

**UPVC**  
PRESSURE



## uPVC

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## PRESSURE

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## OVERVIEW

Gulf Eternit Trading (GET) a part of Future Pipe Industries Group (FPIG), is a supplier of uPVC Pipes and Fitting according to the latest standards, where products are continuously monitored thru Quality Control to ensure meeting the requirements of the International standards and specifications.

## ACCREDITATIONS

Future Pipe Group is accredited for the Quality Management System (BS EN ISO 9001:2000) and Environmental Management System (BS EN ISO 14001:1996). In addition, certificates of the suitability to transmit potable water from the Water Regulation Advisory Scheme (WRAS) Great Britain and the National Sanitation Foundation (NSF) USA.



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## **1. INTRODUCTION**

Gulf Eternit Trading (GET) a part of Future Pipe Industries Group (FPIG), is a supplier of uPVC Pipes and Fitting according to the latest standards, where products are continuously monitored thru Quality Control to ensure meeting the requirements of the International standards and specifications.

The smooth bore of uPVC pressure pipe offers less resistance to flow than conventional pipes. As result, it has excellent flow characteristics with minimal frictional loss. uPVC pipe is non-toxic, and imports neither taste nor odor, making it ideally suited for potable water supply.

The maximum sustained working pressures of uPVC pipes are based on the fluid temperature at 20°C. For use at higher fluid temperature (up to a maximum of 60°C), refer to the graph in Appendix A for selecting the correct class of pipe.

uPVC has exceptional resistance to attack from all concentrations of alkalis and to high concentrations of acids. uPVC pipes should not be considered for use with aromatic and chlorinated hydrocarbons, ketones, esters and ethers. A detailed list of chemicals and their effect on uPVC pipe is given in Appendix B.

uPVC pipe is immune to all types of corrosion that takes place in underground piping systems. As uPVC is non-conductive, the effects of galvanic and electrochemical corrosion are non-existent in uPVC piping systems, making it an ideal dueling system for Electrical and Telephone cables.

GET is supplier of uPVC pipe in different International Standards to suit various applications viz. pressure pipes for water distribution, soil-waste and ventilating pipes, underground drain and sewer pipes, cable ducts for Electrical and telephone cables and conduits for Electrical wiring installations.

A detailed list of our product range and dimensions are given in the following pages.

## 2. GENERAL PROPERTIES OF uPVC MATERIAL

Being a thermoplastic material, uPVC physical properties vary with temperature. The relationship between temperature and working pressure is shown in appendix-A Therefore, it is important to take into account the temperature conditions in selecting the Class of the pipe.

Property	Unit	Value
Density	gr./cc	1.4 - 1.45
Tensile strength	M Pa	45 - 50
Elongation	%	80 - 150
Compressive strength	M Pa	59
Modulus of elasticity	M Pa	3000
Specific heat	Cal/g/°C	0.24
Thermal conductivity	Kcal/m/h °C	0.12
Heat distortion temperature at 18.5Kgf/cm <sup>2</sup>	°C	70
5Kg. Vicat softening point	°C	80
Linear expansion	mm/m/ °C	0.08
Volume resistivity	Ohm/cm	10.5
Flammability	Self extinguishing	

## 3. MANUFACTURING STANDARDS

Manufacturing Standards are mainly based on BS, DIN and ISO Standards. The ISO is represented by all the developed countries in the world and its recommendations are based on various expert proposals presented by these member countries.

Also incorporated into its manufacturing range certain popular sizes of other standards viz. ETISALAT, ASTM etc., in order to serve customers interest.

Upon specific request from the customers, also produces non-standards-pipes, which are specifically formulated to suit customer requirements.

## 4. MANUFACTURING RANGE

uPVC pipes come in DIN/ISO Standard sizes from 12 mm to 315 mm outside diameter in various pressure classes 4, 6, 10 and 16 bar.

Pressure pipes are manufactured from 1/2 to 8" nominal size in classes C, D and E.

uPVC pipes are available with plain ends or integral socketed ends suitable for solvent welding (S/W). Also most of the pressure pipes from dia 63mm upwards are available with push-fit (R/R) sockets in various pressure classes. The standard length of pipe is 6 meters including the integral sockets.

**uPVC Pipes to BS EN 1452:2000 for Water Supply**

Nominal Size	Mean Outside Diameter		Minimum Wall Thickness		
	Minimum mm	Maximum mm	(Class - C) PN-9	(Class - D) PN-12	(Class - E) PN-15
1/2	21.2	21.5	-	-	1.7
3/4	26.6	26.9	-	-	1.9
1	33.4	33.7	-	-	2.2
1 1/4	42.1	42.4		2.2	2.7
1 1/2	48.1	48.4	-	2.5	3.1
2	60.2	60.5	2.5	3.1	3.9
*3	88.7	89.1	3.5	4.6	5.7
*4	114.1	114.5	4.5	6.0	7.3
*6	168.0	168.5	6.6	8.8	10.8
*8	218.8	219.4	7.8	10.3	12.6

**Note:** Pipe can be produced to BS 3505:1986 upon customer request.

- Pipes to this specification will be supplied in 6-meter lengths with Integral Solvent Weld Socket or plain ends in dark grey color.

\* These sizes are also available with Push-Fit (R/R) socket in Class C, D and E, upon request.

\* 12" dia is also available in class C, D and E.

- Effect of material on water quality

The samples tested have satisfied the criteria set out in BS 6920:

Part 1: 1990 when tested in accordance with the methods specified in BS 6920:

Part 2: 1990 "Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water: Methods of Test:"

**uPVC PIPES TO DIN 8061 / 8062 (Based on ISO 161/1 Metric Series)**

Outside Diameter mm	Series - 2 4 bar (Class - 4) mm	Series - 3 6 bar (Class - 6) mm	Series-4 10 bar (Class - 10) mm	Series-5 16 bar (Class - 16) mm
12	-	-	-	1.0
16	-	-	-	1.2
20	-	-	-	1.5
25	-	-	-	1.9
32	-	-	1.8	2.4
40	-	1.8	1.9	3.0
50	-	1.8	2.4	3.7
*63	-	1.9	3.0	4.7
*75	1.8	2.2	3.6	5.6
*90	1.8	2.7	4.3	6.7
*110	2.2	3.2	5.3	8.2
*160	3.2	4.7	7.7	11.9
*200	4.0	5.9	9.6	14.9
*225	(4.5)	6.6	10.8	16.7
*250	(4.9)	7.3	11.9	18.6
*315	6.2	9.2	15.0	23.4

- The above dimensions are based on ISO Standard ISO 161 /1-1978 and equation  

$$e = \frac{p.d.}{2\sigma+p}$$
 where N/mm<sup>2</sup>
  - The pressure rating given above in bars is the working pressure at 20°C
  - The tolerances on outside diameter and wall thickness are based on ISO 3606-1976.
  - Pipes will be supplied in 6-meter lengths with integral Solvent Weld Socket or plain ends in dark grey color.
- \* These sizes are also available with Push-Fit (R/R) Sockets in 6, 10 and 16-bar range



## 5. uPVC PRESSURE PIPES ISO 161-1/4422 - EN1452

### Application

Unplasticised Polyvinyl Chloride (uPVC) Pressure Pipes are manufactured in accordance ISO 161-1/4422 & EN 1452 for all pressure classes PN6, PN10, PN 12.5, PN 16 and PN 20 in a range from Dia 50mm to 315mm suitable for transfer of pressurized Potable Water lines.

