SPECIFICATIONS FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPES, FITTINGS, SPECIALS & ACCESSORIES FOR DRAINAGE & SEWERAGE APPLICATIONS

Revised on 29.01.2024

SPECIFICATIONS FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPES, FITTINGS, SPECIALS, ACCESSORIES FOR DRAINAGE & SEWERAGE APPLICATIONS

1.0 GENERAL

1.1 Ambient Conditions

All items of materials and equipment shall be in every respect suitable for storage, installation, use and operation in the conditions of temperature and humidity appertaining in Sri Lanka.

The annual average temperature is 35 °C while the relative humidity varies generally from 70% during the day to 90% at night. The pH of wastewater to be conveyed ranges from 5.5 – 9.0.

The climate is hot and the sunlight is intense. The temperature of wastewater to be conveyed in the pipelines will be below 400C and surfaces exposed to the sunlight may rise to higher temperatures.

1.2 Definitions

The definitions given in the relevant standards which are referred to in the specification shall apply for the terms used in this specification.

1.3 Materials

All pipes & fittings shall be of black colour and shall comply to the Clause 2.5 of the Technical Specification hereof.

1.4 Inspection and Testing

The Contractor shall supply, furnish and prepare the necessary test pieces and samples of all materials and supply the labour facilities and appliances for such testing as may be required to be carried out in his premises according to this specification. If there are no facilities at his manufacturer's factory for making the prescribed tests the Contractor shall bear the cost of carrying out the tests elsewhere.

The Engineer, his representative or nominated inspection authority shall have full access to all parts of the manufacturing plant that are concerned with the testing, furnishing and preparation of materials for the performance and testing of work under this Specification.

The Contractor shall furnish the Engineer or his representative or nominal inspection authority with reasonable facilities and space at no cost to the employer for the inspection, testing and obtaining of such information, as he desires regarding the character of material in use and the progress and manner of the work.

The manufacturer shall provide results of tests conducted, in accordance with the standards given in the Specification.

1.5 Marking of Pipes, Fittings and Specials

All markings described below shall be legible and indelible unless otherwise specified.

All pipes and fittings shall be marked as specified in clause 11.1 & 11.2 of BSEN 12201-02:2011+A1:2013, ISO 8772:2006, ISO 21138-1:2007, ISO 13272:2011 and as specified in the Table 1 hereof. The manufacturer's Name, Identification Mark and the PN rating shall be marked legibly and indelibly on the pipes together with the information shown below.

Marking shall be in such a way that it does not initiate cracks or other types of failures and that normal storage, weathering, handling, installation and use shall not affect the legibility of the markings.

During the manufacturing process, the pipe shall be marked with pertinent product and process information at approximately 1 m intervals along the pipe.

Specifications require at least the following information to be included. Colours of markings shall be visible at a glance.

- Manufacturer's identification or logo,
- Standard number (Specification number)
- The designation of the pipe material (PE 100)
- The dimensions (Nominal outside diameter, nominal wall thickness – d_n x e_n)
- The outside diameter tolerance (A or B)
- The Production Period (date and code)
- The Nominal Pressure (PN)
- SDR Series

In addition to the information given above following information to be marked on the fitting.

- In case of a bend, bending angle and incase of unequal tee branch line size and main line size.
- Pressure rating at relevant temperature
- Standard dimension ratio (SDR)
- Fusion time (Seconds)
- Cooling time (minutes)
- System voltage
- Moulded-in identification and appropriate product information
- Terminal pin size of electro fusion fittings

Table 1 – Marking

Item	Lettering Heights (mm) for pipes/fittings above 160 mm dia	Lettering Heights (mm) for pipes/fittings below 160 mm dia
Pipes		
NWSDB	50 mm dia. at 3m intervals	25 mm dia at 3m intervals
Sewer	50 mm dia. at 3m intervals	25 mm dia at 3m intervals
SDR	25 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Manufacturing Standard	15 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Outside Diameter	25 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Production period (date & code)	25 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Nominal Pressure	25 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Other	25 mm dia. at 3m intervals	15 mm dia. at 3m intervals
Fittings		
NWSDB	50 mm dia.	25 mm dia
Sewer	50 mm dia.	25 mm dia
SDR	25 mm dia.	15 mm dia.
Manufacturing Standard	15 mm dia.	15 mm dia.
Outside Diameter	25 mm dia.	15 mm dia.
Production period (date & code)	25 mm dia.	15 mm dia.
Nominal Pressure	25 mm dia.	15 mm dia.
Other	25 mm dia.	15 mm dia.

All fittings must be packed in such a way to allow instant use on site without additional cleaning. All electro-fusion fittings must be packed in transparent protective bags. The electro-fusion fittings must then be packed in carton boxes. The Contractor shall label and clearly mark all crates and boxes legibly and indelibly as specified in the notes forming a part of this Specification.

All fittings shall be marked with the corresponding item number in the Bills of Quantities or any other number specified by the Engineer. An individual data

carrier card in compliance with ISO 7810 and ISO 7811 containing a magnetic strip and appropriate bar codes as well as manual setting information for data transfer purposes must be supplied with each item as appropriately.

1.6 Protection during Delivery

The Contractor shall provide methodology of protection of pipes and fittings, to the approval of the Engineer and obtain written approval prior to the pipes and fittings leaving the place of manufacture and shall maintain such protection until the items reach their destination in order to guard effectively against damage during handling transit and storage and ingress of foreign matter inside the pipes & fittings.

All fittings shall be securely packed in crates and boxes to prevent damage during delivery. The cost of packing shall be deemed to be included in the Contract rates and crates will not be returned.

The manufacturer shall provide necessary details to the shipping line on precautions to be taken during loading/unloading handling & transport of the pipes & fittings and other components, in the sea, manufacturer shall provide to the purchaser a set of recommendations of manufacturer for handling, loading, unloading, transporting and storing of polyethylene pipes and fittings.

1.7 Storing, Handling and Hauling of Pipes, Fittings and Specials

All materials shall be stored in an approved location and in such a manner as to preserve their quality and condition as recommended by the manufacturer.

All materials should be carefully inspected at the time of delivery and any defective material set aside before accepting the delivery into stores. Any such defects should be notified to the manufacturer immediately.

Materials and components shall be handled in such a manner as to avoid any damage or contamination and in accordance with all applicable recommendations of the manufacturer's recommendations.

1.7.1 General Principles

The recommendations for handling and storage are the same for PE 80 and PE 100 pipes due to their increased stiffness, even greater care may be required in the handling of PE 100 pipe coils than PE 80 pipes of similar wall thickness.

Polyethylene is a tough resilient material which is relatively light and easy to handle although it is prone to damage through scouring by sharp objects. Therefore careful handling is always required and the dragging of straight pipe and coils should be avoided.

The maximum allowable depth of scoring of the external surface of the pipe is 3% of the wall thickness. Pipes and fittings showing obvious defects or excessive

scoring should be withdrawn, clearly identified as unsuitable and, where appropriate, returned to the source of supply.

