. Only suitable equipment may be used for loading and unloading. In the case of pipes made of unplasticized PVC, in particular, abrupt stresses at temperatures below +5°C must be avoided because of the influence of temperature on their resistance to impact.

In the case of pipes with external protection, wide slings or other devices which do not damage the external protection must be used. The use of chains or bare steel wire is not permitted.

Pipes with a bituminous coating must be handled in such a way that the effects and influence of high and low temperatures do not give rise to damage. If wire or chain hooks are used, they must be padded in order to prevent damage to the pipe ends.

### 5.1.2 Transport to the construction site

During transport to the construction site, pipeline components must be kept apart by suitable intermediate layers and be secured against rolling, shifting, sagging and vibration.

### 5.1.3 Storage

Pipeline components must be so stored that they do not come into contact with harmful substances. The pipeline components must not be internally soiled by earth, mud, sewage or similar substances. If such soiling has been unavoidable, the pipeline components must be cleaned before being installed.

Pipes with bituminous external protection must not be stored directly on ground covered with vegetation because plant sprouts and shoots can grow into the external protection. Damage due to stony storage surfaces must also be avoided. Storage on stacking timber is recommended.

Stacking and stack heights must be so selected that damage to and permanent distortion of the pipes and damage to the external protection do not occur. The instructions of the pipe manufacturer determine the maximum stack height of pipes.

In the case of plastic pipes, stacks of pipes must not exceed the following heights:

**Pipes of PVC: 1.5 m**
**Pipes of PE : 1.0 m**

Stacks of pipes must be secured against rolling apart. If pipeline components must be stored in the open in frosty weather, care must be taken that they do not freeze to the ground. Where long periods of storage are involved, pipeline components made of materials sensitive to temperature and light (e.g., plastics, rubber) or with external protection sensitive to light or temperature must be protected against sunlight (e.g. by covering, coating with white paint, etc.).

### 5.1.4 Transport on the construction site

Where necessary, suitable transport equipment must be used for transport on the construction site. Dragging or prolonged rolling are not permissible.

## 5.2 Pipe Trenches

The width of pipe trenches as a working space must be sufficient for proper installation of pipeline components. Before the pipes are laid, the pipe trench must be checked for correct depth and width and also for the condition of the trench bottom.

### 5.2.1 Dewatering

During pipe-laying operations, working spaces (pipe trenches and socket holes) must be kept free of water.

### 5.2.2 Depth of cover

The pipe trench must be formed and excavated in such a way that all pipes are finally laid at a frost-free depth (depth of cover usually 1.0 to 1.9 m, depending on climate, nominal diameter and soil conditions).

### 5.2.3 Trench bottom

The trench bottom must be so constructed that the pipeline rests on it throughout its length. If necessary, appropriate cavities must be excavated in the trench bottom at joint points. Unintended high and low points must be avoided.

The bottom of trench excavations shall be carefully prepared to a firm even surface so that the barrels of the pipes when laid are well bedded down for their whole length. Mud, rock projections, boulders, hard spots and local soft spots shall be removed and replaced with selected fill material consolidated to the required level. The width of the excavations shall be sufficient to allow the pipes to be properly bedded, jointed and backfilled. Joint holes or recesses, made as short as practicable, shall be formed in the trench bottoms so that joints can be made properly.

Where rock is encountered, the trench shall be cut at least 150 mm deeper than other ground and made up with well rammed material.

### 5.2.4 Bedding

The bedding shall ensure even distribution of pressure in the bedding zone. Pipeline components must be laid in such a way that neither linear nor point support occurs. Cavities of adequate size must, therefore, be provided in the trench bottom for sockets and couplings.

In the case of the usual type of bedding, a support angle of about 60° is suitable for pipes and fittings of small and medium nominal diameter (up to about DN 500) (Refer to DIN 19630).

If pipes (or fittings) are designed for a different form of bedding or for a larger support angle, the bedding and embedding are to be constructed accordingly.

#### 5.2.4.1 Sand and gravely sand bedding

In rocky and stony ground, the pipe trench must be excavated to a greater depth, depending on the material of the pipe and the external protection. The extra soil removed must be replaced by a layer containing no stones. For this purpose, depending on the material of the pipe, the external protection and the pipe diameter, compactible sand, gravely sand, screened soil-but no slag or other aggressive substances - are applied in a layer of suitable thickness and compacted. After compaction of the fill, the thickness of the stone - free layer of the bottom of the bedding at its lowest level must be 100 mm +1/10 of the numerical value of the nominal diameter of the pipes in mm, with a minimum of 150 mm.

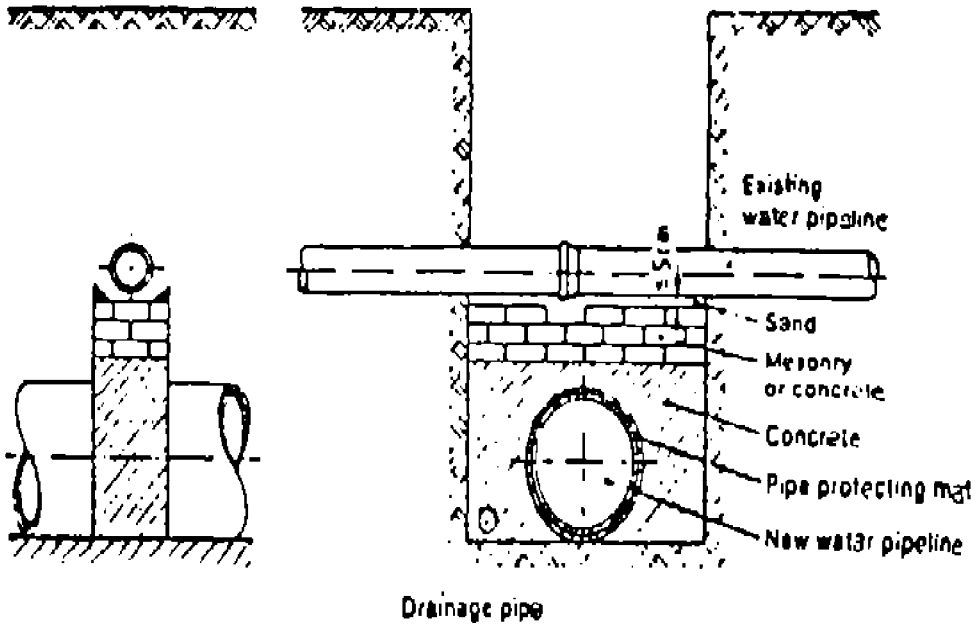
#### 5.2.4.2 Bedding in non-loadbearing soils

In the case of non-loadbearing subsoil, such as soils with a high water content (boggy and tidal marsh soil), special embeddings are necessary such as, for example, mats, pile foundations or reinforced concrete bearing plates.

#### 5.2.4.3 Variations in bedding conditions

Where the bedding conditions in the direction of the pipeline axis is variant, unacceptable stressing of the pipeline components can arise as a result of differing movement in the bedding. Possible protective measures include, for example, a thicker sand embedding or flexible pipe joints coupled with appropriately short pipe lengths in the transition zone.

Also in the case of crossings of other, already existing pipelines, provision must be made for bedding capable of bearing a load which can compensate for the different movements (see Fig. 1). Protective measures must be coordinated with the operators of existing pipelines.




**EXAMPLE OF CONSTRUCTION OF UNDERPINNING OF A CROSSING PIPELINE OF SMALL NOMINAL DIAMETER**

**Fig. 1**

### 5.2.4.4 Special precautions in steeply sloping sections

In steeply sloping sections, suitable precautions must be taken to prevent the backfilled pipe trench from acting as a drain, with the result that the pipe embedding is washed away and the pipeline undermined. Appropriate measures are also necessary to prevent surface run-off along the backfilled pipe trench.

In hilly and steeply sloping sections, the pipeline must also be secured against slipping, for example, by means of force-locking joints actuated by longitudinal forces (that transmit tensile forces in the direction of the pipeline axis), and or transverse arms.

### 5.2.4.5 Pipe laying

Pipes shall be laid in such a manner as will ensure even support throughout their length and shall not rest on their sockets or on bricks, tiles or other makeshift supports. Plastics pipes shall be laid in compliance with CP 312: Parts 1,2 and 3 and on a bed free from sharp stones.

**Note:**

**Pipes should be laid true to line to the general contours of the ground and at a sufficient depth for the pipe diameter to allow for the minimum cover below finished ground level.**

#### 5.2.4.6 Ingress of dirt

Pipes shall be kept clean and immediately before laying each pipe and fitting shall be thoroughly cleansed internally and the open end temporarily capped until jointing takes place. Precautions shall be taken to prevent flotation of the capped pipes, in case the trench becomes flooded.

#### 5.2.4.7 Protective coatings

Coatings, sheathings or wrappings shall be examined for damage, repaired where necessary, and made continuous before trench excavations are backfilled.

### 5.3 Installation of Pipeline Components

#### 5.3.1 Checking

Pipeline components must be checked for obvious damage, cleaned inside if necessary and any damage to the outer and inner protectional coatings must be repaired before they are lowered into the pipe trench (see also 5.5.2).

#### 5.3.2 Placing in the pipe trench

If equipment is required for placing pipeline components, it must be capable of smooth and steady lowering without damage (see also Sub-clause 5.1.1). Where stringing out is adopted, the bending radii must not be less than those permissible in each case.