### Socket Type

uPVC pressure are fitted with an integral socket designed to withstand the applicable design pressure of the pipe. The entire product range is fitted with a Push Fit (R.R.) socket. The socket shall be Solvent Cement (S.C.) socket only for Dia 50mm.

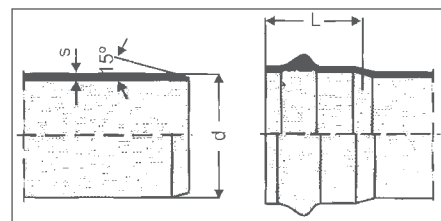
### Range and Dimensions ISO 161-1/4422 - EN 1452

d	S SDR 34.4 (PN 6)	S SDR 21 (PN 10)	S SDR 17 (PN 12.5)	S SDR 13.6 (PN 16)	L*	Socket Type
50	-	2.4	3.0	3.7	50	S.C.
63	1.9	3.0	3.8	4.7	120	R.R.
75	2.2	3.6	4.5	5.6	125	R.R.
90	2.7	4.3	5.4	6.7	135	R.R.

d	S SDR 41 (PN 6)	S SDR 26 (PN 10)	S SDR 17 (PN 12.5)	S SDR 17 (PN 16)	S SDR 17 (PN 20)	L*	Socket Type
110	2.7	4.2	5.3	6.0	8.1	140	R.R.
125	3.1	4.8	6.0	7.4	9.2	148	R.R.
160	4.0	6.2	7.7	9.5	11.8	155	R.R.
200	4.9	7.7	9.6	11.9	14.7	175	R.R.
250	6.2	9.6	11.9	14.8	18.4	192	R.R.
315	7.7	12.1	15.0	18.7	23.2	200	R.R.

For other sizes, thickness and socket type, please contact Gulf Eternit Trading for details.

All pipes are supplied in 6 meter length with Dark Grey color.



**uPVC Pipes to BS 3506:1996 for Industrial Uses**

Nominal Size	Mean Outside Diameter		Wall Thickness				
	Minimum mm	Maximum mm	Class O Non Pressure mm	Class B 6 bar mm	Class C 9 bar mm	Class D 12 bar mm	Class E 15 bar mm
1/2	21.2	21.5	-	-	-	-	1.7
3/4	26.6	26.9	-	-	-	-	1.9
1	33.4	33.7	-	-	-	-	2.2
1 1/4	42.1	42.4	-	-	-	2.2	2.7
1 1/2	48.1	48.4	1.8	-	-	2.5	3.1
2	60.2	60.5	1.8	-	2.5	3.1	3.9
2 1/2	75.0	75.3	1.8	-	3.0	3.9	4.8
*3	88.7	89.1	1.8	2.9	3.5	4.6	5.7
*4	114.1	114.5	2.3	3.4	4.5	6.0	7.3
*6	168.0	168.5	3.1	4.5	6.6	8.8	10.8
8	218.8	219.4	3.1	5.3	7.8	10.3	12.6

- Pipes to this specification will be supplied in 6-meter lengths with Integral Solvent Weld Socket or plain ends, in dark grey color.

\* These Sizes are also available with Push-Fit (R/R) sockets in class C, D and E.

\* 12" dia is also available in class C, D and E.

- Please note that it is clearly stated in this specification that "pipe complying with BS3505 is deemed to comply the corresponding class in this standard".

**uPVC Ducts For Electrical/ Telephone Cables as per B.P.O./ Etisalat Specifications**

Duct Number	Outside Diameter		Wall Thickness	
	Mean O.D. mm	Tolerance mm	Minimum Inch	Tolerance Inch
56	53.9	±0.1	1.55	+0.15
54D	96.5	± 0.2	3.25	+ 0.40
57	114.3	± 0.2	3.40	+ 0.40
57A	114.3	± 0.2	4.50	+ 0.40

- Pipes to this specification will be supplied in 6 meter lengths, with Integral Solvent Weld socket or plain ends in black color.

## 6. HANDLING, STORAGE AND TRANSPORTATION

uPVC pipes are strong though light in weight (being about one-fifth the weight of steel or cast iron). The following instructions should be followed for Storage, Handling and Transportation of uPVC pipes.

### **Storage & Handling:**

- a) Pipes should be given adequate support at all times, and should be stacked on a flat surface free of sharp objects.
- b) Pipes should be uniformly supported throughout their length. 3-inch wide timber supports should be placed beneath the pipes with a spacing not greater than 1.5 meters.
- c) Pipe stack height should be kept to a minimum in such a way that the bottom pipes do not deform, and the stack should be provided with side supports at spacings not greater than 1.5 meters.
- d) Socketed pipes should be stacked in layers with sockets placed at alternate ends of the stack, and with the sockets protruding so as to avoid deformation of sockets and to ensure even support for the pipe lengths.
- e) In U.A.E. and other surrounding Gulf countries, the uPVC pipes should not be stored for extended periods under direct sunlight to avoid ultraviolet degradation. Even if the pipes are stored under cover the stack heights should be reduced to a minimum when high ambient temperatures are encountered.
- f) Since the soundness of the joint depends on the condition of the spigot and socket, special care could be taken at all times to avoid damage to these ends.

### **Transportation:**

- a) When loading pipes onto vehicles, care should be taken to avoid impact and ensure the vehicle board is free of any sharp objects like nails, cope irons etc.
- b) Where mechanical handling is employed, metal slings, hooks and chains must not come into direct contact with the pipe.
- c) While in transit, pipe should be well secured and well supported over their entire length.
- d) Loose pipes may be off loaded from vehicles by rolling them gently over the timbers without causing any impact to the pipe, while crated pipes could be offloaded using forklifts or cranes.

## 7. SOLVENT CEMENT JOINTING OF uPVC PIPES

All uPVC pipes up to 315mm diameter can be supplied complete with integral solvent weld sockets. All sockets are slightly tapered for easy spigot entry. A pressure-tight joint is formed when the spigot is bonded into the socket by the action of solvent cement applied to both bonding surfaces.

The following procedure is to be strictly followed to make a leak proof joint:

- 1) Mark depth of entry of the spigot and the alignment mark.
- 2) Thoroughly abrade spigot and socket bonding surfaces using sandpaper.
- 3) Clean bonding surfaces with cleaning fluid (MEK cleaner).
- 4) Using a clean brush apply cement evenly and in one coat to spigot and socket in longitudinal strokes. Where loose fits are found a second coat should be applied to the spigot end.
- 5) Immediately and without twisting insert spigot into the socket until entry-mark, hold in position for few seconds then wipe off excess cement.

### Important Notes:

- Drying time varies according to ambient temperature, pipe diameter, type and amount of cement used. However, allow a minimum of 24 hrs before pressure testing.
- Replace the lid of the container as soon as the cement is applied and observe the instructions given on the container.
- Solvent cement and cleaner should be stored in a cool and dry place.
- Never dilute the solvent cement with any other fluids.



## 8. PUSH-FIT (R/R) JOINTING OF UPVC PIPES

The Push-Fit (R/R) socket is formed as an integral part of the pipe. The elastomeric sealing ring locates positively within the socket groove permitting easy entry of the spigot while ensuring a pressure-tight seal under all recommended working pressures.

### Joining Procedure

- 1) Carefully clean and examine the spigot, rubber sealing ring and the inside of the socket.
- 2) Form a loop and insert the rubber ring with the thickest edge innermost.
- 3) Allow the ring to seat evenly around the groove, finally snapping into position by pressing down on the remaining portion of the loop.
- 4) Lubricate the chamfered end of the pipe a minimum distance of half the spigot length.
- 5) Push the pipe into the socket up to the insertion mark previously made after making sure that the pipes are aligned both in horizontal and vertical planes.



