

SYABAS' STANDARD SPECIFICATION FOR PIPE LAYING WOKS

First Edition : May 2007

F: HIGH DENSITY POLYETHYLENE (HDPE) PIPES AND FITTINGS

1.0 GENERAL

This specification is applicable to High Density Polyethylene (HDPE) Pipe for water supply systems and shall conform to JKR Standard Specification JKR 202000-0053-99 and MS 1058:2002.

Relevant standards are:-

BS 4505	Specification for flanges and bolting for pipes, valves & fittings. Metric series.
BS EN 545	DI pipes, fittings, accessories & their joints for water pipelines – Requirements & test methods
BS 970 Pt. 1	General Inspection and Testing Procedures and Specified requirements for Stainless Steel.
AS 1646	Standard Specification for Elastomeric joint rings for Waterworks purposes.
MS 672:99	Specification for rubber seals in water supply, drainage, & sewerage pipelines.
BS 5292	Jointing materials & components for installation using water, low pressure steam.
BS 2789	Specification for Iron castings with spheroidal nodular graphite.
BS EN 1563	Specification for Founding – Spheroidal graphite cast iron.
BS EN 10025	Hot rolled products of non-alloy structural steels and their – Technical delivery conditions.
BS 3643	ISO metric screw threads.
BS 4190	ISO metric black hexagon bolts, screws and nuts.
BS 6681	Specification for Malleable cast iron.
BS 6920	Specification for Suitability of non-metallic products for use in contact with water intended for human consumption w.r.t to their effect on the quality of the water.
AS/NZS 4158	Thermal-bonded polymeric coatings on valves and fitting for water industry purposes Liquid Epoxy Coating Systems For The Interior And Exterior Of Steel Water Pipelines.
WIS 4-52-03	Water Industry Specification for anti-corrosion coatings on threaded fasteners

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ISO 12162	Thermoplastics materials for pipes and fitting for pressure applications – Classification and designation – overall service (design) coefficient.
ISO 12176-1:98	Plastics pipes and fittings – Equipment for fusion jointing polyethylene systems – Part 1 : Butt Fusion.
EN 712	Thermoplastics piping system – End load – bearing mechanical joints between pressure pipes and fittings – Test method for resistance to pull – out under constant longitudinal force.
EN 713	Plastics piping system – Mechanical joints between fittings and polyolefin pressure pipes – Test method for leak tightness under internal pressure whilst subjected to bending.
EN 715	Thermoplastics piping systems – Mechanical and cemented joints between pressure pipes and fittings – Test method for leak tightness under internal pressure, including end thrust.
EN 921	Thermoplastics pipes – Determination of resistance to internal pressure at constant temperature.
ISO 13953:1995	Polyethylene pipes and fittings – Determination of tensile strength of test piece from butt fused joint.
ISO 13954:1997	Plastics pipes and fittings – Peel de-cohesion test for polyethylene (PE) electro-fusion assemblies of nominal outside diameter greater than or equal to 90mm.
ISO 13955:1997	Plastics pipes and fittings – Crushing de-cohesion test for polyethylene (PE) electro-fusion assemblies.
ISO 13956:1995	Plastics pipes and fittings – Pull out de-cohesion test for polyethylene electro-fusion assemblies.

2.0 MATERIAL

The High Density Polyethylene (HDPE) Pipe shall be made from base polymer and shall conform to the requirements as specified in MS 1058 Part 1:2002.

The base polymer shall be a single grade of polyethylene, PE 80 with a derived density greater than 0.93g/cm³ tested at 20° C.

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.

3.0 COLOUR

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The colour of the pipes shall be black with blue stripes. The material for stripes shall be of the same type of resin as used in the compound for the pipe.

4.0 PIPE CLASSIFICATION AND DIMENSION

All HDPE Pipes must be from Class PE 80 with Nominal Pressure (PN) 12.5 and Standard Dimensions Ratio (SDR) 11 with the minimum strength at 20° C.

Wall thickness and nominal diameter of PE 80 pipes are given below.

NOM. DIAMETER FOR OTHER PIPES (mm)	WALL THICKNESS (mm)	INTERNAL DIAMETER (mm)	OUTSIDE DIAMETER (mm)
20	2.0	18	20
25	2.3	22.7	25
32	3.0	29	32
40	3.7	36.3	40
50	4.6	45.4	50
63	5.8	57.2	63
75	6.8	68.2	75
90	8.2	81.8	90
110	10.0	100	110
125	11.4	113.6	125
140	12.7	127.3	140
160	14.6	145.4	160
180	16.4	163.6	180
200	18.2	181.8	200
225	20.5	204.5	225
250	22.7	227.3	250
280	25.4	254.6	280
315	28.6	286.4	315
355	32.2	322.8	355
400	36.3	363.7	400
450	40.9	409.1	450
500	45.4	454.6	500
560	50.8		
630	57.2		

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5.0 TOLERANCE

The tolerance for wall thickness is determined by the difference between the wall thickness and the nominal wall thickness as follow:

NOM. DIAMETER FOR OTHER PIPES (mm)	PN 12.5		PN 16	
	WALL THICKNESS (mm) Min	WALL THICKNESS (mm) Max	WALL THICKNESS (mm) Min	WALL THICKNESS (mm) Max
20	2.0	2.3	2.0	2.3
25	2.3	2.7	2.3	2.7
32	3.0	3.4	3.0	3.4
40	3.7	4.2	3.6	4.1
50	4.6	5.2	4.5	5.1
63	5.8	6.5	5.6	6.3
75	6.8	7.6	8.4	9.4
90	8.2	9.2	10.1	11.3
110	10.0	11.1	12.3	13.7
125	11.4	12.7	14.0	15.7
140	12.7	14.1	15.7	17.4
160	14.6	16.2	17.9	19.8
180	16.4	18.2	20.1	22.3
200	18.2	20.2	22.4	26.0
225	20.5	22.7	25.2	27.9
250	22.7	25.1	27.9	30.8
280	25.4	28.1	31.3	34.6
315	28.6	31.6	35.2	38.9
355	32.2	35.6	39.7	43.8
400	36.3	40.4	44.7	49.3
450	40.9	45.1	50.3	55.5
500	45.4	50.1	55.8	61.5
560	50.8	56		
630	57.2	63.1		

6.0 LENGTH

The required length of HDPE pipes in coil for nominal diameter 63 mm and below will be 100 meter.

The standard length of HDPE pipes for nominal diameter 125 mm and above shall be 9m or 12m.

7.0 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.

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8.0 ROUTINE TESTS

The pipe suppliers shall, as and when requested by the S.O., furnish results of the routine tests carried out in accordance with the requirements as stipulated in MS 1058: Part 1 : 2002.

The minimum Oxidation Induction Time (OIT) for pipes fitting shall be 80 min. The manufacturer must have their own differential Thermal Analyzer or Differential Scanning Calorimeter available for SYABAS' representatives to carry out the OIT.

9.0 PIPE MARKINGS

All pipes must have the following markings:

- Manufacturer's name or trade mark
- Dimensions
- Material supplier and material class (PE 80)
- Pipe Class (PN)
- The word SYABAS (50mm high) in capital letter
- SIRIM/IKRAM and QAS Number.
- Year of manufacture (last two digits)
- Batch production number

10.0 PIPE FITTINGS

10.1 Types of pipe fittings

The following types fittings shall comply to MS 1058 or EN 12201 –3

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

10.2 Spigot Fittings

Spigot fittings fall under three classes as shown below.

Class	Description
Moulded	Injection moulded fittings
Fabricated	Fitting which are assembled using butt fusion joints
PE 80 min. (PN 12.5 pressure rating)	Fittings shaped from moulded fittings or pipes without fusion

The dimensions of spigots up to and including nominal size 63 shall conform to the requirements of standards.

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10.3 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. All PE100 fittings shall be jointed by couplers only.

10.4 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 conforming to MS 1058 or EN 12201-3 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 conform to the requirements specified in MS 1058 or BS EN 12201-5 of Table below as applicable.

