13-SDMS-03

REV. 00

SPECIFICATIONS

FOR

TELECOMMUNICATION DUCTS AND DUCT ACCESSORIES

CONTENTS

1 Objectives

The aim of this document is to provide information on the Multi Bundled (Mini & Micro) HDPE Ducts used for the construction of underground duct system for fiber optic cables in the outside plant (OSP) for SEC FTTX access network, and Double Wall Corrugated Duct (DWC) for long haul shall be used as optional, if required. They are intended to be installed by direct-buried in a normal SEC specified trench in green field or Mini-trench in brown field at SEC standard depths. The proposed Multi Bundled (Mini & Micro) HDPE Ducts & DWC Duct are intended for housing of fiber optic cables installed by traditional pulling and blowing techniques.

2 Scope

This document specifies the minimum technical requirements for design, engineering, construction, manufacture, inspection, testing and performance of High Density Polyethylene (HDPE) ducts and their accessories to be supplied to Saudi Electric Company (SEC) for FTTX access network deployment.

3 Applicable codes & standards

This Distribution Material Standard Specification shall be read in conjunction with the latest revision of Distribution General Specification titled "01-SDMS-01, Rev 01" which shall be considered as an integral part of this standard.

The latest revision/amendments of the following codes and standards shall be applicable for the equipment/material covered in this Distribution Material Standard Specification. In case of any conflict, the vendor/manufacturer may propose equipment/material conforming to one group of industry codes and standards quoted hereunder without jeopardizing the requirements of this standard specification.

- ISO 9001:2008 Quality management system
- ISO 12162 Standard for Thermoplastics Materials for pipes and Fittings for pressure applications
- ISO/TR 10358 High density polyethylene pipes and fittings – Combined Chemical resistance Classification Table
- DIN 8074 Polyethylene (PE) Pipes - Dimensions.
- DIN 8075 Polyethylene (PE) Pipes –General quality requirements and testing.
- ASTM D 1525 Test Method for Vicat Softening Temperature of Plastics
- ASTM D 1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
- ASTM D 1473 Standard Test Method for Slow Crack Growth - Polyethylene Notch test.
- ASTM D 1603 Test Method for Carbon Black in Olefin Plastics
- ASTM D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe &

Fittings.

- ASTM D 256 Test Method for Tensile Properties of Plastics
- ASTM D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics
- ASTM D 638 Test Method for Determining the Pendulum Impact Resistance of Notched Specimen Plastics.
- ASTM D 746 Test Method for Brittleness Temperature of Plastics
- ASTM D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- ASTM D 1238 Plastometer Test Method for Flow Rates of Thermoplastics by Extrusion
- ASTM D 2240 Test Method for Rubber Property – Durometer Hardness
- ASTM D 2837 Test Method for obtaining Hydrostatic Design Basis for Thermoplastic pipe material.
- ASTM D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- ASTM F 2160 (HDPE) Standard Specification for Solid Wall High Density Polyethylene Conduit Based on Controlled Outside Diameter (OD).
- ASTM F 2176 Polyethylene Standard Specification for Mechanical Couplings Used on Conduit, Duct and Inner-duct
- Telcordia GR-356 Generic Requirements for Telecommunications Conduit, Inner-duct, Duct and Accessories

4 Definitions and abbreviations

- DWC Double Wall Corrugated Ducts
- Mini Ducts Ducts which available sizes, with OD of 20 mm and above.
- Micro Ducts Ducts which available size, with OD of below then 20 mm.
- HDPE High Density Polyethylene
- MRS Minimum Required Strength
- SDR Standard Dimensional Ratio
- PN Nominal Pressure (Bar)
- ID Inside Diameter
- OD Outside Diameter

5 Requirements

5.1 General requirements

5.1.1 The Multi Bundled (Mini & Micro) HDPE Ducts & DWC with its accessories shall be compatible with the latest installation standards and maintenance practices for the telecommunication's duct system.