## 9. INSTALLATION

### Trench Preparation:

The width of the trench at the crown of the pipe should be as narrow as possible but should be not less than the outside diameter of the pipe plus 300mm to allow proper compaction of the side fill material. The trench bottom should be carefully examined for the presence of hard objects such as flints, rocky projections etc. Ideally the prepared bedding should consist of a free-running granular material passing a 19mm sieve but with minimum of fine particles or silt which will affect the compaction.

The thickness of the prepared bedding should be at least 100mm. It should be well compacted and brought to an even surface so as to provide uniform support to the pipe.

### Pipe Laying:

#### a) Push-Fit (R/R) Socket Pipes:

uPVC pipes with integral Push-Fit (R/R) sockets should preferably be installed and joined in the trench. Pipes up to 6" in diameter may, if necessary, be joined at the trench side and thereafter snaked into the trench. In such cases, extreme care should be taken to ensure that no separation of the joints occurs during this operation, and the joints should be checked after the pipe is in position to ensure they are intact.

The Push-Fit (R/R) sockets will not resist end thrust, hence the pipes should be laid on a prepared bedding as described above and anchored at all changes of direction, valves, reducers and blank ends.

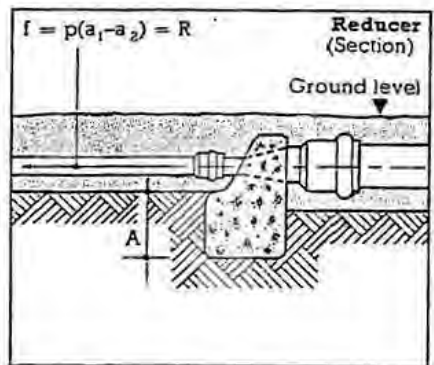
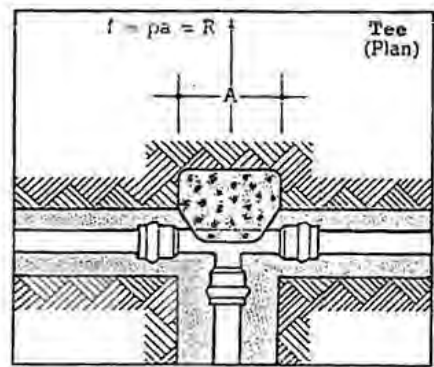
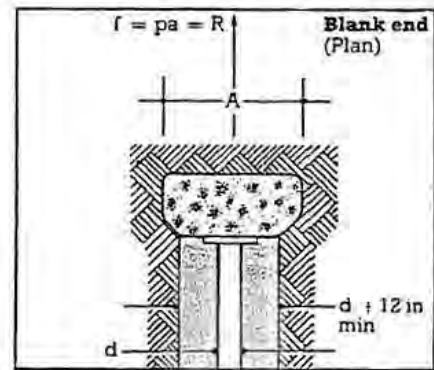
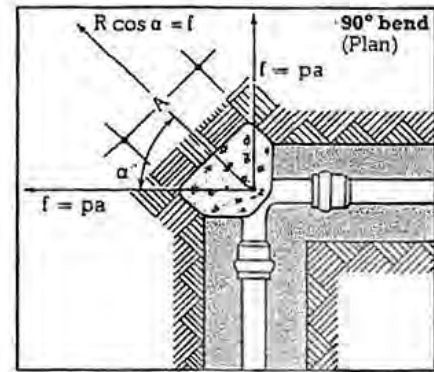
(For typical anchor details see the figures on the right side).

All temporary pipe supports, leveling pegs etc. must be removed from beneath the pipe prior to back filling.

The amount of expansion and contraction of buried pipes carrying cold water will normally be small and easily accommodated by the Push-Fit (R/R) socket.

#### b) Solvent Cement Socket Pipes:

In order to take the fullest advantage of the flexibility of the pipe lines made by uPVC pipes and jointed by solvent welding techniques, pipe should be jointed at the trench side and then snaked into the trench. A minimum of four hours should be allowed between making the last joint and snaking a long length of pipe into the trench. It is not at all essential to adopt this technique and pipe may individually be jointed in the trench if preferred.



In all cases the required area of the thrust block at position A is obtained by dividing the resultant force R by the bearing capacity of the soil.

Note:

- = cross sectional area of pipe bore
- = max. applied pressure (e.g. field test pressure)
- = axial force
- = resultant force

### Side Filling

Before commencing to place side-fill material, all trench sheeting should be partially withdrawn and pipe bedding checked for stones or other hard objects which may have fallen into the trench after the pipe was laid.

In order to develop reaction from the side-fill, which is necessary for a flexible pipe to sustain top load, some deformation of the pipe's cross section must occur. It is generally considered that the maximum vertical deflection of the pipe should be within 5% of the pipe's outside diameter.

To ensure that the 5% maximum deflection is not exceeded, the selection, placing and compaction of side-fill material is of supreme importance. Granular material as described in "Trench Preparation" and having a compaction fraction of 0.1 or less, should be placed carefully between the pipe and trench walls and thoroughly compacted by hand in layers not exceeding 75mm. This should continue up to a level of at least 100mm above the crown of the pipe.

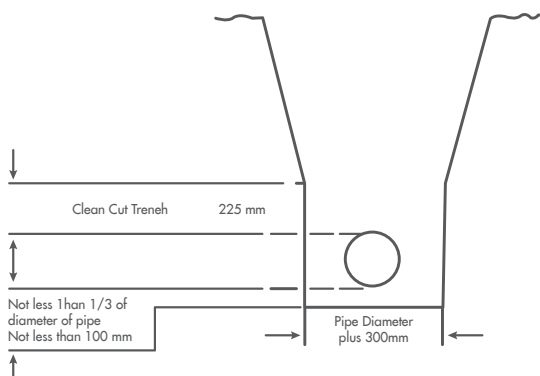
### Backfilling

Selected excavated material may be used for the remainder of the back-filling, except the special consideration of its suitability may be necessary where the risk of surface subsidence is a consideration e.g. under roads. The backfill material should be compacted in 300mm layers or in compliance with any special requirements of the specifications. Stones or any other objects larger than 150mm should be used.

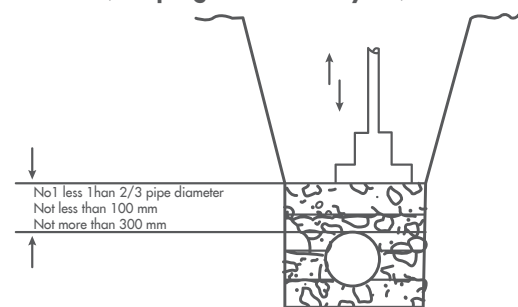
Heavy mechanical compactors should not be used until the fill has reached a height of at least 300mm above the crown of the pipe

### Examples of Trench Preparation and Backfilling

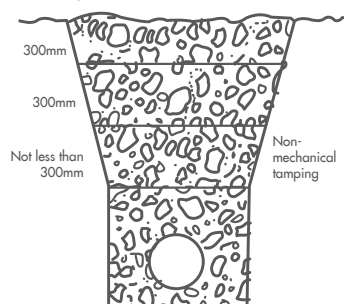
#### Trench Preparation



#### Compacting Layers of Side and Backfill (Tamping in 75mm Layers)



#### Normal Filling (300mm layers tamped by non-mechanical means)



When pipelines are laid in hot climatic conditions it is advisable to fill the pipe with cold water to bring the pipe lengths to the normal contracted dimension.

