MANUAL FOR CERTIFICATION OF UNPLASTICISED PVC PIPES FOR POTABLE WATER SUPPLIES AS PER IS 4985

(FIRST ISSUE )

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Manual for Certification of ‘Unplasticised PVC pipes for potable water supplies’ as per IS 4985

Section 1 General

1.1 FOREWORD

The product certification scheme of the Bureau of Indian Standards, now under Bureau of Indian standards Act 1986, is in operation for more than four decades covering a wide variety of products. The wide experience in the area has brought a fair amount of rationalization in the certification process. This has resulted in the formulation of the Operation Manual for Product Certification (referred to as OMPC in this manual) prescribing rules and practices generally applicable to all products. Product related rules/guidelines are periodically issued to cover the specific requirements of different products. Still, in view of the wide spread of the certification operations, differences are found in the application of these guidelines in the BIS certification offices in different parts of the country. Therefore, it has been decided to bring out Sectoral manuals as guideline documents covering certification requirements of specific products/group of products. This Manual, one in the series, has been prepared to ensure uniformity in the certification practices in respect of Unplasticised Poly Vinyl Chloride (UPVC) pipes covered by IS 4985.

This manual is strictly an internal document intended for use by the certification marks officers of BIS.

In this manual, some useful information relating to the product characteristics, a few design aspects, limitations and constraints in its use, which is considered useful to the user, are included in a brief manner. This manual takes into consideration the generally acceptable practices.

THIS DOCUMENT IS INTENDED FOR INTERNAL USE BY BIS INSPECTING OFFICERS WHO SHOULD HOWEVER DO NOT TREAT SUCH DOCUMENT AS REPLACEMENT FOR REFERRED STANDARDS OR THAT OF RELEVANT SCHEME FOR TESTING AND INSPECTION (STI). STANDARDS AND OTHER DOCUMENTS (STI ETC.) REFERRED ARE AS APPLICABLE AT THE TIME OF PREPARATION OF MANUAL HOWEVER, LATEST STANDARDS/OTHER DOCUMENTS AS IMPLEMENTED SHALL BE REFERRED.

1.2 SCOPE

This Manual deals with the certification of Unplasticised Poly Vinyl Chloride Pipes for potable water supplies as per
IS 4985 (referred to as ‘standard’ or ‘specification’ or ‘IS 4985’ in this manual) under the BIS Product Certification Scheme.

This manual is based on the Indian Standard IS 4985, the OMPC, and the guidelines specific to UPVC pipes issued from time to time. It is intended to assist the certification personnel in understanding and appreciating the various requirements of the product as prescribed in IS 4985 and other related standards. This manual is not a substitute for the standards, OMPC and the guidelines mentioned above, to which reference may be made in case of doubt or any conflict and for complete information.

At the time of writing this manual, IS 4985: 2000 was in force. Therefore, although based on IS 4985: 2000, the standard is referred to as IS 4985 without reference to the year of publication, so that any revisions to the manual as a result of further revisions in the standards becomes convenient.

1.3 INTRODUCTION

Although plastic pipes were in use in Europe as early as 1930s, in India, use of PVC pipes can be traced to 1960s especially for water transportation. Nearly two-thirds of PVC production in the world is consumed in the construction and building industry. Pipes are the largest single articles, consuming about one third of PVC production. With the increase in popularity, the BIS (then ISI) standardized PVC pipes and thus the first issue of IS 4985 was brought out in 1968 covering pipes from 16 to 315 mm. The standard has since undergone three revisions and the current revision in 2000. The standard is greatly in line with ISO 4422 keeping in view the requirements of the global market.
Section 2
Product Description

2.1 General

The main use of pipes is in liquid and gas transportation, although use of pipes as a general construction material is on the increase.

Pipes made from cast iron, nodular iron and fabricated steel are in use for a long time in various applications. Pipes for supplying drinking water are mostly made of polyethylene (PE) or polyvinyl chloride (PVC). Unplasticised PVC pipes are greatly used for transportation of water. It is an extruded product from a blend of polymer resin and various additives.

Plastics belong to the group of newer pipe materials. With the development of new methods for producing plastics on an industrial scale in the 1930s, it became possible to manufacture plastic pipes economically. By the middle of the 30s, plastics were already being used in Germany to make pressure pipelines.

UPVC pipes are now in increased use as an alternate to cast iron, ductile iron and steep pipes. UPVC pipes are highly economical in comparison to pipes made from other materials. Plastic pipes offer high corrosion resistance to aggressive chemical media. Moreover, due to very smooth surfaces, the pipes are not prone to crust formation on the internal surface, which can have a detrimental effect on the water carrying capacity of the pipe. Ease of handling due to lightweight, and ease of laying and installation are other advantages. Plastic lends itself to extrusion, which has made possible uninterrupted production of pipes in continuous lengths. But, UPVC pipes having a fair amount of rigidity cannot take undue bends. Therefore, although made in continuous lengths, the pipe has to be cut into convenient lengths before they can be joined and laid into a pipeline. The standard permits use of solvent cement or using elastomeric rings for joining unit lengths of UPVC pipes.

UPVC pipes have their negative features as well. They require great care during laying. They are susceptible to damages when laid above ground level, and also due to impacts and external blows.

The additives used in the extrusion of pipes may constitute toxic, organoleptic or microbial growth hazard affecting the quality of water flowing through the pipes. The additives may also affect the physical, chemical and fabrication properties of the pipes. The standard has addressed these aspects by specifying the requirements for opacity and effects on water besides minimum requirements for chemical and mechanical properties of the pipes.

2.2 Design aspects

In IS 4985, the pipes are divided into six classes, Class 1 to Class 6, indicating the working pressures. The pipes are designed for a maximum safe working stress of 8.6 MPa at 27°C. For a given outside diameter, the Class designation is governed by the wall thickness.

The pipes are available with plain ends and with sockets. The socket can be suitable for solvent cement jointing and elastomer ring jointing. In either case, a close control will be required on the dimensional requirements.
2.3 Scope of usefulness

Besides extensive use as water carrying pipes in houses and apartments, UPVC pipes are finding increased use in irrigation systems. UPVC pipes are used to carry water in the drip irrigation and sprinkler systems before the laterals and distributors take over the function of delivering water to the roots and leaves of the plants. With the development of pipes up to 600mm in diameter, and introduction of Class 6(12.5 kgf/mm²), UPVC pipes are able to demonstrate the suitability as an alternate to cast iron or steel pipes.

2.4 Limitations of UPVC pipes

   a) They are susceptible to damages due to external pressures and external blows in above ground level applications,

   b) Unless controlled, the pipe material including the additives may constitute a toxic, organoleptic or microbial growth hazard. The constituents and their non-uniform blending affect the fabrication or welding of the pipe or impair the chemical and physical properties of the pipe.

Reduced wall thicknesses, failure to withstand the designed pressures, leakages in pipeline are some of the failures observed in UPVC pipes as a product. Complaints received are also of similar nature.
Section 3
Specifications

3.1 General

IS 4985 is one of the most widely implemented standards. It is a comprehensive specification covering the raw material, classification, material composition, dimensional requirements, physical and chemical characteristics, mechanical properties; sampling criteria, test requirements and acceptance criteria. The details of accessories like sealing rings are also included. The methods of test are covered in separate standards although the newly introduced test details have been covered in the standard itself.