#### 5.3.3 Pipe cuts

Pipe cuts must be smooth. The start and end of the cut must not be staggered. Unevennesses in the cut surface and burrs must be removed. Pipe ends must be properly machined as appropriate to the material and the type of joint.

#### 5.3.4 Longitudinal gradient

Pipelines must be laid according to the structural drawings with the prescribed gradient.

#### 5.3.5 Distances from underground installations

##### 5.3.5.1 General

Distances from underground installations must be fixed in the light of the following safety considerations:

- Prevention of excessive transmission of forces;
- no undue temperature effects caused, for example, by district heating and cables;
- ensuring of adequate working spaces for laying and repair work;
- maintenance of a safety margin to avoid dangerous contacts with cables and proximity between pipelines and cables;
- electrically effective separation from all other metal conductors in the light of cathodic corrosion protection.

##### 5.3.5.2 Distance from structures

The horizontal distance from foundations and similar underground installations shall not be less than 0.40 m.

#### 5.3.5.3 Distance from pipelines and cables

Where there is (lateral) proximity or where the pipeline runs parallel to other pipelines and cables, the distance from them shall not be less than 0.40 m. At bottlenecks too, a distance of 0.20 m shall be maintained. If the spacing at bottlenecks has to be further reduced, suitable steps must be taken to prevent direct contact. Such steps must be agreed with the AR.

#### 5.3.5.4 Crossings with pipelines and cables

In the case of crossings with pipelines and cables, a spacing of 0.2 m shall be adhered to. If this is not possible, contact must be prevented by, e.g. interposition of non-conducting shells or plates. The possibility of transmission of forces must be excluded. This step must be agreed with the AR.

#### 5.3.5.5 Distance between drinking water pipelines and sewers

The drinking water pipeline shall be above the sewer. Sub-clauses 5.3.5.3 and 5.3.5.4 apply to the distances to be observed.

### 5.3.6 Protection of the pipeline against contamination

During laying, the pipeline must be protected against avoidable soiling. The pipeline must be cleaned. This can, for example, be done with a scraper, by pulling through a tightly fitting pipe brush and also, if entry into the pipeline is possible, by hand. When work is interrupted and on the conclusion of work, all openings must be closed so that they are watertight, by suitable means such as plugs, covers, blank flanges.

### 5.3.7 Fitting of valves

Valves and their by-passes must be fitted in an unstressed condition. Any forces exerted must be harmlessly deflected. Where necessary, the weight loading must be taken up by foundations.

## 5.4 Making of Pipe Joints

### 5.4.1 General requirements

Pipeline components must be connected in such a way that the pipeline is tight and takes up static and dynamic stresses. Bolts must be tightened crosswise around the entire circumference, in order to achieve even and adequate pressure in the sealing elements.

### 5.4.2 Force-locking pipe joints not actuated by longitudinal forces

Socket joints are usually force-locking pipe joints not actuated by longitudinal forces. When forming socket joints, care must be taken that the sealing rings seat accurately. In the case of bends, branches and the like, forces must be deflected via abutments into the surrounding soil.

The non-manipulative type of compression joint, as its name implies, does not require any working of the pipe end other than cutting square. The joint is made tight by means of a loose ring or sleeve that grips the outside wall of the pipe when the coupling nut is tightened. The manufacturer’s recommendations should be followed.

#### 5.4.3 Force-locking pipe joint actuated by longitudinal forces (manufacturer's instructions should be followed)

In the manipulative type of compression joint the end of the pipe is flared, cupped or belled with special forming tools and is compressed by means of a coupling nut against a shaped end of corresponding section on the fitting or a loose thimble. See Clause 6.3.1 and 6.3.2 of DIN 19630 for metallic and plastic pipes.

#### 5.4.4 Lubricants and sealing mediums

Only those lubricants and sealing mediums which cannot adversely affect the quality of drinking water may be used for making pipe joints in drinking water pipelines. In addition, lubricants and sealing mediums must not exert any harmful influence on pipeline components. There must also be no question of harmful interaction between pipeline components on the one hand and lubricants and sealing mediums on the other hand.

### 5.5 Corrosion Protection

#### 5.5.1 External protection by anticorrosive coatings (passive corrosion protection)

Water pipelines must be able to withstand the exposure to corrosion to be expected from outside. If the material is insufficiently resistant, external protection of adequate mechanical stressability must be provided. The conditions of installation and operation are the decisive factors in the selection of pipe coatings, depending on the pipe materials selected.

##### 5.5.1.1 Steel pipes

Steel pipes must be provided with external protection according to design specifications based on IPS-E-TP-270.

##### 5.5.1.2 Pipes of ductile cast-iron

Depending on the type of soil, pipes of ductile cast iron must have external protection according to design specifications based on IPS-E-TP-270.

##### 5.5.1.3 Plastic pipes

No coating is necessary for plastic pipes.

##### 5.5.1.4 Pipes of cement-bound materials

In normal cases, pipes of cement-bound materials do not require any external protection. DIN 4035 specifies the circumstances in which external protection is necessary for reinforced concrete pressure pipes and, where appropriate, for prestressed concrete pressure pipes, and DIN 19 800 Part 2 for asbestos cement pipes.

#### 5.5.2 Subsequent external protection

Repairs and additions to the pipe coating at faulty points and at pipe joints must be effected according to the manufacturer's instructions.

Flanges, after being cleaned, derusted and dried, shall be protected by plastic strips, bitumen strips, by pouring round anticorrosive mediums or by shrunk-on formed parts.

In the case of bitumen and plastic coatings, care must be taken that no sharp-edged backfilling material is used, that no lasting heat effects, such as from district heating pipelines, are experienced and that no harmful substances such as oil and grease come into contact with the coating.

When laying pipeline components made of metallic materials with an electrically non-conducting coating to the pipes, the coatings must be tested with an electrical testing apparatus and, if necessary, properly repaired. The test voltage is at least 5 kV plus 5 kV per mm of thickness of the insulating layer, but with a maximum of 20 kV.

### 5.5.3 Internal protection

Water pipeline must be able to withstand the chemically corrosive stresses to be expected from inside. Should the material itself be insufficiently resistant, there must be appropriate internal protection.

## 5.6 Embedding the Pipeline

To a large extent, the load and stress distribution at the circumference of the pipe determines the embedding. Bedding and embedding are often constructed together. For embedding, suitable soil, which does not harm the pipeline components or the coating, must be placed in layers on both sides of the pipeline and at least up to the middle of pipe diameter.

Pipelines liable to buoy upwards must be provided with safety precautions against uplift. In vegetation areas, placing and compacting in layers can, where appropriate,be dispensed with.

## 5.7 Backfilling of the Pipe Trench

Backfilling of the trench above the min. or max. height of embedding should be effected according to the requirements of the project. If trenches are in the roads, the degree of compaction of backfill should conform with specified compaction degree of the road sub-base.

In vegetation areas, compacting and restoration of the surface of the ground must be done in such a way that damage due to plant growth is largely prevented.

## 5.8 Special Structural Measures

### 5.8.1 Crossings with traffic routes

In the case of crossings of traffic routes, the specifications of the appropriate administrative bodies such as the Ministry of Roads, railway authorities, municipalities etc., must be observed and adhered to.

### 5.8.2 Working and safety strips

A working strip is necessary for the construction of pipelines. The width of the working strip depends on the nominal diameter of the pipeline and on local conditions.

**Note:**

**Easements or "right of ways" serving the preservation and operating reliability of the pipeline must be procured by contracts or servitudes.**

Other than in public traffic areas, water pipelines shall be protected by a safety strip to ensure satisfactory maintenance and to exclude external influences which could endanger the condition of the pipeline. Structures having nothing to do with the pipeline must not be erected within the safety strip. The safety strip must be kept free of vegetation which could adversely affect safety and maintenance of the pipelines.

The center of the safety strip shall correspond to the axis of the pipeline. The width of the safety strip shall be:

| Nominal Size of Pipeline | Width of Safety Strip |
|---|---|
| up to DN 150 | 4 m |
| over DN 150 up to DN 400 | 6 m |
| over DN 400 up to DN 600 | 8 m |
| over DN 600 | 10 m |

Where there are compelling reasons, the figures listed may be reduced by up to 2 m over short stretches and at constrained points.

In the case of pipelines running parallel, the width of the safety strip increases by the distance between the outermost pipelines.

The final route of pipelines should permit ready and adequate access from public highways for the equipment and materials necessary to carry out planned inspections, maintenance and emergency repairs.

## 5.9 Pressure Test, Disinfection, Filling of the Pipeline

### 5.9.1 Purpose

This Standard specifies the methods of testing the pipes, pipe joints and fittings for leakage, and the safe positioning of a pressure pipeline before being put into operation.

### 5.9.2 Pressure test

Pipelines constructed with pressure pipes for the conveyance of drinking water, or water for industrial use must be subjected to an internal pressure test (preliminary test plus main test) according to requirements of DIN 4279 Part 1 to Part 10, before backfilling.

The test pressure as per DIN 4279 Part 1 is: 1.5 × the nominal operating pressure for pipelines with a:-

- permissible working pressure of up to 10 bar* and,
- nominal operating pressure +5 bar for pipelines with a permissible working pressure of over 10 bar.

The duration of the test depends on pipe type and nominal width (see DIN 4279 part 1 to part 8). In principle the test section should be chosen in such a way that the test pressure at the highest point of the pipeline is equivalent to at least 1.1 times the nominal pressure.

