CUBIS SYSTEMS
A CRH COMPANY

MULTIduct™ Cable Protection

Material & Product Properties

www.cubis-systems.com
technical@cubis-systems.com

V2.7 08/07/2020

BRIEF

The purpose of this document is to provide product characteristics and key material properties for the black High Density Polyethylene (HDPE) MULTIduct™ product range.

CONTENTS

1. GENERAL

General properties of the material used to manufacture MULTIduct™.

- HDPE
- UV Stabilised (2% Carbon Black)
- Classed as Non-Hazardous to the Environment
- Fully Recyclable - Commodity Polymer (Recycling Symbol: 2)
- Parts produced from up to 100% recycled HDPE
- Halogen Free

2. MECHANICAL CHARACTERISTICS

Key mechanical properties of the material used to manufacture MULTIduct™, from both in house tests and generically known values.

Characteristic	Test Method	Value
Tensile Strength	ISO 527	22 - 26 MPa
Young's Modulus	ISO 527	>800 MPa
Flexural Modulus	ISO 178	800 to 1100 N/mm^2
Notched Izod Impact Strength	ISO 180 - 1A	4 to 6 KJ/m^3
Density	ISO 1183-1	0.955 to 0.958 g/cm^3

3. THERMAL CHARACTERISTICS

Relevant thermal properties of the material used to manufacture MULTIduct™, from both independent third party tests and generically known values.

Characteristic	Test Method	Value
Thermal Conductivity (K-Factor)*	ASTM E1530-11 at 23°C	0.34 $W{\cdot}m^{-1}{\cdot}K^{-1}$
Thermal Resistance (R-Value)*	ASTM E1530-11 at 23°C	0.0091 $m^2{\cdot}K{\cdot}W^{-1}$
Thermal Conductivity (K-Factor)*	ASTM E1530-11 at 60°C	0.33 $W{\cdot}m^{-1}{\cdot}K^{-1}$
Thermal Resistance (R-Value)*	ASTM E1530-11 at 60°C	0.0096 $m^2{\cdot}K{\cdot}W^{-1}$
Melt Temperature (DSC)	ASTM D3418	+120 to +131 °C
Glass Transition Temperature (DSC)	ASTM D3418	-120 to -110 °C
Service Temperature		-40 to +80 °C
Vicat Softening Temperature	ASTM D1525	+112 to +121 °C
Coefficient of linear thermal expansion	ISO 11359-2	161 x 10-6 m/m.°C
*Test Performed: Resistance To Thermal Transmission Of Materials By The Guarded Heat Flow Meter Technique		

4. ELECTRICAL CHARACTERISTICS

Relevant electrical properties of the material used to manufacture MULTIduct™, conducted by an independent third party. HDPE is a Non-Polar Polymer.

Characteristic	Test Method	Value
Dielectric Strength	ASTM D149-09 (2013) Method A, Short-Time Test	> 462 V/mil
Dielectric Breakdown Voltage	ASTM D149-09 (2013) Method A, Short-Time Test	83.2 kV
Note: ">" indicates no burn through - the electricity arced around the edge of the specimen near the voltage limit of the instrument. Test Performed: Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies		
Dielectric Constant	ASTM D150-11 at 1 MHz	2.27 K
Dielectric Constant	ASTM D150-11 at 1 KHz	2.27 K
Test Performed: A-C Loss Characteristics and Permittivity (Dielectric Constant) using a Guarded Parallel Plate Electrode Type		
Surface Resistivity	ASTM D257-14	> 5.24E+15 ohm/square
Volume Resistivity	ASTM D257-14	> 2.276.39E+15 ohm/cm
Note: ">" Means sample exceeded the measuring capabilities of the Megohmmeter. Test Performed: D-C Resistance Of Insulating Materials using a Guarded Parallel Plate Electrode Type		

5. FIRE BEHAVIOUR

Fire behavioural properties of the standard material used to manufacture MULTIduct™, from both in house tests and independent third party test houses.

Characteristic	Test Method	Value
Standard Product Supplied Solid 190x90mm Test Specimens (Unfoamed Samples)	DIN 53438-2	K2
Standard Product Supplied Full Product Test Piece (Part of similar wall thickness tested: Foamed Samples)	UL 94	HB

6. OTHER PROPERTIES

Generic properties well known regarding HDPE.

Characteristic	Test Method	Value
Chemical Resistance	-	Excellent - HDPE has excellent chemical resistance such as; ethanol, acetone, diesel etc. and is unaffected by sulphate ground conditions - See Chemicals Resistance Table in section 9 below.
Water Absorption Non-Polar Polymer	-	0.01%

7. FINISHED PRODUCT TESTS TO ENATS 12-24 MECHANICAL PROPERTY TESTS

In-house tests preformed as per mechanical test requirements outlined in the ENATS 12-24 Technical specification for plastic ducts. Includes 5% deflection test at 75°C and cold drop impact tests at -5°C.

