E: DUCTILE IRON PIPES AND FITTINGS

1.0 GENERAL

This specification is applicable to Ductile Iron Pipes for water supply systems and shall conform to BS EN 545:2002.

These specifications will provide necessary information on the product dimension and requirements for the supply of pipes only.

2.0 PIPES

The pipe shall be manufactured with socket and spigot, plain-ends and flanged-ends of Class 40 or Class K9.

For all specials/fittings, the products shall be of minimum Class K12.

All Ductile Iron Pipes and accessories shall be designed to withstand hydraulic working pressure of PN 16.

All flanges shall be of ductile iron complying with BS EN 545 : 2002 or equivalent standards.

3.0 MANUFACTURING PROCESS

Pipes and the accessories of Ductile Iron may subjected to suitable heat treatment in order to give them the required mechanical characteristics or tensile properties as shown below:-

CHARACTERISTICS	CENTRIFUGALLY CAST PIPES	FITTINGS
	DN 100 to 800	DN 100 to 800
TENSILE STRENGTH (N/mm^2)	420 (Min)	420 (Min)
ELONGATION (%)	10 (Min)	5 (Min)
HARDNESS (HB)	230 (Max)	250 (Max)

Table 1

4.0 DIAMETER AND SHELL THICKNESS

All straight pipes shall have an effective length of 6.0 meter.

The diameter and shell thickness of standard pipes shall be as shown below:-

PIPE DIAMETER (mm)		SHELL THICKNESS (mm)		
NOMINAL DIAMETER (DN)	OUTSIDE DIAMETER (OD)	PIPE CLASS (CLASS 40)	PIPE CLASS (K 9)	SPECIALS / FITTINGS CLASS (K 12)
100	118	4.8	6.0	7.2
150	170	5.0	6.0	7.8
200	222	5.4	6.3	8.4
250	274	5.8	6.8	9.0
300	326	6.2	7.2	9.6
350	378	7.0	7.7	10.2
400	429	7.8	8.1	10.8
450	480	-	8.6	11.4
500	532	-	9.0	12.0
600	635	-	9.9	13.2

5.0 COATING AND LINING FOR PIPES

The external coating of D.I. Pipes and specials/fittings shall consist of a layer of Metallic zinc covered by a layer of a bitumen coating and loose polyethylene sleeving.

The mean mass of zinc per unit area shall not be less than 130g / m^2.

The metallic zinc coating shall cover the external surface of the pipe and provide a dense continuous, uniform layer. It shall be free from such defects as bare patches or lack adhesion. The uniformity of the coating shall be checked by visual inspection.

Damage to coating where the area of total removal of metallic zinc has a width exceeding 5 mm and areas left uncoated shall be repaired. Repaired shall be carried out either by:

- Metallic zinc spray, or
- Application of zinc – rich paint containing at least 90% of zinc by mass of dry film; the mean mass of applied paint shall not less than 150g / m^2.

Bitumen coating shall not be less than 70μm. It shall uniformly cover the whole surface of metallic zinc layer and free from such defects as bare patches or lack of adhesion. The uniformity of the finishing layer shall be checked by visual inspection. Unless otherwise specified, the finishing layer of bituminous product shall be coated externally with either one of the following :

- Coal – tar epoxy (epoxy content approximately 12%)

- Standard coating materials as specified in BS 4147:1980 Type I (bitumen based, hot applied), or

- Standard coating materials as specified in BS 3416:1976 Type II (bitumen based, cold applied)

Loose Polyethylene Sleeving shall be as specified in ISO 8180 : 1985 Ductile Iron Pipes – Polyethylene sleeving and ISO/DIS 8180 Ductile Iron Pipes for site application.

The sleeving shall be fitted to effect a smooth, closely contoured envelope with minimum barrels and socket gaps. There shall be sufficient slack in contouring to allow the sleeving to follow the profile to the spigot socket interface to prevent damage during backfill.

Adhesives tape shall be used to seal the free edges of sleeving. The function of the tape is to inhibit ingress, circulation or passage of ground water inside the encasement adjacent to the pipe.

The seal is recognized as not only being watertight but still effective in severely limiting ground water flow.

To assist handling during application and installation, the free edge of the fold shall be circumference taped at one meter intervals along the barrel of the pipe.

Any damage to the sleeving shall be repaired using tape and cut sections of sleeving before back filling.

6.0 INTERNAL LINING OF CEMENT MORTAR

All D.I. Pipes and specials/fittings shall be mortar-lined internally.

The lining shall be applied by a centrifugal spinning process or a centrifugal spray head or a combination of those methods.

The cement mortar mix shall comprise of cement, sand and water. Chloride free admixture may be used if necessary.

The ratio by mass of sand to cement shall not exceed 3.5.

The compressive strength of the cement mortar after 28 days of curing shall be not less than 50 Mpa.