**Note:**

**For nominal operating pressure or working pressure see Clause 11.2.3 of IPS-E-CE-340.**

#### 5.9.2.1 Preliminary test

The preliminary test comprises the preparatory steps leading up to the main test. It can be incorporated into the main test subject to local conditions and type of pipe.

#### 5.9.2.2 Main test

The main test should be carried out at given test pressures, normally in sections of pipeline between 500 and 1500 meter in length dependent upon local conditions, e.g. geodetic variations in altitude.

The pressure test procedure comprising of bracing and anchoring of the pipeline, filling of the pipeline, measurement of pressure and temperature and measurement of the water to be added should be executed as specified in DIN 4279 Parts 1 to 8. Vents or other connections shall be opened to eliminate air from lines which are to receive a hydrostatic test. Lines shall be thoroughly purged of air before hydrostatic test pressure is applied. Vents shall be open when systems are drained so not to create buckling from a vacuum effect. Welded, flanged or screwed connections must not be painted or otherwise covered before completion of pressure testing.

After completion of hydrostatic testing, all temporary blanks and blinds shall be removed and all lines completely drained. Any valves, orifice plates, expansion joints and short pieces of piping which might have been removed shall be reinstalled with proper and undamaged gaskets in place. Valves which were closed solely for hydrostatic testing shall be opened. After lines have been drained with vents open, temporary piping supports, if any, shall be removed so that insulation and painting may be completed.

*** 1 bar = 0.980665 atmospheric pressure ($kg/cm^2$).**

#### 5.9.2.3 Execution of the test

If a preliminary test is conducted, the times for the duration of testing should be taken from Table 1.

**TABLE 1**

| NOMINAL WIDTH (NW) (m) | DURATION OF TEST h ≈ |
|---|---|
| up to 200 | 3 |
| 250 to 400 | 6 |
| over 400 | 12 |

If no preliminary test is conducted, the times for the duration of testing should be taken from Table 2.

If a preliminary test has taken place, the times for the duration of testing should be taken from Table 3.

**TABLE 2**

| NOMINAL WIDTH (NW) (m) | DURATION OF TEST h ≈ |
|---|---|
| up to 200 | 3 |
| 250 to 400 | 6 |
| 500 to 700 | 18 |
| over 700 | 24 |

**TABLE 3**

| NOMINAL WIDTH (NW) (m) | DURATION OF TEST h ≈ |
|---|---|
| up to 400 | 3 |
| 500 to 700 | 12 |
| over 700 | 24 |

**The duration of the test is independent of pipe type and nominal width.**

#### 5.9.2.4 Assessment of the test

The conditions of testing can be considered to be fullfilled if, at the end of the test no drop in pressure can be established that exceeds the values given in Table 4.

**TABLE 4**

| NOMINAL PRESSURE BAR | TEST PRESSURE BAR | DROP IN PRESSURE MAX. |
|---|---|---|
| 10 | 15 | 0.1 |
| 16 | 21 | 0.15 |
| over 16 | NP + 5 | 0.2 |

### 5.9.3 Permissible leakage

Leakage allowed in new mains is frequently specified in contracts, varying from 5.5 to 23 l/mm diameter per km per 24 hours at the working pressure.

The specifications generally require that no pipe installation be accepted until the leakage is less than that indicated by the formula:

$$L = \frac{ND^{p}\overline{P}}{C}$$

in which L is the allowable leakage, N is the number of joints in the length of line tested, D is the nominal diameter of the pipe, P is the average test pressure during the leakage test, and C is a constant depending on units and is equal to 326 (l/hour, mm, kPa). For measurement of leakage a test pressure of 50 percent above the normal operating pressure for at least 30 min. is recommended. It should be recognized that leakage can also occur from the service connections as well as the joints.

Care should be taken that no air has been retained in the pipe being tested.

### 5.9.4 Disinfection of drinking water pipelines

Drinking water pipelines must be disinfected after successful fulfillment of the test. Before disinfection the main should be flushed at a velocity of at least 0.76 m/s. The use of a foam or rigid "pig" which is either driven through the line by the water pressure or pulled through by a cable is desirable. Mains have been satisfactorily disinfected with various chlorine compounds, potassium permanganate and copper sulfate.

There is no satisfactory substitute for initial cleanliness of the mains. No disinfectant will kill bacteria which are sheltered by debris. Cleaning with "pig" and flushing at a velocity of at least 0.76 m/s should be followed by filling with water containing a free residual chlorine concentration of at least 1.0 mg/lit. A free residual of at least 0.5 mg/l must remain after 24 hours. Following this procedure bacteriological analyses of the water should be conducted to insure its suitability. If total bacterial counts exceed 500/ml or any coliform bacteria are found, the line should be filled with water containing 50 mg/l available chlorine which should not decrease b low 25 mg/l in the 24 hour holding period.

Water containing the disinfectant must be harmlessly disposed of. After being disinfected, the pipeline must be flushed until the water is of drinking water quality. In the case of pipes with a water-absorbent inner wall, it is advisable to carry out disinfection at the same time as the pressure test.

When it is necessary to repair or cut into an existing main, disinfection will also be necessary. No rule can be given as to Methods, but by the use of fire hydrants for flushing and especially made taps the procedure given above may be followed.

### 5.9.5 Filling

Filling of the pipeline shall take place from the lowest point. For complete venting, adequate vents must be available at all high points. The inflow must be adjusted accordingly. The venting procedure must be controlled.

### 5.10 As Built Drawings

After termination of the work and acceptance of the installations, the laid pipeline components must be surveyed and accordingly "As Built" drawings prepared and filed in two separate places. Any subsequent modifications shall be entered in the documents.

## 6. INSTALLATION OF WATER PIPES IN BUILDINGS

### 6.1 Handling of Materials

Pipes, fittings and components shall be handled carefully to reduce damage. They should be stored so as to prevent contamination of the inside by dirt, mud, foul water, etc.*

### 6.2 Jointing of Pipes

#### 6.2.1 General

All proprietary joints shall be made in accordance with the manufacturer's instructions. Care shall be taken to establish satisfactory jointing techniques for all water service pipework. When making joints by welding, brazing or soldering, precautions shall be taken to avoid the risk of fire. All burrs shall be removed from the ends of pipes and any jointing materials used shall be prevented from entering the waterways. All piping and fittings shall be cleaned internally and free from particles of sand, soil, metal filings and chips, etc.

**Note:**

**Jointing of potable water pipework should be in accordance with the advice in Appendix A.**

#### 6.2.2 Cast iron pipes

**6.2.2.1** Flexible mechanical joints shall be made in accordance with the manufacturer's instructions.

**6.2.2.2** For molten lead joints, the spigot and socket shall be centered with rings of dry yarn caulked tightly into the bottom of the spigot to prevent the entry of lead into the bore of the pipe and to prevent contact of lead with the water. Synthetic yarns that do not promote the growth of bacteria shall be used to prevent contamination of the water. The remainder of the joint space shall be filled with either molten lead (taking care that no dross enters the joint), cold wire, strip or spun lead (lead wool). The joint shall be caulked to a smooth finish with pneumatic tools or a hand hammer of mass not less than 1.5 kg. When working with spun lead, caulking tools shall be of a thickness to fill the joint space, ensuring thorough consolidation of the material to the full depth of the socket.

Lead joints shall be finished about 3 mm inside the face of the socket.

**6.2.2.3** Flange joints shall be made with screwed or cast on flanges as specified in 6.2.3.3.

*** Manufacturers' advice should be followed concerning how their products should be loaded, transported, unloaded and stored.**

### 6.2.3 Steel pipes

**6.2.3.1** Welded joints shall not be used where a protective lining would be damaged by heat, or where the pipework is employed as a primary circulation to an indirect hot water heating system (see IPS-E-AR-100).

**6.2.3.2** Screwed joints in steel piping shall be made with screwed socket joints using wrough-iron, steel or malleable cast-iron fittings. A thread filler shall be used. Exposed threads left after jointing shall be painted or, where installed underground, thickly coated with bituminous or other suitable corrosion preventative agent.

**6.2.3.3** Flange joints shall be made with screwed or welded flanges of steel or cast-iron using jointing rings and, if necessary, a suitable jointing paste. The nuts shall be carefully tightened, in opposite pairs, until the jointing ring is sufficiently compressed between the flanges for a watertight joint.

### 6.2.4 Unplasticized PVC pipes

#### 6.2.4.1 Mechanical joints

Mechanical joints in unplasticized PVC piping of sizes 2 and upwards shall be made in accordance with BS 4346: Part 2, by the use of push-fit integral elastomeric sealing rings which are compressed when the plain ended pipes are inserted into the adjoining sockets. The plain pipe ends shall be chamfered and the surfaces cleaned and lubricated.

The chamfered pipe end shall be inserted fully into the adjoining socket (except where provision is to be made for expansion) or as far as any locating mark put on the spigot end by the manufacturer. The sealing rings shall comply with BS 2494.

#### 6.2.4.2 Compression joints

Compression joints shall only be used with unplasticized PVC piping of size 2 and smaller. The joints shall be of the non-manipulative type. Care shall be taken to avoid over-tightening.

#### 6.2.4.3 Solvent cement welded joints

Solvent cement welded joints in unplasticized PVC piping shall be made using a solvent cement complying with BS 4346: Part 3 recommended by the manufacturer of the pipe. The dimensions of the spigots and sockets shall comply with BS 4346: Part 1 and reference shall be made to CP 312: Part 2 for jointing methods.