Note: ENATS 12-24 is a technical specification for plastic ducts for buried electric cables. It has been designed to meet the requirements of the Electricity Industry and the New Roads and Street Works Act 1991 (UK) for circular section plastic ducts. Any alterations in testing to suit a square / rectangular duct (i.e. MULTIduct™) shall be highlighted.

Material: MULTIduct™ is manufactured using HDPE material, as per permitted material type in section 1 of ENATS 12-24.

Classification: Class 1 Ducts as per section 6.1 of ENATS 12-24.

Dimensions: MULTIduct™ 4, 6 and 9 way (standard) meet the requirements of Class 1 duct - 100mm nominal inside diameter. The 4 way XL MULTIduct™ (160mm) falls between the preferred values of 150 to 188mm as per table 8.1 in ENATS 12-24.

	Section	ENATS 12-24 Requirements	MULTIduct™	Meets Requirements Y/N?
Construction	9.1 (a)	Circular cross section	Square	Not circular, however it meets 100mm class 1 internal dimension requirements
	9.1 (a)	Smooth internal bore	Smooth Inner walls	Yes
	9.1 (b)	Both ends of duct shall be cleanly cut perpendicular to the central axis of the duct	Moulded in 1 m length joining sections	Yes
	9.1 (c)	The material shall be free from cracks, inclusions, delamination's or other defects	Manufacturing location has an accredited Quality Management System in place to ISO 9001.	Yes
	9.1 (d)	Any profiled structure of a cellular wall shall be complete, with no break in the cell walls	Yes	Yes
	9.1 (e)	Non-coilable duct sections shall be substantially straight	1 m moulded sections, not extruded.	Yes

7.1. ENATS 12-24, SECTION 10 - MECHANICAL PROPERTIES

Section 10.2.5 Deflection Test to 5% at an Elevated Temperature of 75°C: For Class 1 Ducts.

Products Tested	Test Criteria	Test Standard	Key Equipment Used
4 Way MULTIduct™ 6 Way MULTIduct™ 9 Way MULTIduct™ 4 Way XL MULTIduct™ Cut to 200mm lengths, top & bottom ribs removed, manufactured at least 10 days before.	Class 1 Ducts - To confirm that the MULTIduct™ product range is capable of meeting resistance to compression as per BS EN 61386-24:2010 (section 10.2) and meet the technical specification ENATS 12-24 Section 10.2.5. This test determines the force applied at 5% deflection of the product is greater than 450 Newtons after conditioning at 75°C for over 1 hour.	BS EN 61386-24:2010 (section 10.2) & ENATS 12-24 Section 10.2. For Class 1 Ducts	Universal Testing Machine (UTM) fitted with a 10KN (10,000 Newtons) load cell and flat steel compression test plates 250 * 150mm (Difference: Larger plate size than required as per section 10.2.4 in BS EN 61386-24). Large Industrial Testing Oven

SUMMARY OF RESULTS: 75°C 5% DEFLECTION TEST

Sample	Test Speed	1st Measurement Avg. (Before Test)	2nd Measurement Avg. (After Test)	Applied Force at 5% Deflection (End Strain Point)	ENATS 12-24 Permissible Force	ENATS Pass / Fail
4 Way	15 mm/min	OD: 230 x 230 mm ID: 215 x 215 mm	OD: 230 x 229 mm ID: 215 x 214 mm	Avg 7123.3 N	450 N	Pass - Class 1
6 Way	15 mm/min	OD: 230 x 343 mm ID: 215 x 323 mm	OD: 230 x 342 mm ID: 215 x 322 mm	Avg 9003.3 N	450 N	Pass - Class 1
9 Way	15 mm/min	OD: 343 x 343 mm ID: 323 x 323 mm	OD: 343 x 342.5 mm ID: 323 x 322.5 mm	Avg + 10000 N	450 N	Pass - Class 1
4 Way XL	15 mm/min	OD: 343 x 343 mm ID: 323 x 323 mm	OD: 343 x 341.5 mm ID: 323 x 321.5 mm	Avg 4857.8 N	450 N	Pass - Class 1

7.2. ENATS 12-24, SECTION 10 - MECHANICAL PROPERTIES

Section 10.3.2 Drop Impact Tests at a Min Temperature of -5°C

ENATS 12-24 Requirements: the impact energy values shall be as specified in Table 102 "Normal" column. The below table lists the relevant Class 1 requirements:

Nominal Size of Conduit (mm)	NORMAL (N)		
	Mass of Hammer (kg) *(Tolerance: +1%)*	Fall Height (mm) *(Tolerance: -1%)*	Energy (Joules)
91 - 140 mm ducts	5 kg	570 mm	28J
> 140 mm ducts	5 kg	800 mm	40J

Difference: An In-House custom drop impact test rig was used for the test, the rig has a 21.5 kg hammer, therefore the potential energy (PE) formula was adjusted to reflect this increase in mass, this resulted in a reduced drop height of 200mm, equating to a energy value of over 42 Joules, which is greater than the maximum required energy for the largest sized duct. The maximum energy value of > 42J was used for testing all MULTIduct™ sizes, including ducts that are less 140mm, as a demonstration of the products toughness.