The general properties of polyethylene are unaffected by low ambient temperatures but, having very smooth surfaces, the pipes and fittings become slippery in wet or frosty weather. Particular attention should be given to effective securing and storage under such conditions. Extra care should also be taken when handling large diameter prefabricated fittings during very cold weather.

The packaging of pipes by the manufacturer is normally consistent with the requirement to prevent damage and to comply with safety considerations. Usually pipes are delivered strapped into convenient bundles or banded coils. Fittings are normally supplied in separate bags or cartons together with any associated small items, such as bolts and gaskets.

As far as practicable the protective packaging (pallets, strapping, bags etc.) should be kept intact until the material is required for use. The temporary capping or plugging of pipe ends is recommended.

Pipes and fittings likely to be stored outside should be covered by a tarpaulin or black polyethylene sheeting to prevent ultra violet degradation from sunlight. Electro fusion fittings should be stored under cover and in their protective packaging.

1.7.2 Transport and Delivery

For transporting bulk loads, vehicles should be provided with a clean flat bed, free from nails or other projections, which may cause damage. If high sided lorries are used, special care must be taken to prevent slippage or excessive bowing of the pipes and extra protection given at all sharp edges.

Care should be taken to avoid positioning pipes and fittings near or adjacent to exhaust systems or other heat sources and to avoid possible contamination from materials such as diesel oil.

Metal chains or slings should not be brought into direct contact with the material. Webbed slings of polypropylene or nylon are recommended. Straight pipes should be fully supported and bound together. Pipes must not rest on the integral socket, if one is incorporated.

When transporting 'pupped' fittings, these should not be loaded in a way that could distort the pupped end.

Both vertical and horizontal deliveries of coiled pipes are permissible, although in the case of horizontal transportation special notification may be required for highway authorities in respect of wide load regulations.

Following the quality control inspection and testing, caps or plugs are to be provided to protect the jointing surfaces during transportation and storage. The

finished and protected pipes are then carefully packed into manageable units (bundles or coils) prepared for shipments.

1.7.3 Off Loading

1.7.3.1 Bundled Pipes

When lifting by crane, non metallic wide band slings or ropes should be used, and for pipe lengths greater than 6 m, load spreading beams of a length at least equivalent to one quarter of the length of the pipe or bundle pack should be employed.

Chains or end hooks should not be used. Care should be taken to avoid damage to pipes and pipe ends during lifting, particularly those pipes with couplers.

Some bending should be allowed for in the middle of the lift when loading and unloading pipes and, because of this, lifting points should always be well spread and evenly spaced.

Standard bundle packs, 6 m long, may be handled by fork lift trucks but due allowance should be made for the flexible nature of the pipes in the positioning of the forks and the raising of the load.

Bundle packs greater than 6m long should be handled either by a side loader with a minimum of four supporting forks, or by a crane using a spreader beam and suitable slings. Individual pipes may be and led in the same way. Off-loading on site may be made easier by using skid timbers and rope slings.

1.7.3.2 Coiled Pipes

Pipe coils shall be transported inside containers from place of manufacture. Manufacturer/Tenderer (Contractor) shall ensure that coils of pipes are not exposed to direct sunlight at any place, during transit. Tenderer (Contractor) shall deliver the pipe containers in closed condition to purchaser's stores as directed and only inside the purchaser's warehouse, the containers shall be opened for inspection. Tenderer(Contractor) in coordination with the purchaser shall make arrangements for customs clearance, when the containers are brought to storage warehouse.

Reinforced adhesive tape at least 50 mm wide should be used for banding. Complete coils are secured by outer and intermediate bands and individual layers are also independently secured. These should not be removed until the pipe is required for actual use.

Before unstrapping pipe form the coil or drum, both pipe ends must be firmly mechanically restrained. The band securing the outer end of the pipe should be removed first and the movement of the free end carefully controlled. This removal should be followed with those securing successive layers. No more bands should be removed than necessary to release the length of pipe immediately required. After sufficient pipe has been cut from the coil the protective end cap must be

replaced on the remainder. The outer end of the pipe should be suitably re-marked as such.

When removed from the coil or drum, the pipe will be oval and curved. The extent of ovality and curvature will depend upon the temperature, SDR rating, pipe diameter, coil diameter and material type. Although both ovality and curvature will reduce naturally with time, special hardware is available to facilitate handling and jointing.
(See the fig. 1 in Annex - C hereof, showing the proper handling methods for coils)

1.7.3.3 Fittings

Hooks should not be used to lift fittings which are generally supplied in cardboard boxes or polyethylene bags.

1.7.3.4 Storage at Depot

Materials of different polymer manufacture should be kept separately and clearly identified.

All polyethylene pipes should preferably be stored under cover and protected from direct sunlight until required for use. Where storage facilities necessitate the material to be exposed externally, suitable opaque protective sheeting should be used.

All pipe stacks should be made on sufficiently firm, leveled ground and free from stone to support the weight of the pipes and any necessary lifting equipment. Stacking heights should be kept to a minimum and without exceeding the manufacturer's recommendation and adequate space allocated for lifting machinery to manoeuvre (more carefully and often with difficulty) without causing accidental damage.

For safety and the convenience of handling, the stacking height for bundles should not be more than 3 meters. To prevent possible deformation of the pipes, bundles must be stored timber to timber.

The Bidder shall make arrangements to stack wrapped/bagged coils neatly on robust pallets (free from projections), in Central Stores, conforming to the following maximum stack heights.

- 2 coils for 90 mm diameter pipe
- 1 coils for 110 mm diameter pipe
- 1 coils for 125 mm diameter pipe
- 1 coils for 180 mm diameter pipe

Forklift trucks shall not be used to load and unload pipe except where coils are neatly stacked on pallets or coils and are provided with slings.

For similar reasons, pipe coils should be stored flat and the number of coils per stack should be limited to;

Where individual pipe lengths are stacked in pyramidal fashion, deformation may occur in the lower layers, particularly in warm weather. Such stacks should therefore be no more than 1 meter high. Socketed pipes should be stacked with the sockets at alternate ends and with the sockets protruding to avoid uneven stacking which may permanently distort the pipes.

Polyethylene fittings should be stored under cover, preferably on racking and in the manufacturer's protective wrapping or cartons which should be kept intact until the fitting is required for use.

At all times pipes and fittings should be stored away from exhaust outlets and all other high temperature sources. Care should also be taken to avoid contact with lubricating or hydraulic oils, gasoline, solvents and other aggressive chemicals.

All special tools and equipment associated with the jointing of PE pipes and fittings should be stored separately and securely until they are required for use. The heating faces of fusion tools should be kept in a position where the surfaces are protected from scratching or other damage. Tools incorporating cutting edges should likewise be protected from damage that could cause poor joint preparation.

1.8 Packing of Bolts, Joint Rings and Gaskets

Bolts of the same length and size (and their accompanying nuts and washers) shall be packed together in boxes not exceeding 100 kg. gross weight.

Joint rings and gaskets shall be packed in boxes and separate packages shall be provided for each size and description of ring or gasket.

