DuraMulti DB Technical Specification

Guide for Handling and Installation of various variants
DuraMulti DB

1 Technical specification

1.1 General information

The installation performance of a blown system is dependent on many factors, including the type of installation equipment used, the compressed air flow rate, the ambient air conditions (humidity, temperature, etc.), shape of the route and the length of the route. Hence the physical characteristics of the microduct optical fibre cable, microduct fibre unit or microduct (e.g. dimension, weight, stiffness, etc.) will affect how the product performs under these varying conditions. Key installation attributes are identified in the relevant family specifications, which also contain the appropriate test methods and associated acceptance criteria based on the type of system being installed.

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1.2 Range of the product

- DuraMulti is a configuration of MicroDucts over-sheathed with a thin HDPE sheath.
- The over-sheath is designed so it can be blown or pulled into a conduit (duct) or buried directly into the ground by plowing, open trench or directional bore.
- The configuration of DuraMulti bundles can be customized for each customer installation requirement.

1.2.1 Handling

DuraMulti products are delivered in many different ways of packaging depending on customer request and product dimensions.

According to your delivery type, please refer to our Handling Guidelines below:

Big Wooden Drums DBx	*TS-GU-DB1 Drum handling*
FAST-IN Drums	*TS-GU-FI Drum handling*
Coils	*TS-GU-CO Coils handling*

1.2.2 Storing

The DuraMultiDB is fully protected with the external black sheathing which is carefully formulated to withstand temperature and UV radiation as well. The Future path when exposed to outside weathering is fully protected for a period of 10-12 months. However, to avoid permanent changes due to heat it is recommended to be stored in a shaded area. The Future paths are to be stored away from source like flame, welding or any high heat emitting source. The Storage and operating conditions are -40^{0}C to +60^{0}C the humidity of 95% is permissible.

1.2.3 Packaging

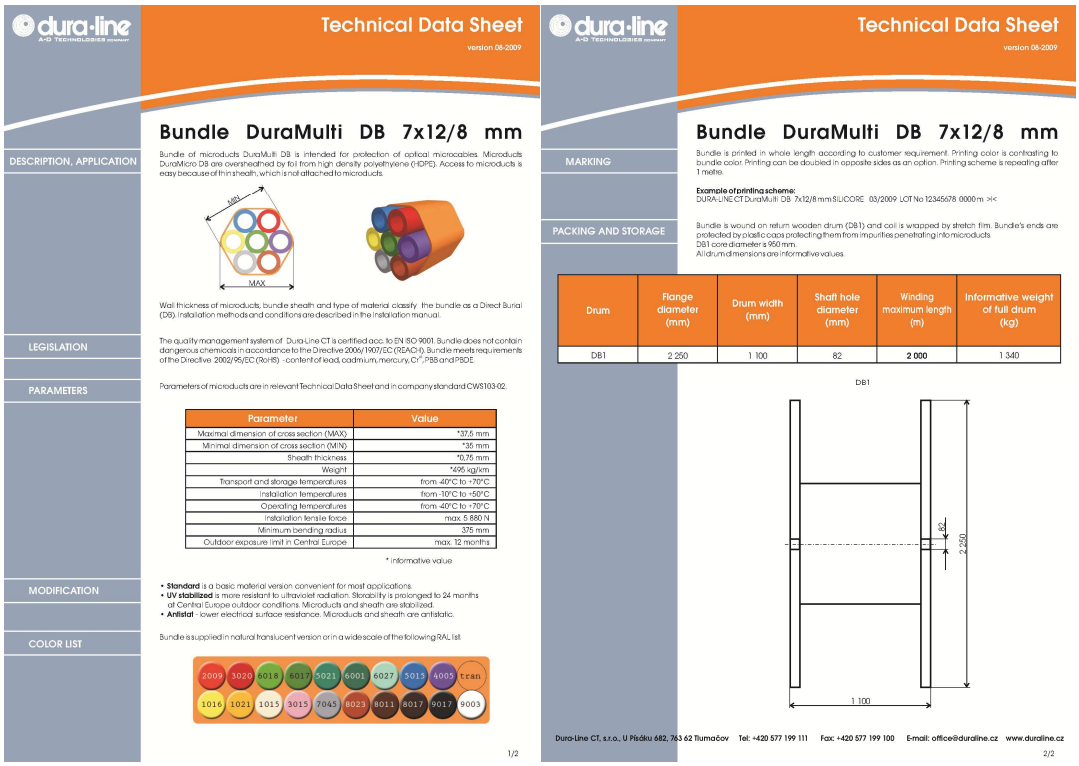
DuraMulti DB microducts are standardly wound on the big wooden drums.