Overall Dimension of Duct (Internal Average)	*Mass of Hammer (m)*	*Fall Height (h)*	Gravity (g)	Resultant Energy (PE)	ENATS Pass / Fail
	Kg (Tol: 0 to +1%)	(Tol: 0 to -1%)	m/sec2	Joules	
4 Way Std: 215 x 215mm	21.5 kg	200mm	9.81	42.183 J	Pass - Class 1
6 Way Std: 215 x 323mm	21.5 kg	200mm	9.81	42.183 J	Pass - Class 1
9 Way Std: 323 x 323mm	21.5 kg	200mm	9.81	42.183 J	Pass - Class 1
4 Way XL: 323 x 323mm	21.5 kg	200mm	9.81	42.183 J	Pass - Class 1

8. UV STABILITY

Independent UV stability test conducted by third party, on material used to manufacture MULTIduct™.

A foamed HDPE product (of the same material composition at the time and a similar wall thickness) was exposed to accelerated UV Exposure as per ASTM D756 Procedure A; the test consisted of a repetitive cycle of 4 hours of UV light (UVB-313 lamp) at 60°C followed by 4 hours condensation (UV light off) at 50°C for a total of 1000 hours. Weight and Shape Changes of the part was determined and the flexural strength was determined before and after exposure as per ASTM D790. This test was performed by Calcoast Analytical Materials Chemistry Lab. Note: the material formulation has since been revised to enhance the UV performance of the MULTIduct™ product.

Specimen	Average Weight Change (%)	Average Dimensional Changes (%)		
		Length	Width	Thickness
Specimens exposed to 1000 hours of Accelerated UV Exposure	-0.04	<0.05	No Change	No Change

Specimen	Average Flexural Strength (PSI)	Average Change in Flexural Strength (%)
Unexposed Specimen	1472	
Exposed Specimen	1561	6.1

9. CHEMICAL RESISTANCE

Independent chemical resistance test conducted by third party, on material used to manufacture MULTIduct™.

Three samples of foamed HDPE product (of the same material composition and a similar wall thickness) were exposed to each of the listed chemicals for 168 hours. Weight and shape changes were determined before and after exposure to the chemical reagents as per ASTM D756. This test was performed by Calcoast Analytical Materials Chemistry Lab.

Chemical Reagent	Average Weight Change (%)	Average Dimensional Changes (%)		
		Length	Width	Thickness
Acetic Acid (5%)	0.09	< 0.005	-0.61	No Change
Hydrochloric Acid (0.1N)	0.02	0.17	-1.78	No Change
Sulphuric Acid (0.1N)	0.01	-0.09	-0.35	No Change
Sodium Carbonate (0.1N)	0.06	<0.05	-0.35	-0.12
Calcium Carbonate (0.1N)	0.01	<0.05	-0.35	No Change
Sodium Chloride (5%)	0.02	-0.08	0.42	No Change
Sodium Sulphate (0.1N)	0.04	-0.06	-0.74	No Change
Sodium Hydroxide (0.1N)	0.03	< 0.05	-0.49	-0.28
Transformer Oil (Mineral Oil)	0.56	< 0.05	0.6	0.24

Specimen	Average Flexural Strength (PSI)	Average Change in Flexural Strength (%)
Unexposed Specimen	1472	
Acetic Acid (5%)	1411	4.2
Hydrochloric Acid (0.1N)	1457	1
Sulphuric Acid (0.1N)	1408	4.4
Sodium Carbonate (0.1N)	1459	0.8
Calcium Carbonate (0.1N)	1368	7.1
Sodium Chloride (5%)	1375	6.6
Sodium Sulphate (0.1N)	1353	8.1
Sodium Hydroxide (0.1N)	1433	2.4
Transformer Oil (Mineral Oil)	1452	2.3

10. INGRESS PROTECTION

Independent ingress protection test conducted by third parties, on finished MULTIduct™ products.

Six pairs of each MULTductTM size were subjected to water flows for a standard time as per IEC 60529 and BS EN 60529: 1992 + A2: 2013: Degrees of Protection provided by Enclosures. The internal voids of the products were observed to witness any ingress of water. These tests were performed by Anecto-Steris Labs and Alphatech Labs.

Sample	Gasket	IP Rating	Pass/Fail
4 Way	Yes	IPX4	Pass
	No	IPX3	Pass
6 Way	Yes	IPX4	Pass
	No	IPX3	Pass
9 Way	Yes	IPX4	Pass
	No	IPX3	Pass
4 Way XL	Yes	IPX4	Pass
	No	IPX3	Pass
4 Way Micro	No	IPX4	Pass
6 Way Micro	No	IPX4	Pass