In the process of development and revisions from 1968 until the present revision in the year 2000, the following major modifications have been incorporated to the standard:

a) Number of classifications increased to six, and the range of sizes extended to 630mm.
b) Bell or socket ended pipes suitable for solvent cement jointing and elastomeric sealing ring jointing introduced,
c) Pipes suitable for plumbing works introduced,
d) Long term and short term hydraulic tests replaced by internal hydrostatic tests in line with international practice,
e) The sampling plan revised on the basis of the industrial practice,
f) The opacity test brought in line with ISO 4422 and an alternate method added,
g) Some of the test methods covered in a separate standard IS 12235(Parts 1 to 11),
h) The impact resistance test to bring more in line with ISO 3127.

With these modifications, IS 4985 has been brought to a great extent in line with ISO 4422 keeping in view the requirements of the global market.

The standard IS 4985 is a self-explanatory document. Some of the provisions are reproduced in this manual for sake of clarity. For other situations extensive references are made to IS 4985. Therefore, frequent reference to the standard is required for complete understanding of its various provisions.

3.1 Composition

The petrochemical industry produces basic raw materials, such as ethylene, propylene and vinyl chloride. Further derivatives include basic plastics, such as polyethylene. Plastics are mixtures containing polymers as main components. PVC is the most versatile of all plastics because of its blending capability with plasticizers, stabilizers and many other additives. This is important, as all PVC polymers need heat stabilizers in order to be able to withstand the processing temperatures. Other chemicals, such as fillers, plasticizers, flame-retardants, antioxidants, lubricants, heat stabilizers and colour pigments, are added to produce plastics from same polymer with different characteristics.

The standard specifies that the material for manufacturing the pipes should consist substantially of Unplasticised
Polyvinyl Chloride to which may be added only those additives needed to facilitate manufacture of pipe and the production of sound and durable pipe of good surface finish, mechanical strength and opacity under conditions of use. The type and quantities of additives used individually or together should ensure that the pipes are sound and meet the health and strength requirements of the standard.

- They do not constitute a toxic, organoleptic or microbial growth hazard,
- They do not impair the fabrication or welding properties of the pipe,
- They do not impair the chemical and mechanical properties (in particular long-term mechanical strength and impact strength) as defined in IS 4985.

The additives used should be selected from IS 10148 and should be well blended to ensure uniform dispersion.

Vinyl chloride monomer, an important constituent in the raw material for producing PVC, may lead to health hazards. The vinyl chloride monomer being a highly flammable gas can also lead to fire hazards. The occupational limit value of the vinyl chloride monomer is 5 ppm. Considering these factors, the standard specifies a limit of 5 ppm on the monomer (VCM monomer) content in the resin (see IS 10151 for the requirements of PVC resin and the method of test for determining the monomer content).

The material composition should be based on PVC resin having a K-value (this is a characteristic of the PVC resin which describes the length of the polymer molecules) of 64 or greater when tested in accordance with IS 4669.

To ensure conformity to the requirements of VCM content and the K-value of the resin being used, a certificate may be obtained from the manufacturer of the resin, unless the same is tested in an independent laboratory. The frequency of this test report or confirmatory certificate is once every three months.

The standard permits addition of manufacturer’s own rework material to the composition (see 2.1 above for the definition of reworked material). The manufacturer should declare the quantity of the reworked material. The standard does not permit use of any other rework material.

### 3.2 Dimensions

The mean outside diameter, outside diameter at any point, Average (Max), minimum and maximum wall thicknesses and their tolerances with respect to the nominal size and different working pressures are given in Table 1 of IS 4985. This Table is based on metric series of pipe dimensions given in ISO 161/1 in respect of pipe dimensions and ISO 4422. The wall thickness is based on a safe working stress of 8.6 MPa at 27º C.

The extrusion process of making pipes is influenced by several factors such as the material composition including the basic resin, additives and their dispersion, and parameters such as speed of extrusion and temperature variation during the process of manufacture. These factors, if not effectively controlled will result in
distortion, uneven wall thickness, ovality beyond permissible limits and finally the chemical, physical and mechanical properties and performance characteristics of the pipes. It is therefore necessary that the dimensional characteristics are monitored and controlled to within the specified tolerances prescribed in IS 4985.

For Class 1, 2 and 3 of all sizes, the requirement of ‘Outside diameter at any point’ need not be applied, as the ratio of minimum wall thickness to nominal outside diameter does not exceed 0.035 in these cases.

The wall thickness of plain pipe and the plain portion of the socket ended pipes are prescribed in Table 1 of IS 4985: 2000.

Wall thickness at any point is a requirement to ensure conformity of the wall thickness of the pipe throughout the entire length. This can be measured and controlled by destructive or nondestructive method at any point along the length of the pipe using methods described in the standard.

3.2.3 The mean outside diameter, outside diameter at any point and wall thickness of plumbing pipes are given in Table 2 of the standard.

3.2.4 Length

The effective length of a pipe is the length that contributes to the length of the pipeline laid. Method of measuring the effective length of plain and socket ended pipes is given in 7.1.4 and Fig. 2 of the standard. If length of pipe is a contractual requirement, the effective length should not be less than that specified. The preferred lengths are 4, 5 and 6m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and purchaser.

3.3 Dimensions of Sockets

The process of making socket ends independent of pipe making process. But, the sockets should be reasonably parallel to the pipe axis.

3.3.1 Sockets for solvent cement Joining

The effectiveness of the joints with solvent cement depends on the bond established by the cement layer between the pipe surfaces. The joint should provide good seating for the pipe ends and an annular space for the cement coverage. Therefore, the length of the socket and the mean socket internal diameter are important dimensions of this type of joint. The standard in Clause 7.2 prescribes a minimum length for the socket and a formula for its calculation.

Since the socket length has a minimum value and no tolerance is given to this dimension, it is not practical to measure the socket except by specially tooled equipment, for locating the mid point of the socket. Being unique, such equipment will not necessarily give the correct figures for a pipe of other manufacturer.
3.3.2 Sockets for elastomeric sealing ring joints

In this type of joining, the elastomeric ring in the socket groove ensures water tightness. It is therefore important that the dimensions are controlled to within the limits specified. At the same time, the wall thickness of the socket portion including the portions constituting the ring groove and the neck should be not less than the minimum wall thickness of the plain portion of the pipe as specified in Table 1 of IS 4985. The minimum depth of engagement for sockets for use with elastomeric rings and other related dimensions are given in 7.2.1.2, Fig. 5 and Table 5 of the standard. The maximum inner diameter of groove in combination with the inner diameter of the sealing ring and the average outer diameter of the pipe shall ensure that the joint satisfies the pressure rating as given in Table 6 of the standard.

The joints incorporating elastomeric sealing rings should comply with the hydrostatic pressure requirements of the pipes. The minimum wall thickness of the sockets at any point, except the sealing ring groove, shall not be less than the minimum wall thickness of the connecting pipe.

3.4 Sealing rings

The sealing rings should be in accordance with one of the types, Type 1 to Type 6, as per IS 5382. The manufacturer should specify the type of sealing ring being offered. The design of the sealing ring is left to the manufacturer as long as the pipe with sealing ring meets the requirements of the specification.

To demonstrate conformity of sealing rings to IS 5382, a test report may be obtained from the manufacturer of the sealing rings. The frequency of such report of conformity is once in 3 months.

3.5 Pipe ends

The ends of plain as well as bell ended pipes meant for solvent cementing should be reasonably square to the pipe axis or may be chamfered at the plain end.

The plain-ended pipes to be used for elastomeric sealing ring type joints are to be chamfered at approximately 15° to the axis of the pipe. For details of chamfering reference may be made to Fig. 6 of IS 4985.