Each box and package therein shall be clearly labeled stating the number, size and description of the contents.

1.9 Manufacturer's Certificate

The Contractor shall supply to the Engineer a certificate stating that each item supplied has been subjected to the tests laid down herein and conforms in all respects to this Specification or such other Specification which has been submitted to and approved by the Engineer.

1.10 Quality and Workmanship

All pipes, fittings, Nuts & Bolts, and accessories shall be manufactured in compliance with the ISO 9001:2015 quality management system standards for the manufacturing factory. In addition to product quality control tests the manufacturers also must perform and satisfy long term type tests to demonstrate long term performance of pipe as detailed in relevant standards. Quality Management System Certification should be from an organization which is a member of International Accreditation Forum (IAF) having the scope of the accreditation for PE pipes and fittings to issue such certification and the manufacturer shall have this certification valid during the supply and delivery of the materials. Document evidence regarding accreditation together with the scope of certification should be provided.

1.10.1 Quality Assurance (Q/A) at Manufacturer's Works

The manufacturer shall operate a quality assurance scheme complying with ISO 9001:2015 and on award of order shall submit a copy of his quality assurance guidelines, as issued to his production works sections. Material Quality Certificate shall be from one of the Independent Testing Agencies, which is indicated in the Condition of Contract, shall be provided by the contractor. This shall include the following items, detailing the frequency of quality assurance checking.

a. Raw Materials

i. Vetting and recording of certificates provided by the raw material manufacturer (S).

ii. Chemical testing of raw material and frequency of tests.

b. Pipe Manufacture (for each pipe diameter)

i. Checking of extrusion compound temperature at the extruder (state the temperature) and state its consequence on quality.

ii. Temperature of water bath/sprayed water cooling system on extruded pipe.

iii. Maintenance of pull force on extruded pipe.

i. Procedure for resumption of production after an interruption on the production line (e.g. power failures, change of pipe production batches, etc.)

ii. Hourly production records.

iii. Frequency of calibration of testing equipments

iv. Inspection of stock yards (visually) and packing methods.

2.0 TECHNICAL REQUIREMENTS FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPES, FITTINGS, SPECIALS AND ACCESSORIES FOR SEWERAGE AND SEWERAGE APPLICATIONS

2.1 Scope

This specification covers polyethylene pipes and associated fittings for the use of drainage and sewerage applications.

2.2 Reference Standards

EN12201-1:2011	Plastic piping System for Water Supply, and for drainage and sewerage under pressure Polyethylene (PE) Part 1- General
EN12201-2:2011/A1:2013	Part 2- Pipes
EN12201-3:2011/A1:2012	Part 3- Fittings
EN12201-4:2011	Part 4- Valves
EN12201-5:2011	Part 5- Fitness for purpose of the system
ISO 4427-1:2019	Plastic piping System for Water Supply, and for drainage and sewerage under pressure Polyethylene (PE) Part 1- General Part 2- Pipes Part 3- Fittings Part 5- Fitness for purpose of the system
EN ISO 1167-1:2006	Thermoplastics pipes, fittings & assembles for the conveyance of fluids. Determination of the resistance to internal pressure. Part 1- General Method
EN ISO 1167-2:2006	Part 2- Preparation of Pipe test pieces
ISO 8772:2006	Plastics piping systems for non-pressure underground drainage and sewerage – Polyethylene (PE)
ISO 21138-1:2007	Plastics piping systems for non-pressure underground drainage and sewerage -- Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) -- Part 1: Material specifications and performance criteria for pipes, fittings and system
ISO 13272:2011	Plastics piping systems for non-pressure underground drainage and sewerage -- Unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP), polypropylene with mineral modifiers (PP-MD) and polyethylene (PE) -- Specifications for manholes and inspection chambers in traffic areas and underground installations.

EN 1515:2000	Flanges & their joints, bolting, selection of bolting
EN 1092-2:1997	Flanges & their joints circular flanges for pipes, valves, fittings & accessories PN designated Cast iron flanges.
EN 1514-2:2014	Flanges and their joints. Gaskets for PN-designated flanges. Spiral wound gaskets for use with steel flanges
EN ISO 12162:2009	Thermoplastics materials for pipes and fittings for pressure applications. Classification, designation and design coefficient.
BS 7874 : 1998	Method of test for microbiological deterioration of elastomeric seals for joints in pipe work and pipe
EN 681-1:1996	Elastomeric seals, material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber
ISO 13761:2017	Plastic pipes and fittings – Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20 degrees C.
ISO 12176-1:2017	Plastics pipes and fittings – Equipment for fusion jointing polyethylene systems – Part 1 : Butt Fusion.
ISO 12176-2:2008	– Part 2 : Electrofusion.
ISO 6259-1:2015	Thermoplastic pipes – Determination of tensile properties. Part 1: General test method
ISO 6964:2019	Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method
ISO 1133-1:-2022	Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method
ISO 2505:2005	Thermoplastics pipes — Longitudinal reversion — Test method and parameters
ISO 9001: 2015	Quality management system certificate
ASTM F2620	Standard practice for Heat Fusion of Polyethylene Pipe and Fittings (Socket Fusion)
PD CEN/TS 12201-7:2014	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Guidance for the assessment of conformity
DIN 16963 1-15 series	Pipes joints and elements for high Density Polyethylene (PE) pressure pipe lines.

BS EN ISO 898-1: 2013	Mechanical properties of fasteners made of carbon steel and alloy steel Bolts, screws and studs with specified property classes. Coarse thread and fine pitch thread.
BS EN ISO 898-2:-2022	Fasteners. Mechanical properties of fasteners made of carbon steel and alloy steel Nuts with specified property classes.
BS EN ISO 898-3:-2018	Fasteners. Mechanical properties of fasteners made of carbon steel and alloy steel Flat washers with specified property classes.
BS 4190:2014	ISO metric black hexagon bolts, screws and nuts Specification.
BS EN ISO 10684:2004	Fasteners. Hot dip galvanized coatings.
WIS 4-52-03:1994	Specification for Anti-corrosion Coatings on Threaded Fasteners.
BS EN ISO 3506:2020	Fasteners. Mechanical properties of corrosion-resistant stainless steel fasteners Bolts, screws and studs with specified grades and property classes

2.3 Definitions

The definitions given in the relevant standards which are referred to in the specification, shall apply for the terms used in this specification.

2.4 Classification

2.4.1 The terms PE 100 are a classification developed in line with a decision taken at CEN/TC 155, the European Technical Committee drafting plastics piping system standards for polyethylene products for sewerage applications.

2.4.2 According to this classification, as detailed in ISO12162: 2009, material of PE 100 has a MRS value of 10 MPa. The International Standards Organization (ISO) technical procedure ISO TR 9080 [(3)] identifies these MRS values derived from the 50 year extrapolated 97.5% Lower Confidence Limit (LCL) failure stress.

2.5 Materials

The High Density Polyethylene (HDPE) Pipe shall be made from base polymer and shall conform to the requirements as specified in ISO 12162. The base polymer shall be a single grade of polyethylene, with a derived density greater than 0.93g/cm³ tested at 20° C. The raw material used in manufacturing process shall be of reputed suppliers and comply with the following characteristics tabulated in Table 2 in Annex A.