5.1.2 The High Density Polyethylene (HDPE), used for the manufacturing of Multi Bundled (Mini & Micro) Ducts & DWC, which shall be of high quality PE100 and virgin raw materials. Recycled HDPE shall NOT be accepted.

5.1.3 Any alternative proposals for Type and Acceptance Testing will be subject to technical evaluation by SEC with regards to satisfactory compliance with the material and product qualities implied by this specification.

5.1.4 The HDPE Ducts, to be supplied in specified sizes and configurations, categorized as Multi Bundled (Mini & Micro) HDPE Ducts & Double Wall Corrugated Ducts (DWC).

5.1.5 The HDPE Ducts supplied with built-in sub-ducts or inner-ducts, shall be flexible and easy to install.

5.1.6 The (Mini & Micro) HDPE Ducts shall have inner and outer surfaces that are clean and free from grooves, cracks, blisters, shrink holes or any other defects or foreign matters, which might impair the blowing performance of the ducts installed.

5.1.7 The (Mini & Micro) HDPE Ducts shall be acceptably rounded to support maximum blowing distance. It shall be supplied with its ends neat, smooth and cut cleanly at right angles or perpendicular to the axis of the ducts.

5.1.8 The HDPE Ducts shall be highly resistant to all kinds of corrosive liquids, aggressive media and chemicals usually found in the ground.

5.1.9 The HDPE Ducts shall have no requirement for end load restraint for fusion weld system.

5.1.10 The HDPE Ducts shall be flexible and ducts shall contain correct type of quoting for protection against Ultra Violet (UV) degradation.

5.1.11 The Multi Bundled (Mini & Micro) HDPE Ducts & DWC and its accessories shall be unaffected by all kinds of corrosive liquids and other compounds which exist in the underground system.

5.1.12 All material used in the HDPE Ducts shall be non-toxic and dermatologically safe.

5.1.13 The manufacturing of the HDPE Ducts shall take place in a production environment which is ISO certified in accordance with the ISO 9001:2008 for quality management system.

5.2 Long term performance requirements

5.2.1 The HDPE Ducts supplied in compliance with this specification shall be capable of withstanding the typical service conditions of the Kingdom of Saudi Arabia for a period of fifty (50) years without detriment to the physical characteristics of the products.

5.2.2 The HDPE Ducts shall be designed, manufactured by virgin raw materials only and packaged so that the physical characteristics shall not degrade when exposed to the environmental conditions of Saudi Arabia and the expected environmental conditions during storage and transportation outside of the Kingdom. The environmental conditions of Saudi Arabia may include ambient air temperature variations from -10°C to +55°C. In addition, direct solar radiation is known to increase the temperature of some outside plant to approximately 70°C.

5.3 Design requirements

5.3.1 The minimum & maximum ambient temperature shall be -10°C to +70°C

5.3.2 The HDPE Ducts, shall be designed to offer proper protection, rendering it suitable for installation in different environments as per the specifications stated in Sections 5.2.2.

5.3.3 Multi Bundled (Mini & Micro) HDPE Ducts & DWC Ducts requirements

5.3.3.1 The Plain HDPE Ducts shall be supplied according to the requirements specified below.

5.3.3.2 Multi Bundled (Mini & Micro) HDPE Ducts & DWC Ducts :

a) Material : PE 100 High density polyethylene (HDPE), as virgin raw material

b) Multi Bundled (Mini & Micro) HDPE Ducts & DWC Duct, Dimensions (DIN 8074), See Table 1.

Table 1 – Multi Bundled (Mini & Micro) HDPE & DWC Ducts Dimensions

Multi Bundled Mini Duct				Duct inside Bundle			
Type	**Mini Duct**	**OD**	**Sheath**	**OD**	**ID**	**Sheath**	**SDR**
1	7 way 25/20 mm	78	1.5	25	20	2.5	11
2	7 way 20/16 mm	63	1.5	20	16	2	10
Multi Bundled Micro Duct				**Duct inside Bundle**			
Type	**Micro Duct**	**OD**	**Sheath**	**OD**	**ID**	**Sheath**	**SDR**
3	4 way 12/8 mm	26	1	12	8	2	6
Double Wall Corrugated (DWC) Duct				**Duct inside Bundle**			
Type	**DWC Duct**	**OD**	**DWC Sheath**	**OD**	**ID**	**Sheath**	**SDR**
4	4 way 32/28 mm	77	10	32	28	2	16