3.6 Physical and chemical characteristics

3.6.1 Visual Appearance

The colour of the pipe should be light gray although slight variations in the appearance of the colour are permitted.

The pipes should have smooth internal and external surfaces, clean and free from grooving and other defects. Slight shallow longitudinal grooves or irregularities, which are the inherent features of extrusion process, are permitted, provided the wall thickness remains within the permissible limits.

3.6.2 Opacity

The difference between the GI pipe and UPVC pipe is that GI pipes are opaque...
and do not permit microbiological growth, where as UPVC pipes exposed to sunlight may provide opportunities for such growths. One purpose of using additives is to render the pipe opaque. However, formulations containing additives, such as plasticizers and lubricants, may support the growth of microorganisms. The standard stipulates that the wall of the pipe should be opaque enough not to transmit more than 0.2 percent of the visible light falling on it. The test for opacity should be conducted by the method prescribed in IS 12235 (Part 3).

3.6.3 Effect on water

Polymers are considered to be chemically inert and do not pose a health hazard. Chemical hazards are related to the additives and intermediate products present in plastics at various production stages, where the monomers and other intermediates are present. Polymers are normally resistant to microbes, mildew, fungi and bacteria when they are pure materials. However, formulations containing additives, such as plasticizers and lubricants, may support the growth of microorganisms. The most common stabilizers are epoxies, phosphites, and organometallic salts of tin, lead, barium, lead, zinc, and cadmium. These are the sources of health hazards. They also support the growth of microorganisms.

The standard requires that the pipes shall not have any detrimental effect on the composition of water flowing through them. Based on the ‘Guidelines for Drinking Water: Recommendations’—WHO, Geneva, 1984, the standard specifies limits on the quantities of lead, dialkyl tin C4 and higher homologues (measured as tin), and any other toxic substances extracted from the internal walls of the pipe. For purpose of this requirement, the manufacturer should disclose “any other toxic substances” present. The limit of all the ‘other toxic substances’, including the two mentioned in the standard should not exceed the specified limit of 0.01 mg/l.

3.6.4 Reversion test

After the extrusion process, the pipe is subjected to chilling process with simultaneous ‘hauling’ operation in order to control the outside diameter and wall thickness and also the straightness of the pipe. These operations may result in locked up stresses in the pipe, which may lead to variations in dimensions and failures in the strength requirements. The standard therefore prescribes a length variation of not more than 5% when tested as per IS 12235 (Part 5).

3.6.5 Vicat Softening Temperature

In order to control the plasticity of the pipe material and also to exercise a control on the content of the plasticizers, the standard prescribes that the softening temperature should not be less than 80°C when tested as per IS 12235(Part-2).

3.6.6 Density

In order to ensure raw material integrity and control the effect of the additives and use of own rework material on the pipe strength characteristics, the standard prescribes a density requirement between 1.40 and 1.46 when determined as per IS 12235(Part-2). Density is an important requirement, which will help in matching and establishing of control units while investigating complaints.

3.6.7 Sulphated Ash Content
As a supplement to the density requirement, the standard prescribes a maximum limit of 11 percent for the Sulphated ash content, when tested as per the method prescribed in Annex B.

3.7 Mechanical properties

3.7.1 Hydrostatic Characteristics

a) Internal hydrostatic test is an important test and the pipe shall not fail during the test duration. The requirements given in Table 6 apply to plain pipes and socket ends with solvent cement joints. Test parameters for integral sealing ring sockets (with elastomeric sealing rings). The test is of two types, type test and acceptance test, and both tests are conducted at stress values higher than working stress (1.16 to 4.19 times working stress). The three test parameters i.e., the test temperature, test duration and test pressure are controlled, monitored and maintained throughout the test. The tests are to be conducted as per the procedure given in IS 12235(Part 8/sec 1).

b) The type test is for a duration of 1000 hours at a temperature of 60°C and at a test pressure of 1.16 times the working pressure. The acceptance test is conducted at a temperature of 27°C, for duration of 1 hour maintaining a test pressure of 4.19 times the working pressure. For details of test requirements, reference may be made to Table 6 of the standard.

c) Sockets with integral sealing rings (sockets with elastomeric sealing rings) are also subjected to type and acceptance tests but at a temperature of 27°C, and at lower test pressures. The test parameters vary with the diameter. For details of test requirements, reference may be made to Table 7 of the standard.

d) Plumbing pipes are designed with a higher wall thickness giving importance to rigidity and not for providing a higher working pressure. Therefore, the type test is not applicable to plumbing pipes, and the acceptance test at 27°C is to be conducted at a test pressure of 3.6 MPa for 1 h.

3.7.2 Resistance to External Blows

In order to ensure that the pipes are capable of standing the external pressures, impact and the rigors during installation and above ground situations, the standard specifies a test for resistance to external blows. The pipes should have a true impact rate of not more than 10 percent when tested by the method prescribed in Annex C of the standard. In the case of socketed pipes, the test should be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket.

3.8 Sampling and criteria for conformity

3.8.1 General The pipes should satisfy the various requirements of the standard before they could be accepted as conforming to the standard IS 4985. The tests are carried out on samples of pipes drawn from the production lot offered
for acceptance. The sampling procedure and the criteria of conformity are given in Annex D of IS 4985. It is interesting to note that the standard clearly spells out the sequence in which the tests are to be conducted and the required sampling pattern. This sampling procedure is basically for acceptance of lots of pipes, either by the manufacturer as an internal quality assurance exercise, or by purchasers or inspection agencies for confirmatory testing. For the BIS certification marks scheme, the operating document i.e., the Scheme of Testing and Inspection (referred to as STI hereafter) specifies a sampling plan in line with IS 4985, and is to be followed by the licensee manufacturers before applying the standard mark on the pipes. If for any reason, lot inspection and acceptance is to be resorted to, then the sampling plan of the STI may be followed.

3.8.2 Type tests These tests are intended to prove the suitability and performance of a new material composition or a new size of a pipe. Therefore, such tests are to be conducted only when a change is made in the polymer composition or when a new size of pipe is to be introduced.

While acceptance tests are to be carried out for every lot, type tests are normally valid for one year. At the end of the validity period or earlier, the testing authority may call for a fresh sample for carrying out the type tests.

3.8.3 Acceptance Tests These are the tests carried out on samples selected from a lot for the purpose of acceptance of a lot.

3.8.4 Lot For purposes of sampling, all PVC pipes in a single consignment of the same class, same size and manufactured under essentially similar condition constitutes a lot.

3.8.5 For ascertaining conformity of the lot to the requirements of the specification, samples should be tested from each lot separately.

3.8.6 The sampling requirements are specified in detail in the standard itself for different test requirements. The details include the sample size, acceptance and rejection criteria and also the method of ensuring the randomness of selection giving reference to IS 4905.

3.8.6.1 In the case of test for external blows, It should be noted that the sample size, cumulative sample size, acceptance number and rejection number in Table 16 of the standard represent the number of times the test is to be carried out and do not represent either the number of pipe samples or number of blows or number of failures.

3.8.6.2 Since the opacity depends on the thickness of the pipe, the thinnest pipe manufactured should be tested for opacity requirements.