**Note:**

**Joints may also be made using integral sockets formed in the pipes and solvent cemented.**

#### 6.2.4.4 Flanged joints

Flanged joints used for connections to valves and fittings shall use full-face flanges or stubflanges, both with corrosion resistant or immune backing rings and bolting.

### 6.2.5 Polyethylene pipes

**6.2.5.1** For general specifications of materials and workmanship refer to IPS-M-PI-190/2, Part IV.

**6.2.5.2** Mechanical joints shall be made in accordance with CP 312 using either plastics or metal proprietary compression fittings, e.g., brass, gun metal or malleable iron. These shall include insert liners to support the bore of the pipe except where the manufacturer of the fitting instructs otherwise.

**6.2.5.3** To ensure satisfactory jointing of the materials from which the pipe and fittings are made compatibility shall be established. The manufacturer's instructions shall be carefully followed.

No attempt shall be made to joint polyethylene piping by solvent cement welding.

### 6.3 Jointing Pipes to Cisterns and Tanks

#### 6.3.1 General

Cisterns and tanks shall be properly supported to avoid undue stress on the pipe connections and deformation of the cistern or tank when filled, and holes shall be correctly positioned for the connection of pipes to cisterns and tanks. All debris, filings, borings and blanks shall be removed from the inside of the cistern or tank.

Holes shall not be cut with flame cutters.

#### 6.3.2 Steel pipes to cisterns and tanks of different materials (steel, galv. steel or glass reinforced plastics)

The threaded end of the pipe shall be secured in the hole in the cistern or tank either by backnuts and washers both inside and outside (soft washers being used additionally with glass reinforced plastics or where there are irregular surfaces) or by using bolted or welded flanged connections.

### 6.4 Valve Chambers and Surface Boxes (see Standard Dwg. No. IPS-D-CE-190 & 191)

Surface boxes shall be provided to give access to operate valves and hydrants, and shall be supported on concrete or brickwork which shall not be allowed to rest on the pipes and transmit loads to them, allowance being made for settlement.

Alternatively, vertical guard pipes or precast concrete sections shall be provided to enclose the spindles of valves. Brick or concrete hydrant chambers shall be constructed of sufficient dimensions to permit repairs to be carried out to the fittings.

**Note:**

**This requirement also applies to other valve chambers.**

### 6.5 Branch Connections for Buildings

#### 6.5.1 Branch pipes of rigid materials

Any rigid branch pipe shall be connected to the ferrule on the pipe by a short length of suitable flexible pipe.

**Note:**

**This is to permit differential movement of the pipe and branch pipes without liability to fracture.**

#### 6.5.2 Position of ferrule in a pipe

The ferrule shall be set with the branch pipe leading off parallel to the pipe before turning into its proper course. Unless a swivel ferrule is used, the turn shall be arranged in a clockwise direction to ensure that if settlement of the pipe takes place, the joint between the ferrule and the pipe is being tightened.

### 6.5.3 Allowance for movement

Underground piping of plastics shall be laid with slight deviations to allow for minor subsidence or temperature changes.

### 6.5.4 Branch pipe connections

Branch pipes shall be connected to a main pipe by using one of two methods, depending upon the size of the pipes to be jointed namely Ferrule or Tee or Leadless collar.

The method used shall be as given in Table 5.

**TABLE 5 - METHOD OF BRANCH PIPE CONNECTION**

| NOMINAL SIZE OF BRANCH PIPES | | NOMINAL DIAMETER OF MAIN PIPE | | | | |
|---|---|---|---|---|---|---|
| | | 80 mm | 100 mm | 150 mm | 200 mm | 250 mm and over |
| mm | in. | | | | | |
| 15 | ½ | F | F | F | F | F |
| 22 | ¾ | T | F | F | F | F |
| 25 | 1 | T | T | F | F | F |
| 35 | 1¼ | T | T | T | F | F |
| 42 | 1½ | T | T | T | F | F |
| 54 | 2 | T | T | T | T | F |

**F: Ferrule**
**T: Tee or Leadless collar.**

### 6.5.5 Building entry

Every underground pipe entering a building shall do so at the level given in working drawings. (see also Clause 9.3 of IPS-E-CE-360).

## 6.6 Pipework in Buildings

### 6.6.1 Allowance for thermal movement

In installations that do not have limited straight runs and many bends and offsets, allowance for expansion and contraction of the pipes shall be made by forming expansion loops, by introducing changes of direction to avoid long straight runs or by fitting proprietary expansion joints.

**Note:**

**This is particularly important where temperature changes are considerable (e.g.,hot water distribution pipework) and where the pipe material has a relatively large coefficient of thermal expansion (e.g., unplasticized PVC). In installations with limited straight runs and many bends and offsets, thermal movement is accommodated automatically.**

### 6.6.2 Fixings for iron pipe

Iron pipe shall be secured by heavy weight holderbats of iron or low carbon steel either built in or bolted to the structure.

### 6.6.3 Fixings for steel pipe

Steel piping shall be secured by steel, copper alloy, suitable plastics clips or brackets. Copper clips or brackets shall not be used for fixing steel piping.

### 6.6.4 Fixings of insulated piping

Piping that is insulated shall be secured on clips or brackets that allow sufficient space behind the back of the pipe and the batten or wall to which the pipe is fixed for the insulation to be properly installed.

### 6.6.5 Concealed piping

Piping shall be housed in properly constructed builders work ducts (riser shafts) or wall chases and have access for maintenance and inspection.

**Note:**

**Ducts and chases should be constructed as the building structure is erected and should be finished smooth to receive pipe fixings.**

### 6.6.6 Piping passing through structural timbers

Structural timbers shall not be notched or bored in such a way that the integrity of the structure is compromised. For recommended positions of notches and holes in timber beams and joints refer to Clause 13.7.9 and Fig. 19 of BS 6700.

### 6.6.7 Clearance of structural members

Piping laid through notches, holes, cut-outs or chases shall not be subjected to external pressure, and shall be free to expand or contract. Piping through walls and floors shall be sleeved. Where pipes are located in unheated surroundings such as open passages, they shall be laid at a depth sufficient to afford protection against freezing, if frost protection cannot be provided by other means. Pipe ducts shall be capable of being vented and drained.

## 6.7 Disinfection of an Installation

### 6.7.1 Flushing

Every new domestic water service directly connected to pressure main shall be thoroughly flushed with fresh water drawn direct from the water supplier's mains, immediately before being taken into use.

### 6.7.2 Disinfection-general

Where chlorinated water that has been used to disinfect an installation is to be discharged into a sewer, the authority responsible for that sewer shall be informed.

Where this water is to be discharged into a natural water-course or into a drain leading to the same, the authority responsible for land drainage and pollution control shall be informed.

Where any pipework under mains pressure or upstream of any back-siphonage device within the installation is to be disinfected, the water supplier shall be informed.

### 6.7.3 Disinfection of installations within buildings that have central storage cisterns (Clause 6.1.1 (a) of IPS-E-CE-360)

All visible dirt and debris shall be removed from the cistern. The cistern and distributing pipes shall be filled with clean water and then drained until empty of all water. The cistern shall then be filled with water again and the supply closed.

A measured quantity of sodium hypochlorite solution of known strength shall be added to the water in the cistern to give a free residual chlorine concentration of 50 mg/L (50 ppm) in the water. The cistern shall be left to stand for 1 h. Then each draw-off fitting shall be successively opened working progressively away from the cistern. Each tap and draw-off fitting shall be closed when the water discharged begins to smell of chlorine. The cistern shall not be allowed to become empty during this operation; if necessary it shall be refilled and chlorinated as above. The cistern and pipes shall then remain charged for a further 1 h.

The tap farthest from the cistern shall be opened and the level of free residual chlorine in the water discharged from the tap shall be measured. If the concentration of free residual chlorine is less than 30 mg/L (30 ppm) the disinfecting process shall be repeated.

Finally, the cistern and pipes shall remain charged with chlorinated water for at least 16 h, e.g., overnight, and then thoroughly flushed out with clean water until the free residual chlorine concentration at the taps is not greater than that present in the clean water from the water supplier's mains.

**Note:**

**Proprietary solutions of sodium hypochlorite should be used in accordance with the manufacturer's instructions having due regard for health and safety. A graduated container should be used to measure out the volume of solution required for disinfection. This can be calculated from the manufacturer's literature.**

## 6.8 Identifying and Recording Piping Locations

### 6.8.1 Location of pipe and valves

Consideration shall be given to the need to locate the position of pipes and valves. Surface boxes shall be lettered to indicate what service is below them. Where possible, durable markers with stamped or set-in indexes shall be set up to indicate the pipe service, the size, the position and depth below the surface.

### 6.8.2 Identification of above ground piping

Where aesthetically acceptable, water piping shall be color banded and coded in accordance with IPS-C-AR-110.

In any building other than a single dwelling, every supply pipe and every pipe for supplying water solely for fire fighting purposes shall be clearly and indelibly marked to distinguish them from each other and from every other pipe in the building.

**Note:**

**Fire fighting water is not necessarily potable water. Settled raw water with 40-50 ppm turbidity is considered adequate in oil industries.**

### 6.8.3 Record drawings

During the installation of a water supply system, records of all pipe runs, cisterns, valves, outlets, etc., shall be kept. On completion of the works, drawings shall be prepared on durable material of the 'as fixed' installation. These record drawings shall be handed to the AR.