Each coil is wrapped by a stretch black foil for UV protection. Microduct's ends are closed by plastic caps protecting them from impurities penetrating into microduct.

The best packaging option should be clarified with our customer support team in advance. We can offer more transport variants and customized solutions.

1.2.4 Datasheets and CWS

For each configuration of DuraMulti bundle we have controlled documentation - Datasheet and CWS. Always check availability of your configuration and read carefully technical parameters to make sure the product fully meets your requirements.



Technical datasheet example

2 Installation techniques

2.1 Laying instruction

This section discusses various DuraMultiDB installation options in general terms and should not be interpreted as a step-by-step guide or “operations manual.” The user should contact the equipment manufacturer for more detailed instruction, as operating procedures will vary with equipment.

NOTE: The consequences of striking gas or power lines (above and below ground) during installation can be dangerous, possibly deadly. Before digging, it is critical to ensure that all existing underground service lines (gas, water, power, etc.) in the vicinity are located and marked. It is recommended to contact the local “Call before You Dig” agency to ensure these provisions are made. Furthermore, prior to installation, consult any applicable local codes.

2.1.1 Trench quality

- The trench should be dug as straight, level and rock free as possible.
- Avoid curves smaller than the conduit’s allowable bend radius.
- Undercut inside corners to increase the radius of the bend. Should there be a rapid grade change, use back-fill to support the conduit.

Excavate the trench to the desired depth (follow your local standards and authorities, but never less than freezing depth), and remove all rocks and large stones from the bottom of the trench to prevent damage to the conduit. Push some clean fill (fine material, without stones) into the trench to cushion the conduit as it is installed in the trench. Supplemental trenches should be made to all offset enclosure locations. Trench intersections should be excavated to provide adequate space to make sweeping bends in the DuraMultiDB conduit. Fill the trench and compact as required. Tamp the trench to provide compaction that will prevent the trench backfill from settling.

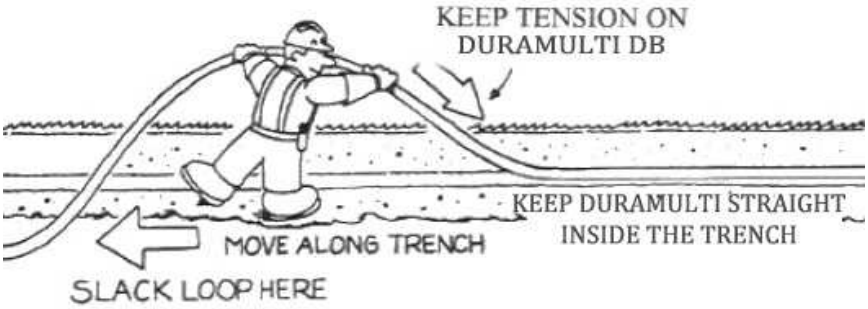
Any Rock or Stones can cause damage to DuraMutliDB. Therefore, if the soil is rocky then sand bed and cover is necessary to protect conduit against damage.

Uniformity of support and proper alignment of the pipe require a trench bottom of stable soils and free of protruding rocks. Good practice often requires over-excavation and replacement of the foundation material with a suitably-graded soil mixture to inhibit migration of fines and subsequent loss of pipe support.
Bedding is required to establish line and grade and to provide firm, but not hard, pipe support. Compacted granular material over a flat trench foundation should be spread evenly and compacted.

2.1.2 Placing DuraMultiDB into an open trench

An important consideration for open-trench installations of DurMultiDB is that the conduit should be straightened to remove any residual "shape memory" from the coil, which can create a tortuous path for the cable and cause significant challenges to cable installation afterwards. See *201010 TD - Tight bundle spiraling effect – elimination* document for further details.

Conduit placement can be accomplished by pulling the conduit into the trench from a stationary reel or by laying the conduit into the trench from a moving reel, usually attached to a trailer.
Spacers should be used when placing multiple DuraMultiDB in a trench. Spacers prevent the ducts from twisting over and around each other. By keeping the ducts in straight alignment, cable-pulling tensions are reduced. When water is present in the trench, or when using extremely wet concrete slurry, floating of the conduit can be restricted through the use of the spacers.