The required thickness of the cement mortar lining and its tolerance shall be as stipulated in Table 2.

NOMINAL DIAMETER (DN)	THICKNESS OF CEMENT LINING (MM)		MAXIMUM CRACK WIDTH AND RADIAL DISPLACEMENT
	NOMINAL VALUE	LIMIT DEVIATION*	
40 to 300	4	- 1.5	0.4
350 to 600	5	- 2.0	0.5
** Only the lower limits are given*			

7.0 RUBBER RING / GASKETS

Rubber rings/ gaskets for ductile iron pipes and accessories shall be such size and shape of manufacturer's designs as to provide a pressure tight seal for the life expectancy of the pipeline under specified working, transient and test pressure conditions.

Rubber gasket materials shall be of EPDM complying with the requirements of MS 672 :1999, AS 1646 :1992 or BS EN 681 with of 55 – 85 IHRD with a minimum volume of 40% of polymer in rubber compound.

8.0 TESTING AND INSPECTION

All ductile iron pipe and accessories shall comply to sampling frequencies and tests in accordance with the Standards referred.

9.0 PACKING

All ductile iron pipes shall be individually packed with proper methods and protected from damage during transit.

10.0 MARKING ON DUCTILE IRON PIPES

The following cast-on or cold-stamped marks shall appear on the socket end of each pipe :

- The manufacturer's identification mark.
- The year of manufacture (the last two digits).
- The indicators that the pipe is ductile iron, " D.I. ".
- The nominal diameter (i.e. DN .....).
- The rating of flanges where applicable (i.e. PN .....).

- Standard Reference – BS EN 545:2002.
- The word **SYABAS (50mm high)** in capital letters.
- Class designation (Class 40 or K9)
- Serial Number

11.0 PRE- DELIVERY INSPECTION AND EVALUATION

It is the responsibility of the Tenderer to inform SYABAS for inspection purposes during manufacturing before delivery.

SYABAS reserved the right to inspect and witness the testing of product offered.

At any time, when requested, the supplier is to provide SYABAS a sample of the product for evaluation purposes. All costs shall be borne by the Supplier.

If at any time the Supplier failed to deliver the required sample, the product is deemed to have failed to comply with the Specification.

12.0 CERTIFICATION

Manufacturers or Suppliers are required to provide a copy of the certificate and test reports either from SIRIM, IKRAM or other recognized certification bodies.

Test reports required shall be those tests conducted within a period of a year.

SYABAS reserved the right to refuse offer or reject supply if the relevant documents are not enclosed.

13.0 JOINTING AND ASSEMBLY

13.1 Jointing Instruction

Before assembling the joint, the spigot of the pipe and interior of socket of the adjacent pipe shall both be thoroughly cleaned.

Insertion of Gasket

The gasket shall be wiped clean and flexed and then placed in the socket with bulb leading. The groove in the gasket must be located on the retaining bead in the socket, and the retaining heel of the gasket firmly bedded in its seat so that the heel of the gasket is not proud of the mouth of the pipe. The Contractor shall ensure the gasket fits evenly around the whole circumference, removing any bugles that prevent the proper entry of the spigot end.

Lubrication

A thin film of lubricant is then applied to the inside surface of the gasket which will be in contact with the entering spigot. In addition, a thin film of lubricant should be applied to the outside surface of the spigot end.

Initial Entry of Spigot

The spigot of the pipe jointed must be aligned and entered carefully into the adjacent socket until it makes contact with the gasket. Final assembly of the joint is completed from this position.

Completely Assembled Joint

Joint assembly is completed by forcing the spigot end of the entering pipe past the gasket, which is this compressed, until the first painted strip on the end of the pipe disappear and the second painted strip is approximately flushed with the socket face. If joint is difficult to assemble, the spigot should be removed and rotated 90 degree before attempting to assemble a second time. If the joint is still difficult to assemble, the spigot should be removed and the gasket examined.

Deflection

The joints can be deflected in any directions up to 5 degree for pipes up to 300mm diameter nominal size, up to 4 degree for 350mm and 400mm size and up to 3 degree for 450mm to 700mm.

All spigot must be chamfered.

When making a joint, pipes should always be in line and if required, deflection made after jonting.

13.2 Method of Assembly

Assembly of the joint shall simple, and may accordingly be carried out by any of the following methods:-

Crowbar Method

Complete entry of the spigot into the socket may be obtained by pushing with a crowbar or a suitable lever against the face of the socket of the entering pipe.

Fork Tool Method

This method may be used for 100mm and 150mm pipe. The fork is placed over and behind the socket of the last pipe laid. A wire rope with eye at one end and a hood at the other is connected to the socket of the pipe to be jointed. The fork is now pulled in direction of arrow and the spigot enters the socket. Reasonable force shall only be used.