Check the joints to ensure that socket insertion depth is satisfactory.

## 10. SITE PRESSURE TESTING

The purpose of a site pressure test is to establish that the installed section of Pipeline under test and in particular all joints and fittings will withstand the design working pressure plus a safety margin without leakage. Generally a test pressure of 1.5 times the working pressure for the installed pipe is adequate. All site pressure testing of uPVC pressure pipes should be carried out hydrostatically and under no circumstances should compressed air be used for testing as this may result in injury or damage.

Several acceptable specifications are available for applying hydrostatic pressure tests to pipelines. The method described below is one commonly used and intended as a guide only.

### Test Procedure

- 1) Slowly fill the pipe with water taking care to release all entrapped air in the process.
- 2) Gradually raise the pressure in the system to the specified test pressure. From timing point of view, the test can be said to have started when the test pressure is reached and the flow to the system from the pump is disconnected.
- 3) The system remains under pressure for a specified period.
- 4) Should there be a drop in pressure at the end of the specified period, then a measured quantity of water is pumped into the system until the original test pressure be reached.
- 5) The pipe shall be judged to have passed the test satisfactorily if the quantity of water required to restore the test pressure does not exceed the amount calculated by the formula:  
4.5 litres/1.6 kilometres of pipe/25 mm of internal diameter/30m Head of test pressure/24 hrs.

Because of the elastic characteristics and relatively high thermal expansion and contraction of uPVC, it is advisable to conduct a preliminary test for a duration of 12 hours, at 1.5 times the working pressure, followed by the main test at 1.3 times the working pressure for a duration of 3 hours for diameters up to 6", and 6 hours for above 6" diameter pipes. By conducting the preliminary test, any change in volume of the pipeline caused by the internal pressure, time and temperature factors can be avoided, so that the reading obtained in the main test will provide unambiguous evidence on the soundness of the tested section.

Variations of the above nature are more evident in the case of exposed pipes under free and conditions than in the case of backfilled pipes. A convenient and acceptable practice is to backfill the pipe trench prior to testing taking care to leave all pipe joints, fittings, connections etc., exposed until the test is done and judged satisfactory.

Where pressure tests are carried out on lines not completely filled with water, surge pressures of sufficient magnitude that cause bursts may occur. Care should be taken to ensure that all air is released from the line through bleed valves located in the line at points of maximum elevation. Where possible the line should be filled from a lowest point. One method of ensuring that the line is completely free of air is for a foam swab to be forced through the line under the pressure of the incoming water.



## 11. uPVC SLOTTED PIPES FOR SURFACE WATER AND UNDER DRAINAGE

### Introduction

Slotted uPVC pipe for drainage applications has an advantage over traditional clay and porous concrete materials. PVC slotted pipes are well suited for storm drainage application, especially in the Middle East. uPVC has exceptional flow characteristics and the infiltration rates are greater than a fully porous concrete pipe for any given size. The pipes are available in 6-meter lengths, socketted at one end for positive location and accurate alignment.

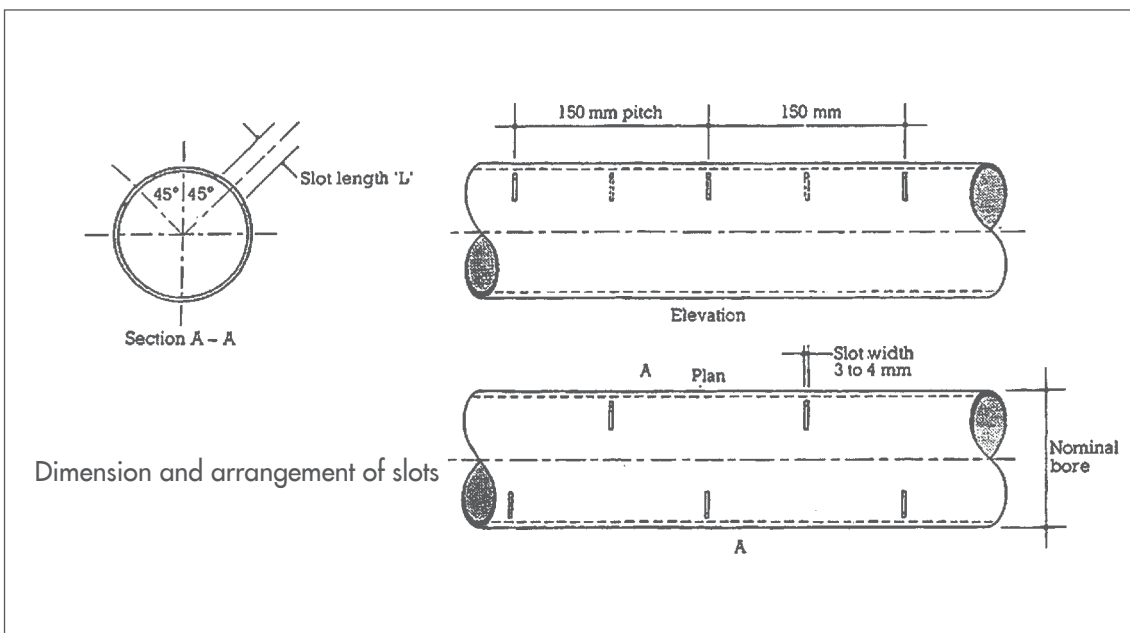
### Purpose and Use

The purpose of these slotted drain pipes is to control the water content of a roadway formation and sub-base, to collect large quantities of roadway surface water, or to act as both collector and formation drain. Provided sufficient capacity is available, it is also permissible for the slotted drainpipe to be used as the main carrier. This 'one pipe' system is being increasingly adopted in motorway and trunk road drainage projects.

### Slot Geometry

The slots are designed to give at least the minimum infiltration rates for porous concrete pipes as specified by BS 5911: Part 114: 1992 concrete porous pipes for drainage.

Two longitudinal rows of slots are machine cut in the pipe and are separated radially. Longitudinally, slot centres are staggered and the details are given in Table-1



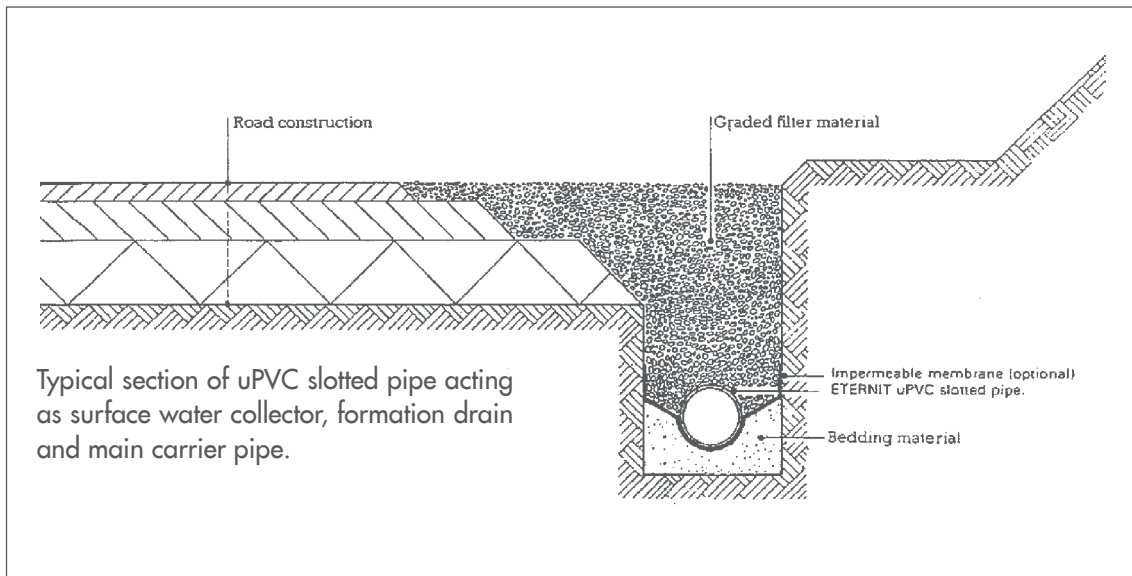
**Table - 1**

Nominal Dia mm	Slot length (mm)		Slot Width (mm)		Min. Slot Area mm <sup>2</sup> /m	Pitch mm
	Min.	Max.	Min.	Max.		
110	65	70	3.2	4	2704	150
160	65	70	3.2	4	2704	150
200	65	70	3.2	4	2704	150
225	65	70	3.2	4	2704	150
250	68	73	3.2	4	2829	150
315	81	86	3.2	4	3370	150