3.8.6.3 Small size pipes have larger surface exposure than large diameter pipes with respect to discharge (area of cross section). Therefore, for carrying out the test for effect on water, samples from the smallest size of pipe from each machine should be selected.
Section 4
Manufacturing Process and Controls

4.1 Raw Materials

The specification requirement on the composition of the material has been dealt with in the section on specification. A broad list of normally used raw material used in the manufacture of UPVC pipes is given below for information:

a) Unplasticised PVC resin,
b) Titanium Dioxide,
c) Hydrocarbon Wax,
d) Stearic acid,
e) Calcium carbonate

It should be ensured that the additives selected do not constitute a toxic, organoleptic or microbial growth hazard, at the same time do not impair the fabrication or welding properties of the pipe, and meet the chemical and mechanical properties (in particular long-term mechanical strength and impact strength) as defined in IS 4985.

The additives used should be selected from IS 10148 and should be well blended to ensure uniform dispersion.

4.2 Manufacturing Process

Production of UPVC pipes consists of plasticizing and homogenizing the PVC compound and shaping it into pipe in an extruder. The PVC resin and the additives are mixed in a heater/cooler mixer to form the PVC compound. Mixing is an important stage of the manufacturing process, and has an impact on classification of pipes. Thus formed compound is fed into the extruder through a spiral flow conveyer and hopper. The compound gets molten in the heating zone of the extruder, which is then extruded into pipes passing through a mandrel/die arrangement. Normally, single screw or twin-screw type extruders are used. Single screw extruders are used for producing small size pipes with thick wall thickness. Twin-screw extruders ensure good homogeneity of the blend, can produce large sizes and thickness, and have higher productivity. Different mandrel/die combinations are used for different pipe sizes. In the vacuum sizing/pressure tank, the dimensions are controlled to within the tolerances required. The pipe is then passed through chilled water in a spray tank where the pipe attains its rigidity. The extruded pipe is passed through a traction (also called hauling) arrangement to extract the pipe at a regulated speed. This also controls the dimensions of the pipe.

The pipes are then cut to size in a cutter. Since the cutter platform moves with the extruded pipe, cutting process does not hinder the extrusion process.

One end of the cut pipes is then processed for socketing. The pipe end is heated on a heating coil and sleeved over a mandrel machined to the socket inner dimensions to get the socket profile. Some manufacturers emboss their brand name and other details at this stage.
In Figure 1 is given a typical flow chart of the manufacturing process.

### 4.3 Manufacturing machinery

A list of the manufacturing machinery is given in Annexure 1.

### 4.4 Control Points

The following controls are required for satisfactory extrusion of pipes meeting the requirements of the standard:

- a) Composition of the blend,
- b) Mixing of the ingredients, depending on the resin, additives, size and class of pipe; the mixing temperature is about 150°C.
- c) The mixed ingredients are cooled to about 45°C before being fed into the extruder,
- d) The heating zone of the extruder is maintained around 185°C, but this is again dependant on the ingredients, size and class of pipe,
- e) The clearances and settings of the mandrel, die, sizer, pin etc., to suit the size and class (wall thickness) being extruded,
- f) Temperature of the cooling water is maintained around 12°C, depending on the ingredients, size and class of pipe,
- g) Speed of extrusion, hauling speed depending on the parameters mentioned above,
- h) Setting of cutter for the length suiting the tolerances,

For socketing, the pipe ends are heated to about 150°C, before sleeving on to the mandrel accurately machined for the dimensions specified in the standard. Normally UPVC pipe manufacturing does not involve any out sourcing except the maintenance of the dies and mandrels and the infrastructure.

### 4.5 Environmental and Hygienic conditions

The manufacturer should ensure enough room for the manufacturing activity, besides adequate space for the utilities, adequate storage space for the raw material and finished goods. The PVC resin and additives generate fumes when heated and during processing. Some of these fumes may be hazardous. The premises therefore should have adequate ventilation. The workmen may also have to be provided with masks. The hazardous characteristics relating to use of UPVC pipes are dealt in relevant sections as appropriate.
Section 4-1
Inspection and Testing

4.1.0 Lot and Control Unit

IS 4985: 2000 defines ‘Lot’ as the single consignment of UPVC pipes of the same class, size and manufactured under the same conditions. This definition is to be used for acceptance of a lot of pipes.

For the operation of the BIS certification marks scheme, the term ‘control unit.’ Is used. Presently, a ‘Control Unit’ is defined as a continuous run of pipe from ‘one machine’, of ‘one size and class’ of pipe from one extrusion compound up to a maximum of 48 hours duration (see the STI). Perhaps for this reason, for visual and dimensional requirements, there is a departure from the sample size of ‘lot’ and ‘control unit’. Retest sampling size and for all other requirements, the sample size given in IS 4985: 2000 would be applicable.

4.1.1 Tests on raw material

The requirements of the PVC resin and the additives have been covered in earlier paragraphs.

Each consignment of the unplasticised PVC resin, and the additives are to be tested for the requirements of IS 10148:1982 including VCM and K value requirements for resin, unless backed by test certificates issued by the manufacturer. The tests may be carried out at an approved independent laboratory.

4.1.2 Tests on pipes

IS 4985 describes in detail the tests to be carried, sampling method and acceptance criteria for pipes. Annex C of IS 4985 also prescribes the sequence of carrying the various tests.
Section 4-2
Test Methods

4-2.0 General

Methods of carrying out the test for sulphated ash content and the test for resistance to external blows at 0°C are covered in IS 4985: 2000 itself. The other test methods are covered in the appropriate Parts of IS 12235: 2004.

While the standards themselves are clear and self-explanatory, some of the important aspects to be kept in mind are given below for each test.

The results should comply with the requirements of relevant tests specified in IS 4985: 2000.

4-2.1 Visual appearance (10.1 of IS 4985: 2000)

Colour of pipe—Light Grey, slight variations permitted. Internal and external surfaces should be smooth, clean and free from grooving and other defects. Slight shallow longitudinal grooving is permissible provided the wall thickness remains within permissible limits. Therefore look for such areas and check the wall thickness. This is a subjective test.

4-2.2 Dimensional requirements

Mean outside diameter, diameter at any point and wall thickness to be measured as per IS 12235 (Parts 1). A Pi-tape to satisfy the requirements of 3.3 and 3.3.1 of IS 12235(Part 1) with an accuracy of 0.05mm can be used. Vernier with adequate jaw extension can also be used for pipes up to 110mm.

Result to be calculated/rounded off to 0.1mm.

4-2.3 Opacity (IS 12235 (Part 3))

Opacity is the measurement of light flux passing through the test specimen cut from a pipe or fitting. Either of the two given methods can be used for the test. Points to be borne in mind are:

a) The alignment of the installation to be checked and calibrated as indicated ensuring an accuracy of 0.02 percent in the range 0 to 0.2 percent.

b) Thinnest wall thickness to be selected for testing.

c) The percent of light flux to be measured by the indicators attached to the equipment with the sample and without the sample.

4-2.4 Effect on water (IS 12235(Part 4))

This is a test for the determination of the detrimental effect on the composition of water flowing through pipes manufactured according to IS 4985:

a) Pre washing of the pipe inner surfaces to be made as per 3.1.1 of IS 4985.

b) This test calls for use of a large quantity of water flowing at a rate of 3 m/min for a period of 6h. However, during this pre-washing period, a non-interfering core may be used to save water, but maintaining a flow rate of 3m/min.
c) Extractions to be taken after the standard solutions are allowed to stand for 48h.