No rework material is allowable for the manufacture of the pipes. No additives that may contribute to toxic hazard impair the fabrication of properties and chemical and physical properties in particular to long term mechanical and strength is allowed.

Required manufacturing pressure class due to temperature correction

For imported HDPE Pipes and fittings manufacturer shall calculate the required manufacturing pressure class for the required pressure class specified in the Bills of Quantities based on the temperature in Sri Lanka. Relevant factors shall be obtained from Annex A of EN 12201 -1:2011or ISO 4427 Part -1:2019.

Manufacturing Pressure = PN/f_T

The continuous allowable operating pressure (PFA) is derived from the following formula

PFA = f_T X f_A X PN

Where,

f_T = Co-efficient according to Table A-1

f_A = derating factor related to the application (for the conveyance of water, the maximum value of $f_A = 1$)

PN = nominal pressure (Specified pressure class in the Bills of Quantities)

Accordingly, manufacturer shall supply higher pressure class pipes & fittings based on the above calculation.

2.5.1 Pipes

Polyethylene pipes shall be flexible and in pipe form or coil form complying with standards given in the reference standards in the document.

Jointing Methods

1. Electro-fusion – Temperature, time, alignment
2. Butt-fusion – Temperature, time, alignment
3. Compression – Gaskets
4. Socket fusion – Temperature, time, alignment

2.5.2 Appearance

The internal and external surfaces of pipes must smooth, clean and free from scoring, cavities and other surface defects which may affect pipe performance. The ends of pipe shall cut cleanly and square to the axis of the pipe. Appearance shall be checked at the point of manufacture.

2.5.3 Fittings

Polyethylene fittings shall be manufactured by injection moulding, factory welding or formed in the factory complying with the standards referred in the document. The fittings of nominal diameter equal to 300 mm or lesser than 300 mm are of injection moulding fittings. The fittings of nominal diameter greater than 300 mm may be of fabricated fittings.

Fittings shall be suitable either for electro fusion or butt welding as specified in the Bill of quantities. All dimensions of electro fusion fittings must be fusible with one fusion machine.

2.5.3.1 Types of pipe fittings

The following types of fittings shall comply with EN12201:03:2011+A1:2012

a) Spigot fittings
b) Electro-fusion fittings and
c) Mechanical fittings and joints
d) Socket fusion fittings

2.5.3.1.1 Spigot Fittings

Spigot fittings fall under two clauses as shown below.

Class	Description
Moulded	Injection moulded fittings
Fabricated	Fitting which are assembled using butt-fusion joints

2.5.3.1.2 Electro-fusion Fittings

Electro-fusion fittings shall be injection moulded fittings made of PE but incorporating integral heating element(s) to enable fusion jointing with PE pipes.

2.5.3.1.3 Mechanical Joints and Fittings

i. General

Metal and plastic fittings available for use with PE pipe are:

- Polymeric coated Flanged and other adaptors
- Mechanical type couplers c/w restrainer

The materials and constituent elements used in making the fitting (including elastomers, greases and any metal parts) shall be as resistant to the external and internal environments as the other elements of the piping system and shall have a life expectancy under the following conditions as least equal to that of the PE pipe confirming to EN12201-3:2011 with which they are intended to be used:

a) During storage :
b) Under the effect of the fluids being conveyed :
c) Taking account of the service environment and operating conditions.

The requirements for the level of material performance for non-polyethylene parts shall be at least as stringent as that of the PE pipe systems.

All mechanical joints and fittings shall be of approved types designed specifically for PE pipe system. They shall be supplied with all necessary coupling rings, nuts, bolts, washers, rubber rings/sealing gaskets and restrainers/stiffeners.

All mechanical joints, fittings and systems shall confirm to the requirements specified in EN12201-5:2011/ISO 4427-5:2019 of Table below as applicable.

Characteristics for fitness for purpose of the joint, fitting of system.

Characteristics	Test Method
Hydrostatic strength at room temperature	EN ISO 1167-3:2007
Peel decohesion test PE electrofusion assemblies of nominal outside diameter $\geq$ 90mm	ISO 13954:1997 ISO 13955:1997
Resistance to tensile force	ISO 13953:2001
Mechanical Joints	
Leak tightness under internal pressure including end thrust	EN ISO 3458:2015
Leak tightness under internal pressure when subjected to bending	EN ISO 3503:2015
Plastics piping systems, Elastomeric sealing rings type joints and mechanical joints for thermoplastic pressure piping for leak tightness under external hydrostatic pressure	EN ISO 3459:-2022
Resistance to pull out under constant longitudinal force	EN ISO 3501:-2022

2.5.3.1.4 Socket Fusion Fittings

The socket fusion technique consists of simultaneously heating both the external surface of the pipe end and the internal surface of the socket fitting until the material reaches the recommended fusion temperature, inspection of the melt pattern, insertion of the pipe end into the socket, and holding it in place until the joint cools. Mechanical equipment is available to hold the both the pipe and the fitting and should be used for sizes larger than 2" and to assist in alignment. The procedures in ASTM international F 2620 is applicable.

2.5.3.2 Compression Fittings, Nuts for PE Pipes

Couplings, flange adaptors etc shall be compatible with the pipes specified in item 5.1 hereof; together with following;

- All bodies shall be injection moulded from recognized top quality poly propylene.
- Bodies shall be coloured black
- Bodies must have moulded in manufacturer identification, material and series information and dimension of the outside pipe diameter.
- All male and female threads shall be injection moulded to the ISO 7/1 standards.
- Nuts must have UV resistance of grade 8 of ASTM D2585.

2.5.3.3 Joint Rings

The physical properties of elastomeric joint rings shall comply with Table 2 of EN 681-1:1996, ISO 21138-1:2007, ISO 13272:2011. The joint rings shall also comply with the relevant provisions in BS 7874:1 1998 for effects on wastewater quality and resistance to microbiological deterioration.

Joint rings shall be supplied by the pipe manufacturer.

Each joint ring shall be marked clearly and durably in accordance with the following information in a manner that does not interfere with the sealing function of the ring, in complying with clause 10 of EN 681-1:1996.

a). The nominal size

b). Manufacturer's identification

c). The number of the EN or ISO with seal type designation

d). Abbreviation for the elastomer

2.5.3.4 Flanges

All flanges dimensionally shall be in accordance with EN 1092-2:1997 (Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast iron flanges) and EN 1515-1:2000 Flanges and their joints Bolting. The screw threads in the pipes and fittings shall be complying with ISO Metric Screw Threads (ISO 7-1:1994 and ISO 7-2:2000).

2.5.3.5 Flange Joints for Pipes and Pipeline Fittings

Flanges for pipes and pipeline fittings shall unless otherwise stated comply with EN 1092: Part 2: 1997. Flanges shall be of PN16 nominal pressure rating and shall be raised faced, unless otherwise stated.