- These pipes will be supplied with wall thickness as specified in BS EN - 1401 with all thickness as given under Series-3 of DIN 8061/8062 specification.

**Note:**

1. uPVC slotted pipes in other diameters and thicknesses can be supplied upon request.
2. uPVC pipes with other slot geometry can be supplied upon request.



## 12. FLOW CHARACTERISTICS

The smooth bore of uPVC pressure pipes offers less resistance to flow than conventional pipes. The pipe wall is resistant to corrosive attacks and accretion or build-up are almost unknown, this superior performance will not be diminished during the life of the uPVC pressure piping.

Loss in straight pipes: The Kinematic energy of a fluid flowing in a pipeline decreases with the increasing distance, which is due to the friction between the fluid and the pipe wall.

The smoother the inner surface of the pipe, the less the friction. This loss of energy is called frictional or head loss and is calculated from the following formula.

$$H_r = \frac{L}{D} \cdot f \cdot \frac{V^2}{2g} \quad (\text{Darcy- Weisback's Formula})$$

Where

- H<sub>r</sub> = Loss of head in straight pipe (m)
- L = Length of pipeline (m)
- D = Inside diameter of the pipe (m)
- v = Velocity of liquid (m/sec)
- g = Gravitational acceleration
- f = Friction factor

### Loss in Fittings and Valves

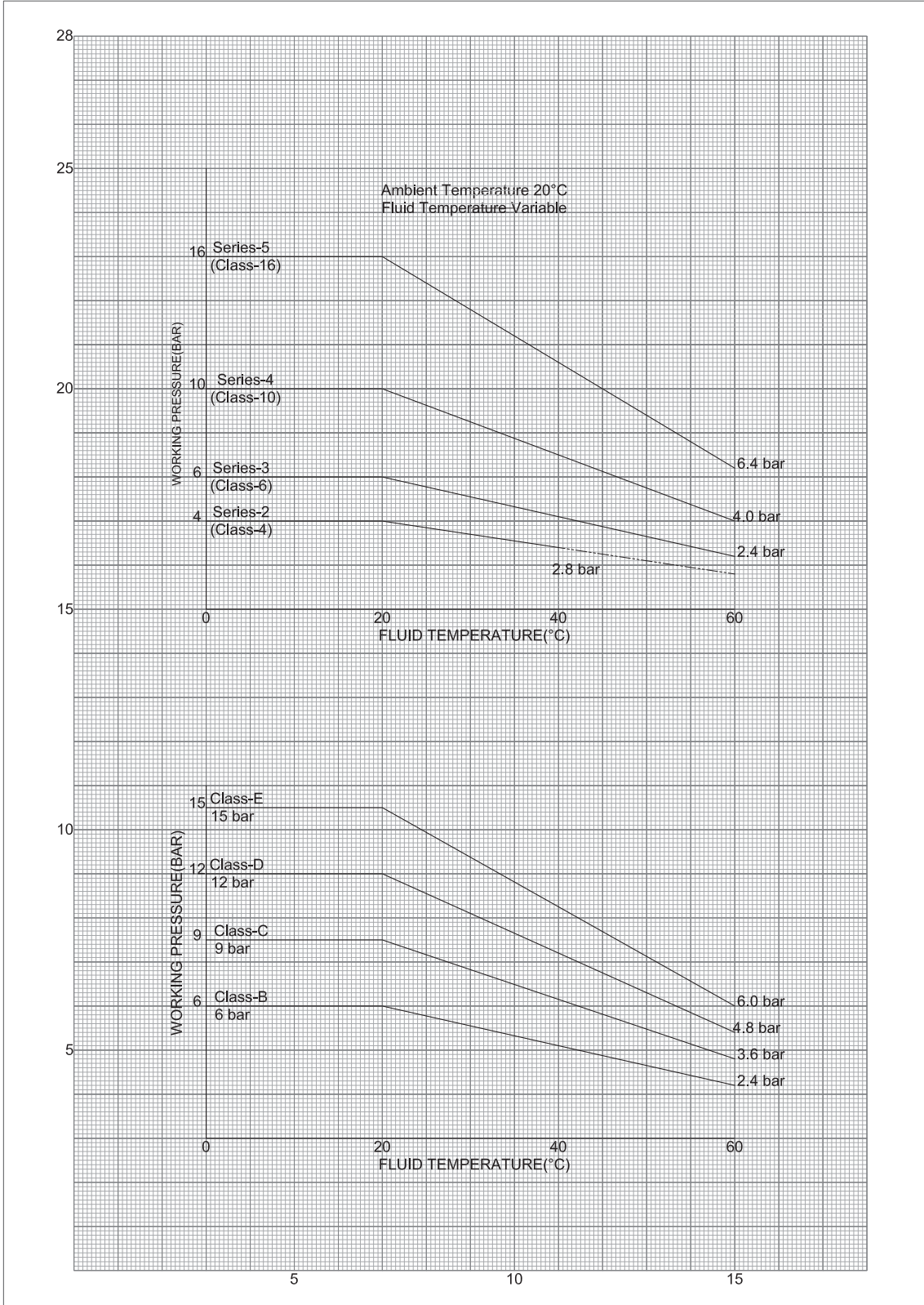
$$H_r = K \cdot \frac{V^2}{2g} \cdot N$$

Where N = Number of fittings (bends, elbows, tees, valves, etc.)

K = Constant, depending on the type of fittings (see below):

Elbow 45°	K = 0.40
Elbow 90°	K = 1.00
long Radius Bend 22 1/2°	K = 0.10
long Radius Bend 45°	K = 0.20
long Radius Bend 90°	K = 0.40
Tee (Flow in line)	K = 0.35
Tee (Flow in line to branch)	K = 1.20
Tee (Flow in branch to line)	K = 0.80
Valves	K = 0.70
Fully released valve	K = 0.50

## APPENDIX - A: EFFECT OF TEMPERATURE ON PRESSURE RATING OF UPVC PRESSURE PIPES



## APPENDIX - B: TABLES OF CHEMICAL RESISTANCE OF uPVC

### Introduction

The resistance of plastic pipe materials to a wide range of chemical is listed in the following tables. The chemical names used in the tables are wherever possible in accordance with the recommendations contained in BS 2474; other chemical names commonly used are frequently included as well with a cross-reference to the preferred name. The symbols used in the tables are as follows:

S - Satisfactory

U - Unsatisfactory. So rated because of decomposition, solution, swelling, loss of ductility etc., of the samples tested.