4-2.5 Longitudinal Reversion (IS 12235(Part 5/Sec 1 and 2)

a) The test can be carried out either in an air oven or in a bath of mono- or polyethylene glycol, glycerol or mineral oil free from aromatic hydrocarbons.

b) Monoethelene glycol is toxic and can be fire hazardous. Therefore, polyethylene is preferred as it has a high boiling point and does not pose such hazards.

c) In the liquid bath method, the specimen should not touch the sides or bottom of the bath, and the 15mm end and the two scribe marks to be completely immersed in the bath. The test area to be at least 30mm from the air/liquid surface. The bath to be continuously stirred to maintain a temperature of 150±2°C.

d) The immersion time depends on the wall thickness of the pipe and ranges from 15 to 60min.(see 3.2 of IS 12235 Part5/Sec 1).

e) In the air oven method, the oven should have an internal circulation fan, and the whole interior to be maintained automatically at 150±2°C. The specimen to be kept in the oven ranges from 60min to 240min depending on the wall thickness.

f) After the specified periods, the specimen to be laid on its side and cooled in air to room temperature

g) In either method, the distance between the scribed marks to be measured before and after the test with a pair of vernier calipers used to scribe the lines to have an accuracy of at least 0.02mm. The result of the test is to be expressed as the percentage change in the distance (see 10.4 of IS 4985: 2000 for the test requirements).

4-2.6 Vicat Softening Temperature (IS 12235 (Part 2))

Vicat Softening temperature is an indication of the softening tendency of the UPVC pipes in ambient temperature conditions. Vicat softening temperature is that temperature when the standard indenter penetrates 1 mm into the surface of the test specimen cut from the wall of the pipe or fitting, under a test load of 50 ± 1 N.

Some of the important aspects of this test are the following:

a) The rigid frame with a freely moving rod with a load bearing plate,

b) The circular indenting tip 3mm long, 1.000±0.015mm².

c) Micrometer Dial gauge graduated in divisions of 0.01 mm,

d) Load carrying plate,

e) Heating bath of suitable liquid and with controlled heating and cooling facility,

f) Use of air as the heating medium, with corrections for the temperature differences between the air and the specimen,

 g) Thickness of the specimen, the wall thickness reduced by machining where required,

h) Conditioning of the specimen,

i) Test procedure to ensure uniform heating, and the method of recording the results.
The above mentioned factors are only to draw the attention to the care to be exercised during the test, but reference to be made to the detailed procedure given in the standard.

4-2.7 Density

The details are given in IS 12235 (Part 14) identical to ISO 1183: 1987.

4-2.8 Hydrostatic Characteristics (IS 12235(Part 8/ Sec 1 to Sec 4))

a) Internal Hydrostatic test for pipes as per IS 12235(Part 8/ Sec 1)

This is a test conducted at constant pressure and temperature for a fixed duration of time as prescribed in IS 4985: 2000.

The test set up has the following features:

a) Of the two types of end caps Type A end caps rigidly connected to the test specimen but not to each other, hence transmitting end thrust and a longitudinal stress to the specimen (see Fig 1 of IS 12235 (Part 8/ Sec 1).

Type A end caps are to be used for testing pipes to IS 4985: 2000.

b) Type B caps made of steel, ensuring sealing on to the external surface of the specimen and connected to each other, hence not transmitting the hydrostatic end thrust to the specimen (see Fig 2 of IS 12235(Part 8/ Sec 1.).

c) A tank filled with water or any other suitable liquid kept at a constant temperature of 27 or 60°C to within a mean of 1°C and a maximum deviation of 2°C. Water, the normally used liquid, should be free from impurities.

d) It should be ensured that specimens do not come in contact with themselves or with the sides of the tank.

e) Rate of application of test pressure, tolerances to be controlled as per procedure. The tolerance on pressure is to be kept as small possible, as results are strongly influenced by pressure.

f) As far as possible, the pressures are to be applied to individual specimens. However, application of pressure to several pieces is permitted, provided there is no danger of interferences in the event of a failure of a sample.

g) To maintain the pressure within the specified tolerances, the test set up should be capable of resetting the pressure to the specified value, if for any reason it drops slightly.

h) The timer should be capable of recording the duration of the pressure applications up to the moment of failure or leakage. The equipment used should be sensitive to pressure variations due to leaks or a failure and be capable of stopping the timer and, if necessary, closing the pressure circuit for the test specimen concerned.

Calibration of the apparatus
The temperature, pressure and temperature time measuring devices should have the ranges and least counts commensurate with the requirements of IS 4985. They should be calibrated to accuracy compatible with the scales used and at a frequency commensurate with the conditions of use using master gauges.

Calculation of Test pressure (Clause 5.2 of IS 12235(Part 8/Sec 1))

The test pressure in MPa should be calculated to three significant decimal places using the given formula.

Test Procedure

The test is to be conducted only after 24 hours of production of pipes, except for the manufacturing checks like wall thickness, outside diameter and length.

The test procedure is very clearly given in IS 12235/8/1. Points to be borne in mind are conditioning of the specimen, applying and maintaining the test pressure, temperature and the duration of time especially during failure of the test equipment.

Assessment of results

If a failure occurs, record the type of failure as brittle or ductile. (A failure is brittle, if no plastic deformation has occurred in the failure zone. A failure is ductile if accompanied by plastic deformation (bulging, stretching), visible without magnification, in the failure zone). This information will be a useful guide for failure investigations.

If a break occurs in a test specimen at a distance of less than that equal to the mean outside diameter from the end cap, it shall not be considered as a failure. The result should be disregarded and test repeated using another test specimen.

b) Test for resistance to Internal Hydrostatic pressure, Leak tightness of Elastomeric Sealing Ring Type Socket Joints as per IS 12235(Part 8): Sec 2: Rings subjected to positive internal pressure and with angular deflection
   Sec 3: Rings subjected to negative internal pressure and angular deflection
   Sec 4: Rings subjected to positive internal pressure without angular deflection

These tests are similar to that on UPVC pipes but have to be conducted for three conditions as seen above. Points to be noted are:

a) Specimen to be tested after 24 h of production of the pipes.

b) The joints to be assembled as per manufacture’s instructions. Where required, the pipe used to be of the same pressure class as the joint.

c) The test set up is an important factor, especially when negative pressure is involved.

d) As in pipes, close control and monitoring the pressure, temperature and time parameters is required.

e) The test parameters to conform to the specified requirements.
Section 4-3
Test Equipment

4-3.1 A list of testing equipment required to carry out the various tests on UPVC pipes is given in Annex 2. The list is not exhaustive and is only indicative. The capacity of the test equipment depends on the range of size and class of pipes to be tested. The number of sets of the equipment depends on the number of samples generated, which in turn is dependant on the quantum of production.

Vast developments are taking place in plastic processing technology. At the same time developments are taking place in test methods and testing methods as well. Sophisticated equipments are now available with time and labor saving features. It is necessary that such developments be taken into consideration while deciding on the adequacy of the test facilities. From the point of view of certification it is important that the testing facilities are adequate for demonstrating the conformance of the product to the specification requirements.

4-3.2 Test equipment peripherals

As adjunct to test equipment, the following peripherals and utilities would be required:

- a) Power source to ensure running of the equipment (may also include the manufacturing equipment) and their continuous operation where required.
- b) Facility for preparation of test specimens. It is an accepted practice to outsource operations like cutting, machining, welding etc.
- c) Utilities like Power generator, air compressor, boiler for steam generation, material handling equipment and packing facilities will be required.
- d) Facility for the maintenance of the equipment. Servicing and maintenance by the equipment manufacturer is an accepted practice.
- e) Glassware, reagents and chemicals and specific liquids specified in the test methods.
- f) Adequate water source.
Section 5
Certification Criteria

5.0 General

For more than three decades, UPVC pipes are being certified under the BIS Product Certification Scheme. The self-certification scheme is to be operated by the manufacturers having valid licenses to use the standard mark (ISI Mark) by following the Scheme of Testing and Inspection (referred to as STI in this manual) prescribed by the BIS, besides meeting other formalities. The scheme ensures a quality system with controls on raw materials, manufacturing and testing competence, storing facilities, complaints handling mechanism etc. It should be borne in mind that the certification is a means of providing assurance that a product complies with the specified standards. At the same time, being a primarily voluntary scheme, it should be treated as a quality assistance programme designed to render service to those opting for the scheme.