5.3.4 Multi Bundled (Mini & Micro) HDPE Duct and DWC Duct

5.3.4.1 Four type of HDPE multi bundled ducts are being specified, two types of them will be (7 way) third type will be (4 way) and fourth type will be DWC

Ducts with 4 way subducts as per dimension & configurations specified in clause no. 5.3.4.2, 5.3.4.3, 5.3.4.4 and 5.3.4.5.

5.3.4.2 **Type 1-Multi bundled duct (7 way):** Seven units of mini-ducts with 25 mm OD and 20 mm ID, inside a 78 mm OD HDPE standard-ducted sheath, with respective dimensions specified in Table-1, and as illustrated in Appendix 8.1 (a).

5.3.4.3 **Type 2-Multi bundled duct (7 way):** Seven units of mini-ducts with 20 mm OD and 16 mm ID, inside a 63 mm OD HDPE standard-ducted sheath, with respective dimensions specified in Table-1, and as illustrated in Appendix 8.1 (b).

5.3.4.4 **Type 3-Multi bundled duct (4 way):** Four units of micro-ducts with 12 mm OD and 8 mm ID, inside a 26 mm OD HDPE standard-ducted sheath, with respective dimensions specified in Table-1, and as illustrated in Appendix 8.1 (c).

5.3.4.5 **Type 4-Double Wall Corrugated Duct (with 4 way subduct):** Four units of mini-ducts with 32 mm OD and 28 mm ID, inside a 77 mm OD DWC Duct standard-ducted sheath, with respective dimensions specified in Table-1, and as illustrated in Appendix 8.2.

5.3.4.6 OD Tolerances: ± 0.5 percent (maximum) of Nominal values.

5.3.4.7 Color of Multi bundled Ducts outer sheath:

- 78 mm ducted sheath: Green color outer jacket with four equally spaced Yellow stripes.
- 63 mm duct: Blue color outer jacket with four equally spaced Yellow stripes.
- 26 mm duct: Orange color outer jacket with four equally spaced Yellow stripes

5.3.4.8 Color of DWC Duct Outer sheath;

- 77 mm DWC Duct: Orange Color outer corrugated;

5.3.4.9 Color of Multi bundled sub ducts & subducts inside DWC Duct:

- **Type 1 & Type 2 Multi bundled Mini duct (7 way):** 1. Yellow, 2. Blue, 3. Green, 4. Red, 5. Grey, 6. White, 7. Orange.
- **Type 3 Multi bundled Micro duct (4 way):** 1. Yellow, 2. Blue, 3. Green, 4. Red.
- **Type 4 DWC Duct with 4 way subduct:** 1. Yellow, 2. Blue, 3. Green, 4. Red.

5.3.4.10 Supply length: 300, 600, 900 and 1200 m, unless otherwise requested or agreed.

5.3.5 Wall designs

5.3.5.1 Outer wall: Shall be smooth and free from defects.

5.3.5.2 Inner walls: Shall be with low coefficient of friction can be either smooth, permanently lubricated co-extruded layer or longitudinally ribbed with:

- Smooth-wall: The internal surface shall be smooth.
- Ribbed-wall: Ribs shall be rounded and shall not protrude into the bore by more than 0.4 mm.

5.3.6 Other design criteria

5.3.6.1 Bending: minimum permissible bending radius of Multi bundled (Mini & Micro) HDPE & DWC Ducts shall be complied with below Table 2.