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

Characteristics	Test Method
Hydrostatic strength at 80°	EN 921
Cohesive resistance for Electro – fusion Socket fittings For electrofusion saddle fittings	ISO 13954 ISO 13955 ISO 13956
Resistance to tensile force	ISO 13953
Mechanical joints	
Leak tightness under internal pressure	EN 715
Leak tightness under internal pressure when Subjected to bending (up to and including 63mm)	EN 713
External pressure test	EN 911
Resistance to pull out under constant longitudinal force	EN 712

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ii) Plastic Parts

All fittings/components shall conform to the relevant EN standards. Alternative standards may be utilized in cases where suitable EN standards do not exist provided a fitness for purpose can be demonstrated.

iii) Metal Parts

All metal parts shall be made of ductile iron (BS 2789) of Grade 420/12) or carbon steel (BS EN 10025 Grade S275, S355JR or BS 4360 43A) or stainless steel (BS970 Part1). No gray cast iron shall be used.

All metal components (except parts made of stainless steel BS 970) of the mechanical joints and fittings shall undergo the necessary surface preparation for polyamide coating purposes. Bituminous coating is not allowed. Either one of the following polymeric coating is acceptable:

- For coating using either fusion-bonded epoxy powder or polyamide 11 (RISLAN) Bonded Polyamide 11 or not less than 350 μm for Fusion Bonded Epoxy as specified in AS/NZ 4158:1:1994.
- For coating using cold applied high solid liquid epoxy (solvent or solventless) which meet the requirement of AWWA C210-84, the coating thickness shall not be less than 356 μm .

The metal flanges shall be in accordance with PN 16 in BS 4504 or BS En 1092.

iv) Elastomers

The rubber wedge joint rings shall have a hardness range of 66-75 IRHD and shall meet the requirements as detailed in MS 672-1999 or AS 1646 : 1992

Flange gaskets shall be of flat section minimum 5mm thick (medium grade) (Hardness 60 \pm 5 RHD) rubber reinforced with two-ply flexible fabric and complying with BS 5292.

v) Bolts, Nuts and Washers

The bolts and nuts shall be hexagonal and shall be in accordance with BS 4190. The bolts, studs, nuts and washers used shall be made of stainless steel or hot-dipped galvanized carbon steel coated with fusion bonded epoxy powder or polyamide 11 to the finished thickness of coating between 75 μm and 125 μm according to WIS 4 – 52 –03 –1994. Cold applied high solid epoxy shall be used to repair the damaged coatings on the bolts and nuts after fastening.

vi) Effect on water quality

When used under condition for which they are designed, materials used for fittings intended for the conveyance of water for human consumption shall comply with BS 6920.

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10.5 Backing Ring (Slip On Flange) to suit HDPE Pipe

i) Material

Materials used shall not to be inferior to:-

- a) Ductile Iron BS 2789 Grade 420/12 or 500/7
 BS EN 1563 Grade 400/15 or 500/7
- b) Carbon Steel BS 4360 grade 43A
 BS EN 10025 Grade S275, S355JR

ii) Drilling Detail

Flanges shall be machined and still to BS 4504/BS EN 545 Table 16 and shall be protected from corrosion as in clause "Metal Parts"

iii) Dimension

Dimension of backing Ring made of ductile iron or carbon steel shall be shown below

Dimension of Backing Ring (Slip on Flange) to suit PE Pipe

Pipe O.D	Nominal Bore	Flange O.D. D	Flange I.D. C	Pitch Circle Diameter K	Diameter of Bolt Hole H	Bolt		Flange Thickness T	
						Size	Nos	Carbon Steel	Ductile Iron
50	40	150	62	110	18	16	4	16.0	19.0
63	50	165	78	125	18	16	4	18.0	19.0
75	65	185	92	145	18	16	4	18.0	19.0
90	80	200	108	160	18	16	8	20.0	19.0
110	100	220	128	180	18	16	8	20.0	19.0
125	100	220	135	180	18	16	8	20.0	19.0
160	150	285	178	240	22	20	8	22.0	19.0
180	150	285	188	240	22	20	8	22.0	19.0
200	200	340	235	295	22	20	12	24.0	20.0
225	200	340	238	295	22	20	12	24.0	20.0
250	250	405	288	355	26	24	12	26.0	22.0
280	250	405	294	355	26	24	12	26.0	22.0
315	300	460	338	410	26	24	12	28.0	24.5
355	350	520	376	470	26	24	16	32.0	26.5
400	400	580	430	525	30	27	16	36.0	28.0
450	450	640	517	585	30	27	20	40.0	30.0
500	500	715	533	650	33	30	20	44.0	31.5
560	600	840	618	770	36	33	20	52.0	36.0
630	600	840	645	770	36	33	20	52.0	36.0

All dimension in millimeter (mm)

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iv) Workmanship

- a) All casting shall be homogenous, smooth and shall be free from flaws, cracks, blowholes, cuts or other harmful defects. All surfaces in close proximity to the pipe shall be smooth and free from sharp edges.
- b) All steel flanges cut from plate shall have their surfaces machine finished and shall be free from surface defects.

10.6 Storage

10.6.1 Storage at Depot

All materials should be carefully inspected at the time of delivery and any defective material set-aside before accepting the delivery into stores. The defective materials should be return to the suppliers immediately.

Pipes and fittings should be used in the order of delivery to ensure the correct rotation of stock.

All pipe stacks should be made on sufficiently firm, flat ground to support the weight of the pipes and any necessary lifting equipment. Stacking heights should generally be kept to a minimum and adequate space allocated for lifting machinery to manoeuvre without causing accidental damage.

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

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

- 7 coils for 20mm pipe
- 6 coils for 25mm pipe
- 5 coils for 32mm pipe
- 4 coils for 50mm pipe
- 3 coils for 63mm pipe
- 2 coils for 90mm pipe
- 1 coils for 110, 125 and 180 pipes.

Where individual pipe lengths are stacked in pyramidal fashion, deformation may occur in the lower layers. Such stacks should therefore be not greater than 1m high.

Electro-fusion and compression 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 except spigot fittings.

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 tool and equipment associated with the jointing of pipes and fittings should be stored separately and securely until they are required for use.

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10.6.2 Storage on Site

All pipe store locations should be on suitably firm, level ground, free from damaging material with adequate access for construction vehicles and/or lifting equipment.

In all storage sites, careful consideration should be given to the following aspects:

- Security of all materials and equipment from theft, vandalism, accidental damage or contamination.
- Safety of pedestrians.
- The movement of traffic and construction equipment

When stringing is adopted, pipes should be placed well clear of the excavators and away from excavated material area. They should be wedged to prevent accidental movement. Where necessary protective barriers complete with adequate warning signs and lights should be erected.

11.0 PRE – DELIVERY INSPECTION AND EVALUATION

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

SYABAS reserved the right to inspect and witness the testing of product offered. If the product fails the mandatory test, the manufacturer will be notified and a second cut section will be tested. If the second cut section fails, the product will be rejected from use in the state.

At any time, when requested, the supplier is to provide SYABAS a sample of the product offered for evaluation purposes. All costs 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 specifications and the product will not be further used in the project..

12.0 HANDLING, TRANSPORT AND STORAGE

12.1 General

Polyethylene pipes are characterized by being tough and resilient and are relatively light. Though it is easy to handle, they are prone to damage by scoring by sharp objects. Therefore, careful handling is always required and the dragging of straight pipes and coils should be avoided whenever possible.

The maximum allowance depth of scoring of the external surface of the pipe is 5% of the wall thickness. Pipes and fittings showing obvious defects, excessive scoring or sharp deep cut even if less than 5% of the wall thickness should be withdrawn and returned to the suppliers.

Pipes up to 125mm are usually supplied and delivered loose or strapped into convenient bundles or banded coils. Fittings are normally supplied in separate bags or cartons/pallets.

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12.2 Transport and Delivery

For transporting bulk loads the vehicles should be provided with a clean flat bed, free from nails or other projections which may cause damage.