Flanges in accordance with EN 598, ISO 7186 are dimensionally compatible with EN1092-2:1997.

Flanged joints shall be complete with all nuts, bolts, gaskets and two washers per bolt.

The flanges of all fittings shall be integrally cast. The flanges of flanged pipes shall either be integrally cast or screwed or factory welded unless otherwise stated. 'Factory welded' means that the flanges are welded to the pipes at the point of manufacture under factory conditions with inspection agency certification.

The Contractor shall be responsible for checking and ensuring that mating flanges are compatible in all cases, including where connections are required to pipe work and valves associated with pumping plant and inlet/outlet pipe work at service reservoirs or other structures.

2.5.3.6 Steel Flange Converter

Steel Flange Converter shall be made out of polyethylene and shall be conform to the EN12201:03:2011+A1:2012 & EN 12201-5:2011 specification for mechanical fittings and joints including flanges for polyethylene pipes for conveyance of wastewater made of metal or plastics or a combination of both.

2.5.3.7 Gaskets for Flanged Joints

Gaskets for flanged pipe joints shall be of the inside bolt circle type and the dimensions shall comply with EN 1514-2:2014 (Flanges and their joints. Gaskets for PN-designated flanges. Spiral wound gaskets for use with steel flanges)

The physical properties of gaskets shall comply with BS 7874:1998 (Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines for effects on wastewater quality and resistance to microbiological deterioration.

The Gaskets shall also comply with the relevant provisions in BS 7874:1998 for effects on water quality and resistance to microbiological deterioration.

The Gasket material shall be EPDM and shall be of average hardness of 65-75.

The Gaskets shall be supplied by the manufacturer and shall suit for PN 16 flanges unless otherwise stated.

Each gasket shall be marked clearly and durably in accordance with the following information in a manner that does not interfere with the sealing function of the gasket, in complying with clause 10 of EN 681-1:1996.

a). The nominal size
b). Manufacturers identification
c). The number of the BS or BSEN with seal type designation.
d). Abbreviation for the elastomer

2.5.3.8 Nuts, Bolts and Washers

The nuts, bolts and washers for High Density Polyethylene (HDPE) flanged joints for Sewerage applications shall be of Hot Dipped Galvanized carbon steel, Property class 8.8, hexagonal head bolts and shall comply with the specified standards: product markings, materials, and mechanical properties for bolts, nuts, and washers respectively by BS EN ISO 898-1:2013 (Property Class 8.8), BS EN ISO 898-2: 2022, and BS EN ISO 898-3: 2018; dimensions and tolerances by BS 4190:2014; and hot dip galvanizing by BS EN ISO 10684:2004.

They shall be coated with fusion bonded epoxy powder or polyamide 11 to finished thickness of coating between 75 µm and 125 µm according to WIS 4-52-03:1994.

For general dimensions and tolerances of black hexagon bolts, screws and nuts with ISO metric threads, in diameters from 5 mm to 68 mm, refer BS 4190:2014.

The lengths of the bolts shall be sufficient to ensure that nuts are full threaded when tightened in their final position with two threads showing.

Two washers per each bolt shall be supplied for providing under the head of the bolt and under the nut.

If the flange bolts expose to corrosive environment, the nuts and bolts should be stainless-steel that meet the requirements of BS EN ISO 3506: 2020 and shall be coated with suitable anti-seizing material to prevent galling during tightening.

2.5.4 Testing

Testing shall be carried out fully in accordance with the requirements of ISO 4427:2019, EN12201-1:2011, EN12201-2:2011 or equivalent standard acceptable to the purchaser

Test parameters of physical and mechanical characteristics for pipes & fittings shall be as indicated in Table 3, 4, 5, 6 in Annex B, C, D & E.

2.6 Dimensions of Pipes and Fittings

Dimension of standard pipes shall conform to the following standards.

EN12201-1:2011	Plastic piping System for Water Supply, and for drainage and sewerage Polyethylene (PE) Part 1-General
EN12201-2:2011	Plastic piping System for Water Supply and for drainage and sewerage under pressure. Polyethylene (PE). pipes
ISO 8772:2006	Plastics piping systems for non-pressure underground drainage and sewerage – Polyethylene (PE)

EN12201-3:2011	Plastic piping System for Water Supply and for drainage and sewerage under pressure. Polyethylene (PE). Fittings
EN 12201-5:2011	Plastic piping system for water supply and for drainage and sewerage under pressure – Polyethylene (PE)
EN ISO 1167-1:2006	Thermoplastics pipes for the conveyance of fluids. Determination of the resistance to internal pressure. General Method
EN ISO 1167-2:2006	Thermoplastics pipes for the conveyance of fluids. Determination of the resistance to internal pressure. Preparation of Pipe test pieces
ISO 11922–1:2018	Thermoplastic pipes for the conveyance of fluid - Dimensions & tolerances – Part I metric series

Standard lengths of a straight pipe shall be 12 m. unless otherwise stated.

Dimensions of fittings shall conform to the following standards.

EN12201-3:2011/A1:2012	Plastic piping System for Water Supply, and for drainage and sewerage under pressure Polyethylene (PE) Part 3- Fittings

2.7 Method of manufacturing of pipes & fittings

2.7.1 Manufacturing of PE Pipes and Fittings

2.7.1.1 The contractor shall submit full details of manufacturing process that he intended to use with the bid. The Material Quality Certificates shall be from one of the **Independent Testing Agencies**, which is indicated in the Condition of Contract, shall be provided by the contractor.

Base Polymer Compound position, antioxidants, rework material and colour shall be in accordance with WIS 4-32-15, BS 3412:1992 and EN ISO 12162:2009.

2.7.2 Production Quality Control

2.7.2.1 The manufacture of PE pipe is a continuous processing which necessitates strict and accurate control of both materials and plant to achieve the required quality. A range of quality control tests pressures in the relevant standards should be applied within the scope of a quality assurance in accordance with EN ISO 9001: 2015.

2.7.2.2 These control procedures shall include followings and should be submitted with the bid.

- Quality testing of raw materials, i.e. base compound.
- Checks on the uniformity and consistency of the granules
- Control of processing parameters in terms of temperature, pressure, flow rates, haul off speed and energy input
- Visual inspection of the pipes to check general appearance, dimensional compliance and any indication of inclusions or processing flaws in pipe barrels and jointing ends,
- Production short term tests, to identify any variations in the plant function.

2.7.2.3 Essential short-term quality control tests and procedures are described in the relevant Water Industry Specifications include the following and the test certificates as per the Annex A-E shall be submitted,

- appearance and surface condition
- dimensions
- thermal stability
- elongation at break
- hydrostatic pressure test at 80^0 C
- short term pressure test

2.7.3 Product Type Tests

2.7.3.1 In addition to 'production quality control' tests, there are a number of important longer-term "Type Tests" that must be undertaken to demonstrate the long-term performance of the pipe in accordance with EN12201:1:2011. These tests are also required whenever there is any change in such parameters as formulation, size, classification or processing technique. A type test certificate shall be submitted.

