	PBAPP SPECIFICATION FOR DUCTILE IRON (DI) PIPE	
	Material Evaluation Technical Committee (METC)	
	Document No : PBA/PIPE/DI PIPE	Revision No : 01
	Classification : PUBLIC	Effective Date : 18 June 2019

1.0 SCOPE

This Material Specification details the minimum requirements for the design, manufacture, testing, inspection and supply of Ductile Iron (DI) pipe to be used for the transport and distribution of potable water.

The project is in various locations in the Penang state. However, PBAPP reserves the rights to add/ delete/ change the locations as per requirement, all as instructed and directed by the Engineer.

2.0 STANDARDS, CODES AND GUIDELINES

All activities relating to this section of the specification shall comply with the following or approved equivalent standards. The following codes and standards, to the extent specified herein, form a part of this specification. The latest edition of these codes and standards shall govern the work.

BS EN 545 : DUCTILE IRON PIPES, FITTINGS, ACCESSORIES AND THEIR JOINTS FOR WATER PIPELINES - Requirements and Test Methods

BS EN 1563 : FOUNDING - SPHEROIDAL GRAPHITE CAST IRONS

BS EN 1092-2 : FLANGE AND THEIR JOINTS. CIRCULAR FLANGES FOR PIPES, VALVE, FITTINGS AND ACCESSORIES, PN DESIGNATED. CAST IRON FLANGES.


BS EN 14901 : DUCTILE IRON PIPES, FITTINGS AND ACCESSORIES. EPOXY COATING (HEAVY DUTY) OF DUCTILE IRON FITTINGS AND ACCESSORIES. REQUIREMENT AND TEST METHODS.

*(*Refer to the latest revision of the above standards when making any reference)*

3.0 TECHNICAL REQUIREMENTS

3.1 General

The pipe shall be *spigot and socket end* which centrifugally cast in metal mould and the dimension of the pipes to be as stated in clause 4.0 of this specification. **With BS EN 545 as reference, the PBAPP only approved CLASS 40 of DI pipe.**

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The method of manufacturing for ductile iron pipe as well as the chemical composition, heat treatment shall be at the discretion of the manufacturer. However, the manufacturer must take into consideration for the subsequent tests stipulated in BS EN 1563.

3.2 Effect on Water Quality

Components of a pipe system include several materials, when used under the condition for which they are designed, in permanent or in temporary contact with water intended for human consumption, the components shall not change the quality of that water to such extent that it fails to comply with the requirements of World Health Organisation in its "Guidelines for Drinking Water Quality" or Malaysia "National Drinking Water Standards" on the "Quality of Water Intended for Human Consumption", whichever is more stringent in each case.

Materials in contact with drinking water shall be certified by an internationally recognised authority, such as the SIRIM Products Certification Scheme, as being non-tainting and suitable for being in permanent contact with potable water at temperatures of up to 60°C.


3.3 Joints

3.3.1 Spigot and Socket Joint

The joint of each pipe shall be spigot and socket 'T' type push-on joint. ***The shape of the pipe and joint shall follow Figure 1 below.***

Manufacturer shall submit drawings of the actual socket head dimension of their pipes and values of OL, Lu, DOS, and X.

Note: "e" thickness of the pipe materials shall extend through end of the socket. This means that the socket thickness cannot be less than value of "e" of the pipe.