D - Some attack or absorption. The material may be considered for use when alternative materials are unsatisfactory, and where limited life is acceptable. When plastics are to be used with such chemicals, full scale trials under realistic conditions are particularly necessary.

\* - Predicted results. In order to cover as wide a range of named chemicals as possible, the resistance of plastics to some chemicals has been predicted from its resistance to other chemicals which have similar composition.

† - Reference should be made to Section 21 (pipes for food and drink other than water) of BS CP 312 Part 1: 1973.

Chemical	Concentration	Temperature	
		20°C	60°C
Ace taldehyde	40%(w/v) soln.	S	U
Acetic acid	100% 10% (v/v) soln. 60% (v/v) glacial	U S S U	U S D U
Acetic anhydride		U	U
Acetone		U	U
Acetonitrile			U*
Acetophenetidine		S*	S*
Acetophenone		U*	U*
Adipic acid		S	D
Alcohols, see specific alcohols			
Aliphatic hydrocarbons		S	S
Allyl alcohol		D	U
Allyl chloride		U	U
Alum, see aluminium			
Potassium sulphate			
Aluminium acetate		S*	S*
Aluminium chloride		S	S
Aluminium flouride		S*	S*
Aluminium hydroxide		S*	S*
Aluminium Nitrate		S	S
Aluminium oxalate		S*	S*
Aluminium oxychloride		S	S
Aluminium potassium Sulphate (alum)			
Aluminium sulphate		S	S
Ammonia		S	S
Ammonia solution (ammonium hydroxide)		S U	S U*
Ammonium bicarboate see ammonium hydrogen carbonate	Dry gas liquid 35% (m/v) soln. (0-88 g/ml)	S	S
Ammonium carbonate		S	S
Ammonium chloride		S	S
Ammonium ferrous citrate		S*	S*
Ammonium fluoride		S	S
Ammonium hydrogen carbonate		S	S
Ammonium hydroxide see ammonia solution			
Ammonium metaphosphate		S	S
Ammonium nitrate		S	S
Ammonium orthophosphate		S*	S*
Ammonium oxalate		S*	S*
Ammonium persulphate		S	S
Ammonium sulphate		S	S
Ammonium sulphide		S	S
Ammonium thiocynate		S	S
Ammonium zinc chloride (zinc ammonium chloride)		S*	S*
Amyl acetate		U	U
Amyl alcohol		S*	U
Amyl chloride		U	U
Aniline		U	U
Aniline hydrochloride		U	U
Aniline sulphate		U	U
Animal oils †		S*	S*
Antraquinone		S	U
Antraquinonesulphonic acid		S	U
Antinorony chloride		S	S*

\*\*Containing 3 parts by volume of concentrated hydrochloric acid to one part by volume of concentrated nitric acid

\*\*At 20% concentration

Chemical	Concentration	Temperature	
		20°C	60°C
Aqua regia **	Conc.	U	U
Aromatic hydrocarbons		U	U
Arsenic acid (syrupy)	75% (m/m) Or 2g/ml	S	D
Aryl sulphonic acid		S	U
Barium carbonate		S*	S*
Barium chloride		S*	S*
Barium hydroxide		S	S
Barium sulphate		S*	S*
Barium sulphide		S	S
Beer †		S	
Benzaldehyde	Trace 100%	U U	U U
Benzene		U	U
Benzoic acid		D	U
Benzoyl chloride		U*	U*
Benzyl acetate		U	U*
Benzyl alcohol (phenylcarbinol)		U*	U*
Bismuth carbonate		S	S
Borax, see disodium tetraborate			
Boric acid		S	S
Boron trifluoride		S	
Brine		S	S
Bromine	Trace 100% dry gas Liquid	S U* U	U U U
Bromomethane (methylbromide)		U*	U*
Butadiene		S	S
Butane		S	S
Butanediols		U	U
Butanols (butyl alcohols)		S	D
Butyl acetate		U	U
Butyl chloride		U*	U*
isoButyl methyl ketone (4-methylpentan-2-one)		U*	U*
Butylphenols		U	U
Butyraldehyde		U*	U*
Butyric acid	20% aq. soln. Conc.	S U	U* U
Calcium carbonate		S	S
Calcium chlorate		S	S
Calcium chloride	aq. soln.	S	S
Calcium hydrogen sulphite (calcium bisulphite)		S*	S*
Calcium hydroxide		S	S
Calcium hypochlorite		S	S
Calcium nitrate		S	S
Calcium orthophosphates		S*	S*
Calcium sulphate		S	S
Calcium sulphide		S	S
Carbon dioxide (gas)	U	S	S
Carbon disulphide			
Carbon monoxide		S	S
Carbon tetrachloride		D	U
Casein		S*	S*
Castor Oil †		S	S
Cetyl alcohol, see hexadecanol			
Chloral hydrate		S	S
Chloric acid		S	S**

Chemical	Concentration	Temperature	
		20°C	60°C
Chlorine, gas	10% dry 100% dry 10% moist	D	U
		D	U
		U	U
Chlorine	Sat.aq.soln.	D	U*
Chlorine trifluoride		U*	U*
Chloroacetic acid		S	D
Chlorobenzene		U	U
Chloroethane (ethyl chloride)		U	U
2-Chloroethanol (ethylene chlorohydrin)		U	U
Chloroform		U	U
Chloromethane (methyl chloride)		U	U
Chlorosulphonic acid		D	U
Chromic acid	plating soln.	S	S
Chromic potassium sulphate (chrome alum)		S	S
Cider †		S*	
Citric acid †		S	S
Copper ** chloride		S*	S*
Copper ** cyanide		S*	S*
Copper ** fluoride		S	S
Copper **nitrate		S*	S*
Copper **sulphate		S	S
Cresote		U	U
Cresols		U	U
Cresylic acid		U	U*
Crotonaldehyde		U	U
Cyclohexanol		U	U
Cyclohexanone		U	U
Detergent (synthetic)	diluted for use	S	S*
Developers (photographic)		S	S
Dextrin		S	S
Dextrose †	sat. soln.	S	S
Diamyl ether		U*	U*
Diazo salts		S	S
Dibromoethane (ethylene dibromide)		U*	U*
Dibutyl phthalate		U*	U*
Dichlorobenzene		U*	U*
Dichlorodifluoromethane		S	
Dichloroethane (ethylene dichloride)		U	U
Dichloroethylene		U*	U*
1,2-Dichloropropane (propylene dichloride)		U	U
Diethyl ether		U	U
Diethyl ketone		U*	U*
Diethyl sulphate (ethyl sulphate)		U	U
Digol (diethylene glycol)		S*	S*
Dimethylsulphate (methyl sulphate)		S	U
Dimethylamine		S	S
Dimethylcarbinol, see Isopropyl alcohol			
Diocetyl phthalate		U*	U*
Dioxan		U*	U*
Diphenyl ether		U	U
Disodium phosphate, see disodium hydrogen orthophosphate			
Dodecanoic acid (lauric)		S	S