Unwinding

DuraMultiDB can be delivered on site either in coil or on wooden drum.
Coil must be placed on a vertical/Horizontal de-coiler (eg. FAST-IN drum) to unwind DuraMulti into the open trench. Once the trench is ready in all respects for placement of DuraMultiDB into it, straps on the coil are cut appropriately and de-coiler is slowly rotated to unwind the DuraMultiDB along the trench plane.

Preferably, DuraMulti DB is delivered on wooden drum. Installing DuraMultiDB into an open trench from a drum, following basic rules should be

followed:

- conduit should be uncoiled from the bottom and not from the top of the reel.
- During uncoiling process, decoiler should be rotated slowly to avoid overspining of reel which can result in damage to the DuraMultiDB
- DuraMultiDB can be placed into a open trench either directly from the coil or temporarily laid alongside the trench and placed later on to eliminate shape memory.

Horizontal Directional Drilling (H.D.D)
When DuraMultiDB is installed by H.D.D where open trenching is not possible / permitted, operator that is executing the laying of DuraMultiDB by H.D.D machine should refer and abide to the product specifications for maximum allowable pulling force that can be exerted on the DuraMultiDB for safe installation.

2.1.3 Tensile strength

Regardless of the installation method, mechanical stress is of great concern during conduit placement. Exceeding the maximum allowable pulling tension or the minimum allowable bending radius can damage DuraMultiDB. Read carefully TDS and CWS corresponding to your DuraMultiDB configuration for allowable pulling tensions.
During conduit pulling placement, attention should be given to the number of sweeps, bends or offsets and their distribution over the pull. Tail loading is the tension in the cable caused by the mass of the conduit on the reel and reel brakes. Tail loading is controlled by two methods. Using minimal braking during the pay-off of the conduit from the reel at times can minimize tension; no braking is preferred. Rotating the reel in the direction of pay-off can also minimize tail loading.
Breakaway swivels should be placed on the conduit to ensure that the maximum allowable tension for that specific conduit type is not exceeded. The swivel is placed between the winch line and pulling grip. A breakaway swivel is required for each conduit.

2.1.4 Ambient temperature

The DuraMultiDB bundles can be handled and buried at temperatures between -10°C and +50°C. When the temperature is below -10°C the ducts get brittle and under stress, especially under impact stress, they can crack. Storing the ducts without handling them under temperatures common in our climate (up to -30°C) no damage or deterioration of mechanical properties of the ducts will occur.

When the ducts are buried the inner wall has to be kept dry and clean. Any moisture, earth, sand and other impurity can increase the coefficient of friction between the inner wall of the duct and the cable sheath, which may cause significant reduction of the cable installation distances.

2.1.5 Bending radius

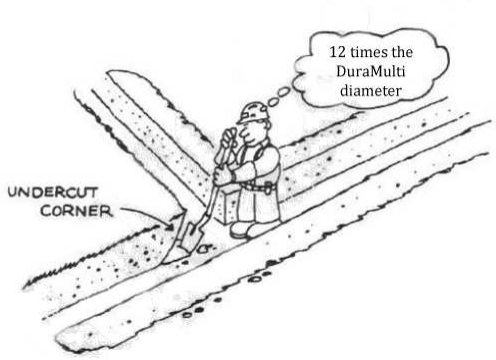
The minimum bending radius is always connected with the size of your DuraMutliDB bundle.

See the appropriate TDS of your configuration for reference. Anyway there is basic rule – never exceed the limits of:

Minimal bend radius > 10 x MAX OD

Also ambient temperature makes a difference. The lower temperature is the bigger bending radius has to be used for safe installation.

NOTE: The bigger the bending radius was applied the bigger the blowing distance will be later when blowing cable in.



Also any vertical offsets should be avoided or made as smooth as possible.

2.1.6 Labeling/Marking

If required, the microduct, protected microduct, microduct optical fibre cable and microduct
fiber unit shall be marked for identification purposes as agreed between the customer and
supplier.
It is recommended to put labels at least at:

- each access point (duct ends, manholes, handholes, distribution points etc.)
- every 3-5 meters if there is no marking on the ducts itself
- connection and branching points

2.1.7 Trench back fill

It is best to place the best quality soil directly on and around the conduit.