Table. 2 Permissible bending radius of proposed Multi Bundled (Mini & Micro) HDPE & DWC Ducts

Multi Bundled (Mini & Micro) Duct & DWC Duct	**Recommended Field Minimum Bending Radius (Mtr)**
Bending Radius with outer sheath (Mini & Micro)	
7 way 25/20 mm	1.05
7 way 20/16 mm	0.85
4 way 12/8 mm	0.46
Bending Radius without outer sheath (Mini & Micro)	
7 way 25/20 mm	0.5
7 way 20/16 mm	0.4
4 way 12/8 mm	0.25
Bending Radius with outer sheath (DWC Duct)	
4 way 32/28 mm	1.05
Bending Radius without outer sheath (DWC Duct)	
4 way 32/28 mm	0.5

5.3.6.2 Cutting: Can be cut using either a specialized cutter, or a sharp knife or a metal or woodworking saw.

5.3.6.3 Labelling: The following information shall be clearly marked on the duct at the intervals of 1 meter throughout the whole length of the duct. The marking shall be durable, clear and distinct to the naked eye from a minimum distance of 50cm.

- HDPE Ducts Labelling Example: SEC – HDPE - PE100 - SDR code, No. of mini or micro ducts, OD/ID mm, "Manufacturer Name",

Production Year, Country of Origin, The Meter Sequential Length Markings.

5.3.6.4 Air Pressure: HDPE ducts shall be used for lower, shall be used for cable pulling and blowing with compressed air. The ducts shall withstand a minimum air pressure of 16 bars (PN16).

5.3.7 Multi bundled (Mini & Micro) HDPE ducts & DWC Duct accessories

5.3.7.1 HDPE duct jointing:

a) All of joint fittings must be compliant to ASTM F 2176.
b) The HDPE duct can be joint using the Mechanical or any equivalent technique such as fusion method.
c) The Mechanical joint fitting is installed by pushing the back nut, spring follower and rubber and iron grip-ring on to the plain pipe end, and then inserting into the socket of the filling. The back nut is then tightened by hand.
d) Shall be easily removable, once fixed.
e) No special machine required to install the fitting as shown in Appendix 8.3.
f) Joint fittings shall be designed and suitable for pulling & blown purpose.
g) Joint fittings shall be designed with various sizes to accommodate all single duct & sub duct OD sizes as 78, 77, 63 and 26 mm.
h) The connector for Mini & Micro duct with diameter of 32, 25, 20 and 12 mm or lower shall withstand a pressure of 16 bars clause 5.3.6.4.

5.3.7.2 HDPE Duct & DWC Sealing Plug: Used for sealing the duct ends before cable installation, prevents ingress of dirt, water, moisture, insects etc. As shown in Appendix 8.3.

5.4 Material Properties and Type Test Method

5.4.1 The HDPE ducts & DWC Duct shall meet all the material properties and test methods as specified in ASTM F2160 as listed in Table 3 below, with customized sizes and dimensions to metric measurements (DIN 8074) as mentioned in Table 1 above.

Table 3 – Material Properties & Test Methods

Clause	Properties	Requirements	Type Test Method
5.4.1.1	HDPE Raw Materials	HDPE PE100-, Silicore (inner lubricated) Virgin Raw Material Only	
a)	Primary properties	Identified by ASTM D3350 with	ASTM F2160

Clause	Properties	Requirements	Type Test Method
		Minimum Cell Classification Limits of PE 345440 C/E.	
5.4.1.2	Material Primary Properties		
a)	Density (Compound)	0.941 to 0.955 g / cc (Cell 3 or 4 as per ASTM D3350)	ASTM D 792
b)	Melt flow index at 19° C /2.16 Kg	< 0.15 g/10min (Cell 4 as per ASTM D3350)	ASTM D 1238 E
c)	Flexural Modulus	552 - < 1103 MPa (Cell 4 or 5 as per ASTM D3350).	ASTM D 790
d)	Tensile Strength	21 - <24 Mpa (Cell 4 as per ASTM D3350)	ASTM D 638
e)	Slow Crack Growth Resistance (10% Igepal)	F20 >600 hours ESCR per ASTM D 1693 Condition C; or >10 hours per ASTM F 1473 PENT. (Cell 4 as per ASTM D3350)	ASTM D 1693 ASTM F 1473
f)	Hydrostatic Design Basis	Not Pressure Rated (Cell 0 as per ASTM D3350)	ASTM D 2837
g)	Color and UV resistance	C - Black with 2% Min. Carbon Black. E - Colored with UV stabilizer. Note that Carbon black content, 2.25 ± 0.25 % as per ASTM D1603	ASTM D 3350
h)	Other	All values at 23° C unless specified otherwise.	-
5.4.1.3	Physical Properties		
a)	Induction Temp (DSC)	220 °C	ASTM D 3350
b)	Poisson Ratio	0.45	-
c)	Izod Impact (Notch)	> 2.5 ft.lb/in	ASTM D 256
d)	Co-efficient of friction	<= 0.15	Telcordia GR-356
e)	Ovality	(prior to bundling or coiling) % Ovality = [(ODmax – ODmin) / (ODmax + ODmin)] ×100 < 5%	ASTM D 2160

