Microduct Fiber Optic Cable
Installation Procedure

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1.0 SCOPE

The instructions in this document give guidelines of how to install Draka's Microduct Fiber Optic Cable into microducts. This cable is specifically designed to be blown into microduct, thus the cable incorporates several performance differences from standard Outside Plant fiber optic cable. Special procedures and handling instructions must be applied for this product.

2.0 SPECIFICATIONS

Prior to installation of the Draka Microduct Fiber Optic Cable, the cable installation contractor shall read, understand and comply with specifications outlined in this document. Should there be any questions or concerns, Draka can be contacted at 1-800-979-9862.

3.0 SAFETY

3.1 PERSONAL PROTECTIVE EQUIPMENT

Draka strongly recommends the use of approved personal protective equipment for outside plant construction in the performance of this procedure.

3.2 TRAFFIC

All state and local traffic control codes and regulations should be met including the use of safety equipment such as reflective safety vests, warning signs, barricades, lighting if work is being performed during non-daylight hours.

3.3 CABLE PROTECTION - REEL TRANSPORTATION & HANDLING

3.3.1 While loading or unloading cable reels, care must be taken to prevent collision with other reels, or damage to the reel itself.

3.3.2 The reel should not be rolled a long distance. If it is necessary to roll the reel, it should be rolled in the direction indicated by the arrow shown on the reel.

3.3.3 The reel should always be located on a flat surface and blocks placed to prevent it from rolling in either direction.

3.3.4 The cable on the reel should be covered until just prior to installation to protect the jacket from exposure to the sun. Limiting exposure to the exposure can also improve installation performance.

3.3.5 The reel should never be placed on it's side.

3.3.6 The reel should never be dropped (i.e. off of a flatbed truck).

4.0 MICRODUCT/CONDUIT INSPECTION

(INSPECTING THE MICRODUCT BEFORE CABLE INSTALLATION)

4.1 Apply air pressure to microduct to test for system integrity according to the Blowing Equipment Manufacturers (BEM) recommended points within the system. Poor microduct splices or a malfunctioning air compressor may cause the air pressure to be too low. If the air pressure is too high, the duct may be kinked, clogged or restricted by some foreign matter.

4.2 It is recommended to use a foam cylinder to clean duct and remove water and debris prior to cable installation.

4.3 Blow a small ball, approximately 10 % smaller than the inside diameter of the duct, through the microduct to verify that the duct is not restricted. This should be conducted just prior to microduct cable installation.

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5.0 CABLE INSTALLATION

5.1 PRE-INSTALLATION CABLE INSPECTION AND OTDR TESTING

It is strongly recommended that the cable be tested using an OTDR and the values recorded prior to installation at 1310 nm and 1550 nm to ensure compliance with attenuation specifications. The cable should also be visually inspected for any damage that may have occurred during shipping. If there are questions or concerns, contact Draka at 1-800-879-9862.

5.2 REEL PLACEMENT

The cable reel should be on a reel trailer, reel jacks, or reel stands located on level ground with reel shafts mounted on ball bearings or bushings. Reels should be center mounted with cones for easy pull-off. The reel should be positioned where the cable coming off the reel minimizes the cables' angle going into the blowing equipment. A person must assist turning the cable reel during the installation to minimize cable tension. Also, this person should be watching the cable reel to insure no wraps are overlapped and be able to stop the reel in case of emergency to avoid cable damage. The Microduct Cable should not be allowed to drag across course surfaces that might damage the outer jacket.

5.3 DUCT LUBRICANT

Duct lubricant is recommended for cable installation at all times. Please refer to the Blowing Equipment Manufacturer's procedures for recommended lubricant type and amount. Re-apply lubricant as necessary to limit friction and ease cable-blowing installation.

5.4 BLOWING EQUIPMENT SETUP / OPERATION

NOTE: Contact Draka Customer Service at 1-800-879-9862 to receive a list of approved Blowing Equipment Manufacturers. Draka strongly recommends installation of Microduct cable according to the Blowing Equipment Manufacturers Operating Procedures. Deviation from these procedures may void Draka Cable Manufacturers' Warranty.

5.4.1 For Blowing Equipment Manufacturer specific operational details, see Appendix A, B, C and D.

5.4.2 Ensure the blowing equipment is clean and in proper working condition. Clean the Blowing Equipment drive mechanism as often as possible to optimize blowing performance.