- **DO NOT place any rocks directly on the conduit.**
- Allow at least 2 – 4 inches (5 – 10 cm) of clean, uniform soil to cushion the conduit.
- If possible, utilize sand for padding the conduit.

It provides a more stable environment for the DuraMultiDB conduit, prohibiting damage from rocks and allowing water to drain away from conduit easily. More importantly is the protection it can provide during future excavation near your facilities. The apparent change in soil condition provides warning that there is a utility buried there. This should not replace the practice of placing warning tape, but rather should serve as a supplement.

- warning tape should be placed typically 200-300mm above the DuraMultiDB conduit.

Not only is backfill utilized to fill the trench, but it also serves a very specific design function. The main purpose of the backfill material is to provide adequate support and protection for the DuraMultiDB conduit. By ensuring the backfill is solid and continuous, damage can be prevented from surface traffic, falling rock or lifting due to the trench filling with water.

It is important that the initial backfill be consolidated to ensure continuous contact and support of the conduit.

All trenches should be backfilled as soon as practicable, but not later than the end of each working day. Also, care should be taken to protect excavated soil from collecting moisture while the trench is prepared and pipe is laid. Uniformity of the underlying soil that forms the trench bottom will avoid stress concentrations and associated irregular pipe deformations.

2.1.8 Summary – basic steps to follow

The successful performance of buried pipelines of all materials is dependent on the interest, care and attention to detail on the part of the contractor. Installation contractors should have a basic understanding of the pipe/soil composites structure. This will enable the contractor to anticipate problems that may arise from poor construction practice not otherwise recognized as such. The following are the key areas of consideration:

- Proper excavation and preparation of the trench will inhibit unanticipated longitudinal and cross-sectional strains and stresses in the pipe.
- Use Only fine soil as a backfill
- Warning tape above the conduit
- Work within material limits – respect technical specs (min. bend radius, tensile strength, ambient temperature etc.)
- Always follow your local safety rules

2.2 Cutting DuraMultiDB

Always use appropriate tools for DuraMulti bundle cutting. We recommend to use Duct Shears, Longitudinal cutter and microduct shears (see Chapter 3.2).

Never use tools creating burr, e.g. saw.

The cut of the DuraMultiDB bundle and individual microducts has to be straight right-angled for proper connection with PUSH-FIT connectors.

2.3 Inline connection

DuraMulti bundle with thin oversheath was designed for quick and easy inline or branch connections of microducts.

1. A minimum of 50cm of jacket removal is recommended for a straight or branch splice application
2. The two ends of the DuraMulti to be coupled together should overlap a minimum of 50cm after the product has been placed in open trench or manhole.
3. Mark the jacket approximately 50cm from the end.

4. Longitudinally slit the oversheath from the end at least twice on opposite sides of DuraMulti between the microducts. Work carefully not cutting into microducts.
5. Peel and cut off sheathing. Wrap the duct tape around the sheathing ends. Examine the microducts to ensure that no damage to them has occurred in the previous process.
6. Begin the coupling process by selecting one of the microducts and using microduct cutting tool. Cut one microduct a few centimeters from where the sheath ends and select appropriate microduct from the other side and cut it where the end of the previously cut microduct meet.
7. Connect the two ends together with a customer approved connector.
8. Continue with the remaining microducts in the same manner while staggering the connectors across the sheath opening.

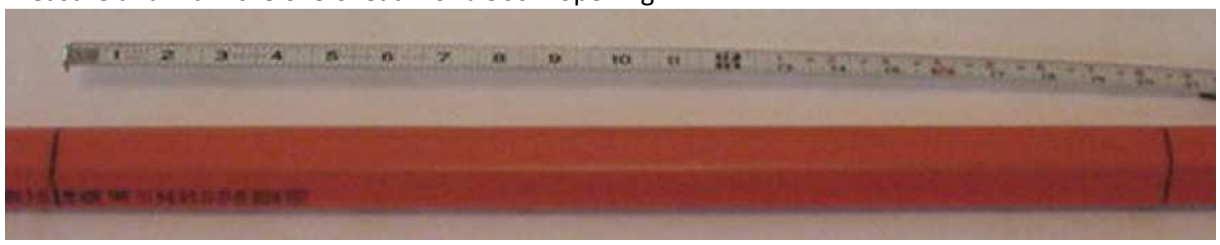
Ensure the microduct ends are inserted fully into the connector to avoid connector failure.