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

Straight pipes should be fully supported or bound together.

Metal chains or slings should not be brought into direct contact with the pipe. Webbed sling of polyethylene or nylon are recommended.

When transporting pipes of different sizes, pipes of higher-pressure class shall be loaded underneath. If the pipes are transported one inside another, the smaller pipes shall be removed first and piled separately.

Both vertical and horizontal deliveries of coiled pipes are permissible.

12.3 Off Loading

12.3.1 Bundled Pipes

When lifting by crane, non-metallic wide band slings or ropes should be used. For pipe length greater than 6m, load spreading bars of a length at least equivalent to one quarter of the length of the pipe or bundlepack 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.

Some bending should be allowed for in the middle of the lift when loading and unloading pipes. However to avoid excess bending, lifting points should always be well and evenly spaced.

Six meters long bundlepacks may be handled by fork lift trucks but the positioning of the forks shall cause minimum bending of the pipes.

Bundlepacks longer than 6m long should be handled either by side loader with a minimum of four supporting forks, or by a crane using a spreader beam and suitable slings. Off loading on site may be made easier by using skid timbers and rope slings.

12.3.2 Coiled Pipes

Coils of pipes can be handled by fork lift truck. Where individual coils are too heavy for manual lifting, a fork lift truck with suitable protected boom attachments should be used. They should NOT be rolled off the edge of loading platforms or trailers.

Complete coils are secured by outer and intermediate bands and individual layers are also independently secured. Plastic tape at least 10mm wide should be used for banding.

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The bands should not be removed until the pipe is required for use. The bands securing the outer end of the pipe should be removed first and the movement of the free end carefully controlled. This should be followed by those securing successive layers, and only those bands necessary to release the length of pipe immediately required should be cut and removed.

When removed from the coil or drum, the pipe will be oval and curved. Although both ovality and curvature will reduce with time, special tools are available to facilitate handling and jointing.

12.3.3 Fittings

Hocks should not be used to lift fittings which are generally supplied with cardboard boxes. Special care should be taken in the handling of "pup" fittings to ensure that the weight of the fittings is not transferred to the fabricated joint.

13.0 CERTIFICATION

Manufacturer or supplier is requirement to provide a copy of the certificate and test report either from SIRIM, IKRAM or other recognised certification body.

Test reports should be those tests conducted within a year period.

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

14.0 HDPE PIPE JOINTING

Pipe joining for pipes buried underground, below pavement or slab or concealed in slab shall use electro-fusion or fully automatic butt fusion jointing unless instructed otherwise by S.O.

15.0 JOINTING BY BUTT FUSION

15.1 General

Butt fusion is process of welding HDPE pipes and fittings using an electrically heated plate. It is suitable for jointing HDPE pipes and fittings of size from 110 : OD and above. However, only pipes and fittings of the same material type, size and rating shall be butt welded, e.g. PE 100 pipes should not currently be welded to PE 80 pipes. PN 10 pipe should not be welded to PN 6 pipe or fitting.

The following table shows the recommended conditions.

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Single pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature 210(+ 10/-5) °C

Outside diameter	SDR	Wall Thickness (minimum)	Bead-up Interface Stress	Initial Bead Size (approx.)	Soak Time	Minimum Soak Interface Stress	Maximum Plate Removal Time	Fusion and Cooling Interface Stress	Cooling Time in Clamps	Typical Final Overall Bead Width	
										Min	Max
(mm)		(mm)	(MPa)	(mm)	(seconds)	(MPa)	(seconds)	(MPa)	(Minutes)	(mm)	(mm)
90	21	4.3	0.150	2	105	0	10	0.150	15.0	8	15
90	17.6	5.1	0.150	2	110	0	10	0.150	15.0	8	15
90	13.6	6.6	0.150	2	125	0	10	0.150	15.0	9	15
90	11	8.2	0.150	2	140	0	10	0.150	15.0	9	16
90	9	10	0.150	2	160	0	10	0.150	20.0	9	16
110	21	5.2	0.150	2	115	0	10	0.150	15.0	8	15
110	17.6	6.3	0.150	2	125	0	10	0.150	15.0	9	16
110	17	6.5	0.150	2	126	0	10	0.150	15.0	9	16
110	13.6	8.1	0.150	2	141	0	10	0.150	15.0	9	16
110	11	10.0	0.150	2	160	0	10	0.150	15.0	10	17
110	9	12.2	0.150	2	185	0	10	0.150	20.0	10	17
125	21	6.0	0.150	2	120	0	10	0.150	15.0	8	16
125	17.6	7.1	0.150	2	130	0	10	0.150	15.0	9	16
125	17	7.4	0.150	2	145	0	10	0.150	15.0	9	16
125	13.6	9.2	0.150	2	150	0	10	0.150	15.0	9	16
125	11	11.4	0.150	2	175	0	10	0.150	15.0	10	18
125	9	13.9	0.150	2	199	0	10	0.150	20.0	11	18
140	21	6.7	0.150	2	125	0	10	0.150	15.0	9	16
140	17.6	8.0	0.150	2	140	0	10	0.150	15.0	9	16
140	17	8.2	0.150	2	145	0	10	0.150	15.0	9	16
140	13.6	10.3	0.150	2	165	0	10	0.150	20.0	11	18
140	11	12.7	0.150	2	185	0	10	0.150	20.0	10	17
140	9	15.6	0.150	2	215	0	10	0.150	20.0	11	18
Tolerance			±0.02		±3			±0.02			

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Single pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature 210(+ 10/-5) °C

Outside diameter	SDR	Wall Thickness (minimum)	Bead-up Interface Stress	Initial Bead Size (approx.)	Soak Time	Minimum Soak Interface Stress	Maximum Plate Removal Time	Fusion and Cooling Interface Stress	Cooling Time in Clamps	Typical Final Overall Bead Width	
										Min	Max
(mm)		(mm)	(MPa)	(mm)	(seconds)	(MPa)	(seconds)	(MPa)	(Minutes)	(mm)	(mm)
160	21	7.6	0.150	2	135	0	10	0.150	15.0	9	16
160	17.6	9.1	0.150	2	150	0	10	0.150	15.0	10	17
160	17	9.4	0.150	2	154	0	10	0.150	15.0	10	17
160	13.6	11.8	0.150	2	180	0	10	0.150	20.0	10	18
160	11	14.8	0.150	2	205	0	10	0.150	20.0	11	18
160	9	17.8	0.150	2	240	0	10	0.150	20.0	11	19
180	21	8.6	0.150	2	145	0	10	0.150	10.0	9	16
180	17.6	10.2	0.150	2	160	0	10	0.150	20.0	10	17
180	17	10.6	0.150	2	165	0	10	0.150	20.0	10	17
180	13.6	13.2	0.150	2	195	0	10	0.150	20.0	10	17
180	11	16.4	0.150	2	225	0	10	0.150	20.0	11	18
180	9	20.0	0.150	2	260	0	10	0.150	35.0	12	19
200	21	9.5	0.150	2	155	0	10	0.150	15.0	9	16
200	17.6	11.4	0.150	2	175	0	10	0.150	20.0	10	17
200	17	11.8	0.150	2	180	0	10	0.150	20.0	10	17
200	13.6	14.7	0.150	2	205	0	10	0.150	20.0	11	18
200	11	18.2	0.150	2	240	0	10	0.150	20.0	11	19
200	9	22.2	0.150	2	285	0	10	0.150	35.0	12	19
225	21	10.7	0.150	2	170	0	10	0.150	20.0	9	16
225	17.6	12.8	0.150	2	190	0	10	0.150	20.0	10	17
225	17	13.2	0.150	2	195	0	10	0.150	20.0	10	17
225	13.6	16.5	0.150	2	225	0	10	0.150	20.0	11	18
225	11	20.5	0.150	2	265	0	10	0.150	35.0	12	19
225	9	25	0.150	2	310	0	10	0.150	35.0	15	24
250	21	11.9	0.150	2	180	0	10	0.150	20.0	10	17
250	17.6	14.2	0.150	2	200	0	10	0.150	20.0	11	18
250	17	14.7	0.150	2	210	0	10	0.150	20.0	11	18
250	13.6	18.4	0.150	2	245	0	10	0.150	20.0	11	19
250	11	22.7	0.150	2	285	0	10	0.150	35.0	15	24
250	9	27.8	0.150	2	340	0	10	0.150	35.0	16	25
Tolerance			±0.02		±3			±0.02			