Chemical	Concentration	Temperature	
		20°C	60°C
Dodecanol (lauryl alcohol)		S*	S*
Emulsifiers	All	S*	S*
Emulsions (photographic)		S	S
Ethane		S*	
Ethanedoil (ethyleneglycol)		S	S
Ethanol (ethyl alcohol) †	95-100% 40% (v/v) aq. Soln.	S	S
		S	D
Ethers (see also diethyl ether)		U	U
Ethyl acetate		U	U
Ethyl acrylate		U	U
Ethyl alcohol, see ethanol ethyl butyrate		U*	U*
Ethyl chloride, see chloroethane			
Ethyl formate		U*	U*
Ethyl lactate		U*	U*
Ethyl methyl ketone (methyl ethyl ketone)		U	U
Ethyl sulphate, see diethyl sulphate			
Ethylene chlorohydrin, see 2-chloroethanol			
Ethylene dibromide, see dichloroethane			
Ethylene dichloride, see dichloroethane			
Ethylene glycol, see ethanediol			
Ethylene oxide (oxiran)		U	U
Fatty acids, higher		S	S
Ferric chloride		S	S
Ferric nitrate		S	S
Ferric sulphate		S	S
Ferrous ammonium citrate, see ammonium ferrous citrate			
Ferrous chloride		S*	S*
Ferrous sulphate		S*	S*
Fixing soln. (photographic)		S	S
Fluorine		U	U
Fluorosilicic acid	40% aq. soln. conc.	S	S
		S	S
Formaldehyde	40% (w/w) aq. soln.	S	S
Formic acid	3% aq. soln. 10% aq. soln. 25% aq. soln. 50% aq. soln. 98 - 100%	S	S
		S	S
		S	D
		S	U
		U	U
Fructose †		S	S
Fruit juices †		S	S
Fuel oil		S	S
Fufuraldehyde (fuffural)	100%	U	U
Furfuryl alcohol		U*	U
Gallic acid, see 3, 4, 5-trihydroxybenzoic acid			
Gasoline, see petrol			
Glucose †		S	S
Glycerol		S	S
Glycerol monobenzyl ether		U*	U*

Chemical	Concentration	Temperature	
		20°C	60°C
Glycol, see ethanediol glycollic acid		S	S
Grape sugar †		S	S
Heptane		S	U
Hexadecanol (cetyl alcohol)		S*	S*
Hexanol (hexyl alcohol)		S	S
Hydrobromic acid	50% (w/v) aq. soln. 100% (w/v) aq. soln.	S	S
		S*	S*
Hydrochloric acid	10% (w/v) aq. soln. 22% (w/v) aq. soln. Concentrated (36%)	S	S
		S	S
		S	S
Hydrocyanic acid	10% (w/v) aq. soln.	S	S
Hydrofluoric acid	4% (w/v) aq. soln. 40% (w/v) aq. soln. 60% (w/v) aq. soln. Concentrated	S	S
		S	S
		D	U
		U*	U*
Hydrogen		S	S
Hydrogen bromide	Anhydrous	S*	S*
Hydrogen chloride	Anhydrous	S*	S*
Hydrogen fluoride	Anhydrous	S*	S*
Hydrogen peroxide	3% (w/v) aq. soln. 12% (w/v) aq. soln. 30% (w/v) aq. soln. 90% (w/v) or greater	S	S
		S	S
		S	S
		U	U
Hydrogen sulphide		S	S
Hydroquinone, see quinol		S	S
Hydroxylammonium sulphate			
Hypochlorous acid		D	U*
Iodine	soln. in potassium iodide	U	U
iso-octane (2, 2, 4-trimethylpentane)		S	U
Isophorone		U	U
Isopropanol, see isopropyl alcohol			
Lactic acid	10% (W/v) aq. soln. 100% (w/v) aq.	S	S
		U	U
Lanolin		S*	S*
Latex		S	S
Lauric acid, see dodecanoic acid			
Lauryl alcohol, see dodecanol			
Lead acetate		S	S
Lead arsenate		S*	S*
Lead nitrate		S*	S*

Chemical	Concentration	Temperature	
		20°C	60°C
Lead tetraethyl, see tetraethyl lead			
Linoleic acid		S	S
Linseed oil		S	S
Lubricating oil		S	S
Magnesium carbonate		S	S
Magnesium chloride		S	S
Magnesium hydroxide		S	S
Magnesium nitrate		S	S
Maleic acid	25% (w/v) aq. soln. 50% (w/v) aq. soln. concentrated	S	S
		S	S
		S	S
Malic acid		S	S
Manganese sulphate		S*	S*
Margarine †		S	S
Mercuric chloride		S	S
Mercuric cyanide		S	S
Mercurous nitrate		S	S
Mercury		S	S
Mesityl oxide		U	U
Metallic soaps (water soluble)		S*	S*
Methanol (methyl alcohol)	100% (60% (w/v) aq. soln.	S	D
		S	S*
Methyl acetate		U*	U*
Methyl bromide, see bromomethane			
Methyl isobutyl ketone, see isobutyl methyl ketone			
Methyl chloride, see chloromethane			
Methyl ethyl ketone, see ethyl methyl ketone			
Methyl glycol		S	S
Methyl hydrogen sulphate (methyl sulphuric acid)	50% (w/v) aq. soln. 60% (w/v) aq. soln. 75% (w/v) aq. soln. 90% (w/v) aq. soln.	S	S
		S	S
		S	S
		S	S
		S	S
Methyl methacrylate		U	U
Methyl sulphate, see dimethyl sulphate			
Methylated spirits		S	D
Methylcyclohexanone		U	U
Methyisulphonic acid		S	D
Milk †		S*	S*
Mineral oils		S	S
Mixed acids "			U
Molasses †		S	S
Monochlorobenzene		U*	U*
Naphtha		S	S
Naphthalene		U	U
Nickel chloride		S	S
Nickel nitrate		S	S
Nickel sulphate		S	S
Nicotine		S	S



Chemical	Concentration	Temperature	
		20°C	60°C
Nitronic acid		S	S
Nitric acid	5% (w/v) aq. soln.	S	
	10% (w/v) aq. soln.	S	D
	25% (w/v) aq. soln.	S	D
	50% (w/v) aq. soln.	S	U
	70% (w/v) aq. soln.	D	U
	98% (w/v) aq. soln.	U	U
	Nitrobenzene		U
Nitropropane		U	U
Nitrous fumes	moist	D	U
Nonanol (nonyl alcohol)		S*	S*
Octane		S*	U*
Octa nol (octyl alcohol)		S*	
Oils and fats †		S	S
Oleic acid		S	S
Orthophosphoric acid	20% aq. soln.	S	S
	30% aq. soln.	S	S
	50% aq. soln.	S	S
	95% aq. soln.	S	S
Oxalic acid		S	S
Oxygen		S	S
Ozone		S	S
Palmitic acid	10%	S	S
	70%	S	S
Paraffin		S	S
Paraffin wax		S	S
Pentane		S*	
Perchloric acid	10%	S	D
Petrol		S	U
Petrol/benzene mixture	80:20 ratio	U	U
Petroleum spirit (petroleum ether)		U	U
Phenol		S	U
Phenylcarbinol, see benzyl alcohol			
Phenylhydrazine		U	U
Phenylhydrazine hydrochloride		U	U
Phosgene	Gas	S	U
	Liquid	U	U
Phosphates (see also under ammonium, potassium, sodium etc.)		S*	S*
Phosphine		S	S
Phosphoric acid, see orthophosphoric acid			
Phosphorus		S	U
Phosphorus pentoxide		S	S*
Phosphorus trichloride		U	U
Phosphoryl chloride (phosphorus oxychloride)		U	U
Phthalic anhydride		S*	S*
Picric acid	1% (w/v) aq. soln.	S	S*
	10% (w/v) alc. soln.	U	U

