

Flexible Fabric Innerduct (General Specification)

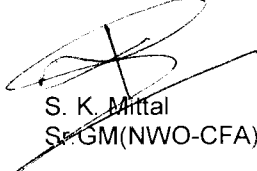
REFERENCES

INTERNATIONAL STANDARD (IS/ASTM/BELLCORE/NES/US etc..)

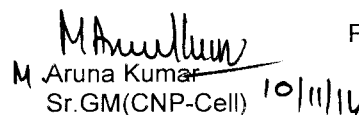
1. ASTM D4518 Standard test method for measuring Static Friction of Coating Surface Bellcore 356 4.1.5
2. Bellcore 356 4.2.5 Bending Test
3. ASTM D1693 Standard test method for environmental stress cracking of Ethylene Plastics Bellcore 356 Core 4.3.1
4. Bellcore 356 4.3.2 Hydrocarbon Resistance
5. Bellcore 356 core 5.3.5 Print Durability
6. ASTM D3418 Standard Test Method for Transition Temperature of Polymers by Differential Scanning Calorimetry
7. ASTM G21 Standard Practice for Determining Resistance Of Polymeric Materials to Fungi
8. MIL PRF 85045 F Performance Specification Cables, Fiber Optic, General specification for Halogen Content Section 3.8.2 and 4.8.2



R. C. Arya
Sr.GM(NWP-CFA)



S. K. Mittal
Sr.GM(NWO-CFA)



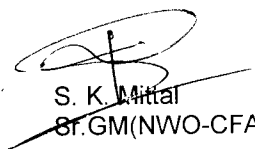
M. Aruna Kumar
Sr.GM(CNP-Cell)

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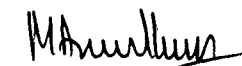
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| 9. NFS 713 | Determination of the Toxicity Index of the Products of Combustion from Small Specimens |
| 10. ASTM E662 | Specific Optical Density of Smoke Generated by Solid Materials |
| 11. ASTM D2863 | Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle Like Combustion of Plastics (Oxygen Index) |
| 12. UL 797 | Standard for Electrical Metallic Tubing Flame Test |
| 13. ASTM 4723 | Coefficient of Thermal Expansion |
| 14. ASTM D1777 | Standard Test Method for Thickness of Textile Material |
| 15. ASTM D5035 | Standard Test Method for Breaking Force and Elongation of Textile Fabrics (2 inch Strip Method) |



R. C. Arya
Sr. GM(NWP-CFA)



S. K. Mittal
Sr. GM(NWO-CFA)

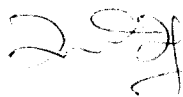


N. Aruna Kumar
Sr. GM(CNP-Cell)

10/11/14

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R. C. Arya
Sr.GM(NWP-CFA)



S. K. Mittal
Sr.GM(NWO-CFA)


N. Aruna Kumar
Sr.GM(CNP-Cell)

10/11/14

Part I. Technical Specification

1. Introduction

This document describes the Generic Requirements of Flexible Fabric Innerduct to be used for communication cable installation as an alternative to conventional rigid. The Flexible Fabric Innerduct shall be designed specifically for the deployment of communication cables in the telecommunication network.

The purpose of Flexible Fabric Innerduct is to enable safe overlay of new cables into an existing occupied duct system, or to maximize the number of cables installed in an existing empty duct system, or to maximize the number of cables installed in duct systems that are to be newly built.

2. Functional Requirement

2.1 Flexible Fabric Innerduct shall be flexible and conform to the shape of the cables placed within. This will result in greatly reducing the wasted space associated with conventional rigid innerduct. In general, Flexible Fabric Innerduct may be installed without any special tools and skilled labour, and, in most general conditions, will require only manual pulling.

2.2 Flexible Fabric Innerduct is designed to be used in existing empty ducts, newly constructed ducts, or congested occupied ducts to maximize cable density and provide duct space efficiency.

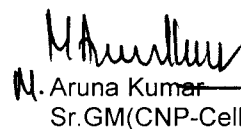
2.3 Several packs of Flexible Fabric Innerduct may be installed at the same time or each individual pack may be installed into the duct over a time period.