SYABAS' STANDARD SPECIFICATION FOR PIPE LAYING WOKS

First Edition : May 2007

Single pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature 210(+ 10/-5) °C

Outside diameter	SDR	Wall Thickness (minimum)	Bead-up Interface Stress	Initial Bead Size (approx.)	Soak Time	Minimum Soak Interface Stress	Maximum Plate Removal Time	Fusion and Cooling Interface Stress	Cooling Time in Clamps	Typical Final Overall Bead Width	
										Min	Max
(mm)		(mm)	(MPa)	(mm)	(seconds)	(MPa)	(seconds)	(MPa)	(Minutes)	(mm)	(mm)
315	21	15.0	0.150	3	210	0	10	0.150	20.0	13	22
315	17.6	17.9	0.150	3	240	0	10	0.150	20.0	14	23
315	17	18.5	0.150	3	245	0	10	0.150	20.0	14	23
315	13.6	23.2	0.150	3	290	0	10	0.150	35.0	15	24
315	11	28.6	0.150	3	345	0	10	0.150	35.0	17	26
315	9	35.0	0.150	3	410	0	10	0.150	45.0	18	27
355	21	16.9	0.150	3	230	0	10	0.150	20.0	14	23
355	17.6	20.2	0.150	3	260	0	10	0.150	35.0	15	24
355	17	20.9	0.150	3	270	0	10	0.150	35.0	15	24
355	13.6	26.1	0.150	3	320	0	10	0.150	35.0	16	25
355	11	32.3	0.150	3	380	0	10	0.150	45.0	18	27
355	9	39.4	0.150	3	455	0	10	0.150	45.0	19	28
400	21	19.0	0.150	3	250	0	10	0.150	20.0	14	23
400	17.6	22.7	0.150	3	285	0	10	0.150	35.0	15	24
400	17	23.5	0.150	3	295	0	10	0.150	35.0	15	24
400	13.6	29.4	0.150	3	355	0	10	0.150	35.0	16	25
400	11	36.4	0.150	3	425	0	10	0.150	45.0	18	27
400	9	44.4	0.150	3	505	0	10	0.150	55.0	20	29
450	21	21.4	0.150	3	274	0	10	0.150	35.0	15	24
450	17.6	25.6	0.150	3	316	0	10	0.150	35.0	16	25
450	17	26.5	0.150	3	325	0	10	0.150	35.0	16	25
450	13.6	33.1	0.150	3	390	0	10	0.150	45.0	18	27
450	11	40.9	0.150	3	470	0	10	0.150	55.0	19	28
450	9	50.0	0.150	3	565	0	10	0.150	65.0	22	31
500	21	23.8	0.150	3	300	0	10	0.150	35.0	15	24
500	17.6	28.4	0.150	3	345	0	10	0.150	35.0	17	26
500	17	29.4	0.150	3	355	0	10	0.150	35.0	17	26
500	13.6	36.8	0.150	3	430	0	10	0.150	45.0	18	27
500	11	45.5	0.150	3	515	0	10	0.150	55.0	20	29
500	9	55.6	0.150	3	620	0	10	0.150	65.0	22	31
Tolerance			±0.02		±3			±0.02			

SYABAS' STANDARD SPECIFICATION FOR PIPE LAYING WOKS

First Edition : May 2007

Single pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature 210(+ 10/-5) °C

Outside diameter	SDR	Wall Thickness (minimum)	Bead-up Interface Stress	Initial Bead Size (approx.)	Soak Time	Minimum Soak Interface Stress	Maximum Plate Removal Time	Fusion and Cooling Interface Stress	Cooling Time in Clamps	Typical Final Overall Bead Width	
										Min	Max
(mm)		(mm)	(MPa)	(mm)	(seconds)	(MPa)	(seconds)	(MPa)	(Minutes)	(mm)	(mm)
560	21	26.7	0.150	3	325	0	10	0.150	35.0	16	25
560	17.6	31.8	0.150	3	375	0	10	0.150	45.0	17	26
560	17	32.9	0.150	3	390	0	10	0.150	45.0	17	26
560	13.6	41.2	0.150	3	470	0	10	0.150	55.0	19	28
560	11	50.9	0.150	3	570	0	10	0.150	65.0	22	31
630	21	30.0	0.150	3	360	0	15	0.150	35.0	17	26
630	17.6	35.8	0.150	3	415	0	15	0.150	45.0	18	27
630	17	37.1	0.150	3	435	0	15	0.150	45.0	18	27
630	13.6	46.3	0.150	3	525	0	15	0.150	55.0	20	29
630	11	57.3	0.150	3	630	0	15	0.150	65.0	23	32
710	21	33.8	0.150	3	400	0	15	0.150	45.0	17	26
710	17.6	40.3	0.150	3	460	0	15	0.150	55.0	19	28
710	17	41.8	0.150	3	480	0	15	0.150	55.0	19	28
710	13.6	52.2	0.150	3	580	0	15	0.150	65.0	22	31
800	21	38.1	0.150	3	440	0	15	0.150	45.0	18	27
800	17.6	45.5	0.150	3	510	0	15	0.150	55.0	20	29
800	17	47.1	0.150	3	535	0	15	0.150	55.0	20	29
800	13.6	58.8	0.150	3	650	0	15	0.150	65.0	23	32
900	21	42.9	0.150	3	490	0	15	0.150	55.0	19	28
900	17.6	51.1	0.150	3	570	0	15	0.150	65.0	22	31
900	17	52.9	0.150	3	595	0	15	0.150	65.0	22	31
1000	21	47.6	0.150	3	535	0	15	0.150	55.0	20	29
1000	17.6	56.8	0.150	3	625	0	15	0.150	65.0	23	32
1000	17	58.8	0.150	3	655	0	15	0.150	65.0	23	32
Tolerance			±0.02		±3			±0.02			