5.1 Operating Manual for Product Certification (OMPC)

From the experience gained in the operation of the BIS Product certification scheme for a wide variety of products, it was felt imperative to specify systematic and uniform procedures to be followed by the various personnel connected with product certification activity all over the country. Publication of the Operating Manual for Product Certification was one of the first steps in this direction. The current version of the OMPC incorporates the guidelines issued to further rationalize the scheme and provides solutions to various situations that may arise during the operation of the scheme within the framework of the BIS Act, Rules and Regulations.

5.2 Sectoral Manual for certification of UPVC Pipes

This (Sectoral) manual as an adjunct to the OMPC covers the certification aspects specific to UPVC pipes, and is based on the guidelines issued from time to time on application of certification principles to UPVC pipes. In the following paragraphs, features specific to certification of UPVC pipes have been dealt with, interpreting the requirements of the standard, the OMPC and the relevant STI as required.

5.3 Scheme of Testing and Inspection

The STI is a very important input in the certification process. It defines, within the framework of relevant standards, the lot, sample size, and frequency of testing for each of the requirements of the product specification. The STI also details the procedures for maintaining appropriate controls and checks supported by records at various stages in the process of product realization. The STI pertaining to certification of UPVC pipes as per IS 4985: 2000 is given in Annex 4.

5.4 Certification of UPVC Pipes

The guidelines and procedures given in the OMPC are general and apply to all products including UPVC pipes. The relevance of these guidelines specific to UPVC pipes is only discussed below. It is needless to say that all the other
provisions of OMPC apply equally well to UPVC pipes as for any other product.

a) Preliminary factory evaluation (2.7 of OMPC)

It is strongly recommended that the preliminary inspection be carried out when the factory is in production. The adequacy of the manufacturing set up to the stage where the standard mark is applied to pipes along with other details may be considered and recorded. The observations may include the following:

1) Expertise developed by the firm in the manufacture of UPVC pipes and other PVC pipes and fittings,
2) Experience in the field of UPVC pipes reflected by the production and supply records and the order books.
3) Number of brands used and the basic differences between them.
4) The brands the manufacturer proposes to cover in the license,
5) How substandard pipes are disposed off,
6) If the pipes are marked on line before testing, effectiveness of the method of removing the standard mark.

b) Verification of manufacturing machinery and testing equipment (2.3.4 of OMPC)

During the preliminary factory evaluation, physical verification of the manufacturing and testing machinery should be made and the ownership should be established with documentary evidence.

c) Factory testing during preliminary factory evaluation (2.7.1.2 of OMPC)

Some of the tests specified in IS 4985 require use of several facilities singly or in association with other sensitive instruments. The test procedures also call for sample preparation, conditioning, elaborate test set up and measuring techniques. The test for internal hydrostatic pressure calls for close synchronization between the pressure, temperature and time measuring equipment. The test for external blows calls for conditioning of samples and conducting the actual test within seconds after the specimen is transferred on to the anvil. It is therefore important that all these tests are conducted during the visit. This way, the tasting capability of the equipment and competence of the testing personnel are both established. The tests that take long duration may be initiated.

d) Drawl Samples (2.8.1 of OMPC)

1) Product Samples during preliminary factory evaluation

Depending on the machine capability and the batch size normally encountered, the pipes have been grouped as follows:

<table>
<thead>
<tr>
<th>Group I</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>WP, Mpa</td>
<td>Size range</td>
</tr>
<tr>
<td>1</td>
<td>0.25</td>
<td>90-110</td>
</tr>
<tr>
<td>2</td>
<td>0.4</td>
<td>63-110</td>
</tr>
<tr>
<td>3</td>
<td>0.6</td>
<td>40-110</td>
</tr>
<tr>
<td>4</td>
<td>0.8</td>
<td>25-110</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
<td>20-110</td>
</tr>
<tr>
<td>6</td>
<td>1.25</td>
<td>20-110</td>
</tr>
</tbody>
</table>
Group II
All classes 125-315

Group III
All classes 355-630
This grouping is to be followed for drawing samples for purpose of grant of certification license and also for inclusion of new varieties to the operating licenses.

Having been satisfied with manufacturer’s capability to produce the pipes meeting the requirements of the specification, one sample from each of the above groups should be drawn and tested in independent laboratories for the requirements of the specification. However, it should be ensured that the applicant/licensee has the necessary manufacturing and testing infrastructure and competence for all the sizes/varieties covered in the group. The samples should preferably drawn from the production line. In case it is not possible to do so, it should be ensured from the production and sales records that the samples are from the material produced from the production line. A declaration should also be obtained from the manufacturer to this effect.

2) Samples of raw material during preliminary evaluation (2.8.2.1 of OMPC)

It is clear from 6.1 of IS 4985 that the resin and additives conforming to IS 10151 and IS 10148 only should be used. However, the standard stipulates that the resin should have the monomer (VCM) content within the limits specified in 3.3.1 of IS 10151, and should have a K-value 64 or greater when tested as per IS 4669. Therefore samples of resin should be drawn and tested for these requirements. For purpose of inclusion of new varieties, resin sample should be drawn if there is a change of source.

3) Sample size (2.8.4 of OMPC)
The sample size should be adequate for testing (and retesting should the need arises) the product for the specified requirements. Normally three lengths of 6 m long pipes would be adequate for carrying out all tests, including the retests. However, in the case of pipes of smaller diameters, say up to 90mm (the number of blows per specimen is restricted), longer lengths of pipe or more specimens would be required to carry out the test for external blows. It should be noted that a minimum of 25 blows are required, and the maximum number of blows depends on the number of failures observed, and the failure region A, B or C. It should be remembered that for retesting for external blows, number of tests carried out is the criterion and not the number of blows.

A counter sample should always be drawn and left with the licensee. The counter sample is to be used when the original sample is lost or damaged or for any specific testing purpose during the operation of the license. Use of counter sample should be resorted to only with specific approval from the competent authority.

In the case of UPVC pipes, all the approved laboratories may not have the facility to conduct tests like the test for effect on water, determination of the VCM content and the K value of the PVC resin. In such cases separate samples as required should be drawn and tested to appropriate laboratories.

e) Applying the Standard Mark and other details on the pipe
The features of the Standard mark and the methods of applying it are covered in detail in 2.6.2 and 2.6.3 of the OMPC. Several methods of marking are permitted, but UPVC pipes are normally marked by stenciling or screen-printing method. Marking is on line and every meter length although the STI stipulates distances of not more than 3 m.