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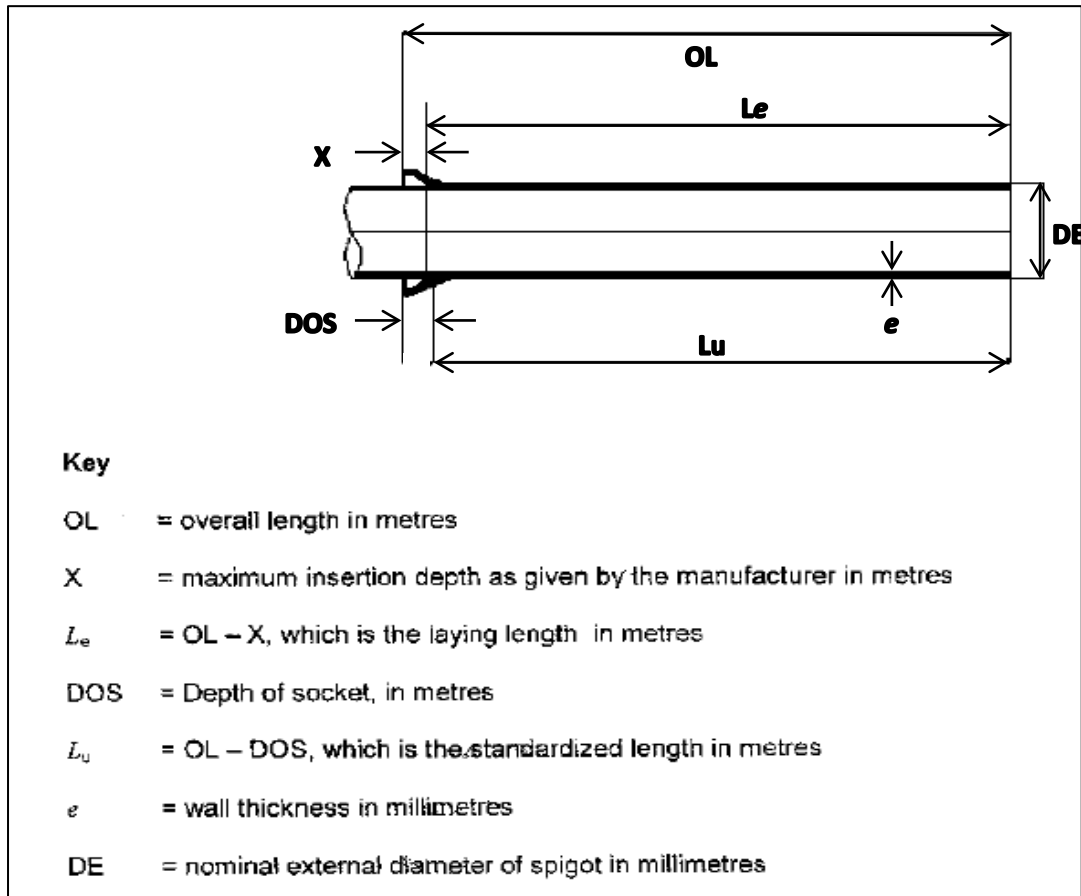


Figure 1 Socket and Spigot Pipe


3.3.2 Elastomeric Seal

The elastomeric seal material shall be EPDM rubber type in accordance to MS 672 or BS EN 681-1, type WA for cold potable water supply. Acceptable hardness range is from 55 to 80 IHRD.

The basic EPDM requirement is the polymer content to be at least 40%. The source of elastomeric seal needs to be tested by accredited laboratory before the elastomeric seal is allowed for use in the piping system.

Performance of the EPDM seals shall include pipe seal under deigned test pressure allowing for maximum joint deflection of 6°.

The EPDM seals shall undergo and pass BS 6920 cytotoxicity test and the rest of clauses stated in BS 6920 part 1 4-8.