SYABAS' STANDARD SPECIFICATION FOR PIPE LAYING WOKS

First Edition : May 2007

Dual pressure butt fusion jointing conditions for PE80 and PE100

Heater Plate Surface Temperature 210(+ 10/-5) °C

Outside diameter	SDR	Wall Thickness (minimum)	Bead-up Interface Stress	Initial Bead Size (approx.)	Soak Time	Minimum Soak Interface Stress	Maximum Plate Removal Time	Fusion and Cooling Interface Stress	Cooling Interface Stress (after 10s)	Cooling Time in Clamps	Typical Final Overall Bead Width	
											Min	Max
(mm)		(mm)	(MPa)	(mm)	(seconds)	(MPa)	(seconds)	(MPa)	(MPa)	(Minute s)	(mm)	(mm)
0	11	22.7	0.150	3	285	0	10	0.150	0.025	35.0	15	24
280	11	25.5	0.150	3	315	0	10	0.150	0.025	35.0	16	25
315	11	28.6	0.150	3	345	0	10	0.150	0.025	35.0	17	25
355	26	13.7	0.150	3	195	0	10	0.150	0.025	20.0	13	22
355	17.6	20.2	0.150	3	260	0	10	0.150	0.025	35.0	15	24
355	11	32.3	0.150	3	385	0	10	0.150	0.025	45.0	18	27
400	26	15.4	0.150	3	215	0	10	0.150	0.025	20.0	14	23
400	17.6	22.7	0.150	3	285	0	10	0.150	0.025	35.0	15	24
400	11	36.4	0.150	3	425	0	10	0.150	0.025	45.0	18	27
450	26	17.3	0.150	3	235	0	10	0.150	0.025	20.0	14	23
450	17.6	25.6	0.150	3	315	0	10	0.150	0.025	35.0	16	25
450	11	40.9	0.150	3	470	0	10	0.150	0.025	45.0	19	28
500	26	19.2	0.150	3	250	0	10	0.150	0.025	29.0	15	21
500	17.6	28.4	0.150	3	345	0	10	0.150	0.025	35.0	17	26
500	11	45.5	0.150	3	515	0	10	0.150	0.025	55.0	20	29
560	26	21.5	0.150	3	275	0	10	0.150	0.025	35.0	15	24
560	17.6	31.8	0.150	3	380	0	10	0.150	0.025	45.0	17	26
560	11	50.9	0.150	3	570	0	10	0.150	0.025	65.0	22	31
630	26	24.2	0.150	3	300	0	15	0.150	0.025	35.0	16	25
630	17.6	35.8	0.150	3	420	0	15	0.150	0.025	45.0	18	27
630	11	57.3	0.150	3	635	0	15	0.150	0.025	65.0	23	32
710	26	27.3	0.150	3	335	0	15	0.150	0.025	35.0	16	25
710	17.6	40.3	0.150	3	465	0	15	0.150	0.025	55.0	19	28
900	26	34.6	0.150	3	405	0	15	0.150	0.025	45.0	18	27
900	17.6	51.1	0.150	3	570	0	15	0.150	0.025	65.0	22	31
1000	26	38.5	0.150	3	445	0	15	0.150	0.025	45.0	18	28
1000	17.6	56.8	0.150	3	630	0	15	0.150	0.025	65.0	23	32
Tolerance			±0.02		±3			±0.02	±0.01			

15.2 Butt Fusion Jointing Equipment

Butt fusion jointing equipment shall be certified in accordance with MS 1058 or ISO 12176-1. Only fully automatic Computerized Numerical Control (CNC) machines or computerized microprocessor based machines shall be used. Manual or Semi Automatic CNC machines are NOT allowed.

a) Chassis and Clamps

The machine shall have a frame containing clamps which are sufficiently robust to re-round and accurately align the pipes to be jointed.

The machine shall have a minimum of two rams mounted on the pie center-line axis. The ram shall move freely and control the movement of any sliding clamps. All slides shall be kept free from rust and lubricated at all times.

b) Hydraulic/pneumatic unit

The unit shall be capable of actuating the clamp unit to provide adequate force and speed of operation. A pressure monitoring device shall be provided to monitor ram pressure.

Unless an automatic machine is used, a data plate permanently attached to the unit setting out jointing and cooling pressures and times for specified sizes of pipe.

Note : It is very important that welding machine can control the secondary pressures accurately as these will sometimes be only slightly greater than the drag pressure.

(c) Trimming tool

The trimming tool shall be capable of being mounted securely within the frame of the jointing machine, so that this equipment can produce accurately matched planed faces.

Trimming blades of the planer shall be sharp and have defect free cutting edges to provide continuous swarf of uniform thickness.

(d) Heater Plate

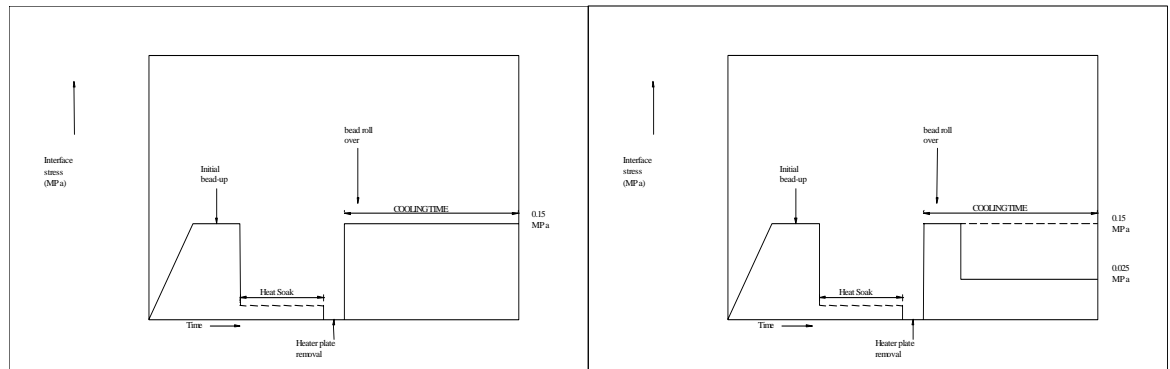
The plate shall be electrically heated and shall be provided with a suitable temperature controller to give a uniform surface temperature of 210 (+10 / -5) °C.

The plate surface shall have a permanent coat of anti-stick material. **ADDITIONAL SPRAY-ON RELEASE AGENTS SHALL NOT BE USED.** The surface shall be free from any contaminants.

The plate shall be fitted with an accurate temperature probe or indicator, accurate to within ± 2 °C in the range of 200° – 240°C. The temperature on both sides of the circumference shall be measured using a digital thermometer with an appropriate surface probe.

(e) Control system

The control system shall be designed to carry out the operations as far as possible automatically at the temperature, time and pressures indicated as required.



Single pressure butt fusion
Jointing cycle (not to scale)

Dual pressure butt fusion
Jointing cycle (not to scale)

In automatic butt-fusion welding machines, the control system shall be capable of being programmed according to the size and rating of the pipe and fitting.

(f) Shelter

A shelter shall be used to provide adequate protection for pipe, fittings and equipment against adverse weather conditions and contamination.

(g) External and internal bead removal if required

External and internal debadders shall be capable of removing the cold bead cleanly in a continuous strip without damage to either joint or bead after the cooling time.

(h) Generator

The generator shall be selected to suit the butt fusion machine capacity and heater plate rating. The specification of the generator shall be supplied by the machine manufacturer

(i) Ancillary equipment

The following equipment shall be made available on site :

- (a) Pipe support rollers
- (b) Pipe cutters
- (c) Digital thermometer with probe
- (d) Timer
- (e) Indelible Marker pen for marking beads
- (f) Bead gauge
- (g) Saw and saw guide
- (h) Pipe end cover
- (i) Spirit level to ensure machine is level
- (j) Ground sheets or base boards
- (k) Clean clothes to wipe the pipes before trimming

15.2.1 Butt Fusion Jointing Method

(a) Definitions

Fusion pressure and cooling pressure : the pressure (in bar) required to provide, on a given machine and for a given size and rating of pipe, an interface stress of 0.15MPa or 0.025MPa as appropriate. This pressure is a function of the ram dimensions and the efficiency of the machine.

Butt-fusion welding machine shall capable of being programmed according to the size and rating of the pipe and /or fitting.

Drag pressure : the minimum pressure (in bar) required to overcome the sliding frictional drag of the pipe and the machine. This must be assessed accurately prior to making each fusion joint and must be added to the ram pressure. This operation is normally carried out automatically when fully automatic fusion machines are used.

Bead-up pressure : the sum of fusion and drag pressures required to provide, on a given machine and for a given size and rating of pipe, an interface stress of 0.15MPa to form the initial bead on the end of the pipe against the heater plate.

Heat soak pressure : the pressure required to maintain the pipe in contact with the heater plate. This is normally the drag pressure.

Bead roll over pressure : the pressure required to provided, on a given machine and for a given size and rating of pipe, an interface stress of 0.15MPa. This has the same value as the initial bead-up pressure.

Plate removal time :the maximum time permitted for the opening of the carriage, removal of the heating plate and closure of the carriage to bring the two hot pipe ends together.

(b) Preparation

(1) Cleaning the trimming tool

The trimming tool surface shall be visually inspected for grease and dirt and cleaned where necessary using clean water and lint-free materials. Particular attention shall be paid to the blade. Blunt or damaged blade shall be replaced.

(2) Cleansing / washing the heater plate

The heater plate shall be thoroughly washed with copious quantities of clean water at the start of a jointing session. It shall also be cold when washed.

Only clean, disposable lint-free materials shall be used to clean the plate.