2.7.3.2 These "Type Tests" are again detailed in the relevant specifications and include the following and the test certificates should be submitted with the bid.

- effect on waste water quality
- resistance to weathering
- long term hydrostatic pressure testing
- resistance to fracture on impact tensile strength
- elongation and weld test

2.7.3.3 Perhaps the most fundamental Type Test is the long term hydrostatic test which is a standard means of predicting the long-term performance of the pipe. In this test, samples are subjected different circumferential (hoop) stresses by pressurization and the subsequent time to pressure is recorded. The individual results are plotted as a log stress versus log time graph. They are then subjected to regression analysis to obtain an extrapolated 50 year stress level.

2.7.3.4 It is worth bearing in mind that the above requirements for long-term performance levels are minimum values and manufacturers usually ensure that their products can comfortably meet these standards, i.e. the pipes have an additional factor of safety built into them to cover any manufacturing variables.

2.8 Tolerances

Tolerances on wall thickness & weight, and length shall be in accordance with EN 12201-2:2011

The tolerances on flange thickness, flange diameter and bolt holes in polyethylene Steel flange converters to be used of connecting different type of material shall conform to EN1092-2:1997.

2.9 Final Acceptance at site

All pipes, fittings, valves and accessories shall conform to the specification at site. Engineer shall carryout necessary inspections at site prior to final acceptance.

2.10 Specification for Butt Fusion Machine

Butt fusion jointing equipment shall be certified in accordance with ISO 12176-1:2017. Only fully automatic Computerized Numerical Control (CNC) machines or computerized microprocessor based machines shall be used.

I. Machine shall be hydraulically operated and suitable for welding of HDPE pipes.

II. Machine shall consist of self –aligning frame and compact dimensions, to be suitable for working on narrow roads.

III. Machine shall be comprised of four clamps in lightweight alloy of which the third one is easily adjustable in order to weld special pieces, and the automatic disconnecting devices to detach the pipes the heating mirror at the end of heating time.

IV. Heating mirror shall be silver stone coated with electronic thermostat and separate thermometer in order to continuously check the temperature of the

heating mirror. Operating electricity requirement of the heating mirror shall be 220±10V, 50Hz.

Also it shall include removable electric facing tool complete with reducing gear, double cutting edged blades, safety micro switch all which allow the engine to start only in operating position.

i. An electrically operated mechanical block device avoiding dislocation during the facing operation. Operating electricity requirement shall be 220±10 V, 50Hz.

ii. A support for facing tool and heating mirror suitable to carry the two parts and to hold them when it is not in use.

iii. Hydraulic double throw pump with precision pressure gauge (class 1.0-100 bar scale and 100mm face to easy reading) incorporates a device which maintains pre-set line pressure even when motor is not running. Allows continuous pressure adjustments and features flexible hoses with quick disconnect dry-lock couplings. Mounted in a tough protective frame, with two transport handles. Operating electricity requirement is 220±10 V 50Hz.

iv. Light weight aluminum reducing inserts (8 inserts per set including 6 inserts for pipes and 2 inserts for fittings) sizes of pipes as stated in the bills of quantities

v. Upper fitting clamp for short fittings as stated in the bills of quantities.

vi. Stub end device with size range as stated in the bills of quantities

vii. A Generator of adequate capacity.

viii. A 2 year warranty to cover all the equipments offered

2.11 Electrofusion Welding Machine

Electrofusion Welding machine, control units and accessories shall be designed and certified for the performance requirements specifies in ISO 12176-2:2008 for use in the construction of joints between PE pipes and electrofusion fittings. All of its features are equal to or higher than the ISO 12176-2:2008. The ISO 12176 - 2:2008 is also applicable to control units with current or voltage control for fitting systems based on standard resistance wire heating technology.

The control unit shall be complete with all accessories and shall have the following features as minimum and any missing data or requirements shall be in accordance to ISO 12176-2:2008.

2.11.1 General Requirements

The portable control unit with its frame and any associated input cable of at least 3m included shall not be heavier than 35kg.

The normal operating temperature of the control unit shall be in the range −10 °C to +40 °C. It shall have back-lit graphical display and shall have a facility to monitor full output voltage and output current throughout the jointing cycle and graphical display of output current and voltage levels. All displays shall be clearly visible both in bright sunlight and in subdued light conditions.

The control unit shall have data logging facility for storing minimum 250 fusion records and facility for data transfer and print out. Required software shall be provided. The unit shall give user friendly step by step operator instructions and printing facility in English Language.

The unit shall have soft start feature to present shock loading on generators.

The control unit shall have temperature compensation facility and protections against fitting overheat.

2.11.2 Electrical Characteristics

The control unit and its accessories shall fulfill the safety requirements specified in the IEC 60335-1, 60335 – 2-45.

The appropriate control units shall be either of following three input voltage classes:

i. SVLV [safety, very low voltage (up to 50 V)],
ii. LV [low voltage (50 V to 250 V)] and
iii. HV [higher voltage (250 V to 400 V)].

The accessories shall not endanger the safety of the technical operators due to the voltage or current in use. When the voltage exceeds 25V, direct contact with live parts shall not be possible during the fusion cycle.

2.11.3 Duty Cycle

The duty cycle for all control units with a classified output power shall be in accordance to the section 5.11 of the ISO 12176-2:2012. The graph of duty cycle related to output power at reference voltage shall be defined by the manufacture for each control unit between 35% and 100% duty cycles.

2.11.4 Compatibility with electro fusion machines

All electro-fusion equipment shall be compatible with welding machines according to ISO 12176 :2012(1 to 4), ISO 13950:2007. All fittings shall be fusible with one fusion machine.

2.11.5 Fusion Indicator

Every electro-fusion accessories shall be provided with at least one fusion indicator, to demonstrate a sufficient pressure welding was present during the electro-fusion process. No discharge of melted PE through this indicator is admitted.

2.11.6 Coils-Wires

All the accessories are "single wired" types. An exception is allowed for the repair saddle as this accessory can be made of two separated shells which both shall be equipped with an electro fusion resistance.

The fittings and coils are designed so that only one complete process cycle is necessary to fully electrofuse the fitting to the adjoining pipe or component.

The coil shall not be displaced when the fitting is assembled with a pipe.

The resistance of the wire at 23^0C shall be as stated by the manufacturer. A tolerance of $\pm$ 10% is accepted.

2.11.7 Maximum Electrical Power

The required power to fuse any electro fitting accessory shall not exceed 4kW.

2.11.8 Cables & Connectors

2.11.8.1 Cables

Input and output cables may be disconnectab le or permanently connected. The cable shall remain flexible over the whole range of normal operating and storage conditions.

If permanently attached cable is provided, its nominal lengths shall be at least 3m and a facility for input cable winding, storage and protection during transport shall be fitted to the control unit.

The nominal length of output cables shall be at least 3m.

2.11.8.2 Connectors

The connectors shall confirm to the requirements given in BS EN 60529 for use in outside weather conditions. The connectors should be suitable for typical terminal connection to electrofusion fitting ISO 4437-3:2014

Other types of connections are only accepted after formal approval of the Engineer.