Clause	Properties	Requirements	Type Test Method
5.4.1.4	Mechanical Properties		
a)	Tensile Strength (Break)	(50 mm/Min.) 38 MPa	ASTM D 638
b)	Tensile Strength (Yield)	(50 mm/Min.) 25 MPa	ASTM D 638
c)	Elongation at break (ultimate)	> 600 %	ASTM D 638
d)	Hardness	> 60 Shore "D"	ASTM D 2240
e)	Pressure	PN16	-
f)	Roundness/Bullet Test for	For each drum or coil for 12/8mm, Mini-duct a bullet with diameter of 85% (min) of the ID will pass through the Mini-duct.	-
5.4.1.5	Thermal Properties		
a)	Brittle Temperature	<-100 °C	ASTM D 746
b)	Vicat Softening Temp	127 °C	ASTM D 1525
c)	Co-efficient of Linear Thermal Expansion	0.2 mm/m °C	ASTM D 696
d)	Specific Heat	2.7-2.9 kj / kg °k	Calorimetric
e)	Thermal conductivity	0.38 W/m. °C	DIN 52612
5.4.1.6	Chemical Properties		
a)	Chemical Resistance	Resistant to hydrous solutions of acids, alkalis and salts as well as To a large number of organic solvents.	DIN 8075 supplement 1 ISO/TR 10358

6 Routine Test

6.1 Manufacturer shall provide complete routine test certificate for following tests conducted in routine for offered Multi bundled (Mini & Micro) HDPE Ducts & DWC Duct as under:

a) Visual inspection on outer and inner surface
b) Dimensions – Diameter and thickness
c) Tensile strength and elongation
d) Reversion test
e) Environmental stress crack resistance
f) Impact strength
g) Crush resistance

h) Mandrel test
i) Quality test
j) Coil test
k) Oxidation induction test
l) Hydraulic characteristics
m) Internal coefficient of friction

7 Packing and shipping

7.1 Packing

7.1.1 The Multi bundled (Mini & Micro) duct & DWC Duct should be supplied in steel reels to protect the HDPE from damage during handling, storage and transportation.

7.1.2 Drum lengths as mentioned in Clause 5.3.4.8. Different cut lengths per drum must be available when requested.

7.1.3 If the duct stored in open area (for a short time only) must be protected from direct sunlight or heat and must not be in contact with hot surfaces.

7.1.4 The HDPE duct accessories shall be sufficiently packaged in a carton box to be protected from damage during handling, storage and transportation.

7.1.5 The individual packages of HDPE duct accessories shall be multi-packed in a strong carton box suitable for shipping, handling and storage, to a maximum weight of 25 Kg.

7.2 Marking

7.2.1 Multi bundled (Mini & Micro) HDPE duct & DWC Duct

The Multi bundled (Mini & Micro) Ducts & DWC Duct reels shall be tagged with weather tight plastic-covered cards with the following information in Arabic and English, on both sides of the reel:

a) SEC Saudi Electric Company.
b) HDPE/DWC <diameter>mm OD duct (Name of the item according to Table-1).
c) MIC Number
d) Length in meter.
e) Country of Origin.
f) Manufacture name or trademark.
g) Month & Year of manufacture.
h) P.O No.