### 6.8.4 Identification of valves installed above ground

Every valve in hot and cold water service pipework installed above ground shall be provided with an identification label, either secured by non-corrodible, incombustible means to the valve or fixed to a permanent structure near the valve. Labels secured to valves shall be of non-corrodible and incombustible material permanently and clearly marked, e.g. by stamping or engraving, with a description of the service concerned and the function of the valve.

Alternatively, the label shall be marked with a reference number for the valve, instead of or in addition to the marking described in this sub-clause, and a durable diagram of the service, showing the valve reference numbers shall be fixed in a readily visible position to a permanent part of the building or structure. Labels fixed near valves shall comply with the requirements for labels secured to valves except that they need not be incombustible.

## 7. CONSTRUCTION OF GRAVITY SEWERS

### 7.1 Setting Out Sewers in Trench

The centerline and top width of trench should be accurately set out, marked and referenced. Temporary bench marks should be established in stable positions where they are unlikely to be disturbed. The transference of levels by straight-edge and spirit level is not recommended and should be avoided where possible. On flat gradients the work should be set out and frequently checked by instrument.

### 7.2 Excavation (see also IPS-C-CE-112 & E-CE-110)

The nature of the ground as revealed by the site investigation, the depth of the trench, and the avoidance of damage to existing (or proposed) structures or underground works, will determine the choice of the method of excavation and the type and strength of support required to the trench sides during construction.

General instructions for excavations are given in IPS-C-CE-112.

The interruption of buried services is undesirable and may be dangerous. Every effort should be made to locate these accurately through local authority before commencing excavation. Trial pits to confirm locations should be hand dug. All pipes, ducts, cables, mains or other services exposed in the trench should be effectively supported, or diverted if necessary. Attention needs to be paid to the temporary and permanent support of these services to avoid subsequent damage. Care should also be taken to minimize ground movement which may damage services alongside the trench.

### 7.3 Dewatering

Where the proposed excavation formation level is below the groundwater table and the grading of the surrounding ground is suitable, it may be desirable to lower the groundwater table locally by pumping during the period of the excavation. The pumping out of water can also carry with it fine material in suspension. This may cause subsidence of existing structures by loss of fines or water or both and it should be carried out under expert advice. Dewatering is usually only possible in soils coarser than silt (i.e. 0.06 mm) with less than 10% passing a 75 μm sieve. Exceptionally, some coarse silts (0.02 mm) may dewater.

Dewatering may be carried out by pumping from a series of well points sunk adjacent to the line of the excavation.

### 7.4 Preparation of Trench

Uniformity of support for a sewer is essential and the trench bottom should be carefully trimmed to the required depth and gradient to provide the proper formation level. A soft or uneven formation should be removed to an economical depth and the resulting cavity refilled with a material which will give uniform support. For structural design of bedding

refer to Clause 12 of IPS- E-CE-380 and Figs. 2 and 3 of the same standard. If rock is encountered at formation level, this may also have to be removed and similarly replaced, except where concrete bedding is to be provided.

### 7.5 Pipe Laying and Jointing

#### 7.5.1 Inspection of pipes preparatory to laying

All pipes, fittings and rubber joint rings and preformed mastic seals should be carefully inspected prior to use, special attention being paid to joint surfaces, grade of mastic seal and protective coatings and linings.

#### 7.5.2 Pipe laying: General

Pipe laying should start at the downstream end, the pipes normally laid with the sockets upstream.

#### 7.5.3 Laying pipes on trench as formation

Where the design permits and if the nature of the ground is such as to allow it to be trimmed to provide a uniform bearing, rigid pipes may be laid on the trench formation. Socket holes should be as short as practicable and should be scraped or cut in the formation, deep enough to give a minimum clearance of 50 mm between the socket and the formation.

If the formation has been over-excavated and does not provide continuous support, low areas should be brought up to the correct level by placing and compacting suitable material.

After the formation has been prepared, the pipes should be laid upon it true to line and level within the specified tolerances. This should be checked for each pipe, and any necessary adjustments to level should be made by raising or lowering the formation, always ensuring that the pipes finally rest evenly on the adjusted formation throughout the length of the barrels. Adjustment should never be made by local packing.

#### 7.5.4 Laying pipes on granular bed

The trench should be excavated to a depth such as to allow the specified thickness of granular bedding material to be placed beneath the units. Any mud should be removed and soft spots either removed or hardened by tamping in gravel or broken stones. Rock projections, boulders or other hard spots should also be removed.

General description for pipe laying are given in Figs. 1 & 2 of IPS-E-CE-380.

In soft clay, disturbance of the trench bottom should be minimized by placing a layer of blinding material about 100 mm thick. Such precautions may also be necessary in bad weather and for wet ground conditions.

Granular bedding material should be placed to the correct level and should extend to the full width of the trench.

Pipes should be laid directly on the granular bed and should then be adjusted to correct line and level within the specified tolerances, i.e.,the pipe invert levels should be constructed to a tolerance of ±20 mm subject to the provision that the pipe gradient should not be less than 90% of that required in the design. Sidefill of either granular material or selected backfill material, depending upon the bedding specified, should be placed and compacted evenly on either side of the pipe taking care not to disturb the line and level.

Measures to prevent migration of fine material from pipe bedding should be undertaken where the pipeline is below groundwater level.

### 7.5.5 Laying pipes with concrete bed, bed and haunch, or surround

Where in situ concrete bedding is required, the trench bottom should be prepared to give a firm foundation as described in 7.4, using a blinding layer if necessary. The level of this formation should allow for a depth of concrete under the pipe barrel of 0.25 D, where D is the nominal pipe bore, or 100 mm, whichever is the greater. The pipes should be supported clear of the trench bottom by means of blocks or cradles placed under the pipes immediately behind each socket and just clear of each spigot, or at both sides of the sleeve, where sleeve joints are used.

The blocks should extend the full depth of the bedding which should be cast monolithically. Free standing blocks may be used if they are of a suitable size which will not tilt or rock when pipes are added to the line. A minimum layer of compressible material should be placed between the support and the pipe to permit the barrel of the pipe to rest uniformly on its bed after normal setting shrinkage of the concrete has occurred. Expanded polystyrene or impregnated fiber building board are suitable for this purpose.

The concrete bed should extend equally on each side of the pipe to a width of 1.25 $B_c$ or $B_c$ + 200 mm, whichever is the greater, where $B_c$ is the outside diameter of pipe barrel, and should not be placed until the pipework has been inspected and deemed satisfactory.

Where flexible joints are employed, the overall flexibility of the pipeline should be maintained by the provision of flexible joints in the concrete. These should be formed through the full cross section of the concrete by providing compressible materials at least 20 mm thick (or that required to ensure the flexibility of the pipe joint), such as expanded polystyrene or impregnated fiber building board, at the face of each pipe socket or at one face of each sleeve. This is to ensure that any subsequent flexing occurs only at a pipe joint.

Care should be taken as follows:

**a)** In the placing of concrete, that the pipes or lateral construction joints are not displaced and flexibility of the joint is not impaired; and

**b)** to avoid excessive shear loads developing at joints, especially immediately below road surfaces.

### 7.5.6 Pipes laid in made ground

Ground which has been formed by loose tipping or has received inadequate compaction during placing may be subject to continuing consolidation and uneven settlement. Pipework laid in such ground should be of flexible material or should have flexible joints to allow uneven settlement to be accommodated without damage or loss of performance. Pipe gradients should be as steep as conditions permit to ensure that a backfall is not induced as a result of settlement.

### 7.5.7 Pipes laid in fluid ground

Where pipework is to be laid in ground which is fluid or water-logged expert advice should be sought.

## 7.6 Jointing Pipes

### 7.6.1 Flexible joints

The pipe manufacturer's instructions regarding the making of the joints should be followed closely. Only sliding ring joints should be lubricated, using the lubricants recommended by the manufacturers. The correct sealing rings should be used in jointing; if the rings are supplied separately from the pipes, care should be taken not to mix up different sizes.

Most types of flexible joint can be made in wet conditions, but it is preferable not to attempt jointing when the pipes are under water. The jointing faces and sealing rings should be clean and free from oil, grease, tar, mud or sand particles, prior to placing the joint ring on the spigot or in the socket or collar as specified.

When joints cannot be made manually, mechanical pulling devices should be used. Any disturbance of the pipe bed should be minimized, and made good. The specified gap should be left between the end of the spigot and the socket of the next pipe to permit movement. With some rolling-ring types of joint there is a tendency for the ring to unroll with small pipes, unless the pipe is temporarily held in the trench, during the pulling-in of the joint.

### 7.6.2 Rigid joints

While flexible joints are quicker to make and preferred, the older traditional rigid joints are still available with some pipe materials and for joining dissimilar pipes. Care should be taken to ensure that where they are used this is consistent with the overall design of the pipeline. If it is necessary to make the occasional rigid joint in a flexibly jointed pipeline, the rigid jointed section should be kept as short as possible.

Cement mortar for joints should be in a ratio of 1:3. The ends of the pipes should be wetted immediately before jointing and the joints kept damp and protected from the sun and wind until covered by the initial backfill. The interior of the pipe should be examined as each joint is made and any intrusions of mortar or gasket removed before further pipes are laid.

Concrete pipes with ogee or rebated joints are normally jointed with mortar but they cannot usually be made completely watertight by this means alone.