9. Optionally, once all the microducts are either coupled or capped, you can install a protective closure or bandage around the splice area. This would just increase the protection of connectors but it is not necessary.

2.4 Branch off

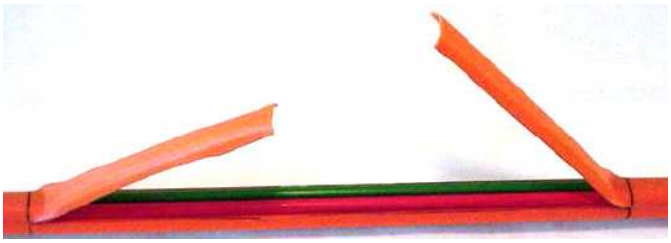
When planning a branch connection, always design it so the new Microduct will enter the branch point facing the incoming fiber.

1. A minimum of 50cm of jacket removal is recommended for a straight or branch splice application
2. Measure and mark the oversheath for a 50cm opening.



3. Cut the sheath longitudinally using cable knife with hooked blade or longitudinal cutter. Always insert the blade of the cutting tool being used into the flat side of the DuraMulti bundle. This will prevent damage to the microducts.

4. Remove the oversheath – using the knife or screw driver, separate the oversheath from microducts and cut the oversheath. Fold the oversheath back and cut it off.



5. Select the microduct to be connected. Cut it and connect it to the new microduct branch. **Note: Microduct that was cut to the field must be capped!**

6. Optionally, any kind of branching closure or tape can be installed to close the connection point. There are many closures either hard or flexible with usually circular entry points.

2.5 Termination

2.5.1 In the ground

As DuraMultiDB contains multi-way microduct tubing's, it is highly imperative to seal the starting end by means of a secured duct cap or end plug on individual micro ducts .This exercise will ensure that each micro-duct is free of any blockade caused by entry of debris, pebbles or foreign particles during laying job, which can hamper the micro cable.

2.6 Integrity and pressure test

These both tests should be performed at the final stage of installation to ensure and certify that the buried DuraMultiDB is without any defects and fit for installation of optic fiber micro cable into its individual microducts.

ATTENTION: During the both tests high air pressure is used and therefore safety precautions has to be always before and during the operations! On the down stream end, the micro duct end must be secured in a mesh wired flexible grip or by other „catcher" to avoid any mishap if any pebble/solid particle may be already resting inside the microduct before the start of testing procedure.

Both tests should be completed

- when new conduit deployment is finished
- before Fiber Optical Cable is blown into conduit
- after any maintenance was done on conduit route

2.6.1 Integrity test

This test is carried out to check and find the location at which the individual microducts of DuraMultiDB might have got deformed due to a sharp bend, kinks, crush, severe indentations in the trench bed or poor workmanship during laying of DuraMultiDB etc.
The possible microduct faults that may show up during the test process are:

- Missing sections of duct
- Micro-connectors not connected
- Leakage at micro-connector
- Kink in the duct
- Blockage in the duct
- Puncture in duct

STEP 1: Air Blow – testing microduct continuity
Allow full discharge of your compressor with 10 bars for 1-5min according to your duct length and ID. At the other end of microduct the air flow has to be appreciable.
Air flow volume at the far microduct end indicates:

- Good airflow – microduct continuity is OK
- Low airflow – loose connector, duct puncture or partial blockage
- No airflow – missing duct, blockage or dis-integrity

STEP 2: Sponge – cleaning the duct
If the Air Blow test passed then you can follow with cleaning the duct from dust, water or other dirt inside. This step should be never skipped if cable blowing should follow!
Sponge diameter must be approx. twice the duct ID, and length 40-50mm. Check with your duct or blowing machine supplier.

1. Wet sponge slightly in blowing lubricant
2. Screw the sponge inside the microduct
3. Blow the sponge through with compressed air using pressure about 10bars.

Note: It can take a few minutes to sponge getting through the microduct route. The smaller diameter of microduct you have the longer time it takes to blow the sponge through!
Make sure that you have „catcher“ in place at the far end of microduct to catch and notice the sponge when it shoots out of microduct.

STEP 3 - SHUTTLE BLOWING - check for sharp bends, kinks, partial blockages or deformations
If the STEP 1 and STEP 2 passed you can follow with shuttle blowing test to approve microduct suitability for cable blowing. This step should be never skipped if cable blowing should follow!