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4.0 DIMENSIONAL REQUIREMENT

4.1 Pipes Thickness

The minimum iron wall thickness of pipes shall be as in the summary of pipe dimension in Table 1. The wall thickness shall be measured by suitable equipment having an error limit $\pm 0.1\text{mm}$

Table 1: Pipe Diameter and Minimum Wall Thickness

Nominal Diameter	Pipe Diameter (mm)		Iron Wall Thickness, <i>e</i> , (mm)
	Outside Diameter (OD)	Limit Deviations	
100	118	+1/ -2.8	3.0
150	170	+1/ -2.9	3.0
200	222	+1/ -3.0	3.1
250	274	+1/ -3.1	3.9
300	326	+1/ -3.3	4.6
350	378	+1/ -3.4	5.3
400	429	+1/ -3.5	6.0
450	480	+1/ -3.6	6.8
500	532	+1/ -3.8	7.5
600	635	+1/ -4.0	8.9

4.2 Pipe Diameter

4.2.1 Outside Diameter (OD)

The outside diameter for coated spigot end of pipes and its maximum allowable limit deviations can be referred in Table 1 above.


The socket and spigot pipes shall be measured at their spigot end by circumferential tape.

4.2.2 Ovality (Out of roundness)

- The ovality of the spigot end shall remain within tolerance of OD for DN40 to DN200;
- The ovality shall not exceed 1% for DN250 to DN600;
- The ovality shall not exceed 2% for DN > 600

4.2.3 Internal Diameter

A tolerance of -10mm is allowed for all classes and sizes. The tolerance only apply to pipes with cement mortar lining thicknesses as stated in Table 2 in Clause 5.2 of this specification. This tolerance only applicable for pipe size up to DN600 of Class 40

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4.3 Length

The spigot and socket pipes shall be supplied with standardized length (Lu) of 6.0 meters ± 100mm with allowable limit deviations of -30/+70mm.

5.0 COATING

5.1 External Coating

The ductile iron pipes shall be coated with metallic zinc coating covered by a finishing layer of a bituminous product or synthetic resin compatible with zinc.

The external coating shall be free from defects such as bare patches or lack of adhesion. **The mean mass of zinc per unit area shall not be less than 200g/m² with a purity of 99.99% of zinc.** The mean thickness for finishing layer shall not be less than 70 µm thickness and local minimum thickness not less than 50 µm.

The inside surface of the socket shall be free of mortar, and shall be coated with bituminous paint or synthetic resin paint.

5.2 Internal Lining

All Ductile Iron pipes shall be mortar-lined internally. The lining shall be applied by 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. Chlorine 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 50Mpa.

Table 2: Thickness of Cement Mortar Lining

Nominal Diameter (DN) CLASS 40	Thickness of Cement Lining (mm)		Maximum Crack Width Radial Displacement (mm)
	Nominal	Limit Deviation	
40 to 300	4.0	-1.5	0.4
350 to 600	5.0	-2.0	0.5
700 to 1200	6.0	-2.5	0.6

5.3 Inside Surface of Socket

The inside surface of the socket shall be free of mortar, and shall be coated with bituminous paint or synthetic resin paint.

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6.0 TESTING


6.1 Minimum Work Test Pressure

All pipes must be tested in accordance to BS EN 545. The hydrostatic pressure for centrifugally cast pipes shall be tested until it reaches 40 bar for Class 40. Total duration of the pressure cycle shall be not less than 15 s, including 10 s at test pressure.

6.2 Manufacturing Process

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

CHARACTERISTICS	CENTRIFUGALLY CAST PIPES	FITTINGS
	DN 100 to 600	DN 100 to 600
Minimum Tensile Strength (N/mm ²)	420 (min)	420 (min)
Elongation (%)	10 (min)	5 (min)
Hardness (HB)	230 (max)	250 (max)

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7.0 QUALITY CONTROL

7.1 Quality Control for Ductile Iron Pipes

The requirements of tests and their frequencies are summarized in **Appendix 1**. There are all together 14 parts in the Quality Control and details of the tests are also summarized in the same Appendix. Refer to the Appendix for quality control setup at plant and the equipment requirements performing such tests.

7.2 Records of Tests

All assignments of pipe and fittings manufactured for PBAPP shall have a complete record and traceability for all tests under the quality control plan. The manufacturer is required at any time to furnish such test report when requested by PBAPP.