## 7.7 Ancillary Items

### 7.7.1 Junctions

Junctions should be inserted at intervals as required for present or future connections, during the construction of the sewers. All junctions which are not immediately connected to laterals should be closed with durable purpose-made watertight caps. The position of each junction should be carefully measured and recorded for as built drawings.

### 7.7.2 Gullies

Gullies should be set vertically and to the correct level; when necessary they should be surrounded in concrete, care being taken to prevent flotation (see Standard Dwg. IPS-D-CE-232).

### 7.7.3 Manholes

Manholes are either built by brickwork or concrete (see Std. Dwgs. IPS-D-CE-250, 251 and 252). Manholes are used to accept several secondary sewer lines to lead them into the main sewer line, or where change of direction in sewer line is required.

## 7.8 Trenchless Construction

Trenchless construction is any means of constructing new, or rehabilitating existing pipes underground without excavating an open trench.

For guidances refer to BS 6164: 1990 "Code of practice for safety in tunneling in the construction industry".

## 7.9 Backfilling (see also IPS-C-CE-112 and E-CE-110)

Generally care and attention should always be given to the placing and compaction of backfill, particularly where it forms part of a load-supporting system, e.g. under roads. Backfilling shall be placed symmetrically to prevent eccentric loading upon or against structures.

### 7.9.1 Sidefill and initial backfill

#### a) Rigid pipes

As soon as possible after completion of the bedding or surround, selected fill should be placed by hand and carefully compacted between the pipes and trench sides and brought up in 150 mm to 250 mm layers to at least 150 mm of compacted material above the pipe crown, taking care to avoid uneven loading and damage to the pipe. See also Clause 12 and Fig. 2 of IPS-E-CE-380.

Where mortar joints or concrete beddings are used, sufficient time should be allowed for them to gain strength to avoid damage during the backfilling operation.

#### b) Flexible pipes

The sidefill for flexible pipes other than ductile iron should be of the same granular material as that used for bedding (see Fig. 3 of IPS-E-CE-380). It should be taken to at least the level of the pipe crown and be carefully compacted. (The load carrying capacity of the pipes depends very largely on the compaction of the sidefill to provide the resistance to lateral deformation.) Selected backfill should then be placed and carefully compacted in layers to give at least one 150 mm layer above the pipe crown.

In most cases, for ductile iron pipes, tamped excavated natural material from the trench will be suitable for backfill. In instances of excessive depths, high vehicular loading or super loading from buildings, etc., or very poor soil properties it may be necessary to bring in a graded granular backfill.

Backfill should be built up in even layers not exceeding 300 mm, each layer being thoroughly compacted before further fill is added. Guidance on the selection of compacting equipment, with techniques and appropriate layer thicknesses for various types of soil is given in IPS-C-CE-112. The aim is to compact the fill as nearly as possible to the same density and moisture content as that of the undisturbed soil in the trench sides, but this is rarely achieved in practice and some subsequent settlement usually occurs. The compacting equipment should be such as to ensure that the pipes are not overloaded during the filling.

### 7.9.2 Backfilling around manholes

The method of backfilling and compacting around manholes should be generally as for trenches. Care should be taken to raise the fill equally all round the manhole shaft to avoid unbalanced lateral loading. Care is also necessary in placing the fill around free-standing manhole shafts which have been constructed in advance of an embankment (e.g. in a valley which is to be filled in subsequently); end-tipping of the fill in the vicinity of the manhole should be avoided.

Where there is a structural risk, precast concrete manholes should be surrounded with concrete 150 mm or more thick, possibly reinforced, depending on the loading conditions.

### 7.9.3 Backfilling around sewage pumping stations

The method of backfilling and compacting around sewage pumping stations that are constructed in open-cut procedure should be generally the same as described in Sub-clause 7.9.2.

## 7.10 Testing of Sewers

### 7.10.1 General

Sewers should be tested and inspected for infiltration and exfiltration to acceptable limits. Initial testing should be applied before any sidefill is placed. This will facilitate replacement of any faulty pipes or joints revealed by the test. Testing after placing backfill will reveal any leakage due to subsequent damage or the displacement of joints.

For the final acceptance test by AR* the line should be water tested from manhole to manhole. Any short branches may be tested concurrently with the main line but branches over approximately 10 m long should be tested separately.

### 7.10.2 Choice of test method

There are two test methods which are relatively simple and technically acceptable; these are based on the loss of either water or air.

As sewers are designed to carry liquids, the water test is to be preferred, but under site conditions an air test is usually quicker and more economical. Hence, contractors are recommended to carry out air tests also at their own cost to avoid replacing of faulty pipes and remaking of joints.

### 7.10.3 Air test

#### 7.10.3.1 General

The air test is easier to carry out than the water test and does not have the problem of providing and disposing of large quantities of water. It provides a rapid test which can be carried out after every third or fourth pipe is laid. This should prevent a faulty pipe or a badly made joint passing unnoticed until it is revealed by a test on a completed length. To replace a faulty pipe or remake a joint in the middle of a pipe run is a time consuming and costly operation. A smoke test can indicate the location of a failure. Air test will be performed only by the jurisdiction of AR.

#### 7.10.3.2 Procedure

For test procedure refer to BS 8005: Part 1.

### 7.10.4 Water test

#### 7.10.4.1 General

Gravity sewers up to and including DN 750 should be tested to an internal pressure represented by 1.2 m head of water above the crown of the pipe at the high end of the line. The test pressure should not exceed 6 m head of water at the lower end and if necessary the test on a pipeline can be carried out in two or more stages. The test pressure should be related to the possible maximum level of groundwater above the sewer.

When pipes larger than DN 750 are to be tested, expert advice and special equipment may be needed.

Gravity drains and private sewers within curtilage up to and including 300 mm diameter should be tested to an internal pressure of 1.5 m head above the invert of the pipe at the high end of the line and not more than 4 m head at the lower end.

Testing should be carried out between inspection chambers, manholes or other suitable points of access and through any accessible branch drains. Where the test head of water is in excess of 4 m at the lowest point of the pipeline under test (including the minimum test head of 1.5 m), solvent welded uPVC pipelines should be allowed to stand for 1 to 2 h before applying the test and should be suitably anchored to prevent flotation when the test is applied before backfilling the trench.

*** AR = Authorized Representative of the Owner.**

#### 7.10.4.2 Test procedure

The following test procedures with the indicated limits of exfiltration can be adopted as acceptable choices.

**a)** Fit an expanding plug, suitably strutted to resist the full hydrostatic head, at the lower end of the pipe and in any branches if necessary. The pipes may need strutting to prevent movement.

**b)** Fit a similar plug and strutting at the higher end but with access for hose and standpipe.

**c)** Fill the system with water ensuring that there are no pockets of entrapped air.

**d)** Fill the standpipe to requisite level.

**e)** Leave for at least 2 h to enable the pipe to become saturated, topping up as necessary.

**f)** After the absorption period measure the loss of water from the system by noting the amount of water needed to maintain the level in the standpipe over a further period of 30 min., the standpipe being topped up at regular intervals of 5 min.

The rate of loss of water should be not greater than 1 litre per hour per meter diameter per meter of pipe run. The water level in the manholes should not drop more than 100 mm.

#### 7.10.4.3 Factors affecting the test

Excessive leakage may be due to the following:

**a)** porous or cracked pipes;
**b)** damaged, faulty or improperly assembled pipe joints;
**c)** trapped air being dissolved;
**d)** defective plugs;
**e)** pipes or plugs moving.

### 7.10.5 Freedom from obstruction

As the work progresses the sewer should be checked for obstructions by visual inspection or by inserting a mandrel or ‘pig’ into the line.

### 7.10.6 Straightness

A sewer should be checked for line and level at all stages of construction. Methods of checking include the following:

**a)** surveyor’s level and staff;
**b)** sight rails, boring rods and travelers;
**c)** laser beams with sighting targets;
**d)** lamp and mirrors.

### 7.10.7 Soundness tests for ancillary works

#### 7.10.7.1 General

Recommendations given in the IPS Standards for the materials, design and construction of manholes, and similar underground chambers should ensure a high level of resistance to water penetration, both inwards and outwards.

Manholes should be so constructed that no appreciable flow of water penetrates the permanent works.

Where construction work has been effectively carried out, visual inspection of ancillary works may be sufficient for acceptance without specific testing. Inspection should always be made to reveal any possible weaknesses in the structure and particular attention should be paid to the following:

**a)** step iron and ladder housings;
**b)** benchings;
**c)** pipes entering or leaving the structure;
**d)** joints in brickwork or blockwork;
**e)** joints between sections of the structure.

If required, the inspection should be followed by specific testing (see 7.10.7.2 to 7.10.7.6).

### 7.10.7.2 Reasons for specific testing

There may be a need for testing to be carried out in any of the following cases:

**a)** for petrol interceptors, suction wells and similar structures;

**b)** where unsatisfactory features have been revealed by inspection, e.g. where there is reason to believe that materials or workmanship have been inadequate;

**c)** in locations where there is fissured chalk or rock, or pervious subsoil;

**d)** where frequent surcharging of the manhole is likely.

### 7.10.7.3 Test head

Manholes less than 1.5 m in depth to invert should be filled with clean water to the underside of the cover and frame located at ground or surface level. Where the depth to the channel invert is 1.5 m or greater, the test head should be not less than 1.5 m. The test head for petrol interceptors, suction wells and similar underground chambers should be not less than 0.5 m above the invert of the highest connection to the chamber.