Trifor or Come along Method

For joint above 150mm a wire rope or chain can be used.

Trench Excavator Method

When the trench is being prepared by using a back hoe or excavator, either machine may also be used to push the spigot home. This system is mainly used on large diameter pipe and a timber header should be placed between the pipe and the bucket to prevent damage to the pipe.

14.0 CUTTING

Ductile iron pipes can be cut by a number of methods.

Where flexible joints are to be made, the cut ends must be trimmed with a file or grinder to remove the burr formed during cutting and a chamfer must be provided.

A Power Driven Abrasive Disc can be used and is suitable for all sizes. There is no need for adjustment to suit pipe size or to attach machinery to the pipe. The abrasive discs are fitted to suitable hand held power tools usually driven by compressed air or small internal combustion engines.

Semi-Rotary Wheel Type Cutters are available, ranging from the standard chain link cutters to more sophisticated tools employing a rigid hinged frame. This type of cutter is normally used on smaller diameter pipe.

It is important when ordering abrasive disc cutting equipment to state that it is for use with ductile iron pipe and to ensure that the disc type, size and the spindle speed of the equipment are compatible.

Rotary and Orbital Pipe Cutters, using cutting tools of the simple lathe or milling saw type respectively, are available throughout the diameter range. Whichever type of cutter is employed the basic machine is attached to the pipe and the cutting tool is driven around the pipe by means of gears on a chain link track. The orbital type cutters have the advantage on the larger sizes of ductile iron pipe in that they a capable of accommodating the avolities which are sometimes present. Some are also capable of forming the chamfer in the same operation. These types of machine are usually driven mechanically, e.g. by compressed air motor although for pipes in the smaller diameter a hand-operated windlass may be employed. In machines using lathe type cutting tools, the cutter heads must have a 7" front rake.

Reciprocating Power Saws may also be used for cutting ductile iron pipe. These tools are usually electrically driven and for this reason they are principally used in depots or workshop where power supply is available.

The pipe DN < 300 the external diameter (measured circumferentially) enable assembly of the joint over a minimum of two thirds of pipe length from the spigot end when the pipes need to be cut on site. For pipes DN > 350 the same applies to a percentage of the pipes.

a) Procedure for pipe cut on site DN > 350

Check the average external diameter of the pipe at the proposed point of the cut. The dimension must comply with the limits specified in the next table.

Average external diameter of pipe

Nominal size DN	Measured circumferentially with standard tape		Measured circumferentially with standard tape	
	Maximum	Maximum	Maximum	Maximum
	mm	mm	mm	mm
350	1191	1177	379	374.5
400	1351	1337	430	425.5
450	1511	1297	481	425.5
500	1674	1660	533	528.5
600	1998	1983	636	631.0

A diameter tape is calibrated to enable diameters to be read off directly when the pipe is measured circumferentially.

After cutting the pipe check the cut end and where is found to be oval, locate and mark the major axis. Measure the length of the major axis. Only where this exceed the dimensions specified in the table, will ovality correction be required prior to jointing.

Note : Cut spigot joint must be chamfered

Maximum major axis of spigot ends

Nominal size DN	For jointing into T-TYPE SOCKET	For jointing into K-TYPE SOCKET
	mm	mm
350	379	379
400	430	430
450	481	481
500	533	533
600	636	636
700	748	739

b) Procedure for full length pipe jointed into K type socket

The major axis of the spigot end of a K type joint pipe is indicated by the short white line painted on the spigot at works.

Measure the length of the major axis, only where this exceeds the appropriate dimension specified in the above table will ovality correction be required prior to jointing.

15.0 OVALITY CORRECTION

Two methods are recommended for ovality correction.

Method A

The use of this method is recommended where it is possible to remove the tackle after ovality correction and subsequent jointing.

Position the timber strut and jack (approximately 5 tons capacity) inside the spigot end of 90 degree to the major axis. Rubber pads should be placed in position to prevent possible damage to the pipe lining. Extend the jack until the major axis has

been reduced to the appropriate limit specified in the table. Complete the jointing operation with the major axis of the spigot vertical.

Note : In some instances, e.g. jointing into couplings, it may be necessary to use two jacks in order to obtain a `round' profile.

Method B

The use of this method is recommended where it is not possible to remove the tackle described in Method A. After ovality correction and subsequent jointing, place the tackle around the spigot end of the pipe at a position approximately 450mm from the pipe end and with major axis of the spigot the re-rounding tackle and protection system to prevent damage.

Tighten the two nuts evenly until the major axis has been reduced to the appropriate limits specified. Complete the jointing operation with the major axis of the spigot vertical. After jointing, remove the tackle.

Note : Where the pipes are to be concreted into a structure they should, if necessary be re-round before this is done and left until the concrete has set, before the re-rounding tackle.