2.11.9 Thermal Safety Requirements

During and after the complete welding process, the temperature shall not endanger the operators nor the supply of the pipeline system being operated at the design pressure during the welding process.

2.11.10 Mechanical Characteristics

All accessories must comply with the mechanical and hydrostatical test as described in the ISO 12176-2:2008 standard.

2.11.11 Bar Code

All accessories shall be provided with an individual bar code, allowing the welding equipment to load and check all the related parameters. The bar code shall be indelible and in accordance with the electro fusion welding machines standards ISO 12176-2:2008.

2.11.12 Ancillary equipment

Any ancillary equipment including welding tent, solvent based marker and clean dry lint-free cloth or paper towel shall be provided with the elctrofusion welding machine.

ANNEX A

Table 2 – Characteristics of the PE compound as granules

Characteristics	Requirements [a]	Test parameters		Test method
		Parameter	Value	
Compound density	≥ 930 kg/m ^{3}	Test temperature Number of Samples	23^0C shall conform to EN ISO 1183-1 and EN ISO 1183-2	EN ISO 1183-1 and EN ISO 1183-2
Carbon black content (black compound)	(2 to 2.5)% by mass	Shall conform to ISO 6964		ISO 6964
Carbon black dispersion (black compound)	Grade ≤ 3 Rating of dispersion A1, A2, A3 or B	Shall conform to ISO 18553[c]		ISO 18553
Pigment dispersion (blue compound)	Grade ≤ 3 Rating of dispersion A1, A2, A3 or B	Shall conform to ISO 18553[c]		ISO 18553
Water content [b]	≤ 300 mg/kg	Number of test pieces [d]	1	EN ISO 15512
Volatile content	≤ 350 mg/kg	Number of test pieces [d]	1	EN 12099
Oxidation induction time	≥ 20 min	Test temperature Number of test pieces [d] Test atmosphere Sample weight	200 ^{0}C [e] 3 Oxygen (15+/-2) mg	ISO 11357-6
Melt mass-flow rate (MFR) for PE 100	(0.2 to 1.4) g/10 min Maximum deviation of ±20% of the nominated value[f]	Load Test temperature Time Number of test pieces [d]	5 kg 190^0C 10 min shall confirm to EN ISO 1133	EN ISO 1133

[a] Conformity to these requirements shall be proved by the compound manufacture.

[b] Only applicable if the measured volatile content is not in conformity with its specified requirement. In case of dispute the requirement for water content shall apply. An alternative test method ISO 760:1978 [5] may be used. The requirement applies to the compound producer at the stage of manufacturing and to the compound user at the stage of processing (if the water content exceeds the limit, drying is required prior to use).

[c] In case of dispute the test pieces for carbon black dispersion and pigment dispersion shall be prepared by the compression method.

[d] The given number of test pieces indicates the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. For guidance see CEN/TS 12201-7 [2].

[e] Test may be carried out as an indirect test at 210^{o}C or 220^{o}C, providing that a clear correlation has been established. In the case of dispute the test temperature shall be 200^{o}C

[f] Nominated value given by the compound producer.

ANNEX B

Table 3 - Physical Characteristics of PE Pipes

Characteristics requirements	Requirements	Test parameters		Test method
		Parameter	Value	
Melt mass-flow rate MFR for PE 100	After processing maximum deviation of ± 20% of the value measured on the batch used to manufacture the pipe	Load Test temperature Time Number of test pieces [a]	5.0 kg 190°C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Oxidation induction time	≥ 20 min	Test temperature Test environment Specimen weight Number of test pieces [a,b]	200°C [c] Oxygen (15±2) mg 3	ISO 11357-6
Longitudinal reversion Wall thickness<16mm	≤ 3% Original appearance of the pipe shall remain	Test temperature Length of test piece Immersion time Test method Number of test pieces [a,]	110°C 200 mm Shall conform to EN ISO 2505 Free Shall conform to EN ISO2505	EN ISO 2505
Effect on water quality [d]	National Regulations apply			

[a] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan; for guidance see CEN/TS 12201-7[2]).

[b] Samples to be taken from the outer and inner wall surfaces

[c] Test may be carried out as an indirect test at 210°C or 220°C providing that there is clear correlation of the results to those at 200°Cproviding clear correlation has been established. In cases of dispute the reference temperature shall be 200°C.

[d] Test methods, parameters and requirements for all properties are under preparation . Until these European Standards are published National Regulations apply (see Introduction).

ANNEX C

Table 4 - Mechanical Characteristics of PE Pipes

Characteristics requirements	Requirements	Test parameters		Test method
		Parameters	Value	
Hydrostatic strength at 20^0C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress[c] for : PE 100	Type A[a] Shall conform to EN ISO 1167-1 3 Water-in-water 20^0C 100 h 12,0 MPa	EN ISO 1167-1 and EN ISO 1167-4
Hydrostatic strength at 80^0C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress[c] for : PE 100	Type A[a] Shall conform to EN ISO 1167-1 3 Water-in-water 80^0C 165 h [c] 5,4 MPa	EN ISO 1167-1 and EN ISO 1167-4
Hydrostatic strength at 80^0C	No failure during of any test pieces	End caps Conditioning period Type of test Test temperature Number of test pieces [b] Test period Circumferential (hoop) stress[c] for : PE 100	Type A)[a] Shall confirm to EN ISO 1167-1 Water-in-water 80^0C 3 1000 h 5,0 MPa	EN ISO 1167-1 and EN ISO 1167-2

Characteristics requirements	Requirements	Test parameters		Test method
		Parameters	Value	
Elongation at break for $e_n \leq 5$ mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 2 100 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and EN ISO 6259-3:1997
Elongation at break for 5 mm < $e_n \leq 12$ mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [a] 50 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and EN ISO 6259-3:1997
Elongation at break for $e_n > 12$ mm	≥ 350 %	Test piece shape Speed of test Number of test pieces [b]	Type 1 [a] 25 mm/min Shall conform to EN ISO 6259-1	EN ISO 6259-1 and EN ISO 6259-3:1997
		OR		
		Test piece shape Speed of test Number of test pieces [b]	Type 3 [a] 10 mm/min Shall conform to EN ISO 6259-1	

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.

[b] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7[3]).

[c] Premature ductile failures are not taken into account. For retest procedure see 7.3.
[d] Machined type 2 test pieces may be used for pipe wall thickness ≤ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

ANNEX D

Table 5 - Physical Characteristics of PE Fittings

Characteristics	**Requirements**	**Test parameters**		**Test method**
		Parameters	**Value**	
Melt mass-flow rate (MFR) for PE 80, and PE 100	Change of MFR by processing $\pm$ 20% [b]	Load Test temperature Test period Number of test pieces [a]	5 kg 190^0C 10 min Shall conform to EN ISO 1133	EN ISO 1133
Oxidation induction time	$\geq$ 20 min	Test temperature Test environment Specimen weight Number of test pieces [a]	200^0C [c] Oxygen (15 $\pm$ 2) mg 3	ISO 11357-6
Effect on Water quality [d]	National regulations apply			

[a] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan; for guidance see CEN/TS 12201-7[2]).