Grease and oily films may be wipe with a clean, disposable lint-free cloth or cleaning material dampened by a suitable solvent when necessary.

(3) **Sitting the equipment**

The butt jointing machine shall be placed on a suitable level baseboard inside a shelter.

To aid alignment of pipes into the machine and for easy of movement, pipes to be jointed shall always be supported on rollers. Pipe strings should be laid out on a level surface where possible.

(4) **Dummy welds**

In order to remove dust from the heater plate, a dummy weld should be carried out at the start of each continuous jointing session, or at a change of pipe size.

A dummy weld can be made using pipe cut-offs of the same size and pressure rating and the pipe to be welded. It is not necessary to actually make a joint, The procedure can be stopped after the full heat soak cycle as specified in Tables.

(c) Setting up

Operate the machine to open clamps and position the planer in its position.

Position pipes in the clamps with ends adjacent to planning tool and with pipe markings aligned. This will assist in obtaining the best match in diameter. Pipes should be jointed so that the pipe markings are uppermost when the pipes are in trench.

Tighten pipe clamps to grip and re-round the pipes.

(d) Trimming

Switch on the trimming tool. The pipe ends shall be moved against the trimming tool until continuous shavings are produced from each pipe end.

Keep the trimming tool turning, whilst separating the pipe ends to avoid steps on the trimmed surfaces. Switch off the planning tool and remove after it has come to rest.

Remove loose shaving from the machine and inside the pipes. Do not touch pipe or fitting ends, to prevent contamination of the clean surfaces.

Visually check that the pipe or pipe and fitting ends are completely planed and repeat planning if necessary.

Bring pipe or pipe and fitting ends together and check there is no visible gap between trimmed surfaces. The maximum permitted outside diameter mismatch shall not exceed 10% of thickness of pipe / fitting.

If the mismatch is greater than that given above then the pipe or pipe and fitting shall be realigned and re-planed.

(e) Bead-up

Check that the heater plate has attained the operating temperature.

Insert and secure the heater plate into position in the machine.

Bring the pipe or pipe and fitting ends into contact with the heater plate using the initial bead-up pressure equivalent to 0.15MPa interface stress.

The typical initial bead size is given in Tables.

(f) Heat soak

After the initial bead-up, the pressure in the system shall be released so that the pressure gauge registers between zero and the drag pressure to control bead growth during heat soak time. Check that the clamps do not move. The pipe or pipe and fitting ends shall be in contact with the heater plate.

(g) Plate removal

During removal of the heater plate, no molten polymer should stick to the heater plate. If it does, then the joint shall be aborted, the plate cleaned and the surface quality of the plate examined. If the plate surface is damaged, the manufacturer's advice should be obtained on cleaning and / or replacement.

The maximum plate removal time, including the time to bring the hot ends together, shall not exceed 10 seconds for pipe not exceeding 630 mm and 15 seconds for pipes exceeding 630mm.

(h) Fusion jointing

Immediately after plate removal the hot pipe and fitting ends shall be brought together in a smooth manner and the pressure raised in accordance to the Tables.

The fused material should "roll" back in a uniform manner and there should be no sign of bubbles or contamination present.

The overall width of the bead is not critical and therefore the bead sizes quoted in Tables are typical only. The uniformity of the bead size around the circumference of the pipe is important as this indicates that the equipment is set up correctly, therefore deviations beyond the limits detailed in Section "Debeading" should be investigated in order to reduce the variation to within the recommended values.

(i) Cooling

The joint should be allowed to cool in the clamps, whilst maintaining the joints at the cooling pressure for at least the time given in Tables for the appropriate pipe.

At the end of the cooling time, the clamps may be released and the jointed pipe or pipe and fitting removed. No handling of the pipe shall take place until the

surface temperature of the bead is below 50 deg. C as measured by a digital thermometer.

(j) Debeading

All external beads, and internal beads if required, shall be removed after the cooling time using a suitable debeading tool. The bead removal tool shall not induce any slits, gouges or defects in the pipe wall.

Butt fusion beads shall be uniform on both sides of the joint i.e. no wrinkles or discontinuities.

The beads shall be bent back at several positions. No evidence of the bead splitting shall be seen. If the bead is seen to split at any point then the joint shall be cut from the pipeline and remade. If a similar defect recurs, all further production jointing shall cease until the equipment has been thoroughly cleaned and examined. New trial joints shall be made and shown to be satisfactory.

(k) Records

Electronic or written records of appropriate joint procedure details shall be kept. The minimum information to be recorded is given in Table below.

Butt Fusion Joint Record

Machine type :	
Serial No. :	
Time :	Date :
Joint number :	
Job No. :	Operator code :
Pipe or pipe and fitting size :	
Joint cycle :	

Parameter	Units	Actual Value	Permissible Values
Bead pressure (no drag)			
Joint pressure (no drag)	bar		
Drag	bar		
Heater temperature	deg. C		
Bead-up pressure	bar		
Initial bead size	Mm		
Heat soak time	sec.		
Heat soak pressure	Bar		
Dwell time (change-over time)	sec.		
Fusion pressure	bar		

(l) Maintenance, service and calibration

All equipment shall be well maintained and kept in a clean condition at all time, both in stores and on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipment and will also depend on usage but should be at least once every 6 months.

15.3 Electro-fusion Socket Jointing

15.3.1 General

With electro-fusion socket fusion, an electrical resistance element is incorporated in the socket of the fitting which, when connected to appropriate power supply, melts and fuses the material of the pipe and fitting together.

The effectiveness of this technique depends on the attention to cleanliness, in particular the removal of the contaminated surface of the pipe over the socket depth.

Electro-fusion fittings are available in the range 20mm to 315mm although larger sizes are now under development.

There are 2 control systems specified – manual time selection and automatic time selection. Both are described in this section.

15.3.2 Equipment

The control box input supply shall be from a nominal 220 volt generator.

NO EXTENSION LEADS SHALL BE USED ON THE CONTROL BOX OUTLET CONNECTORS

WARNING : Control boxes are not intrinsically safe and shall not therefore be taken into the trench.

Pipe surface preparation tool capable of removing the contaminated surface of the pipe in excess of the insertion depth before welding is attempted. The tool shall remove a layer 0.2 – 0.4mm thick from the outer surface of the pipe preferably as a continuous strip of swarf over that length and round the pipe.

NOTE : Hand scrapers can be difficult to use effectively in trench conditions.

Pipe clamps or other approved method for restraining, aligning and re-rounding the pipes during the weld cycle shall be used.

Pipe cutters including saw and saw guide.

15.3.3 Electro-fusion Jointing Method

(a) Preparation

Check that the pipe ends to be jointed are cut square to the axis and any burrs removed.

Wipe pipe ends using clean, disposable, lint-free material to remove traces of dirt or mud, etc.

Mark the area over which the contaminated surface is to be removed, i.e. in excess of the penetration depth, on each pipe to be jointed by placing the socket of the bagged fitting alongside the pipe and. Trace a line round the circumference at the appropriate distance from the pipe end using a suitable marker.

DO NOT REMOVE THE FITTING FROM ITS PACKING AT THIS STAGE

Connect the electro-fusion control box input leads to the generator.

Check that there is sufficient fuel for the generator to complete the joint.

Check that reset stop button, if fitted on the control box, is in the correct mode.

Using the pipe end preparation tool, remove the entire surface of the pipe uniformly, preferably as a continuous swarf over the area identified, i.e. in excess of penetration depth.

(b) Electro-fusion Jointing Procedure

Remove the fitting from its packaging and check that the bore of the fitting is clean and dry. If necessary, dry it with clean, disposable, lint-free material and degrease with a clean cloth dampened by a suitable solvent like acetone liquid.

NOTE 1 : Isopropanol is a suitable cleaner for the material if permitted by the site health and safety regulations.

Insert the pipe ends into the fitting.

NOTE 2 : It is recommended to mark pipe ends with an indelible pen to ensure pipe depth of entry is maintained and a visible record retained when fusion is complete.