Shuttle size which helps to identify all the potential troubles should be as specified in the table below. General recommendation is:

Shuttle OD = 80% MicroDuct ID

Of course length of shuttle can be shorter if the minimum bending radius is not the real limit for the inspection. Typically 4-6mm long shuttles are used to calibrate microducts.

Shuttle size calculation - Microduct DB					
Microduct OD [mm]	**Microduct ID [mm]**	**Wall Thickness [mm]**	**Min. Bend Radius [mm]**	**Shuttle OD [mm]**	**Shuttle Length [mm]**
5	3,5	0,75	50	-	
6	4	1	60	-	
7	3,5	1,75	70	-	
8	4	2	80	-	
10	5,5	2,25	100	4	40
12	8	2	120	6	55
14	10	2	140	8	65
16	12	2	160	9,5	75
40	32	4	400	25	195

Attention: Make sure that you have „catcher“ in place at the far end of microduct to catch and notice the shuttle when it shoots out of microduct. **Flying shuttle can cause severe injury and damage!**

The maximum length of conduit route should not exceed 2km.

2.6.2 Pressure test

Pressure test helps to identify any micro-connector leakage or microduct punctures.
It is proceed only if the integrity test has passed.

1. Terminate both ends of microduct with valve microconnector.
2. Built up pressure to 5.5 bar and close the inlet valve. Wait for some time to stabilize the pressure and repeat until the pressure does not drop.
3. Release the pressure to bring it to 5 bars, if the pressure drops, increase the pressure by opening the inlet valve to build up pressure of 5 bar.
4. Once the pressure is settled (no drop within 1min) start to countdown of 30 minutes.
5. If the pressure does not drop below 4.5 bars within 30 min. the pressure test is passed.

Note: Pressure test rules can differ and can be defined individually by telecom operators. Always ask for specific procedure description.

2.7 Basic rules when cable blowing

1. Use proper blowing equipment
   - Compressor with pressure till 15 bars – each extra bar over 10bars can add some extra length
   - Professional blowing machine like Plumetaz, Lancier etc
   - Well trained and skilled operators, certified by Blowing machine producer or Duraline CT
2. Follow proper blowing procedure
   - Keep you equipment always clean and in good condition
   - Integrity test is a must before blowing cable (see chapter 2.6.1)
   - Use correct amount of lubricant if necessary (according to manufacturer instructions). Too much lubricant works as an adhesive!

- Always spread the lubricant by blowing sponge.
- Ideal ambient temperature range is between 5° to 20°C.
- As a rule always blow downhill wherever possible. Make sure that the average route will permit the cable to be installed on a descending and not an ascending gradient.
- As far as possible the cable should not touch the ground. Figure of eight should be laid on a tarpaulin. Care should be taken to ensure that the cable as it is fed into the machine does not touch the ground.

3. Micro-cable quality
   - Dimension tolerance within 0.1mm
   - Clean surface
   - Certified and tested for the blowing into HDPE microducts
4. Filling ratio within recommended limits (see table below)

			Theoretical calculated values		Proved by practice (500-1000m achieved)	
ID Microduct [mm]	OD Microcable IDEAL [mm]	Filling ratio [%]	OD Microcable MAXIMUM [mm]	Filling ratio [%]	Recommended max. cable OD [mm]	Filling ratio [%]
3,5	1,8	25%	3,0	75%	2,1	36%
5,5	2,8	25%	4,8	75%	3,9	50%
8	4,0	25%	6,9	75%	6,3	62%
10	5,0	25%	8,7	75%	7,6	58%
12	6,0	25%	10,4	75%	9,7	65%
14	7,0	25%	12,1	75%	10,5	56%

3 Accessories

3.1 Straight Micro-Connectors, Reducers, End Plugs

Working with DuraMultiDB bundle brings an advantage of very few accessories which you will need. There is nothing more than connectors, reducers and endplugs to make inline or branch connections. Check with your duct supplier for the available accessories.

3.2 Tools

It is essential always using proper cutting tools. Never use saw or other tools leaving burr, otherwise the connection can have a leakage.
Always check with your duct supplier for the quality tools.

1. Pipe shears – cutting the whole DuraMulti bundle

2. Microduct shears – cutting individual microducts

3. Longitudinal cutter – stripping the sheath off

4. Cable knife with hook blade – stripping the sheath off

4 References and standards

- European Standard EN 60794-5:2007 Optical fiber cables - Part 5: Sectional specification - Microduct cabling for installation by blowing
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