R. C. Arya
Sr.GM(NWP-CFA)



S. K. Mittal
Sr.GM(NWO-CFA)



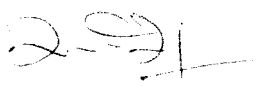
N. Aruna Kumar
Sr.GM(CNP-Cell)

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3. Technical Requirement

3.1 Materials of Construction

Fabric	Warp - Polyester Monofilament Filling - Nylon 6 Monofilament / Polyester Multifilament
565 kg pull tape (standard offering)	High Tenacity Multifilament Polyester Breaking Tensile > 565 Kg Width = 11.5 +/- 3 mm
225 kg pull tape (optional)	High Tenacity Multifilament Polyester Breaking Tensile > 225 Kg Width = 6 +/- 3 mm
815 kg pull tape (optional)	High Tenacity Multifilament Polyester Breaking Tensile > 815 Kg Width = 15 +/- 3 mm
1,125 kg pull tape (optional)	High Tenacity Multifilament Polyester Breaking Tensile > 1,125 Kg Width = 19 +/- 3 mm
MaxGlide Rope (standard offering for 3614 product line)	High Tenacity Multifilament Polyester Core Low Friction Polyethylene Jacket Breaking Tensile > 350 Kg Width = 5 +/- 3 mm Braided Construction
Lubricate	100% Polydimethyl Siloxane
Temperature Range	-30 to 100 degrees Celsius
UV Performance	Do not store unprotected in direct sunlight for more than 30 days
Length Tolerance	-0.0, +0.5%


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

3.2 Physical Properties

SI No	Physical Properties	Standard Values	Test Method
1	<u>Dynamic Coefficient of Friction</u> HDPE vs. HDPE	< 0.30	Test Method-1
2	Bending Test	PASS criteria	Test Method-2
3	Environmental Stress Cracking	PASS Criteria	Test Method-3
4	Hydrocarbon Resistance	< 7.5% Tensile Loss	Test Method-4
5	Print Durability	PASS Criteria	Test Method-5
6	Breaking Tensile	> 38 kg / cm	Test Method-6
7	Melting Point	> 215 Degrees C	Test Method-7
8	Fungi Resistance	PASS Criteria	Test Method-8
9	Halogen Content	Halogen Free	Test Method-9
10	Smoke Toxicity Index	PASS Criteria	Test Method-10
11	Optical Smoke Density	PASS Criteria	Test Method-11
12	Oxygen Index	22 to 24	Test Method-12
13	Flammability, in Electrical Metallic Tubing	PASS Criteria	Test Method-13
14	Fabric Thickness	< 0.8 mm	Test Method-15

3.3 Configuration Dimensions

Style	Max. Cable	Dimensions +/- 3 mm	Target Configuration Dimensions +/- 3 mm	Number
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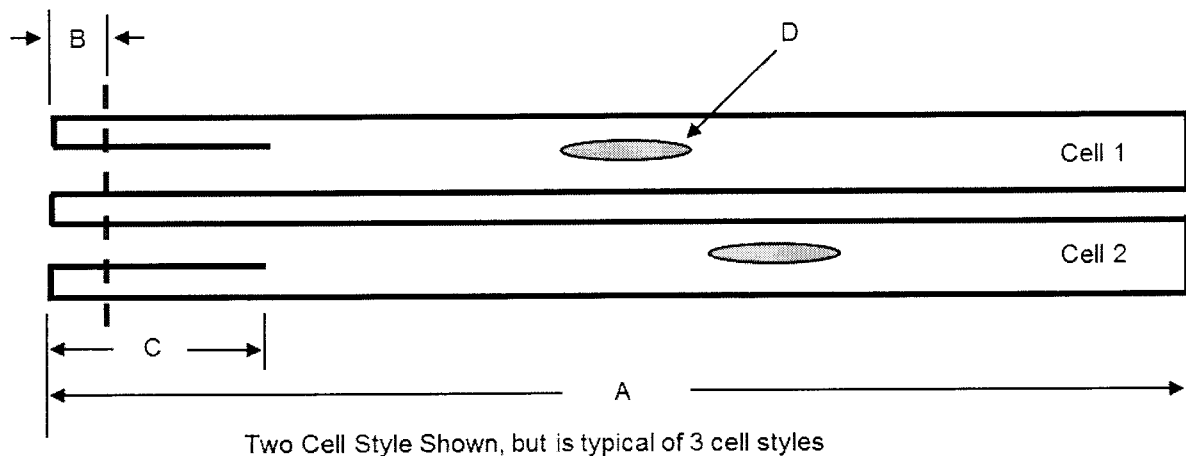

R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

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	OD, mm							of Cells
		Target Cell Circum	Target Cell Diameter	Width A	Seam B	Layer C	Pull Tape Width D	
8638-3	38	163	52	86	4	8	11.5	3
8638-2	38	163	52	86	4	8	11.5	2
6428-3	28	121	38	65	4	8	11.5	3
6428-2	28	121	38	65	4	8	11.5	2
5222-3	22	97	31	53	4	8	11.5	3
5222-2	22	97	31	53	4	8	11.5	2
3614-2	14	65	21	37	4	8	5	2
3614-1	14	65	21	37	4	8	5	1



4. Performance Test Requirements: The Flexible Fabricated inner duct will meet the following test requirements.

4.1 Coefficient of Friction Test is to be carried out as per ASTM D4518 – Standard Test Methods for Measuring Static Friction of Coating Surfaces.