7.2.2 Multi bundled (Mini & Micro) HDPE duct & DWC Duct accessories

Each individual crate and carton shall be marked in legible color with the following information, in Arabic and English, on at least two sides of the package and the carton box.

a) Saudi Electric Company (SEC), Saudi Arabia.
b) Name of the item
c) No. of pieces in package/carton box.
d) MIC Number
e) Country of Origin.
f) Manufacturer's Name or Trademark.
g) Month and Year of Manufacture
h) P.O No.

7.2.3 SEC Standard (editable) Name and MIC Numbers

7.2.3.1 SEC Standard (editable) Name and MIC Numbers for HDPE Bundled Ducts & DWC Duct.

No.	Name of Item	Unit	MIC No.
1	Multi bundled (Mini) HDPE Ducts with 78 mm OD with Pre-installed with 7 X 25 mm Mini-ducts, (Seven units of mini-ducts with 25 mm OD and 20 mm ID, inside a 78 mm OD HDPE jacket sheath)	Meter	
2	Multi bundled (Mini) HDPE Ducts with 63 mm OD with Pre-installed with 7 X 20 mm Mini-ducts, (Seven units of mini-ducts with 20 mm OD and 16 mm ID, inside a 63 mm OD HDPE jacket sheath)	Meter	
3	Multi bundled (Micro) HDPE Ducts with 26 mm OD with Pre-installed with 4 X 12 mm Mini-ducts, (Four units of micro-ducts with 12 mm OD and 8 mm ID, inside a 26 mm OD HDPE jacket sheath)	Meter	
4	Double Wall Corrugated Ducts with 77 mm OD with Pre-installed with 4 X 32 mm Mini-ducts, (Four units of mini-ducts with 32 mm OD and 28 mm ID, inside a 77 mm OD DWC HDPE jacket sheath)	Meter	

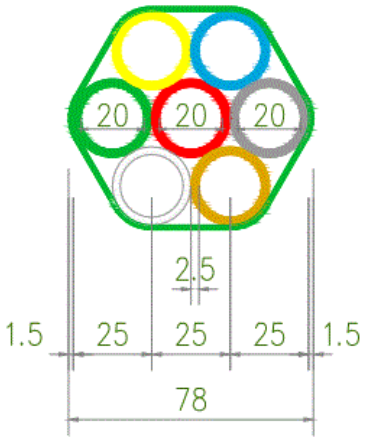
7.2.3.2 HDPE Duct & DWC Duct Accessories

No.	Name of Item	Unit	MIC No.
1	Couplers PN 16 Inner different Duct (Mini & Micro) & DWC sub duct dia	Each	
2	End Caps as per standard (Mini & Micro) Duct Dia.	Each	
3	End Plugs as per standard (Mini & Micro) Duct dia.	Each	

8 Appendix

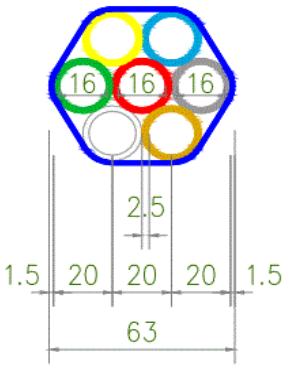
8.1 Multi bundled (Mini & Micro) HDPE Ducts

(a)



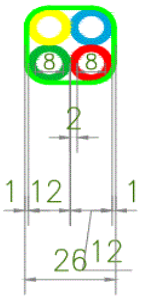
7 way 25/20mm

(b)