The details of marking UPVC pipes given in the STI are in line with the requirements of the standard. For clear and ready identification colour codes are specified for different pressure class of pipes. The gazetted Standard Mark for UPVC pipes is given in Annex 6.

f) Defacing the markings on the sample

The markings made by stenciling or screen printing processes can be removed with some effort. The original markings on the pipe should be removed to conceal the identity of the origin of the product and the details transferred on to the inspection report; and all relevant marking details required by the laboratory for testing purpose should be included in the test request.

g) Test Request (2.8.7.3 of OMPC)

The following information should be included in the test request:

a) For plumbing or for potable water use,
b) Outside diameter,
c) Class of pipe and pressure rating,
d) Batch or lot number,
e) Plain or socket ended,
f) If socket ended, weather for solvent cement joining or for electrometric sealing jointing,
g) Quantity of the rework material used as declared by the manufacturer,
h) The standards/any amendment to be used for testing purpose,
i) Tests to be carried out: All the tests, specific tests to be carried out etc.,
j) Priority of testing, if any test result is to be reported early,

h) Brand Names (2.10.3 of OMPC)

The UPVC pipe industry is spread all over the country. As a result, there is a wide plethora of brand names, owned by the manufacturers and those borrowed from other manufacturers as a good will measure. It is not uncommon to find brand names sold with and without the standard mark. It is strongly recommended that the manufacturers should declare the brand names to be sold with the standard mark, and those are sold with the standard mark only.

i) Market Samples (3.8 of OMPC)

Water supply boards, irrigation and agricultural departments of State and Central Governments, municipal corporations, co-operative sectors, builders of repute and purchase organizations like DGS & D give preference to ISI marked goods. These organizations are potential sources of market samples of UPVC pipes. By keeping liaison with these organizations, their purchase programme can be known in advance. It may thus be possible to plan and procure market samples in an organized manner. The exercise may also lead to fruitful surveillance audits.

j) Testing of samples (3.9 of OMPC)
Samples drawn from the factory during surveillance audits and market samples should be tested for all requirements of the specification. The market samples, when not adequate for carrying all the tests, can be tested for selected requirements to monitor the process control and also study the performance (failure tendencies) of the pipes. The samples drawn during investigation of complaints should first be tested for the requirements reported by the complainant to ensure fast redressal of complaint. The sample should be tested for density requirement for comparison with the recorded values at the factory. This will facilitate matching of control units.

k) Action on Failure of samples (3.9.6 of OMPC)

In simple terms, a critical failure can be defined as one that affects the health and safety of the user, and the performance of the product during the course of its use. In the case of UPVC pipes the standard does not classify any failure as critical. In view of the material characteristics, wrong design of the pipe line, improper jointing and laying also may lead to product failures.

However, keeping in view the process of manufacture, flexibility and methods of jointing and application of the product, occasional failures in the following characteristics may be viewed as non-critical:

- a) Surface finish,
- b) Straightness,
- c) Outside diameter being more than permissible by 0.1mm,
- d) Wall thickness being more than permissible by 0.1mm,
- e) Minor variation in the dimensions connected with socket ends.

l) Endorsements to license

The list of endorsements to a typical license document is given in 3.12.12 of the OMPC. One of the very important endorsements deals with the varieties included in the license. Normally, the varieties covered at the time of granting the license are stated in the grant of license letter itself followed by the Schedule II to the license document. Further additions to the list of varieties are given in the endorsements. Some organized consumers and purchase organizations require that the manufacturers submit these endorsements at the time of tendering. Therefore, these endorsements should be comprehensive and accurately reflect the varieties included in the license.

In Annex 7 of the OMPC, is given Endorsement B, a typical way of covering the inclusion of new varieties. For UPVC pipes, the information should include the following:

- a) Class, pressure rating, nominal sizes (outside diameters),
- a) Plain or socket (bell) ended,
- b) Whether sockets are meant for solvent cement jointing or for elastomer sealing ring jointing.

In view of a large number of pressure ratings and sizes, the pipes have been classified into groups by way of an amendment to the STI given in Annex 3 (see Section of this manual). After testing one representative sample and verifying the availability of the necessary manufacturing and testing
infrastructure, all the sizes in the group are included in the license.
Sequentially read, the endorsements in a chronological order indicate the certification worthiness of the licensee in respect of the product range. The endorsement pattern in OMPC is typical covering the new varieties at any given time of inclusion. But, it is strongly recommended that the endorsement should be in two parts:

Part 1 to indicate the new varieties the new varieties included and the date of inclusion, and
Part 2 to indicate the varieties covered by the license till date.

A typical endorsement is given in Annex 6.
PROCESS FLOW CHART FOR UPVC PIPES

MIXING OF RAW INGREDIENTS IN HOT MIXER VESSELS (PVC RESIN + ADDITIVES)

BLENDED COMPOUND COOLING AT COOLER MIXER VESSELS

VIBRATOR CONVEYOR

SPRING HOPPER

EXTRUDER HOPPER

EXTRUDER BARREL

DIE HEAD

SIZER (COOLER)

COOLING SPRAY TANK

HAUL OFF

CUTTING UNIT

TILTING UNIT

SOCKETING SECTION
INSPECTION STOCK YARD

FINAL INSPECTION AND TESTING

SCRAP YARD (IF FAILS) (IF PASS) SCREEN PRINTING

SCREEN PRINTING

DESPATCH

PROCURING AT STOCK YARD--READY FOR DESPATCH

APPENDIX 1 MANUFACTURING PROCESS-PROCESS CHART
## Annexure 2

## RECOMMENDED LIST OF TEST EQUIPMENTS

<table>
<thead>
<tr>
<th>Ref. Caluse</th>
<th>Testing Requirement</th>
<th>Test equipment/Chemicals &amp; Identification Number (Where applicable)</th>
<th>Required Least Count</th>
<th>Required range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1.2</td>
<td>Wall Thickness</td>
<td>1) Dial Gauge Method OR</td>
<td>0.01mm</td>
<td>As per the thickness of pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Micrometer on which both the fixed and the moving contact point shall be hemispherical. OR</td>
<td>0.01mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Ultrasonic gauge</td>
<td>0.01mm</td>
<td></td>
</tr>
<tr>
<td>7.1.1.2</td>
<td>Outside Diameter at any Point</td>
<td>Vernier Calipers</td>
<td>0.05mm</td>
<td>As per OD of pipe</td>
</tr>
<tr>
<td>7.1.1.1</td>
<td>Mean Outside Diameters</td>
<td>PI Tape</td>
<td>0.05mm</td>
<td></td>
</tr>
<tr>
<td>7.1.4</td>
<td>Effective Length</td>
<td>Metric, woven metallic or glassfibre tape conforming to IS 1269 (Part 1) or metric, steel tape conforming to IS 1269 (Part 2).</td>
<td>1) 1mm.</td>
<td>As per the length of pipe that can be manufactured</td>
</tr>
<tr>
<td></td>
<td>a) Plain Ended Pipe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Socketed Pipe for Elastomeric Sealing Ring</td>
<td>Metric, woven metallic or glassfibre tape conforming to IS 1269 (Part 1) or metric, steel tape conforming to IS 1269 (Part 2).</td>
<td>1) 1mm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Socketed Pipe for Solvent Cement Jointing</td>
<td>Metric, woven metallic or glassfibre tape conforming to IS 1269 (Part 1) or metric, steel tape conforming to IS 1269 (Part 2).</td>
<td>1) 1mm.</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Dimension of Socket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2.1.1</td>
<td>Socketed Pipe for Solvent Cement Jointing</td>
<td>1) Vernier Caliper 2) Inside Caliper 3) Micrometer</td>
<td>1) 0.02 2) NA 3) 0.01</td>
<td>As per OD of pipe</td>
</tr>
</tbody>
</table>