5.4.3 The cable diameter should be measured at several locations and an average diameter determined prior to installation. The equipment should be setup according to the measured average diameter. This measurement should be conducted for each cable reel. Failure to properly setup the machine for the specific cable may result in microduct cable damage.

5.4.4 Draka recommends sealing all ends of the cable to prevent air from penetrating into the cable. A typical "5 minute epoxy," available at most hardware stores, will properly seal the end of the cable. The epoxy should be hard to the touch prior to cable installation.

5.4.5 Air compressor after-coolers are strongly recommended when the ambient air temperature exceeds 80° F. It is not uncommon for the compressed air to exceed 200° F without the use of an after-cooler on a day when the ambient air temperature is 100° F. The air in the duct should never exceed the maximum cable installation temperature, typically 140° F. Excessively hot air can soften the outer jacket, thus increasing friction and limiting installation performance.

5.4.6 It is recommended to perform a "crash" test to determine the maximum cable push force. This should be done on every cable reel. This is done by blocking the end of a short duct section and blowing the cable into the duct where it crashes into the blocked end. This is repeated until a maximum push force is determined that does not damage (i.e. kink, cork screw, fold over) the cable.

5.4.7 Should problems occur during cable installation, immediately contact Draka Customer Service immediately at 1-800-879-9862.

NOTE: Specific machine settings such as air pressure, flow rates, speed, grip wheel tension etc. will be determined and provided by the blowing equipment manufacturer. Draka works with all blowing equipment manufacturers to test blowing equipment for use with Draka Microduct cable and to help identify equipment settings. It is the responsibility of the cable installation contractor to determine if the blowing equipment to be used has been tested and authorized for the specific cable to be installed. The cable installation contractor operating the machine must be properly trained on the use of the blowing machine.

5.5 CABLE HANDLING

The specification sheet for the cable to be installed should be read and understood in order to identify cable installation specifications such as handling limitations and installation temperature range.

5.5.1 MINIMUM BEND RADIUS

The Minimum Bending Radius for all Microduct Cable Designs is 15x the cable diameter for "No Load" & 20x cable diameter for "With Load" applications; unless otherwise specified.

5.5.2 KINKING

Care must be taken at all times to insure the fiber cable is never kinked. This is primarily important during installation as the cable is coming off the reel, "pushing" cable into a duct and at "figure 8" points.

5.5.3 CRUSHING

Microduct fiber cable has reduced crush resistance versus typical fiber cable. Care must be taken at all times to insure the fiber cable is never crushed. This is an issue at all times as the cable can be crushed while on the reel or on the ground. Cable on the ground in a "figure 8" must be protected from vehicular as well as pedestrian traffic at all times. Crew personnel should not be in the habit of walking over, or carrying tools, materials, or equipment over cable lying on the ground.

5.5.4 TENSION

The Microduct Cable is to be installed by microduct cable blowing technology for distances over 700 feet. For distances under 700 feet in a straight run, the Microduct cable can be hand pushed or pulled in via tape / string into a Microduct only. Installation crews must use blowing equipment specifically designed and tested for Microduct fiber cable to avoid damage to the cable. Most microduct fiber cable products have a tension limit of 300 lbs of pull strength, versus 600 lbs for typical outside plant fiber cable. Refer to the specification sheet for the cable in use.

5.6 INSTALLATION DISTANCES AND SPEED

Sections of Microduct can be linked together with couplers in order to achieve continuous duct lengths exceeding 1 mile. Microduct cables have been successfully blown distances in excess of 7000 feet. However, due to variability in duct routes and terrain, Draka recommends a maximum of 5,000ft in a single run for optimal cable installation performance. Lengths greater than 5000ft should have mid-assists (per the Blowing Equipment Manufacturers procedures) or "figure 8" procedures (see section 5.7) every 5000ft or less. Installation speeds for Microduct Cable can range between 100 and 300 feet / minute, depending on blowing equipment and duct run. Draka and the blowing equipment manufacturer recommend safe, controllable speeds. The duct run, including elevation and directional changes can limit blowing distances.

5.7 FIGURE 8 PROCESS

NOTE: USE OF AUTOMATED "FIGURE 8" MACHINES IS STRICTLY PROHIBITED WITHOUT WRITTEN CONSENT OF DRAKA.