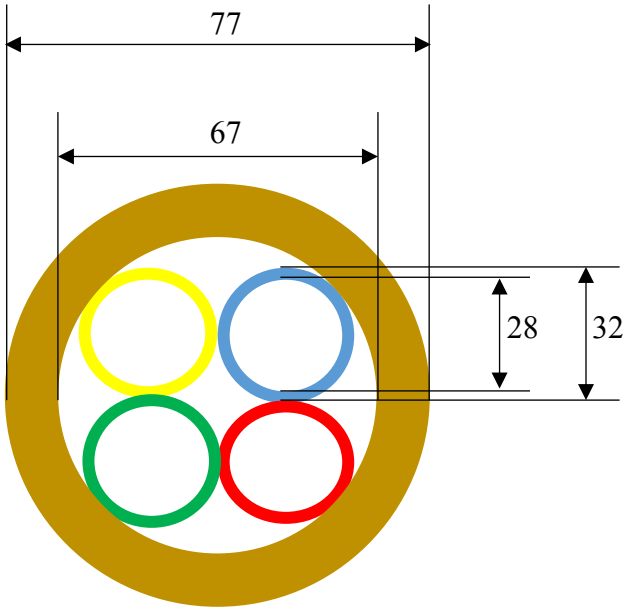
7 way 20/16mm

(c)