---

29
### 7.2.1.2 Socketed Pipe for Elastomeric Sealing Ring

<table>
<thead>
<tr>
<th>Pipe Ends</th>
<th>Angle Protractor</th>
</tr>
</thead>
</table>

| 9.1,9.2 | 1) Vernier Caliper  
2) Inside Caliper  
3) Micrometer |

| 1) 0.02  
2) NA  
3) 0.01 |

| 1° | 15° |

<table>
<thead>
<tr>
<th>Ref. Caluse</th>
<th>Testing Requirement</th>
<th>Test equipment/Chemicals &amp; Identification Number (Where applicable).</th>
<th>Required Least Count</th>
<th>Required range</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Sealing Ring</td>
<td>Type-1,2,3,4,5, and 6 (design is left to the manufacturer as long as the pipe with sealing ring meets the requirement of the specification)</td>
<td>-</td>
<td>IS 5382</td>
</tr>
</tbody>
</table>
| 10.1 & 10.1.1 | Visual Appearance | 1) Colour  
2) Internal & External Surface | NA  
NA |  |

| 10.2 | Opacity (IS-12235) | Opacity Test Apparatus should consist of any of the following one Apparatus for Test Method-1  
a) An adjustable power arc or incandescent lamp, the intensity of light of which is constant to ± 1 percent. When an arc lamp is used, a suitable filter shall be provided to limit the spectrum between 400 and 800 nm (nanometres);  
b) Diaphragm and optical lenses adjusted to obtain parallel and symmetrical incident beams. The diaphragm shall be circular;  
c) A support, arranged so that it maintains the surface of the test specimen to be examined perpendicular to the optical axis and at a fixed distance from the diaphragm cell; and  
d) A photoelectric cell sensitive to light of wave length specified in 2.2.4, used such that the response of the reading or the recording apparatus is a linear and uniform function of the light intensity, from maximum incidence 10 up to at least 0.01 Io.  
OR Apparatus for Test Method-2  
a) Source of light (halogen lamp 1000 W),  
b) Photo-electric cell (with filter correction to match eye response), and  
c) Digital current meter. | Least Count 0.2% | 0 to 100% |

| 10.3 | Effect on water | Testing is done as per IS 12235 (part-4, part 10) | - | As per IS 4985 : 2000 |

| A) Immersion Method | Thermostatically Control Bath in which heat transfer medium is mono-polyethylene glycol, glyceral or mineral oil free from aromatic hydrocarbons. Having facilities for continuous stirring & Temperature maintained at 150°C ± 2°C | ± 2°C | 150°C ± 2°C |

<p>| 1mm | Range upto minimum |</p>
<table>
<thead>
<tr>
<th>Ref. Caluse</th>
<th>Testing Requirement</th>
<th>Test equipment/Chemicals &amp; Identification Number (Where applicable).</th>
<th>Required Least Count</th>
<th>Required range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.5</td>
<td>Vicat Softening temperature</td>
<td>a) Heating Bath equipped with means to raise the Temp. at uniform rate of 50 ± 5° C/h &amp; installed with suitable stirrer &amp; containing following suitable liquid. It is desirable to have a cooling coil in the liquid bath in order to reduce the time required to lower the temperature between determinations. This must be removed or drained before starting a test, as boiling of coolant can affect temperature rise.</td>
<td>0.5°</td>
<td>Not Less than 80° C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Rod — Provided with the load carrying plate (see d), held in a rigid metal frame so that it can move freely in the vertical direction, the base of the frame serving to support the test specimen under the indenting tip at the end of the rod (see Fig. 1 of IS 12235(P-2)).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2 Indenting Tip — Preferably of hardened steel, 3 mm long, of circular cross-section, and area 1.000 k 0.015 mm², fixed at the bottom of the rod (see d). The lower surface of the indenting tip shall be plane and perpendicular to the axis of the rod and be free from burrs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) Load-Carrying Plate — Fitted to the rod (see 3.1), and suitable weights adjusted centrally so that the total thrust applied to the test specimen can be made up to 50 ± 1 N (5.097 k 0.1 kgf). The combined masses of the rod, indenting tip and load-carrying plate shall not exceed 1 N (100 g).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) Thermometer (or any other accurate temperature-measuring device) of appropriate range, and with graduations at least at each 0.5°C. The scale error at any reading shall not exceed 0.5°C. If a mercury-in-glass thermometer is used, it shall be calibrated for the depth of immersion as required under 5.3 of IS 12235(P-2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f) Micrometer Dial Gauge</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Ref. Caluse</td>
<td>Testing Requirement</td>
<td>Test equipment/Chemicals &amp; Identification Number ( Where applicable).</td>
<td>Required Least Count</td>
<td>Required range</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>
| 10.6       | Density             | 1)Analytical Balance  
2)Thermometre  
3)Deminerlised water  
4)Beaker  
5)Corrosion resistant wire | 0.1mg  
1ºC | |
| 10.7       |                      | Silica Crucible or Platinum crucible inert to the material to be tested. The size shall be sufficient so that the crucible is not more than half filled by the test portion of sample. | 0.1 Mg | Minimum 5gm |
|            |                      | Bunsen Burner & Silica Triangle & Tripod or with other suitable heating device | - | - |
|            |                      | Pipette of approx. capacity | - | - |
|            |                      | Dessicater | - | - |
|            |                      | Drying agent | - | - |
|            |                      | Sulphuric Acid  
Density 1.840 kg/M³ | - | - |
<p>| 11.1       | Hydrostatic Pressure Test | 1)Hydraulic pressure for Type / Acceptance with appropriate capacity having time totalizer and water Bath with temperature controller to maintain the required temperature | within a mean of ±1°C and a maximum deviation of +2°C. | |
|            |                      | Pressure measurement devices capable of checking conformity to the specified test pressure, in the case of gauges or similar calibrated pressure measurement devices, the range of the gauge shall be such that the required pressure setting lies within the calibrated range of the device used. | To keep it constant to within +2/-1 percent of the required pressure. | As per calculation |
|            |                      | Timer capable of recording the duration of the pressure applications up to the moment of failure or leakage. | - | Upto 1000 hrs |</p>
<table>
<thead>
<tr>
<th>Wall Thickness</th>
<th>Thermometer or other temperature-measuring device capable of checking conformity to the specified test temperature</th>
<th>1°C</th>
<th>27 &amp; 60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Locking Plugs of Type A or type B</td>
<td>N.A.</td>
<td>As per OD of pipe</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wall Thickness</th>
<th>1) Dial Gauge Method OR</th>
<th>0.01mm</th>
<th>As per the thickness of pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Micrometer on which both the fixed and the moving contact point shall be hemi spherical. OR</td>
<td>0.01mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Ultrasonic gauge</td>
<td>0.01mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resistance to external blows at 0°C</th>
<th>11.2</th>
<th>1 Sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Falling Weight testing machine with height 2000mm as per Fig.7 of IS 4985</td>
<td>± 10mm</td>
<td></td>
</tr>
<tr>
<td>2) Striker Having weight 0.25Kgs, 0.50Kgs &amp; 1.00Kgs</td>
<td>± 0.5 %</td>
<td></td>
</tr>
<tr>
<td>3) Liquid bath or in air maintained at 0°C</td>
<td>± 1°C</td>
<td></td>
</tr>
<tr>
<td>3) Digital Stop Watch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDICES TO MANUAL FOR CERTIFICATION OF UPVC PIPES.

(PLEASE VISIT BIS WEBSITE /INTRANET FOR LATEST CIRCULARS)

1) Scheme of Testing and Inspection, amendments
2) Marking fee schedule,
3) BIS Testing charges,
4) List of laboratories approved by BIS,
5) Gazetted standard mark,
6) Typical endorsement of product in the license document,
7) Typical test report used by BIS laboratories,

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