[b] Value as measured on the fitting relative to the value measured on the compound used.

[c] Test may be carried out as an indirect test at 210^0C or 220 ^{o}C providing that there is clear correlation of the results to those at 200^0C : in cases of dispute the reference temperature shall be 200^0C.

[d] Test methods, parameters and requirements for all properties are under preparation . Until these European Standards are published National Regulations apply.

ANNEX E

Table 6 - Mechanical Characteristics of PE Fittings

Characteristics requirements	Requirements	Test parameters		Test method
		Parameters	Value	
Hydrostatic strength at 20^0C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress [c] for : PE 100	Type A [a] EN ISO 1167-1 Shall conform to EN ISO 1167-1 3 Water-in-water 20^0C 100 h 12,4 MPa	EN ISO 1167-1 and EN ISO 1167-4
Hydrostatic strength at 80^0C	No failure during test period of any test pieces	End caps Conditioning period Number of test pieces [b] Type of test Test temperature Test period Circumferential (hoop) stress [c] for : PE 100	Type A [a] Shall conform to EN ISO 1167-1 3 Water-in-water 80^0C 165 h [d] 5,4 MPa	EN ISO 1167-1 And EN ISO 1167-4
Hydrostatic strength at 80^0C	No failure during test period of any test pieces	End caps Conditioning period Type of test Test temperature Number of test pieces [b] Test period Circumferential (hoop) stress [c] for : PE 100	Type A [a] Shall conform to EN ISO 1167-1 Water-in-water 80^0C 3 1000 h 5,0 MPa	EN ISO 1167-1 and EN ISO 1167-4
Decohesive resistance for electrofusion socket fittings	Length of initiation rupture $\leq L_2$ /3 in brittle failure	Test temperature Number of test pieces [b]	23 ^{o}C Shall conform to ISO 13954 Or ISO 13955	ISO 13954 ISO 13955
Cohesive strength of electrofusion saddle fittings	Ld $\leq$ 50% and Ad $\leq$ 25%, brittle failure	Test temperature Number of test pieces [b]	23 ^{o}C Shall conform to ISO 13956	ISO 13956

Characteristics requirements	Requirements	Test parameters		Test method
		Parameters	Value	
Tensile strength for butt fusion fittings – spigoted fittings	Test to failure: - ductile : pass - brittle : fail	Test temperature Number of test pieces [b]	23 °C Shall conform to ISO 13953	ISO 13953
Impact resistance of tapping tees	No failure, no leaks	Test temperature Mass of striker Height Conditioning period in air in liquid	(0 ± 2) °C (2 500 ± 20) g (2 000 ± 10) mm 4h 2h	EN 1716

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.

[b] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan (for guidance see CEN/TS 12201-7[2]).

[c] The stress shall be calculated using the nominal dimensions of the pipe used in the test assembly.

[d] Premature ductile failures are not taken into account. For retest procedure see 7.4

Note : Loop of sling should be adequately long and strong for lifting the coil

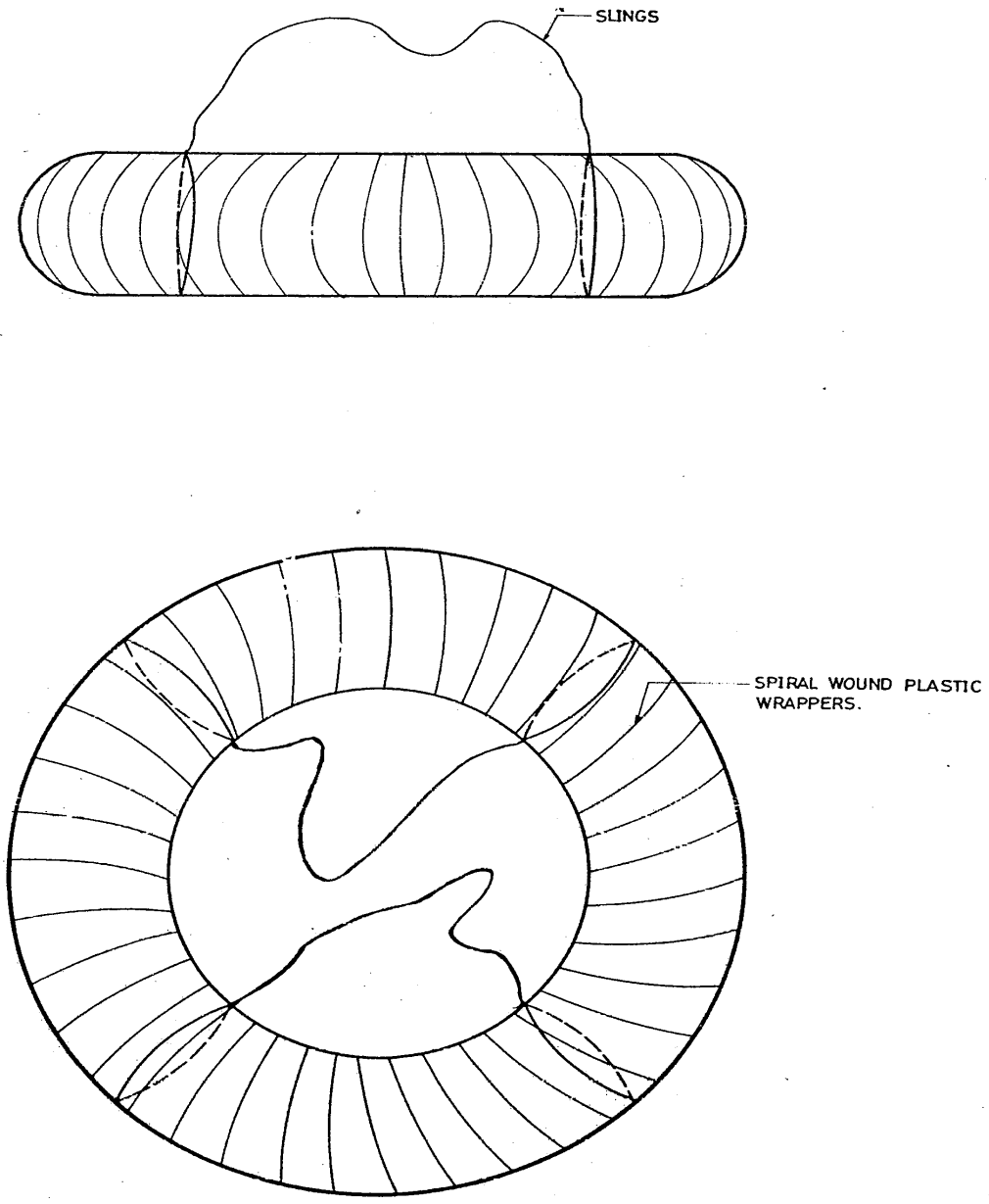

Fig. 1 - SLING ARRANGEMENT FOR LIFTING 63 mm ϕ COILS