Test Method-1: Procedures

a. Clamp test specimen to horizontal base, make sure specimen is set flat on the base.

R. C. Arya
Sr.GM(NWP-CFA)

S. K. Mittal
Sr.GM(NWO-CFA)

M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

- b. Set the test speed at 100 mm / min.
- c. Record force required to just begin motion of test sled – Static COF.
- d. Continue recording the force until the sled has travelled at least 150 mm – Dynamic COF.
- e. Take the average of five specimens.

4.2 Bending Test is to be carried out as per Bellcore 356 Core 4.2.5.

Test Method-2:- Bending Test Pass / Fail Criteria

- a) Test 5 specimens.
- b) Bend test specimens 180 degrees around mandrel, it should take less than 30 seconds.
- c.) Immediately pull specimen away from mandrel and straighten out, it should take less than 30 seconds.
- d) Examine specimens for cracking, kinking, buckling or splitting.

4.3 Environmental Stress Cracking Test is to be carried out as per ASTM D1693 - Standard Test Method for Environmental Stress Cracking of Ethylene Plastics Bellcore 356 Core 4.3.1.

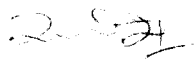
Test Method-3: Environmental Stress Cracking Pass / Fail Criteria

- a) Cut ten specimens for evaluation.
- b) Conditions specimens for 24 hours at 23 +/- 2 degrees C and 50 +/- 5% relative humidity.
- c) Place specimens in test tube filled with undiluted Igepal CO-630.
- d) Immerse all 10 test tubes in constant temperature bath for 192 hours.
- e) Examine each specimen for stress cracking.

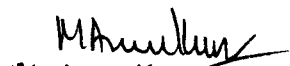
4.4 Hydrocarbon Resistance Test is to be carried out as per standard Bellcore 356 Core 4.3.2.

Test Method-4: Procedures

- a) Condition ten specimens for 24 hours at 23+/-2 degrees C and 50+/-5% relative humidity.
- b) Record the weight and dimension of each specimen.
- c) Test the breaking strength of 5 specimens according procedures detailed in ASTM D2256.
- f) Immerse remaining five specimens in a bath of Normal Heptane for 720 hours at 70 degrees "C".
- g) Stir bath every 24 hours.


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

- h) Remove specimens and allow to drain for 30 minutes then pat dry.
- i) Record the weight and dimensions of each specimen.
- j) Test the breaking strength of the 5 specimens according to procedures detailed in ASTM D2256.
- k) Calculate the average change in weight, dimension and tensile strength.

4.5 Print Durability Test is to be carried out as per test Bellcore 356 core 5.3.5.

Test Method-5: Print Durability Pass / Fail Criteria

- a) Cut a minimum of five test samples.
- b) Place test specimens in constant temperature bath for 7 days.
- c) Remove samples, drain off excess water and place in Crock meter.
- e) Using standard Crock meter cloth begin rubbing motion, finger should traverse 105 mm.
- f) Complete 200 cycles.
- g. Examine print for legibility to the unaided eye.

4.6 Tensile strength- Test is to be carried out as per ASTM D5035, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

Test Method-6: Procedures

- a) Cut five test specimens 2.5 inches wide (in filling direction) by 14 inches long (in warp direction).
- b) Condition samples 23 +/- 2 deg C and 50 +/- 5% relative humidity for 24 hrs prior to test.
- c) Set gauge width to 8 inches – as measured between upper and lower clamp.
- d) Set head speed to 4 inches per minute.
- e) Obtain product construction specification – ie number of warp ends per inch.
- f) Unravel 0.25 inches of warp yarn from each side until final width equals 2 inches and the number of warp ends is within specification.
- g) Clamp specimen in the upper and lower jaws, making sure it is centered and square with clamps.
- h) Measure breaking tensile then record.
- i) Average results of five specimens. Pass / Fail is based on average of five specimens.

4.7 Melting Point- Test is to be carried out as per ASTM D3418 - Standard Test Method for Transition Temperature of Polymers by Differential Scanning Calorimetry.


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell)

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Test Method-7: Procedures

- a) Follow software instructions for First Order Transition (melting and crystallization).
- b) Follow software instructions for Glass Transition.