Using the pipe clamps, secure the pipes so that they cannot move during the fusion cycle. Check that the pipe ends and the fitting are correctly aligned.

If applicable, remove the terminal caps from the fitting.

Start the generator and check that it is functioning correctly.

Connect the control box output leads to the fitting terminal and check that they have been fully inserted.

Switch on the control box where applicable.

Commence the fusion joining procedure in accordance with the control box instruction and check indicated jointing time with time shown on fitting.

Scan the bar code magnetic card which is provided together with the fusion socket. Details of the fusion socket will be displayed on the welding set.

Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display countdown.

On completion of the heating cycle, the melt indicators should have risen. If there is no apparent movement of the melt indicators, the joint should be cut out and a new joint made.

If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting.

NOTE : If the fusion cycle terminates before completion of the countdown, check for faults as indicated by the control box warning lights. Do not attempt a second fusion cycle if countdown of the first cycle reached more than half of the total time required and for at least one hour after the first attempt.

(c) Maintenance , Servicing and Calibration

All equipment shall be well maintained and kept in a clean condition at all time, both in stores and on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipment and will also depend on usage, but should be at least once every 6 months. Guidance shall be sought from the equipment manufacturer and a scheme of calibration and servicing implemented. Particular attention shall be given to the control box and generator.

(d) Records

Written records of appropriate fusion procedure details shall be kept as required using the format approved by the S.O.

15.4 Electro-fusion Saddle Jointing

15.4.1 General

With electro-fusion saddle jointing, an electrical resistance element is incorporated in the base of the saddle which, when connected to an appropriate power supply, melts and fuses the material of the pipe and fitting together.

The effectiveness of this technique depends on attention to cleanliness, in particular the removal of the contaminated surface of the pipe over an area equivalent to the saddle base.

Electro-fusion saddles are available to fit all commonly used main sizes with sizes 20, 25 or 32mm service connections. Outlet connections are also available up to nominal size 180mm.

Two methods of holding the tapping tee saddle during the fusion cycle are used, top loading and under clamping systems. However, because of the variations of equipment used for each method, common procedures for holding the saddle during the fusion cycle cannot be specified. For each type of fitting used, the manufacturer's procedure for holding the fitting during the fusion cycle should be followed.

15.4.2 Equipment

The control box input supply shall be from a nominal 220 volts.

NO EXTENSION LEADS SHALL BE USED ON THE CONTROL BOX OUTLET CONNECTORS.

WARNING : Control boxes are not intrinsically safe and shall not be taken into the trench.

Pipe surface preparation tool capable of removing the contaminated surface of the pipe over the full area of the saddle base. The tool shall remove a surface layer 0.2 – 0.4mm thick.

Pipe-clamp with suitable dimension for making service or branch connections.

15.4.3 Electrofusion Saddle Jointing Method

(a) Preparation

Expose the pipe onto which the tapping tee saddle is to be assembled.

Clean the pipe over the general area on which the saddle is to be assembled using clean, disposable, lint-free material and use clean water only.

Without removing the fitting from its packaging, place it over the required position on the main. Mark the pipe surface all round and clear of the saddle base area.

Remove the surface of the pipe to a depth of 0.2 to 0.4mm over the full area marked using a suitable tool. Remove the swarf.

Check that reset stop button on the control box, if fitted, is in the correct mode.

(b) *Electro-fusion Saddle Jointing Procedure*

Position the fitting base onto the prepared pipe surface and install the saddle clamp to the saddle tee.

Remove the terminal caps from the fitting.

Check that there is sufficient fuel for the generator to complete the joint. Start the generator and check that it is functioning correctly.

Connect the electro-fusion control box input leads to the generator.

Connect the control box output leads to the fitting terminals and check that they have been fully inserted.

Switch on the control box if applicable.

Commence the fusion jointing procedure in accordance with the control box instructions and check indicated joint time shown on fitting.

Press the start button on the control box and check that the heating cycle is proceeding as indicated by the display count-down.

On completion of the heating cycle, the melt indicator should have risen. If there is no apparent movement of the melt indicator, where incorporate, a new saddle joint should be made. Cut the tee of the faulty joint from its base.

If a satisfactory joint has been made, the joint shall be left in the clamps for the cooling time specified on the fitting label.

NOTE : If the fusion cycle terminates before completion of the count-down, check for faults as indicated by the control box warning lights. DO NOT attempt a second fusion cycle.

NOTE : DO NOT attempt to tap the pipe with the integral cutter for at least 10 minutes after completion of the fusion cycle.

(c) Maintenance, Servicing and Calibration

All equipment shall be well maintained and kept in a clean condition at all time, both in stores and on site.

The equipment shall be serviced and calibrated regularly. The frequency at which this is carried out will be different for individual items of equipments and will also depend on usage but should be at least once 6 months. Guidance shall be sought from the equipment manufacturer and a scheme of calibration and servicing implemented. Particular attention shall be given to the control box and generator.

(d) Records

Written records of appropriate fusion procedure details shall be kept as required using the format illustrated below.

ELECTROFUSION JOINT RECORD

Control Box Serial No. :		Units
Operator Code :		
Time :	Date :	sec.
Ambient Temperature :		°C
Joint Number :		
Type of Fitting :		
Target Fusion Time :		sec
Achieved Fusion Time :		sec
Joint Status :		
Power profile :		

A well-made electrofusion saddle joint should have the following features:

The melt indicator should have operated where:

- There should be no melt flowing from round the saddle base;
- There should be evidence of pipe surface preparation round the saddle base.

The following features indicate faults during the assembly / fusion operation:

(1) Fusion indicator fails to operate

- Causes :
- (a) incorrect fusion time selected – too short ;
 - (b) control box out of specification – under voltage;
 - (c) fitting heating coil failure;
 - (d) incorrect fitting for size of main;
 - (e) top load too low on loading tool.

(2) Excess melt indicator or from saddle base

- Causes :
- (a) incorrect fusion time selected – too long;
 - (b) control box out of specification – over voltage;
 - (c) insufficient pressure from top loading assembly tool;
 - (d) time failure – too long;
 - (e) incorrect fitting for size of main;
 - (f) top load too high on loading tool.

(3) Inadequate fusion of saddle base on main

- Causes :
- (a) lack of pipe preparation;
 - (b) fitting heating coil failure.

15.5 Mechanical Joints

(a) General

All mechanical fittings used shall be assembled in accordance with the manufacturer's instructions and all metal fittings should be suitably protected from corrosion as stipulated in clause "Metal Parts".

(b) Transition joint from HDPE pipe to flanged metal fittings

For transition from HDPE pipe to flanged metal fittings, either HDPE stub flanges with metal backing rings or mechanical flanged adaptors of approved types complied with MS 1058 or EN 12201 shall be used. The flanged joint gasket and bolt length used shall be appropriate to the particular adaptor.

When tightening bolts and nuts for the flanges, care should be taken to produce an even torque load (torque wrench) to the limits as follows. The use of a torque wrench is strongly recommended. Typical bolt torques shall be as shown in Table below.

Typical bolt torques

Nominal PE Size (mm)	Standard Flanges		
	Nominal iron Size (mm)	Bolts No.	Torque Nm (+/- 10%)
63	50	4	35
90	80	8	35
125	100	8	35
180	150	8	60
225	200	12	80
250	250	12	100
280	250	12	100
315	300	12	120
355	350	16	150
400	400	16	200
450	450	20	250
500	500	20	300

(c) Branch connection

Normally, branch connections on the main are achieved by introducing fusion tees during installation of the main.

A subsequent branch connection into an existing HDPE main can be achieved by using :

- Standard fusion tee with electro-fusion couplers,
- Standard electro-fusion branch connections,
- Branch saddle electro-fusion fittings,
- Mechanical couplers with restrainers / stiffeners can be used.

16.0 MAIN HDPE PIPE LAYING

16.1 Preparation Of Pipes

Generally HDPE pipes are joined to form a string above ground prior to snaking into the trench. To prevent scoring, pipe rollers should be used.