5.7.1 Management

5.7.1.1 The Installation Plan will indicate the approximate cable length at a "figure 8" point. Based on this figure, the foreman will determine an appropriate size and location for each "figure 8".

5.7.1.2 If the cable length exceeds 1.5 km, it may be best to make two separate "figure 8"s so each will be of a manageable size.

5.7.1.3 Security will be required for each "figure 8". This will be to protect the "figure 8" from traffic, pedestrians, and cable installation equipment.

5.7.2 INTERMEDIATE INSTALLATION (AKA: BI-DIRECTIONAL)

5.7.2.1 For longer length installations, place the cable reel and blowing equipment near a hand/man hole point toward the middle of the duct run.

5.7.2.2 Blow the cable in one direction to the planned splice location.

5.7.2.3 Place the remaining cable in the shape of a "figure 8" for temporary cable management.

5.7.2.4 Performing the "figure 8" in this fashion will leave the exposed cable end on top of the "figure 8" stack.

5.7.2.5 Next, blow the remaining cable length toward the opposing planned cable termination point.

5.7.3 BACKFEED INSTALLATION (AKA: UNI-DIRECTIONAL)

5.7.3.1 Place the cable reel and blowing equipment at the feedhole and blow toward the back-feed hole.

5.7.3.2 At the back-feed hole, blow enough cable out of the hole to ensure ample cable to reach the end of the planned run and for planned storage at each subsequent hole.

5.7.3.3 Also, at the back-feed hole, arrange the cable in the form of a "figure 8". The cable end will be on the bottom side of the cable stack. To continue installation of the cable into the next duct section, it will be necessary to "flip" the "figure 8" stack. This should be done with sufficient personnel to allow for the cable to be carefully and easily handled.

5.7.3.4 To continue the installation, move blowing equipment to the next cable installation leg and repeat steps 4.8.3.2 & 4.8.3.3 to end of run.

5.8 SLACK CABLE

Slack cable can remain in the Microduct after installation for storage.

5.9 CABLE PROTECTION IN A HAND-HOLE

5.9.1 PREPARING THE CABLE COIL

5.9.1.1 Typically, a cable coil will be placed in a hand-hole to provide extra cable in the event of network damage or in the act of splicing fibers. In certain environments, it may be determined that cable protection is required inside a hand-hole due to the threat of rodent damage.

5.9.1.2 With a length of cable extending from the hand-hole that will be used for the coil, first determine the size of the coil that will both fit through the opening properly and also store conveniently inside.

5.9.1.3 Create cable coil to ease cable management.

5.9.1.3.1 Use tape or cable ties to hold the coil together.

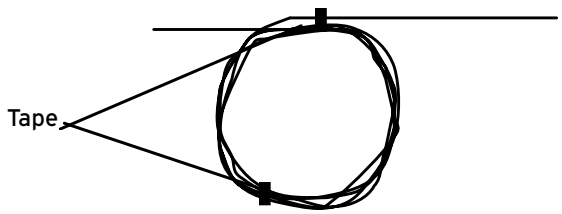


Figure 1: Cable Coil Secured with Tape

5.9.2 PROTECTING THE COIL

5.9.2.1 Once the coil is created, cut three sections of the Slit Loom Tubing, (example: Panduit PN: CLT 188N-6C630) to cover the cable inside the hand-hole. Use section 2 over the cable coil. Place sections 1 & 3 over the cable entry and exit legs to the hand-hole. NOTE: Use shears to cut a V-Slot (at the slit) into each tubing, leg to allow for the tubing to fully cover the cable at the junction point.

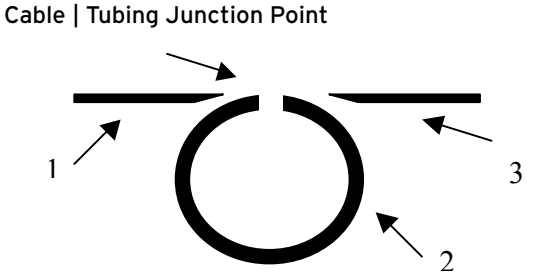


Figure 2: Duct Configuration over cable coil

5.9.2.2 Use cable ties to secure the Slit Tubing at the cable leg junction point. Ensure the tubing ends fully cover any exposed cable. See photo below:

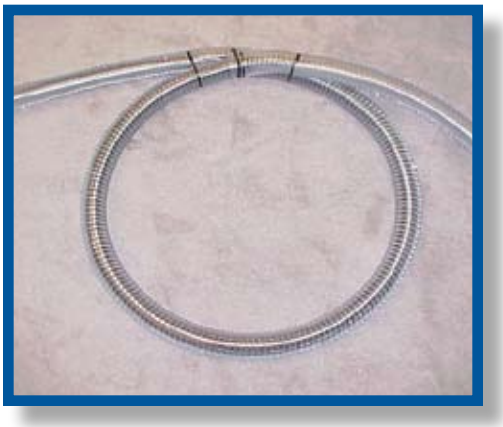


Figure 3: Cable Coil Placed Inside Slit Tube

6.0 CABLE TERMINATION

6.1 The cable must be properly terminated in the closure. This includes proper clamping of the central strength member by using a clamp with a positive stop to prevent CSM pistoning.

6.2 The jacket must be properly secured to prevent jacket retraction or cable slippage.

6.3 Express routing of buffer tubes is not permitted with microduct cable. The tubes shall be opened and express fibers stored in splice trays or routed in furcation tubing (i.e. spiral wrap, etc). Failure to remove the fibers from the tube may result in increased attenuation at colder temperatures.

End of Procedure

APPENDIX A
Installation of Draka Microduct Cables with Plumettaz / Sherman & Reilly CableJet

This appendix highlights important aspects of set-up and operation of the CableJet with Draka Microduct cables. The set-up and operating procedures of the blowing equipment manufacturer must be followed in order to minimize risk of cable damage and for optimal blowing performance.

CABLE END PREPARATION AND SEALING PRIOR TO INSTALLATION

[+] At cable end, remove 1/2" jacket, yarns and buffer tubes, leaving 1/2" central strength member extending beyond the jacket.

[+] Using commercially available 2-part "5 Minute Epoxy", mix the 2 parts according to the product instructions.

[+] Dip the exposed CSM and cable end into the mixed epoxy past the cable jacket 1/4".

[+] Turn cable end upward to allow epoxy to fill buffer tube voids.

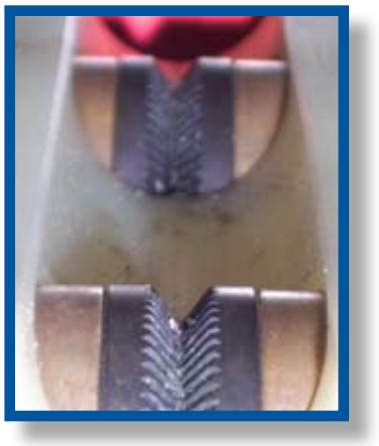
[+] NOTE: Grip cable with disposable rag as epoxy may run down cable jacket.

[+] Allow epoxy to dry in this position.

Drive Rollers

[+] Clean drive rollers prior to each installation with com pressed air and wire brush.

[+] Make sure rollers move side to side and properly separate.



Cable Diameter Measurement

[+] Measure cable diameter prior to each run

[+] Measure at multiple locations and axes

[+] Determine an average diameter

Drive Roller Spacer Configuration

Currently, there are three different drive roller configurations for the CableJet, the 6-9 roller set, the 7-9 roller set, and the 9-18 roller set. Draka Microduct cables can be installed with either the 6-9 or 7-9 roller set if the cable diameter falls within this range.

[+] Check with the CableJet manufacturer to deter mine the drive roller configuration.

[+] Determine the spacer configuration chart to use, depending on drive roller configuration.

[+] Choose spacer configuration from the appropriate table, using average cable diameter measurement.

[+] White spacers are 1.0 mm, Green spacers are 2.0 mm, Black spacers are 5.0 mm.

[+] Failure to follow manufacturer's recommended spacer configuration may result in damage to the cable.

Example: For the 7-9 drive rollers and a cable measuring 7.8 mm average diameter, 2 white spacers should be used in each of the drive rollers.