4 way 12/8mm

8.2 Double Wall Corrugated Duct (DWC) with 4 way 32/28 mm subduct



8.3 HDPE Duct & DWC Duct Accessories

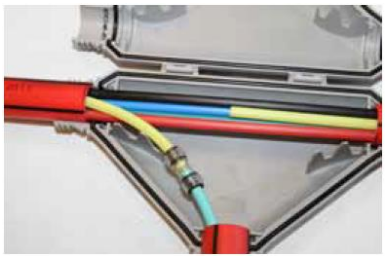
Push Fit Couplers

Reducer Coupler

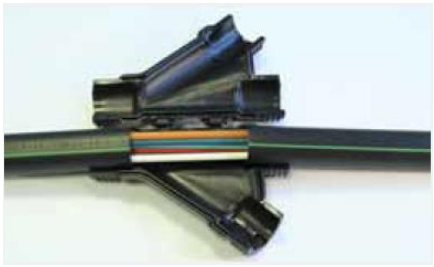
HDPE Duct sealing plugs / end cap

Tools

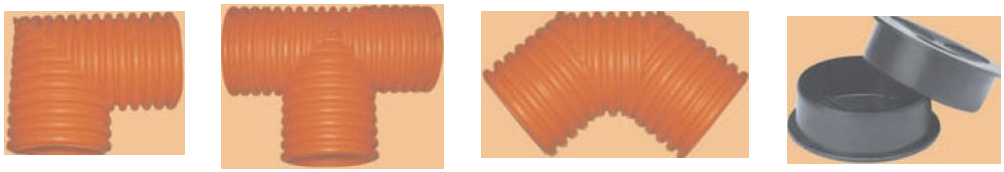
T-Enclosure



YEnclosure

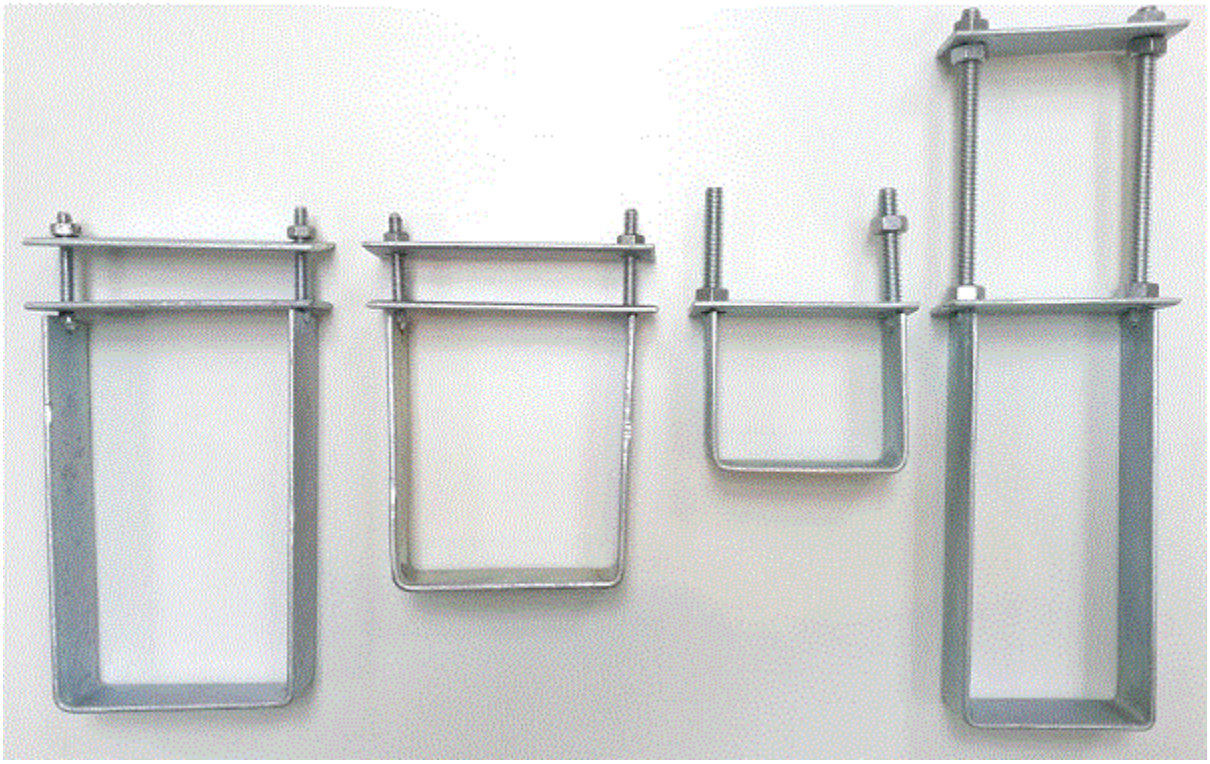


DWC Duct accessories, sealing plugs / end cap



Elbows T-joints Bends End Caps

8.4 Mild Steel Galvanized Metallic spacers for Multi-bundled Ducts



TECHNICAL DATA SCHEDULE

Enquiry No. _____ Item No. _____

Sr. No	Description	Specification Requirement	Specified Values	Vendor Proposed Values
A	**Raw Material**			
1	Density (Base)	0.941 to 0.955 g/cc	*	
2	Melt Flow Rate	< 0.55 g/10mins @190 Deg C & 2.16 Kg load	*	
3	Tensile Strength	≥ 21 N/mm2	*	
4	Induction temp (DSC)	220 Deg C Minimum	*	
B	**Multi bundled mini duct / Micro Duct / DWC Duct**			
1	Workmanship	The sheathing shall have smooth outer surface free from cracks, holes & other defects.	*	
2	Color	As per clause 5.3.4.7, 5.3.4.8 & 5.3.5.9	*	
3	Outer Sheath Thickness (Mini & Micro Ducts)	1.0 ± 0.2mm	*	
4	Outer Sheath Thickness (DWC Ducts)	10.0 ± 0.2mm	*	
5	Bending	Bend radius minimum shall be 30 times OD at temperature 20 Deg C. There shall be no kink.	*	

C	**Test on HDPE Silicore Duct**			
1	Visual Appearance	Co-extruded inner smooth layer of solid permanent lubricant Silicore and smooth outside surface, free from blisters, shrink holes or any other defects or foreign matters, which might impair the blowing performance.	*	
2	Colour	As per clause 5.3.4.7, 5.3.4.8 & 5.3.5.9	*	
3	**Dimensions of Duct**			
	Outer Diameter	As per Table 1	*	
	Inner Diameter	As per Table 1		
	Wall Thickness	As per Table 1	*	
4	Ovality (prior to coiling/ bundling)	< 5%	*	
5	Bending	Minimum permissible bend radius 30 times OD at temperature 20 Deg C.	*	
6	Co-efficient of friction	≤ 0.06	*	
7	Tensile Strength at Yield	≥ 20 MPa	*	
8	Elongation at Break (ultimate)	≥ 400 %	*	
9	Hardness	≥ 60 Shore "D"	*	