PBA/QSH/QMS/01-04 (3)

DOCUMENT AMENDMENT RECORD SHEET (Revision History)

No	Date of Change	Description	Page	Revision	Approved By
1	05 October 2018	New Release	1-13	00	CEO

1.0 Scope

This Material Specification details the minimum requirements for the design, manufacture, testing, inspection and supply of High Density Polyethylene (HDPE) pipe – PE100 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.

MS 1058-1	Polyethylene (PE) piping systems for water supply – Part 1: General
MS 1058-2	Polyethylene (PE) piping systems for water supply – Part 2: Pipes
MS ISO 4065	Thermoplastic pipes – Universal wall thickness table
MS ISO 11922-1	Thermoplastic pipes for the conveyance of fluids – Dimensions and tolerances - Part: 1: Metric series

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

3.0 TECHNICAL REQUIREMENTS

3.1 Material

Material Requirements

The Contractor shall identify the Manufacturer of the resin, the resin type and classification. In addition, the Contractor shall provide evidence that the resin proposed is suitable for use at the design temperature and under the design pressures indicated.

Any changes in the material, the material specification, or the Manufacturer's location shall be subject to prior approval of the PBAPP Sdn. Bhd.

Pipes shall be made of PE100 high density polyethylene (HDPE) virgin material. All materials shall comply with the requirements of MS 1058 and must be listed and valid in the current SPAN product listing list.

Pipes shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, blisters, dents or other damaging defects.

Material shall be uniform in opacity, density, interior smoothness, and other physical properties. It shall have adequate resistance to weathering and other ageing from outside storage for a minimum of two years after manufacture.

The pipe manufacturer shall confirm that all polyethylene fittings to be provided for the pipe systems shall meet the same quality requirements as for the pipes, to ensure the same performance over the design life.

The pipes shall be manufactured from polyethylene containing only those anti-oxidants, UV stabilisers and pigments necessary for the manufacturing process to fulfil the requirements of the specification. All polyethylene material shall be shall be pre-compounded at the resin manufacturer's facility.

The carbon black used in the production of black compound shall have an average (primary) particle size of 10 mm to 25 mm. The carbon black used shall have a maximum tolune extract of 0.1 % when measured in accordance with ASTM D1618.

3.2 Effects on Water Quality

The material of the polyethylene pipes which is in contact with or likely to come in contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water and to be in compliance to MS 1583: Part 1.

The concentrates of substances, chemical and biological agents leached from materials in contact with drinking water, and measurement of the relevant organoleptic / physical parameters, shall not exceed the maximum values recommended by the 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 Physical Properties

The physical characteristics of the PE100 material as granules shall be in accordance with Tables 1 and 2 of MS 1058-1, as further refined in Table 1 given below.

The physical characteristics of the PE100 material in the form of pipes shall comply with the requirements of Table 5 of MS 1058-2.

The minimum required strength (MRS) of the material compound shall be 10 MPa at 20ºC. The design stress shall be 8 MPa and the resin manufacturer shall confirm that the lifecycle durability at 20ºC is a minimum of 100 years.

The design temperature shall be selected in accordance to the average operating and average ambient temperature. The maximum operating pressure of all PE100 pipes shall be de-rated based on the pressure reduction coefficients given in Annex B of MS 1058-1.

Table 1: Additional physical properties of the PE100 materials under this specification

Property	Test Parameter		Requirement	Unit	Test Method
Compound density	23ºC		≥ 930	kg/m^3	ISO 1183
Melt flow rate	(190°C/5.0kg)		0.2 – 1.4	g/10 min	ISO 1133-1
Tensile stress at yield	(50 mm/min)		≥ 23	MPa	ISO 527-2
Slow crack growth (only PE100 material)	Internal test pressure for PE 100	9.2 Bar	No failures during test period	-	ISO 13479
	Test period	165 h			

4.0 Pipe Dimensions and Length

The pipe dimensions for water systems shall be based on standard dimensions according to MS 1058 and a summary of which is given in the following Table 2.

Straight pipe shall be supplied in standard lengths measured at 27ºC ± 2ºC, unless otherwise specified, coil lengths shall not exceed 100 m.