Spacer Configuration for 6-9 Rollers		
Cable Dia	Spacer Width	Spacers
≤ 6.3	0 mm	None
6.4 - 6.9	1 mm	1WH
7.0 - 7.5	2 mm	1GR
7.6 - 8.1	3 mm	1WH,1GR
8.2 - 8.7	4 mm	2GR
8.8 - 9.3	5 mm	1BL

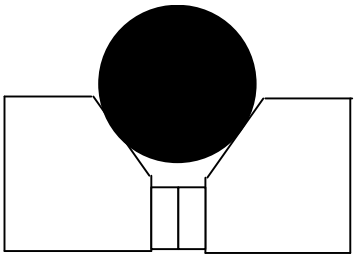
Spacer Configuration for 7-9 Rollers		
Cable Dia	Spacer Width	Spacers
≤ 6.7	0 mm	None
6.8 - 7.3	1 mm	1WH
7.4 - 7.9	2 mm	2WH
8.0 - 8.5	3 mm	1WH,1GR
8.6 - 9.1	4 mm	2GR

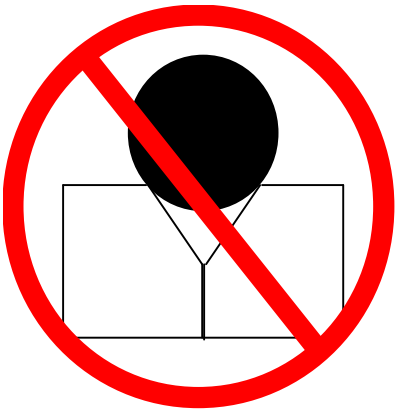
Cable in Drive Rollers

[+] With the correct spacers, the cable should lay in the V-groove between the drive rollers.

[+] The cable contacts the sides of the drive rollers.

[+] The cable should not rest on top of the rollers.



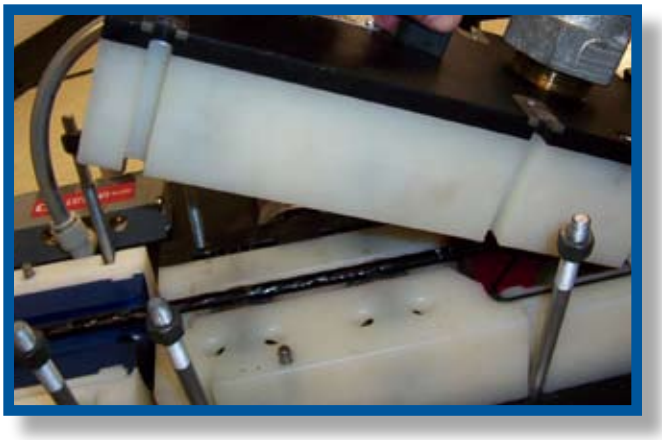


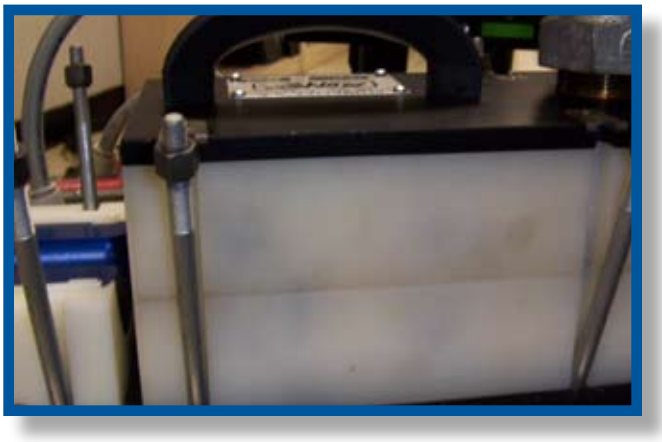
Securing the CableJet

[+] Close the CableJet by replacing the top piece and tightening the nuts by hand only.

[+] The top and bottom pieces should mate together flush, with no gap prior to tightening nuts with T-handle wrench.

[+] No interference should be felt due to cable.





Manual Push-Pull Test

[+] Push and pull the cable through the machine by hand a few times ensuring the cable is seated properly in the drive rollers.

[+] The motor should be heard turning – if it does not turn, open the pusher unit to be sure the cable is not "pinched" and improperly seated. Adjust if necessary. Also, check spacers against cable diameter again to be sure they are correct. Repeat manual push-pull test until motors can be heard turning.

Static Slip Test

[+] Hold the cable in place by hand.

[+] Increase the motor pressure until the drive wheels slip over the cable.

[+] Record the motor pressure, when the wheels slip, to determine maximum motor pressure.

Control of the Cable Reel

[+] One person should control the cable reel and be prepared for emergency stops.

[+] At startup, the reel should be turned by hand to minimize tension.