Where the chamber is located in ground subject to pore pressure, the test head should be the mean water table level based on seasonal variations or test heads previously specified, whichever is the greater.

### 7.10.7.4 Test procedures

Tests should not be carried out until structures have reached sufficient strength to sustain the pressure from testing.

The external faces of a structure should not normally be backfilled or concrete surrounded before the chamber is filled with water to the specified test level. Adequate stability should be ensured during the period of test and subsequent concrete placement and backfilling.

For the tests fit a bag stopper in the outlet of the manhole and expanding plugs or bag stoppers in all other connections. Secure all plugs and stoppers to resist the full hydrostatic head and provide means of safely removing the outlet bag stopper from the surface.

Fill the manhole with clean water to the required test level and allow to stand for at least 8 h for absorption, topping up the level as necessary. Carry out the tests as rapidly as possible.

**Note:**

**These tests should show that the construction is substantially watertight.**

#### 7.10.7.5 Acceptance criteria

The rate of water loss should not exceed 1 L/h per meter diameter per linear meter run of pipe. For various pipe diameters this rate of loss over a 30 min. period may be expressed as follows:

| | |
|---|---|
| DN 100 pipe | 0.05 litres per meter run; |
| DN 150 pipe | 0.08 litres per meter run; |
| DN 225 pipe | 0.12 litres per meter run; |
| DN 300 pipe | 0.15 litres per meter run. |

#### 7.10.7.6 Testing of watertight structures

Sumps, suction wells, mud and oil interceptors, petrol interceptors, oil separators, septic tanks and cesspools should be tested for watertightness as described in 7.10.7.4 but over the full height to surface level and without measurable loss of water after 30 min.

## 8. INSPECTION OF PIPELINES, SERVICES AND INSTALLATIONS

### 8.1 Procedure

#### 8.1.1 General

Inspections and tests shall be undertaken as work proceeds. Prior notice shall be given to the water supplier before any statutory inspections or tests are undertaken. Records of all tests required by the specification shall be kept by the installer.

**Note:**

**Testing should normally take the form of both interim or preliminary and final tests as stated in Clause 5.9.**

#### 8.1.2 Timing

The timing of tests shall be arranged as follows:

**a) Interim Tests:** As soon as practicable after completion of the particular section, with particular attention to all work which will be concealed.

**b) Final Tests:** To be carried out on completion of all work on the water services and prior to handing over.

#### 8.1.3 Inspection

Visual inspections shall be carried out at both interim and final testing in order to detect faults in construction or material not shown up under test but which could lead to failure at a later date, possibly after expiry of the contractual maintenance period.

**Note:**

**This is particularly important in the case of an interim test where the installation will be covered up as work proceeds.**

A careful record shall be kept of such inspections, and notes taken to facilitate the preparation of "as installed" drawings.

In the case of visual inspection of pipelines, particular attention shall be paid to the pipe bed, the line and level of the pipe, irregularities at joint, the correct fitting of air valves, washout valves, sluice valves and other valves together with

any other mains equipment specified, including the correct installation of thrust blocks where required, to ensure that protective coatings are undamaged. Trenches shall be inspected to ensure that excavation is to the correct depth to guard against frost and mechanical damage due to traffic, ploughing or agricultural activities. No part of the pipe trench shall be backfilled until these conditions have been satisfied and the installation seen to comply with the drawings and specifications and the appropriate laws and regulations.

All internal pipework shall be inspected to ensure that it has been securely fixed.

### 8.1.4 Testing of installations within buildings

When the installation is complete it shall be slowly filled with water, with the highest draw-off point open to allow air to be expelled from the system.

If the water is obtained from the water supplier's mains, it shall be taken in accordance with the supplier's requirements. The installation, including all cisterns, tanks, cylinders and water heaters, shall then be inspected for leaks.

**Note:**

**It is desirable that the installation then be tested hydraulically in the following way. Subject the pipes, pipe fittings and connected applicances to a test pressure of at least 1.5 times the maximum working pressure, with the pressure applied and maintained for at least 1 h and check that there is no loss of water or visual evidence of leakage. Water byelaws require that any pipe or fitting that is not readily accessible has to be capable of withstanding twice the maximum working pressure.**

Each draw-off tap, shower fitting and float-operated valve shall be checked for rate of flow against the specified requirements. Performance tests shall also be carried out on any connected specialist items to show that they meet the requirements detailed in the specification.

Defects revealed by any of the foregoing tests shall be remedied and the tests repeated until a satisfactory result is obtained.

## 8.2 Water Distribution Mains

### 8.2.1 General

It is essential that procedures for the operation, modification, repair and inspection of pipelines are formulated and adhered to so that a pipeline continues to function safely whilst in use. The operating body should develop procedures for operating, modifying, repairing and inspecting pipelines based upon the recommendations given here and upon best industry practice.

### 8.2.2 Routine inspection

Routine visual inspection of land pipelines should be made to check on the condition of the pipeline easement. Any third party activity on, or adjacent to the pipeline easement and which could affect the integrity of the pipeline should be investigated. The frequency of such inspection may vary dependent upon local conditions. Any excavation or development occurring near buried pipelines should be monitored.

Arrangements should be made with the Company and occupiers to permit a routine programme of inspection of the route. In the absence of any such arrangement, except in cases of emergency, prior written notice of all pipeline inspections involving entry on land should be given to the occupiers.

All persons carrying out inspections should carry and produce on request adequate means of identification.

### 8.2.3 Water analysis

Regular analyses of water samples at intervals not exceeding 6 months shall be carried out wherever bulk drinking water storage exceeds 1000 L.

**Note:**

**Periodic chemical and bacteriological analysis of water samples is a useful guide to the condition of an installation. The collection and analysis of water samples is particularly recommended for new installations in large buildings or complexes and where extensive repairs or alterations have been carried out to such installations.**

### 8.2.4 Pipework

#### 8.2.4.1 Fixings and supports

Any loose or missing fixings or supports shall be made good. Provision for expansion and contraction shall be checked, particularly in the case of plastics pipework.

#### 8.2.4.2 Joints

Leaking joints shall be tightened or remade, or where necessary the pipework shall be renewed, to stop all leakage.

#### 8.2.4.3 Corrosion and scaling

If inspection reveals corrosion of the pipework or reduced flow rates indicate the possibility of corrosion products or scale obstructing waterways, the cause shall be investigated and appropriate remedial action taken.

**Notes:**

**a) Pipe showing signs of serious external corrosion should be replaced. The replacement pipe should have suitable protection (e.g., factory plastics coated, spirally wrapped or sleeved with an impervious material) or should be of a corrosion resistant material compatible with the remaining pipework.**

**b) Internal corrosion of galvanized steel pipe is usually localized, requiring replacement of the affected section only. The whole pipe length between joints should be replaced to retain continuity of galvanizing or other protection.**

#### 8.2.4.4 Thermal insulation and fire stopping

Any damage to thermal insulation or fire stopping revealed during inspection shall be made good.

**Note:**

**Thermal insulation used for frost protection should be checked at the beginning of each winter.**

### 8.2.5 Terminal fittings and valves

#### 8.2.5.1 Terminal fittings

As soon as any sign of leakage from a float-operated valve (e.g., dripping from a warning pipe) or tap is noticed the fitting shall be rewashered, reseated or replaced as necessary to stop the leakage. The action of self-closing taps shall be checked at regular intervals and any necessary repairs or adjustments carried out.

**Note:**

**In addition to preventing leakage, the free movement of infrequently used float-operated valves, particularly those fitted to the feed and expansion cisterns of hot water or space heating systems should be checked at intervals not exceeding one year (see also IPS-I-AR-115).**

**Spray heads on taps and showers should be cleaned at such intervals as experience indicates.**

**Gland packings on taps should be tightened or renewed as necessary to prevent any leakage while not impeding the normal operation of the fitting.**

#### 8.2.5.2 Stopvalves

Stopvalves shall be operated at least once per year to ensure free movement of working parts.

**Note:**

**Any stiffness or leakage through the gland should be dealt with by lubrication, adjustment or replacement of gland packings or seals. If there is any indication of leakage past the seating the valve should be rewashered, reseated or replaced as necessary. If there is any indication that the waterway is blocked, the valve should be dismantled, cleared and restored to good working order or replaced.**

#### 8.2.5.3 Relief valves

Easing gear fitted to relief valves shall be operated at least once per year to check that the valve has not stuck or become blocked. Any fault revealed shall be corrected immediately.

**Note:**

**Since relief valves are explosion prevention devices it is important to check their operation at regular intervals. Operation of easing gear may sometimes cause the valve to leak and so involve additional attention; this is infinitely preferable to an explosion. For more details refer to IPS-I-AR-115.**

### 8.2.6 Cisterns

Cisterns shall be inspected from time to time to ensure that overflow and warning pipes are clear, that covers are adequate and securely fixed, and that there are no signs of leakage or deterioration likely to result in leakage. Cisterns storing more than 1000 L drinking water shall be inspected at least once every 6 months, those storing less than 1000 L drinking water at least once per year.

## 9. INSPECTION OF SEWERAGE WORKS

### 9.1 General

Surveys of both sewers and manholes are undertaken for several reasons. The nature and detail of the data to be collected will depend on the objective, and may influence the method of recording findings.