Table 2: Pipe Dimensions

Nominal Size OD (mm)	Maximum Ovality (mm)	Mean Outside Diameter		PN16 / SDR11 Wall Thickness	
		Min. (mm)	Max. (mm)	Min. (mm)	Max. (mm)
25	1.2	25.0	25.3	2.3	2.7
32	1.3	32.0	32.3	3.0	3.4
50	1.4	50.0	50.4	4.6	5.2
63	1.5	63.0	63.4	5.8	6.5
90	1.8	90.0	90.6	8.2	9.2
125	2.5	125.0	125.8	11.4	12.7
180	3.6	180.0	181.0	16.4	18.2
225	4.5	225.0	226.4	20.5	22.7

Note:
1) For installation of new piping system or replacement of pipe laying project; PBAPP will only select, utilize and install HDPE pipe size raging from 25mm, 32mm, 63mm and 125mm.

2) For maintenance purpose (from supplier to supply to PBAPP), PBAPP shall purchase the listed above HDPE pipe sizes.

Unless otherwise approved by PBAPP Sdn. Bhd., the maximum diameter of coiled pipes shall not exceed 110mm OD. Pipes shall be coiled such that localized deformation example buckling and kinking is prevented. The minimum internal diameter of the coil shall not be less than 25 times the pipe outside diameter. Standard lengths for straight pipe of diameter 110mm and above shall not be less than 9m.

4.1 Pipe Appearance

When viewed without magnification the internal and external surfaces of PE100 pipes shall be smooth, clean and free from scoring, cavities and other surface defects. The pipe ends shall be cut cleanly and square to the axis of the pipe.

All polyethylene pipes to be used for the transmission and distribution of potable water shall be black and have blue stripes. The number, width and shade of the blue stripes shall be proposed by the pipe manufacturer and be approved by PBAPP Sdn. Bhd., whilst the striping material shall be a PE100, pre-compounded at the resin manufacturer's facility

4.2 Mean Outside Diameter And Out-Of-Roundness (Ovality)

The mean outside diameter d_{em} and the out-of-roundness (ovality) shall be in accordance with Table 3.

Table 3: Mean outside diameter and out-of-roundness

Nominal size DN/OD (mm)	Nominal outside diameter, d_n (mm)	Mean outside diameter		Maximum out of roundness (ovality) [b] (mm)
		d_{em} minimum (mm)	d_{em} maximum [a] (mm)	
25	25	25.0	25.3	1.2
32	32	32.0	32.3	1.3
50	50	50.0	50.4	1.4
63	63	63.0	63.4	1.5
90	90	90.0	90.6	1.8
125	125	125.0	125.8	2.5
180	180	180.0	181.0	3.6
225	225	225.0	226.4	4.5

NOTES:
1. For coiled pipe and straight lengths with diameters ≥ 710 the maximum out-of-roundness is to be agreed between the manufacturer and the purchaser.
2. Tolerance bands in accordance with MS ISO 11922-1[1] are calculated using the formulae, as applicable.

Grade B: $0.006d_n$ rounded up to the next 0.1 mm higher with the minimum value of 0.3 mm and a maximum value of 4.0 mm: and

Grade N: for diameter ≤ 75 mm: $(0.008d_n + 1)$ mm;
for diameter ≥ 90 mm and ≤ 250 mm: $(0.02d_n)$ mm

rounded to the next 0.1 mm higher.

[a] In accordance with ISO 11922-1[1] grade B for sizes ≤ 630 and grade A for sizes ≥ 710.

[b] In accordance with ISO 11922-1[1] grade N for sizes ≤ 630 and is measured at the point of manufacture.

5.0 INSPECTION AND TESTING

5.1 Certification, Documentation and Testing

The manufacturer shall demonstrate that each element of the pipe systems is manufactured in accordance with a national or international certification scheme for polyethylene plastic pipe systems produced for use in utilities.

The raw material and pipe system manufacturers shall document and certify all products and shall undertake all testing required by MS 1058 and this specification. The testing and its reporting shall take the form of Type Tests (TTs) and Batch Release Tests (BRTs).

TTs shall have been undertaken to prove that pipes and their components are capable of conforming to the requirements of MS 1058. They shall have comprised all of the tests listed in the relevant part of MS 1058 and have been undertaken by an independent third party laboratory.

BRTs shall comprise those tests undertaken by raw material and pipe system manufacturers before the release of the system components from the manufacturer’s facilities. As a minimum they shall comprise the tests given in the Pipe Batch Release Testing section of the specification.

5.2 Inspection and Testing Plan

Prior to delivery of any pipes the pipe manufacturer shall provide to PBAPP Sdn. Bhd. with a comprehensive Inspection and Testing Plan (ITP) for their approval. The ITP shall contain all the certificates and documents that shall be provided by the pipe manufacturer, together with details of the type testing and batch release testing that they have previously undertaken and shall undertake. Where the pipe manufacturer cannot themselves undertake the required testing they shall employ an independent third party laboratory to undertake the testing on their behalf.