[+] The reel should be assisted throughout installation to minimize tension.

[+] The cable should enter the CableJet with no tension.

[+] The cable should enter the CableJet at a straight angle.

Keys for Best Blowing Performance

[+] Run all machines at consistent speeds.

[+] Do not try to test the limits of the system.

[+] Stopping and starting the system will cause the installation to take at least 3 times longer.

[+] 5000 ft at 250 ft/min = 20 min

[+] 5000 ft at 200 ft/min = 25 min

[+] Clean cable as it enters the CableJet
  [+] Use rag to wipe off dust and debris.

  [+] Alcohol can be applied to help clean cable, but ensure all alcohol evaporates before entering machine.

  [+] Cleaning the cable keeps the machine clean and efficient.

[+] Clean CableJet after each run
  [+] Spray with compressed air.

  [+] Quick cleaning of drive rollers with brush.

  [+] Inspect machine for any unusual build-up.

Cable Inspection

[+] Inspect cable as often as possible
    [+] At duct exit, mid-points

[+] Look for any unusual signs
  [+] Oval / flat cable
  [+] Jacket damage

Marks on Cable

[+] Observe marks on cable from due to CableJet rollers
  [+] Light parallel line marks are okay

  [+] Deeper triangular marks indicate cable is riding on top of drive rollers, not in V-groove

GOOD MARKS
Light parallel lines indicate side of rollers are contacting cable

BAD MARKS
Deep triangular marks indicate cable is riding on top of rollers

End of Procedure

APPENDIX B
Installation of Draka Microduct Cables with Plumettaz / Sherman & Reilly MicroJet

Approved Microduct Cables for use with the Plumettaz / Sherman & Reilly MicroJet

The following cables have been tested and are approved for use with the Plumettaz / Sherman & Reilly MicroJet:

[+] 7.0 mm (2-72f) Standard Microduct Cable

All other cables have not been tested or are not approved for use with the MicroJet. Contact Draka Customer Service with questions.

This appendix highlights important aspects of set-up and operation of the MicroJet with Draka Microduct cables. The set-up and operating procedures of the blowing equipment manufacturer must be followed in order to minimize risk of cable damage and for optimal blowing performance.

Cable End Preparation for installation

[+] At the cable end, remove 1/2" jacket, yarns and buffer tubes, leaving 1/2" central strength member extending beyond the jacket.

[+] Using commercially available 2-part "5 Minute Epoxy", mix the 2 parts according to the product instructions.

[+] Dip the exposed CSM and cable end into the mixed epoxy past the cable jacket 1/4".

[+] Turn cable end upward to allow epoxy to fill buffer tube voids.

[+] NOTE: Grip cable with disposable rag as epoxy may run down cable jacket.

[+] Allow epoxy to dry in this position.

Drive Wheels

[+] Clean drive rollers prior to each installation with compressed air and wire brush

[+] Make sure the drive wheels properly separate

Static Slip Test

[+] Hold the cable in place by hand

[+] Increase the motor pressure until the drive wheels slip over the cable

[+] Record the motor pressure when the wheels slip

Control of the Cable Reel

[+] One person should control the cable reel

[+] At startup, the reel should be turned by hand to minimize tension

[+] The reel should be assisted throughout installation to minimize tension

[+] The cable should enter the MicroJet with no tension

[+] The cable should enter the MicroJet at a straight angle

Keys for Best Blowing Performance

[+] Run all machines at consistent, controllable speed.

Typical speeds are 125 to150 ft/min

[+] Do not try to test the limits of the system.

[+] Stops an re-starts will cause the installation to take at least 3 times longer

[+] Clean cable as it enters the MicroJet
- [+] Use rag to wipe off dust and debris
- [+] Alcohol can be applied to help clean cable
- [+] Cleaning the cable keeps the machine clean and efficient

[+] Clean MicroJet after each run
- [+] Spray with compressed air
- [+] Quick cleaning of drive rollers with brush

[+] Inspect machine for any unusual build-up

Cable Inspection

[+] Inspect cable as often as possible
- [+] At duct exit, mid-points

[+] Look for any unusual signs
- [+] Oval / flat cable
- [+] Jacket damage

End of Procedure

APPENDIX C
Installation of Draka Microduct Cables with Condux LW Blower

Approved Microduct Cables for use with the Condux LW Blower
The following cables have been tested and are approved for use with the Condux LW Blower.