Common objectives are as follows:

**a)** to investigate causes of poor performance, or of suspected deterioration (e.g. frequent blockage, smell complaints, pipe fragments in manholes);

**b)** to locate and inspect sewers prior to change in their use, or in the use of the surface above them (with the objective of executing necessary repairs);

**c)** to record the condition of a sewer immediately prior to adjacent workings (with the objective of attributing liability for any associated damage);

**d)** to measure the flows and periodically update sewer records.

Internal sewer surveys may be classified as either operational (or service condition) surveys, or as structural surveys.

### 9.2 Operational Surveys

Operational surveys are carried out to provide information on the following:

**a)** the necessity for, and nature and frequency of, cleaning to verify the recommendations given under 9.5;

**b)** possible structural weaknesses which may be indicated by the type of sediment (inflow from voids, rubble, bricks, etc.);

**c)** tree root systems which might cause blockages;

**d)** sediment which may indicate bad or flat construction even though the sewer may be sound;

**e)** the necessity for flushing and cleansing operations;

**f)** heavy concentrations of debris indicating the possibility of collapse;

**g)** the presence of noxious gases indicating sediment and septicity problems which could lead to fabric deterioration.

### 9.3 Structural Surveys

Structural surveys provide information on the following:

**a)** possible renewal or renovation costs;
**b)** major defects which can lead to collapse;
**c)** the condition and life of sewer fabric.

### 9.4 Survey Method

The surveying method for the condition of manholes, sewers, sewage pumping stations, outfall structures etc.,is influenced by survey objective, costs and size of sewer network.

### 9.5 Planned Inspections and Reports

In normal circumstances, regular planned inspections should be made on the existing sewerage works as follows:

#### 9.5.1 Manhole and sewer line surveys

Manholes and sewer lines should be surveyed at 12 month intervals over the first 3 years of its life, and every 3 years thereafter.

The position of all manholes along a length of sewer can be determined by referencing the manhole covers to permanent features of detail on the ground (i.e.,buildings, fences, kerb lines, etc.).

In rural areas the manhole positions can be plotted on to 1/2500 scale maps giving a positional accuracy of ±1m, and for urban areas on to 1/1250 scale maps giving positional accuracy of ±0.15 m.

The sewer centerline should be determined in relation to each manhole center and plotted as an approximate line between manholes. The resulting information should be plotted on to the appropriate map.

All information recorded in the field should be properly indexed and cross-referenced for future use.

Sewer invert and cover levels should be related to Owner's Bench Marks. An accuracy of ±25 mm should be aimed at for all sewer leveling.

Cut marks can be established on manhole frames directly over the sewer invert if possible, and the distance from cut mark to sewer invert is measured very accurately down the manhole shaft. In shallow sewers the invert level may be read directly whilst surface leveling is being carried out.

It is convenient to store collected information on a standard data sheet. The level of the center of each manhole cover should be recorded in the field and booked to the nearest 10 mm on the sewer map.

The survey information thus carried out should be produced in the form of at least a written report.

### 9.5.2 Survey of sewage pumping stations, sewage treatment plants and sewage rising mains and outfalls

In normal circumstances, well designed pumphouses, treatment plants and outfalls should give satisfactory service without routine attention. Evidence of a build-up in wet well of crude sewage pumphouse and continuous operation of the pumps in full capacity is a sign of serious problem demanding emergency inspection.

The sewage pumping stations, sewage treatment plants, rising mains and outfalls should be physically checked and inspected regularly at 6 month intervals over the first 2 years of their life, and every 2 years thereafter.

A build-up of slime or sediment within the rising main and outfall may be observed by increases in the head required to maintain discharge at a given tidal state. If there is a marked decrease in the retention period in the outfall at a given rate of flow, the installation should be monitored regularly as regards hydraulic performance.

Systematic recording of the structural defects such as cracks, settlements, wear and tear at the intervals mentioned above, together with structural failure risk assessment could result in substantial savings by timely preventive measures.

As regards the ultimate outfall into the sea or river, the full route of the pipe should be inspected by engineering divers to note any signs of damage or other unsatisfactory conditions. Particular attention should be given to the following:

**a)** abrasion of the outer protective coating;
**b)** the physical condition of the outfall supporting structure;
**c)** excessive growths of marine organisms at the mouth of outfall.

## 9.6 Inspection and Repair of Accessories

In addition to a detailed inspection of the sewers to ensure that they have been constructed or repaired to the specification and are clear of silt and other debris, all step irons, ladders, landings, guard rails and chains should be checked to ensure that they are securely fixed and set in the correct position. Manhole covers should be correctly set and their frames properly bedded. A check should be made to ensure that any previously live connections have been remade.

The performance of a new or repaired sewer should be monitored for a period.

All statutory undertakers and those directly connecting to the sewer should be advised when the sewer has been put into use. Those responsible for sewer operation and maintenance, pumping stations and treatment works should be notified beforehand of the date when the sewer will be commissioned and advised as soon as it has been put into use.

Final inspection of sewers and manholes constructed under a contract should be made before the completion of the maintenance period in order that any defects can be remedied before the conclusion of the contract.

All drawings of works as executed should be kept. All inspection records should be kept for at least 12 months after completion of the works. Sewer maps should be updated in respect of new sewers, removed sewers and closed sewers.

For operational, maintenance and repair guidances refer to clause 15, 16 and 17 of BS 8005, Part 1: 1987.

### 9.7 Building Drainage

Drainage systems within curtilage should be inspected at regular intervals of 6 to 12 months and, where necessary, thoroughly cleaned out at the same time. Any defects discovered should be made good.

### 9.8 Drainage of Roofs and Paved Areas

#### 9.8.1 Periodic inspection and cleaning

Gutters, rainwater pipes, outlets and gratings should be inspected and thoroughly cleaned once a year, or more often if the building is in or near an industrial area, or is near to trees, or may be subjected to extremes of temperature.

Gullies and channels of paved areas (e.g. car-parks) should be inspected, and cleaned out, regularly. The frequency of inspection and cleaning will need to be based on local experience.

Defects should be remedied as soon as possible after being noted.

# APPENDICES

## APPENDIX A
## JOINTING OF POTABLE WATER PIPEWORK

The table below lists the jointing methods and materials that should be used for jointing potable water pipework.

| No. | TYPE OF JOINT | METHOD OF CONNECTION | JOINTING MATERIAL | PRECAUTIONS/LIMITATIONS |
|---|---|---|---|---|
| 1 | Lead to brass, gunmetal, pipe or fitting | Plumber's wiped soldered joint | Tallow flux | Of very limited application, see 3.2 and 3.3.4 of BS 6700. Also see note at bottom |
| 2 | Galvanized steel (pipe to pipe or fitting), | Screwed joint, where seal is made on the threads | PTFE tape or proprietary sealants | PTFE tape only up to 40 mm (1½) diameter. See note at bottom |
| 3 | Galvanized (pipe to pipe or fittings) | Flanges | Elastomeric joint rings complying with BS 2494, or corrugated metal | See note at bottom |
| 4 | Long screw connector | Screwed pipework with BS 2779 thread | Grummet made of linseed oil based paste and hemp | See note at bottom |
| 5 | Shouldered screw connector | Seal made on shoulder with BS 2779 thread | Elastomeric joint rings complying with BS 2494 and plastics materials | — |
| 6 | Unplasticized PVC (pipe to fitting) | Solvent welded in sockets | Solvent cement complying with BS 4346: Part 3 | — |
| 7 | Unplasticized PVC (pipe to fittings) | Spigot and socket with ring seal, flanges, union connectors | Elastomeric seal complying with BS 2494 lubricants | Lubricant should be compatible with the unplasticized PVC and elastomeric seal |
| 8 | Cast iron (pipe to fitting) | Caulked lead | Sterilized gasket yarn/blue lead | See note at bottom |
| | | Bolted or screwed gland joint | Elastomeric ring complying with BS 2494 | — |
| | | Spigot and socket with ring seal | Elastomeric seal and lubricant | — |
| 9 | Plastic (pipe to tap or float-operated valve) | Union connector | Elastomeric or fiber washer | — |
| 10 | Pipework connections to storage cisterns (galvanized steel, reinforced plastics, polypropylene, polyethylene) | Tank connector/union with flange backnut | Washers: elastomeric, polyethylene, fiber | — |
| 11 | Polyethylene (pipe to fitting) | Non-manipulative fittings | — | Do not use lubricant |
| | | Thermal fusion fittings | — | — |
| 12 | Polybutylene (pipe to pipe or fitting) | Non-manipulative fittings | Lubricant on pipe end when required | Lubricant if used should be listed and compatible with plastics |
| | | Thermal fusion fittings | — | — |
| 13 | Polypropylene (pipe to pipe) | Non-manipulative fittings | Lubricant on pipe end when required | Lubricant if used should be listed and compatible with plastics |
| | | Thermal fusion fittings | — | — |
| 14 | Cross-linked polyethylene (pipe to fitting) | Non-manipulative fittings | Lubricant on pipe end when required | Lubricant if used should be listed and compatible with plastics |
| 15 | Chlorinated PVC (pipe to fitting) | Solvent welded in sockets | Solvent cement | — |

**Note:**

**Where non-listed materials are to be used, due to there being no alternative, the procedure used should be consistent with the manufacturer's instructions taking particular note of the following precautions:**

**a) use least quantity of material to produce good quality joints;**

**b) keep jointing materials clean and free from contamination;**

**c) remove cutting oils and protective coatings, and clean surfaces;**

**d) prevent entry of surplus materials to waterways;**

**e) remove excess materials on completion of the joint.**