5.3 Pipe Batch Release Testing

A pipe batch shall be considered as a continuous production run of a particular pipe OD and wall thickness manufactured from one resin type with no change in the manufacturing process.

A raw material batch shall be considered as a batch of material supplied by the resin producer having an individual identification number or code. For the purposes of this specification it shall also be the raw material used to manufacture a particular pipe batch.

As a minimum, the resin producer and pipe manufacturer, between them, shall undertake the following batch release testing.

Table 4 – Release Tests to be undertaken on Each Raw Material Batch

Characteristics	Reference	Sampling Frequency	No. of Tests or Inspections
Compound density	MS 1058-1 section 4	Once per batch	1
Oxidation induction time	MS 1058-1 section 4	Once per batch	1
Melt mass-flow rate	MS 1058-1 section 4	Once per batch	1
Volatile content	MS 1058-1 section 4	Once per batch	1
Water content	MS 1058-1 section 4	Once per batch	1
Carbon black content	MS 1058-1 section 4	Once per batch	1
Carbon black dispersion	MS 1058-1 section 4	Once per batch	1

Table 5 – Release Tests to be undertaken on Each Batch of Pipes

Characteristics	Reference	Sampling Frequency	No. of Tests or Inspections
Appearance and colour	MS 1058-2 section 5	Continuously	-
Geometrical	MS 1058-2 section 6	Continuously	-
Tensile strength at yield on a sample cut from the pipe	ISO 6259 (Tensile strength to be ≥ 22 MPa)	Once per batch	1
Melt mass-flow rate	MS 1058-2 section 8	Once per batch	1
Elongation at break	MS 1058-2 section 8	Once per batch	1
Oxidation induction time	MS 1058-2 section 8	Once per batch	1
Marking	MS 1058-2 section 11	Each pipe or coil	1

Pipe wall thickness shall be measured and controlled on a continuous basis using and ultrasonic thickness gauge or similar device that shall be regularly calibrated in accordance with the gauge manufacturer's recommendations.

In accordance with the recommendations of ASTM D 638, the maximum thickness of the tensile strength test samples cut from the pipe wall shall be 14 mm. In the event of the pipe wall being thicker than 14 mm the pipe manufacturer shall machine the test samples in accordance with the following Table 6.

Table 6 – Preparation of Samples for Tensile Testing

Pipe Wall Thickness (WT) (mm)	Test Sample Thickness (mm)	No. of samples to be taken from the pipe wall
≤ 14	WT	1
14 < WT ≤ 28	WT/2	2
28 < WT ≤ 42	WT/3	3
42 < WT ≤ 56	WT/4	4
56 < WT ≤ 72	WT/5	5

All testing shall be undertaken in accordance with ISO 6259 and all samples shall achieve a minimum tensile strength at yield of 22 MPa in order for the pipe to pass the test.

5.4 Hydrostatic Testing of Pipes and Fittings

The ITP shall detail the pipe manufacturer's hydrostatic testing regime. As a minimum, the pipe manufacturer shall have, at 12 monthly intervals, produced and hydrostatically tested pipes manufactured using the same grade of resin or resins that are to be used to produce the pipe covered by this specification.

The testing shall comprise all three hydrostatic tests detailed in Table 3 of MS 1058-2 in the case of pipes. In each case the pipe manufacturer shall test 3 pieces, as required by the standard. The size and SDR of the pieces shall be determined by the manufacturer.

5.5 Appointment of an Independent Third Party Inspector

To verify compliance with this specification, PBAPP Sdn. Bhd. reserves the right to appoint an independent Third Party Inspector, at their own cost, to witness the applicable qualification tests, review production records, and inspect general handling and shipping procedures.

5.6 Inspection requirements

The pipe manufacturer shall ensure that all the applicable codes and standards are available at their facility for PBAPP Sdn. Bhd. reference during any visit or inspection.

The pipe manufacturer shall provide full assistance and co-operation for any inspection, when required by PBAPP Sdn. Bhd. or their Independent Third Party Inspector.

When requested, the pipe manufacturer shall provide access to and copies of all material certificates and inspection and test results obtained in the course of quality verification.

5.7 Acceptance Criteria

The following criteria requirements shall be fulfilled by the pipe manufacturer in order for the pipes to be approved and accepted by PBAPP Sdn. Bhd.