Chemical	Concentration	Temperature	
		20°C	60°C
Plating solutions:			
brass		S	S
cadmium		S	S
chromium		S	S
copper		S	S
gold		S	S
indium		S	S
lead		S	S
nickel		S	S
rhodium		S	S
silver		S	S
tin		S	S
zinc		S	S
Polyglycol ethers		U*	U*
Potassium acid sulphate, see potassium hydrogen sulphate			
Potassium antimonate		S*	S*
Potassium bicarbonate, see potassium hydrogen carbonate			
Potassium bichromate, see potassium dichromate			
Potassium bisulphate, see potassium hydrogen sulphite			
Potassium borate		S	S
Potassium bromate		S	S
Potassium bromide		S	S
Potassium carbonate		S	S
Potassium chlorate		S	S
Potassium chloride		S	S
Potassium chromate		S	S
Potassium cuprocyanide		S*	S*
Potassium cyanide		S	S
Potassium dichromate (potassium bichromate)		S	S
Potassium ferricyanide		S	S
Potassium ferrocyanide		S	S
Potassium fluoride		S	S
Potassium hydrogen carbonate (potassium bicarbonate)		S	S
Potassium hydrogen sulphate (potassium acid sulphate)		S*	S*
Potassium hydrogen sulphite (potassiumbisulphite)		S*	S*
Potassium hydroxide	1% (w/v) aq. soln.		
	10(w/v) aq. soln.	S	S
	Conc. soln.	S	S
Potassium hypochlorite		S*	S*
Potassium nitrate		S	S
Potassium orthophosphate		S*	S*
Potassium perborate		S	S
Potassium perchlorate	10% solution	S	S
Potassium permanganate	20% solution	S	S
Potassium persulphate	5% solution	S	S
Potassium sulphate		S	S
Potassium sulphide		S*	S*
Potassium thiosulphate		S*	S*
Propane		S	S

Chemical	Concentration	Temperature	
		20°C	60°C
Propane-1, 2-diol (propylene glycol) Propargyl alcohol (prop-2-yn-1-ol)		S*	S*
Propionic acid	50% aq. soln. 100% aq. soln.	S*	S* U*
isoPropyl alcohol (isopropanol)		S	S
Propylene dichloride, see 1, 2-dichloropropane			
Propylene oxide		U*	U*
Pyridine		U	U
Quinol (hydroquinone)		S*	S*
Rayon coagulating bath		S*	S*
Sulphur trioxide		S*	S*
Salicylic acid		S	S
Seawater		S	S
Selenic acid		U	U
Shortening		S*	S*
Silicic acid		S	S
Silver acetate		S*	S*
Silver cyanide		S	S
Silver nitrate		S	S
Soap solutions (aqueous)		S	S
Sodium acetate		S	S
Sodium acid sulphate, see sodium hydrogen sulphate			
Sodium aluminate		S*	S*
Sodium antimonate		S*	S*
Sodium benzoate		S	D
Sodium bicarbonate, see sodium hydrogen carbonate			
Sodium bisulphate, see sodium hydrogen sulphate			
Sodium bisulphite, see sodium hydrogen sulphite			
Sodium borate, see disodium tetraborate			
Sodium bromide		S	S
Sodium carbonate		S	S
Sodium chlorate		S	S
Sodium chloride		S	S
Sodium cyanide		S*	S*
Sodium ferricyanide		S	S
Sodium ferrocyanide		S	S
Sodium fluoride		S	S
Sodium hydrogen carbonate (sodium bicarbonate)		S	S
disodium hydrogen orthophosphate		S*	S*
Sodium hydrogen sulphate (sodium bisulphate)		S	S
Sodium hydrogen sulphite (sodium bisulphite)		S	S
Sodium hydroxide	1% (w/v) aq. soln. 10% (w/v) aq. soln. 40% (w/v) aq. soln. Conc.	S S S S	S S S S
Sodium hypochlorite	15% available chlorine	S	S
Sodium hyposulphite, see sodium thiosulphate			

Chemical	Concentration	Temperature	
		20°C	60°C
Sodium metaphosphate		S*	S*
Sodium nitrate		S	S
Sodium nitrite		S	S
trisodium orthophosphate		S*	S*
Sodium perborate		S*	S*
Sodium peroxide		S*	S*
Sodium silicate		S*	S*
Sodium sulphate		S	S
Sodium sulphide	aq. soln.	S	S
disodium tetraborate (borax)		S	S
Sodium thiosulphate (sodium hyposulphite)		S*	S*
Soft soap		S*	S*
Stannic chloride		S	S
Stannous chloride		S	S
Starch		S	S
Stearic acid		S	S
Sucrose t		S*	S*
Sulphur		S	S
Sulphur dioxide	dry moist liquid	S S D	S U U
Sulphur trioxide		S	S
Sulphuric acid	10% (w/v) aq. soln. 20% (w/v) aq. soln. 30% (w/v) aq. soln. 40% (w/v) aq. soln. 50% (w/v) aq. soln. 55% (w/v) aq. soln. 60% (w/v) aq. soln. 70% (w/v) aq. soln. 80% (w/v) aq. soln. 90% (w/v) aq. soln. 95% (w/v) aq. soln. 98% (w/v) aq. soln. fluming	S S S S S S S S S D D D U U U*	S S S S S S S S S D D U U U*
Sulphurous acid	10% (w/v) aq. soln. 30% (w/v) aq. soln.	S S	S S
Surface active agents	All	S*	S*
Tallow		S*	S*
Tannic acid		S	S
Tanning extracts		S	S*
Tartaric acid t		S	S
Tetraethyl lead (lead tetraethyl)		S	S
Tetrahydrofuran		U	U
Tetrahydronaphthalene (tetralin)		U	U
Thionyl chloride		U	U
Titanium tetrachloride		U	U

Chemical	Concentration	Temperature	
		20°C	60°C
Toluene		U	U
Transformer oil		S*	S*
Tributyl phosphate		U	U
Trichloroacetic acid		S*	S*
Trichlorobenzene		U*	U*
Trichloroethane		U*	U*
Trichloroethylene		U	U
Tricresyl phosphate, see tritoyl phosphate			
Triethanolamine		S	U
Trigol (triethylene glycol)		S*	S*
3, 4, 5-Trihydroxybenzoic acid (gallic acid)		S*	S*
Trimethylamine		S	U*
Trimethylol propane (2-ethyl-2-hydroxymethyl propanediol)		S	U
Trisodium phosphate, see sodium orthophosphate			
Tritoyl phosphate		U*	U*
Turpentine		S	S
Urea		S	S
Urine		S	S
Vanilla extract t		S*	S*
Vegetable oil t		S	S
Vinegar t		S	S
Vinyl acetate		U	U
Water		S	S
Wetting agents		S*	S*
Whey t		S*	S*
Wines and spirits t		S	S
Xylene		U*	U*
Xylenol		U*	U*
Yeast t		S	S
Zinc ammonium chloride, see ammonium zinc chloride			
Zinc carbonate		S*	S*
Zinc chloride		S	S
Zinc Oxide		S	S
Zinc sulphate			

## LIMITATION OF LIABILITY

While the information, opinions, advice and recommendations contained in this publication have been prepared with proper care, they are offered only in pursuance of the object of providing useful information to assist those interested in technical matters associated with pipeline design, selection and installation.

The information contained herein is not intended to be an exhaustive statement of all relevant data as the successful installation in each case may depend and as the successful installation in each case may depend on numerous factors outside the control of GET (e.g. particular design requirements, site preparation, quality of workmanship during installation etc.), GET accepts no responsibility for or in connection with the quality or standard of any pipeline or installation or its suitability for any purpose when installed.

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GET warrants its uPVC pipes are free from defects caused by fault manufacture or materials, for a period of 12 months from date of delivery.



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