4.8 Fungi Resistance- Test is to be carried out as per ASTM G21 - Standard Practice for Determining Resistance of Polymeric Materials to Fungi.

Test Method-8: Fungi Resistance Pass / Fail Criteria

- a) Cut specimens.
- b) Inoculum level 8.0×10.5^5 - 1.2×10^6 CFU per ml.
- c) Incubate for 28 days at 29 ± 1 degrees C.
- d) Observe and rate growth coverage as compared to control – None, Trace, Light, Medium, or Heavy.
- e) Replicate test a minimum of three times. Trace should be less than 10 %.

4.9 Halogen Content Test is to be carried out as per MIL PRF 85045F - Performance Specification Cables, Fiber Optic, General Specification for Halogen Content Section 3.8.2 and 4.8.2.

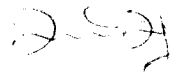
Test Method-9: Procedures

- a) Cut specimens, place in silica boat then place in silica tube furnace.
- b) Supply air through tube at a rate of 1 liter per minute.
- c) Over a 40 minute period, raise temperature of specimen to 800 ± 10 degrees C, hold temp for 20 minutes.
- d) Use selective probes to determine halogen content.
- e) Test Criteria: Maximum Halogen content 0.2%, less than 0.2% is considered "Halogen Free".

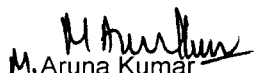
4.10 Smoke Toxicity Index Test is to be carried out as per NES 713 - Determination of the Toxicity Index of the Products of Combustion from Small Specimens.

Test Method-10: Procedures - Smoke Toxicity Index Pass Fail Criteria

Chemical Evaluated	Limit (ppm)*
Acrylonitrile	400
Ammonia (basic gases)	750


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

Carbon Dioxide	100,000
Carbon Monoxide	4000
Formaldehyde	500
Hydrogen Bromide	150
Hydrogen Chloride (acid gases)	500
Hydrogen Cyanide (hydrocyanic acid)	150
Hydrogen Fluoride	100
Hydrogen Sulphide	750
Nitrogen Oxides (nitrous fumes)	250
Phenol	250
Phosgene	25
Sulfur Dioxide	400

*Limit : concentration, in parts per million, of gas fatal to man for a 30 minute exposure time

4.11 Optical Smoke Density Test is to be carried out as per ASTM E662 - Specific Optical Density of Smoke Generated by Solid Materials.

Test Method-11: Optical Smoke Density Pass / Fail Criteria

	Limit	Result
Flaming Mode	@ Dm $\leq$ 250 @ 4 min $\leq$ 50	Within Limit
Non Flaming Mode	@ Dm $\leq$ 300 @ 4 min $\leq$ 50	Within Limit

4.12 Oxygen Index-Test is to be carried out as per ASTM D 2863 - Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle Like Combustion of Plastics (Oxygen Index).

Test Method-12: Procedures

- Test 15 specimens.
- Condition specimens for 88 hours at 23 $\pm$ 2 degrees C and 50 $\pm$ 5% relative humidity.
- Select initial concentration of oxygen and burn specimen, note burning characteristics.
- Alter oxygen concentration until specimen does not burn.

25/11
R. C. Arya
Sr.GM(NWP-CFA)

S. K. Mittal
Sr.GM(NWO-CFA)

M. Aruna Kumar
Sr.GM(CNP-Cell) 10/11/14

4.13 Flammability in Metallic Tubing- Test is to be carried out as per UL 797 - Standard for Electrical Metallic Tubing Flame Test.

Test Method-13: Procedures - Flammability in Metallic Tubing Pass / Fail Criteria

- a) Place sample in the Electrical Metallic Tubing (EMT).
- b) Support EMT enclosing in a horizontal plane under ventilation hood.
- c) Place cotton layer 280 mm below tubing.
- d) Ignite burner and adjust flame to a 38 mm high inner blue cone with an overall height of 100 mm.
- e) Position flame so that inner blue cone is in contact with EMT.
- f) Burn the tube for 60 seconds, shut off valve for 30 seconds and repeat process three times.
- g) Note and record rating.

4.14 Fabric Thickness Test is to be carried out as per ASTM D1777 - Standard Test Method for Thickness of Textile Materials

Test Method-14: Procedures

- a) Cut specimens at least 20% greater in size than the size of the gage's presser foot.
- b) Verify calibration of thickness gage, per manufactures instructions.
- c) Condition samples for 24 hours at 23 +/- 2 degrees C and 50 +/- 5% relative humidity.
- d) Measure thickness of 5 specimens and average the results.