[+] 7.8 mm 32f Teralight Ultra Microduct Cable (Customer Specific Design)

[+] 8.5 mm 32f 600 lb Teralight Ultra Microduct Cable (Customer Specific Design)

Smaller diameter cables have not been tested or are not approved for use with the Condux LW Blower. Contact Draka Customer Service with questions.

This appendix highlights important aspects of set-up and operation of the Condux LW Blower with Draka Microduct cables. The set-up and operating procedures of the blowing equipment manufacturer must be followed in order to minimize risk of cable damage and for optimal blowing performance. Additionally, operators should also obtain and understand the supplemental manual developed by Condux entitled "LW Blower Supplement for Blowing Microcable into Microduct."

Cable Crash Test

The cable crash test is the most critical step during the set-up of the LW blower in order to prevent damage to the cable. A crash test must be performed for each machine and each cable reel such that a piece of the actual cable and duct is tested for each installation. The purpose of the crash test is to set the hydraulic motor leak-off valve such that the motor will not continue to push the cable if a duct obstruction is encountered, thus preventing damage to the cable.

The crash test procedure is outlined in the "LW Blower Supplement for Blowing Microcable into Microduct" manual supplied by Condux.

Warning: Failure to conduct a cable crash test and properly set the motor hydraulic leak-off valve may result in damage to the cable. Draka recommends performing a Crash Test prior to each cable installation.

Testing has shown that Microduct cables can buckle in the machine if the leak-off valve is not properly set for the cable and duct configuration during the crash test, as shown in the pictures below.

Cable Carrier

A cable carrier (a.k.a. birdie, pig, end attachment, air capturing device) must be attached to the cable when using the Condux LW blower. Care must be taken to properly attach the cable carrier to the central strength member of the cable.

The procedure for attachment of the cable carrier to the Microduct cable is outlined in the "LW Blower Supplement for Blowing Microcable into Microduct" manual supplied by Condux.

Installation Speeds

The installation should be run at controllable speeds, typically between 120 and 140 ft/min, as recommended by Condux. A 5000 ft installation can be accomplished in 40 minutes if run at 125 ft/min. Running at faster uncontrollable speeds increases the risk of cable damage if a duct blockage or another unforeseen circumstance is encountered.

Traction Control

If the Condux LW blower is equipped with traction control features, it is recommended to leave the traction control on at all times. Traction control will stop the machine if he tractor drive slips on the cable, or if the maximum or minimum speeds have been reached.

Other keys for optimal blowing performance

[+] The cable should be hand guided into the LW blower to keeping the cable centered in the tractor drive.

[+] The tractor drive should be cleaned after each run using compressed air. Spraying commercially available brake cleaner on the belts will also clean the tractor drive, providing more grip.

NOTE: Ensure the duct pressure always exceeds the push force exerted by the blowing equipment as explained by the blowing equipment manufacturer. Failure to do so causes the cable to be pushed into the duct faster than the "Cable Carrier" is pulling it. This could ultimately cause the cable to corkscrew inside the duct, possibly damaging the cable.

Cable Inspection

[+] Inspect cable as often as possible
  [+] At duct exit, mid-points

[+] Look for any unusual signs
  [+] Oval / flat cable

  [+] Jacket damage

APPENDIX D
Installation of Draka Microduct Cables with Arnco Air-Trak MD

Approved Microduct Cables for use with the Arnco Air-Trak MD

Based on testing of Draka Microduct cables with the Arnco Air-Trak MD blowing equipment, the following cables are approved for use with the Arnco Air-Trak MD. Other models of Arnco blowing equipment must be retrofitted for microduct applications if Draka Microduct cables are to be installed.

[+] 7.0 mm (2-72f) Standard Microduct Cable

[+] 7.8 mm 32f Teralight Ultra Microduct Cable (Customer Specific Design)

[+] 8.4 mm (74-96f) Standard Microduct Cable

[+] 8.5 mm 32f 600 lb Teralight Ultra Microduct Cable (Customer Specific Design)

[+] 11.1 mm (98-144f) Standard Microduct Cable

All other cables have not been tested or are not approved for use with the Arnco Air-Trak MD. Contact Draka Customer Service with questions.

This appendix highlights important aspects of set-up and operation of the Arnco Air-Trak MD with Draka Microduct cables. The set-up and operating procedures of the blowing equipment manufacturer must be followed in order to minimize risk of cable damage and for optimal blowing performance.