Before lowering HDPE pipelines into the trench, a check should be made for cuts, deep scratches or other pipe damage and in fusion jointed systems that the system has cooled sufficient before stress is imposed upon any pre-made joints.

When lowering pipe into the trench, care should again be taken to avoid scoring of the pipe by contact with the sides and bottom of the trench. Use should be made of planks and ropes where appropriate but wire ropes or chains should not be used.

16.2 Laying Of Pipes

Gradual changes in direction of HDPE pipelines can be accommodated by pipe deflection but every effort should be made to keep the pipe as central as possible within the trench to enable adequate compaction of side-fill.

The bending of HDPE pipelines is permissible and the properties of fusion jointed systems enable changes of direction without recourse to the provision of special bends or anchor blocks. However, the pipe should not normally be cold bent to a radius less than 25 times the outside diameter of the pipe. For push-fit or mechanical non end-load resistant jointing systems, anchor blocks to withstand the resultant thrusts must be provided. Under no circumstances should hot bending be attempted on site.

For installation of heavy flanged fittings, provision should be made for concrete support both for the weight and to resist the turning moments associated with valves and hydrants.

HDPE pipes and fitting may be partially or completely surrounded by concrete but they should be protected by 3mm rubber membrane to avoid possible damage during pouring or compaction to prevent high localized stresses.

After completion of an installation, pipe work and fittings should be inspected and made ready for testing to ensure the safety and efficiency of the systems. The trench may be backfilled prior to testing; but it is advisable to leave at least the joints exposed throughout the test.

Complete and accurate records should be taken of the installation. It is useful for records to be taken before the pipes are buried.

To assist the future location of the pipelines, a marker tape shall be laid along the line of the main and connect at each end to either a sluice valve or hydrant. The recommended position of the tape is 350mm below the surface directly above the crown of the pipe.

17.0 INSTALLATION OF SERVICE PIPES

17.1 General

This section gives details of installation of HDPE service pipes. A service pipe is that part of the water supply system which conveys water from the distribution main to the consumer's premises and is subjected to water pressure from that main. It is considered to comprise two sections:

- The COMMUNICATION PIPE is that part of the service pipes from the main up to the and including the consumer's meter situated at the boundary of the consumer's property. The water supply authority is responsible for the installation and maintenance of the communication pipe.
- The SUPPLY PIPE is that part of the service pipe from the consumer's meter into the premises up to the storage cistern. The customer is responsible for the installation and maintenance of the supply pipe.

17.2 Laying of Communication Pipe

Wherever practicable the whole communication pipe should be laid in a straight line at right angles to the main when viewed on plan. This assists future location and identification of these pipes.

Slight snaking of the communication pipe in the vertical plane is permitted without overstressing the connection to the main. However, care must be taken not to kink the pipe and/or impart excess bending moment to the saddle tapping.

The preferred method would seem to be the simple straight connection at right angles to the main with changes in direction or level achieved by installation electrofusion elbows to avoid overstressing of the communication pipe.

Where road and / or drain crossing is required, suitable GI ducting should be provided to accommodate the communication pipe.

18.0 CONNECTION TO HDPE PIPE

18.1 Connection to HDPE Pipe

Connections to HDPE pipe shall vary according to size. Large branch connections are usually effected by standard tees, while medium sizes are effected by branch saddles. Other communication pipe connections (< 63mm) are usually affected by electrofusion saddles.

Electro-fusion saddles have a self-tapping ferrule system whereby the cutter forms an integral part of the ferrule connection and after withdrawal remains within the ferrule head.

Self-tapping ferrules may be electro-fusion jointed on to "live" mains.

18.2 Connection to Pipes of Other Materials

HDPE communication pipes may be connected to pipes of other materials such as AC, UPVC, MS etc. The use of standard under pressure tapping machine are necessary for connection to "live" mains.

Saddle straps are usually required for tapping to AC and uPVC pipes, while traps may also be required for MS pipes.

19.0 JOINTING OF SERVICE PIPES

19.1 Jointing of HDPE Service Pipes

Butt fusion is not normally considered appropriate for the smaller sizes of pipes i.e. < 63mm. The usual method of jointing service pipes is by using electro-fusion couplers

19.2 Jointing of Dissimilar Service Pipes

Where dissimilar service pipe material are to be joined (e.g. when replacing a section of metallic pipe with HDPE), special joint adapters are necessary. Two (2) types of adapters commonly used are:

- Transition electro-fusion couplers

Care should be taken to ensure that all pipe jointing is adopted in accordance with the manufacturer's recommendations.

19.3 Testing and Commissioning of Service Pipes

These requirements will be in accordance with the standard procedure laid down by the water authorities. These standards will normally require, as a minimum, the adequate flushing of the service pipes and the testing of all pipes and joints to the maximum head to which the system is to be subjected.

20.0 REPAIR METHODS

Whilst repairs to burst mains and services are usually carried out in difficult and dirty conditions, every effort should be made to keep all pipe and joint surfaces clean and the working area as dry and uncontaminated as possible through the operation.

The completed repair should be examined and approved under working conditions before re-bedding, side filling and backfilling take place. Special attention should be given to the replacement and compaction of suitable material under and around the repair.

20.1 Repairs to HDPE Pipe

20.1.1 General

The extent of the pipe defect or fracture should be determined to ensure that the remainder of the pipe has not been weakened or damaged in any way. The inspection should also ascertain the extent to which the bed and surround may have been disturbed in the vicinity.

When repairing a burst it is recommended that a short length of pipe (say 1 meter) on each side of the damaged, since the defect may extend on the inner surface of the pipe.

20.1.2 Emergency Repairs

The emergency temporary repair of a HDPE pipe may be carried out by using a split collar in the normal way but a more permanent repair should be undertaken as soon as possible.

20.1.3 Permanent Repairs Using Fusion Joints

Butt fusion jointing is not usually a practical approach in repairing a burst pipe in trench. However, electro-fusion couplers are more commonly used for repair of HDPE pipes.

The repair of a HDPE pipe requires the defective length to be carefully cut out and replaced by a measured length of HDPE pipe. It is important that the replacement pipe is of the same pressure class.

The electro-fusion couplers, after removing the central stopper, may be slipped over the existing pipe ends and fusion joints made. Care must be taken to ensure all ends are cut square and dry and clean prior to jointing. Marking of the pipe will ensure that the coupler is placed centrally over the joint.

Small leaks on HDPE pipe may be repaired by attaching an undrilled electrofusion saddle over the hole of the pipe.

20.1.4 Permanent Repairs Using Mechanical Joints

Another alternative means of jointing the replacement pipe is by means of a special mechanical type repair clamps in accordance with the manufacturer's recommendations.

Mechanical fittings are encouraged for site repair.

20.1.5 Repairs to HDPE Service Pipe

The repair of a HDPE service pipe requires the defective length to be carefully cut out and replaced by a measured length of pipe of the same pressure class using electro-fusion or mechanical end-load resistance couplers.

Small breaks may be repaired using electro-fusion saddle.

There is a wide range of mechanical repair couplers for service pipes. In all cases the manufacturer's recommendations should be followed.

20.1.6 Squeeze-Off Closure Technique

Isolating HDPE pipelines by forcibly pinching or squeezing the walls together is an effective method used in many repair situations where it may be inconvenient and / or expensive to close down and empty pipelines.

The squeeze-off technique involves applying pressure to the outside walls of the pipe across a diameter using two tangential bars. The bars are forced together, collapsing the pipe until a seal is formed by the upper and lower walls meeting.

Squeeze clamps are available for pipe up to 180mm. The following recommendations are given for the use of the squeeze-off technique:

- Only specially designed equipment should be used with correct stops to avoid over compression of the pipe.
- Do not use within 5 pipe diameters of a fitting, fusion joint or a previous squeeze-off operation.

On release of the squeeze the pipe should be:

- Inspected and re-rounded if necessary
- Renewed if there is any indication of damage
- Adequately marked and recorded.