4.16 Identification Marking

Flexible Fabric Innerduct shall be prominently marked with indelible ink, with following information at intervals of every two meters to enable visual identification. The size of the ink marking shall be distinct and easily visible.

- a) Product Style
- b) Product Name
- c) Manufacturing operator's initials and manufacturing line number
- d) Date of manufacture
- e) Length increment
- f) End user name (or initials) if requested


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)


M. Aruna Kumar
Sr.GM(CNP-Cell)

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PART II. GENERAL REQUIREMENT

5. Engineering Requirement

5.1 Flexible Fabric Inner duct shall be made of white color. The color of the duct shall be uniform throughout its entire length.

5.2 Markings on the product will be consistent with clause 4.16 with print quality mentioned in clause 4.4.

5.3 Flexible Fabric Innerduct shall be available in three thread color options. The basic color options shall be black, red, and green.

5.4 Pull tape shall have color markings of Orange, Blue, and White.

6. Reel Dimensions

Reel Name	Material of Construction		Number of Spokes	Height (cm)	Width (cm)
	Flange	Core			
315	Plywood	Fiberboard	N/A	84	36
322	Plywood	Fiberboard	N/A	84	56
415	Plywood	Fiberboard	N/A	122	36
422	Plywood	Fiberboard	N/A	122	56
615	Steel & Plastic	Steel	6	183	36
622	Steel & Plastic	Steel	6	183	56
630	Steel & Plastic	Steel	6	183	76
645	Steel & Plastic	Steel	6	183	114

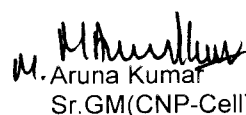
7. Quality Requirement



R. C. Arya
Sr.GM(NWP-CFA)



S. K. Mittal
Sr.GM(NWO-CFA)



M. Aruna Kumar
Sr.GM(CNP-Cell)

10/4/14

The raw material used in the manufacturing of the Flexible Fabric Innerduct shall be such that the service life of duct can be expected to be 30 years.

8. Installation Tools

8.1 Tools

The following tools are required for Flexible Fabric Innerduct installation.

- a) **Swivel (anti-twister)** A swivel shall be used for Flexible Fabric Innerduct installation to reduce the number of the twists during installation.
- b) **Scissors**
- c) **Lubricant** While Flexible Fabric Innerduct is pre-lubricated, additional lubricant may help further reduce the pulling tension during cable installation in the product.
- d) **Reel Stand** Reel stands are required to position the product's reels for installation.
- e) **Pulling Rope** Pulling rope is required to install the product.
- f) **Blowing Adaptor (for air-blowing Flexible Fabric Innerduct)** A blowing adaptor is required if Flexible Fabric Innerduct is blown into the conduit (instead of manual pulling or machine pulling)

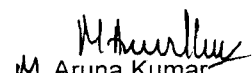
9. Acceptance Test- The acceptance test shall be carried out on samples selected from the lot supplied to the customer for dimensional and visual requirements. The requirement for Tensile strength and Melting Point shall be carried out as per clause 3.2

10. Storage- Prior to inspection all material shall be stored in the supplier's premises in such a manner it will not affect the performance of the product.

11. Packing and Delivery- Until the material reaches the store, the material shall be treated in an appropriate manner of handling to avoid damage. The material shall reach the store on a reel.


R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)
10/11/2014

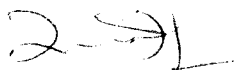

M. Aruna Kumar
Sr.GM(CNP-Cell)
10/11/14

12. ISO Certification The manufacture shall be certified with international quality standard ISO and the certification shall be provided upon request. A quality plan describing the quality assurance system shall be required to be submitted through the supplier.

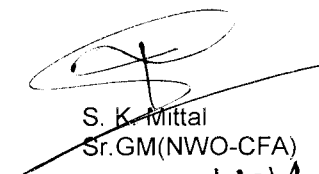
13. Cable Installation Number of cables that may be placed into a conduit.

Conduit ID (mm)	Cable OD (mm)														
	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
33	4	3	2												
50	11	7	5	4	3	2	2								
75	25	17	13	10	7	6	5	4	3	3					
100	45	31	22	17	14	11	9	7	6	5	5	4	4	3	3

Assuming pulling distance of less than 250 meters with aggregate bend angles of less than 135 degrees (minimum of 1 meter bend radius), new empty conduit in clean and undamaged condition. The number of cables placed may increase or decrease depending on the pulling distance, aggregate bend angles, bend radii, and condition of the conduit.



R. C. Arya
Sr.GM(NWP-CFA)


S. K. Mittal
Sr.GM(NWO-CFA)
10/11/2014


Aruna Kumar
Sr.GM(CNP-Cell)
10/11/14