Maximum Push Test

The Maximum Push Test is the most critical step during the set-up of the Arnco Air-Trak MD in order to prevent damage to the cable. The Maximum Push Test must be performed for each machine with a piece of the actual cable and duct that is going to be used. Please consult the Arnco set-up and operating procedures for the detailed "Maximum Push Force Test Procedure."

Warning: Failure to conduct the Maximum Push Test and properly set machine cut-off load may result in damage to the cable.

During the test, a cable sample is loaded into the machine and a short section of blocked duct, as shown in Figure D1. The push force is increased until the cable kinks in the duct or the machine, similar to Figure D2. A kink load (Figure D3) is identified by repeating the test several times. Using the lowest measured kink load, a cut-off load should be set to some value less than that minimum kink load. Recommended cut-off loads should be between 50% and 70% of the measured kink load. The cut-off load should never be set more than 80% of the kink load.

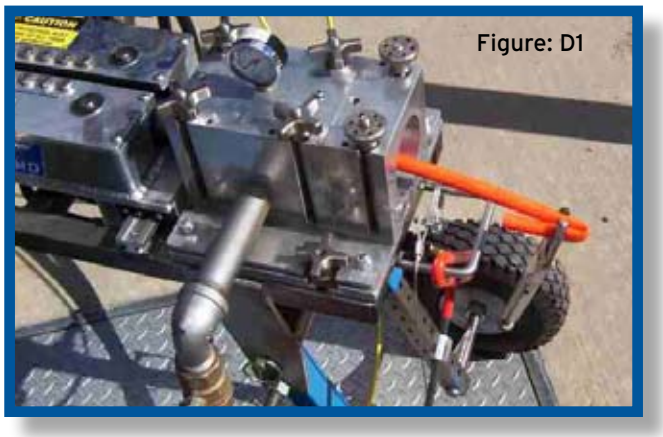


Figure: D1

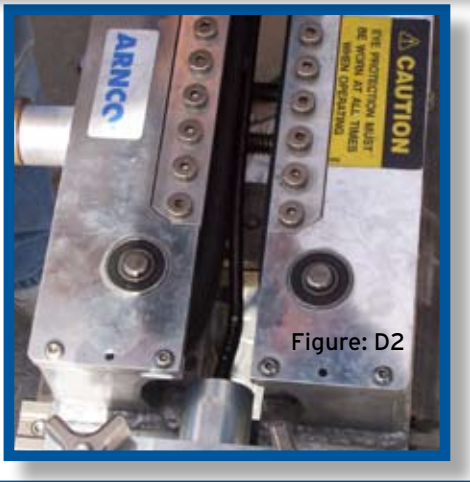


Figure: D2

Figure: D3

Cable Dart

A cable dart (a.k.a. birdie, pig, shuttle, end attachment, air capturing device, cable carrier) must be attached to the cable when using the Arnco Air-Trak MD. Care must be taken to properly attach the cable dart to the end of the cable.

The procedure for attachment of the cable carrier to the Microduct cable is outlined in the Arnco procedures.

Securing the cable in the Air-Trak MD

The cable is secured in the belts of the Air-Trak MD by tightening the housing hand wheel clockwise, brining the housing halves together and in contact with the cable. A stop sleeve is included to prevent over-loading the cable. The wheel should never be turned too tight such that the stop sleeve is in contact with the housing hand wheel. The stop sleeve should never be removed from the blowing equipment.

Installation Speeds

The installation should be run at controllable speeds, typically between 100 and 160 ft/min, as recommended by Arnco. A 5000 ft installation can be accomplished in 40 minutes if run at 125 ft/min. Running at faster uncontrollable speeds increases the risk of cable damage if a duct blockage or another unforeseen circumstance is encountered.

NOTE: Ensure the duct pressure always exceeds the push force exerted by the blowing equipment as explained by the blowing equipment manufacturer. Failure to do so causes the cable to be pushed into the duct faster than the "Cable Dart" is pulling it. This could ultimately cause the cable to corkscrew inside the duct, possibly damaging the cable.

Cable Inspection

[+] Inspect cable as often as possible
  [+] At duct exit, mid-points

[+] Look for any unusual signs
  [+] Oval / flat cable

  [+] Jacket damage

End of Procedure