1) Prior to delivery of pipes the pipe manufacturer shall provide PBAPP Sdn. Bhd. with copies of all the type test results and certification required by MS 1058, this specification and the ITP. These documents shall comprise the Type Test Report.

2) Where available, the Type Test Report shall include a copy of the raw material manufacturer's Data Sheet and Batch Test Certificate or equivalent document covering each batch of raw material to be used in the manufacture of pipes. If these are not available with the pipe manufacturer at the time of submitting the Type Test Report they shall provide when the PE resin is delivered to the pipe manufacturer.

3) The pipe manufacturer shall provide PBAPP Sdn. Bhd. with a copy of the batch release tests identified in the ITP whenever a batch of pipes is delivered to site.

4) If PBAPP Sdn. Bhd. has appointed an independent third party inspector, their report shall be submitted to and approved by the PBAPP Sdn. Bhd., with a copy to the pipe manufacturer, prior to any inspected materials being installed on site.

The PBAPP Sdn. Bhd. may reject any item that does not successfully pass the required tests or fully comply with the requirements of this specification.

When a pipe is rejected, the items manufactured immediately before and after shall be carefully examined and tested at the direction of PBAPP Sdn. Bhd. If further defects are found, then PBAPP Sdn. Bhd. reserves the right to reject the entire batch of pipes.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

In addition to the documentation described in previous sections of this specification the pipe system manufacturer shall submit copies of their current ISO 9001 certificate together with certificates confirming compliance with national and international quality certification schemes.

7.0 PACKING, MARKING AND VENDOR DOCUMENTATION

7.1 Pipe Identification and packing

The marking information and sequence shall comply with MS 1058. All pipes, including test samples shall be clearly and permanently marked using either indent printing in a colour that contrasts with the pipe or a laser marking system

All pipes shall be indelibly marked at maximum intervals of 1m and as a minimum the marking shall indicate at least the following information:

1. International standard number
2. The manufacturer's name and/or trademark together with the production location
3. The dimensions (nominal outside diameter x nominal wall thickness)
4. Pipe series (SDR- Standard Dimensional Ratio)
5. Material and designation
6. Nominal pressure (PN) in bar
7. Production period (date or code)
8. Pipe batch number
9. As the pipes are to carry potable water the word “water” shall be included
10. The quality mark of whichever quality certification scheme the pipes were manufactured under

7.2 Shipping

The Contractor or Supplier shall provide packing and shipping procedures for approval by PBAPP Sdn. Bhd. and shall comply with the following requirements.

7.3 Delivery

The delivery of the HDPE pipe to site shall be no later than six months after the date of manufacture shown on the pipe.

7.4 Weathering

A certificate from the pipe manufacturers shall be provided, confirming that the products may be stored in for minimum of 2 years without any adverse effect.

7.5 Tie-Downs

Tie-downs shall be at least 100 mm wide and be clean and free from sand, gravel and other such materials. For straight length pipe (up to 12 m), a minimum of 6 tie-downs are required.

7.6 Pallets

The pallets shall be suitable for transporting the material from the place of manufacture to the designated receiving location without causing any damage to the pipe. The pallets shall not contain any broken planks or extremities that may damage the coiled pipe or straight lengths. They shall be durable enough to prevent loose pallet nails from gouging the bottom pipe.

7.7 Overhang

Pipe shall not overhang at either end of the trailer.

7.8 Stacking

The contractor or supplier shall not ship small coils stacked inside silos of larger coils. Frames manufactured for the containment of straight lengths of polyethylene pipe during transport and storage shall not contain nails or other fastening devices that may damage the pipe.

7.9 Trucking

Where pipes are transported by vehicles, the vehicles should have a flat bed and be free from sharp edges or projections. During transport, polyethylene pipes shall be protected from diesel fumes and be continuously supported to prevent movement between the material and its support.

7.10 Silo's

Silo packs of coiled pipes shall be squarely stacked and well supported on pallets. Coils shall not overhang the pallets and, shall not be stacked higher than 2.3 m.

7.11 Vendor Documentation

The contractor shall furnish following vendor data as a minimum, during submission of tender:

1. Catalogues/Brochures
2. Dimensional details of pipes
3. Detailed material specifications
4. Certificate for PE100 and associated documents
5. Manufacturer's drawings – optional

6. Complete details of testing facilities available at manufacturer's works

7. Local agent name and address - optional

Tender documents not accompanied by any of above mentioned information/data shall be considered incomplete, and liable to be rejected.