8.0 MARKING

Each pipe shall be marked on the outside surface, at an interval not exceeding 1.5 meters. **For the first five marking below shall be cast-on or cold stamped.** The mark shall show the following information:-


- a) Name or mark of manufacturer
- b) Year of manufacturer
- c) Type of pipe material (Ductile Iron)
- d) Nominal size, DN
- e) The PN rating of flange when applicable
- f) The reference to standard BS EN 545
- g) Pressure Class designation of pipes
- h) PBAPP
- i) Pipe no.

9.0 PACKING

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


10.0 PRE-DELIVERY INSPECTION AND EVALUATION

It is the responsibility of the tenderer to inform PBAPP for inspection purposes during manufacturing and before delivery. PBAPP reserves the right to inspect and witness the testing of product offered. At any time, when requested, the supplier is to provide PBAPP a sample of the product offered for evaluation purpose. All cost shall be borne by the supplier. If at any time the supplier fails to deliver the required sample, the product is deemed to have failed to meet the specification.

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Appendix 1 - Quality Control for Ductile Iron Pipes

No.	QC Check Station	Items	Test/ Inspection Details	Frequency
1.	Incoming inspection	1. Pig Iron 2. Steel Scrap 3. Recarburizer (Low Sulphur) 4. Silicon Carbide 5. Coke 6. Ferrosilicon (FeSi) 7. Magnesium FerroSilicon (MgFeSi) 8. Inoculant 9. Core Sand 10. Cement Lining Sand 11. Cement 12. Zinc Wire 13. Bituminous Paint 14. Rubber Gasket	1. Visual Inspection 2. Mill Certificate/ certificate of Analysis/ Test Certificate or Results/ Certificate of conformance 3. Laboratory Test 4. Dimension Inspection	Every Arrival
2.	Melting	1. Chemical Composition 2. Temperature	1. Carbon Equivalent Test 2. Temperature Measuring	Before Tap out
3.	Magnesium Treatment	1. Chemical Composition 2. Temperature	1. Spectrographic Analysis 2. Temperature Measuring	1. Every Treatment Ladle 2. First pipe for each furnace
4.	Casting	Defects of pipe	Visual Inspection	Every pipe
5.	Annealing	1. Microstructure 2. Tensile Strength and Elongation 3. Hardness	1. Metallographic Examination 2. Tensile and Elongation Test 3. Hardness Test	- First 2 pipes after initial annealing - Every 200 pipes for DN 100-300 - Every 100 pipes for DN 350-600 - Every 50 pipes for DN 700-1000

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Appendix 1 - Quality Control for Ductile Iron Pipes (Cont'd)

No.	QC Check Station	Items	Test/ Inspection Details	Frequency
6.	Grinding and cutting	Residue	Visual Inspection	Every Pipe
7.	Zinc Coating	Zinc Coating Thickness	Zinc Coating	Every 4 hours
8.	Inspection Station	1. Length of Pipe 2. Wall Thickness 3. Dimension 4. Defect of pipes	- Measurement and Inspection - Visual Inspection	- 2% for each pipe size - Every pipe
9.	Hydrostatic Test	Pressure	Hydrostatic Test	Every Pipe
10.	Cement Lining	1. Cement Lining Thickness 2. Appearance	1. Cement Lining Thickness Test 2. Visual Inspection	- 2% for each pipe size - Every pipe
11.	Bitumen Coating	1. Bituminous Paint Thickness 2. Appearance	1. Bituminous Paint Thickness Test 2. Visual Inspection	Every 4 hours
12.	Marking	Correct Identification	Visual Inspection	Every Pipe
13.	Packing	Packed Properly	Visual Inspection	Every Pipe
14.	Final Inspection	1. Cement Lining Surface 2. Bituminous Coating Surface 3. Marking 4. Pipe / Batch no. 5. Packing Condition 6. Spigot End Marking 7. Rubber Gasket	Visual Inspection	Every pipe before Delivery