SUMITOMO ELECTRIC LIGHTWAVE

SUMITOMO RECOMMENDED PROCEDURE

SRP SP-F04-003

FutureFLEX® AIR-BLOWN FIBER® SOLUTIONS

TUBE PRESSURE TESTING PROCEDURE

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1.0 General

1.1 This procedure describes the steps necessary to perform an end-to-end static pressure test on individual FutureFLEX tube spans. Test results are satisfactory when a tube span holds 150 psi pressure for approximately 10 seconds.

1.2 The Pressure Test verifies the airtight integrity of an individual tube span including all its Tube Coupling connections. Leakage problems may impact fiber bundle installation performance and could result in decreased blowing distances. Depending on location and size, a leak point may allow water to enter the tube interior should the tube become submerged. All detected leakage problems must be corrected to ensure a successful fiber bundle installation and the long-term reliability of the FutureFLEX installation.

1.3 **It is mandatory that a Pressure Test shall be performed on all tubes upon completion of the initial tube cable installation** (final tube route set, all clamps and fittings installed, all tube span connections made, etc.).

1.4 **It is also strongly recommended to perform another Pressure Test on an individual tube span just before a fiber bundle is to be installed in it.** The exception is if a fiber bundle will be installed immediately upon completion of the initial tube cable installation the Pressure Test can be performed once.

1.5 Pressure testing can be performed with various pressure sources; Nitrogen Cylinder, Compressed Air Cylinder, or Air Compressor.

1.6 Perform the Pressure Test on all tubes in conjunction with the Tube Obstruction Test (see Sumitomo Recommended Procedure SRP SP-F04-004). Complete the Pressure Test first, correct any leakage problems, and then perform the Obstruction Test.

1.7 Two (2) personnel are required to perform this procedure.

2.0 Safety Precautions

2.1 Pressurized Nitrogen – The use of inert (nonflammable) pressurized Nitrogen (N_2) gas presents several safety concerns.

2.1.1 N_2 is a simple asphyxiate. If large amounts of nitrogen are released into a confined area, the nitrogen can displace the amount of oxygen in air necessary to support life. This can result in a loss of balance, dizziness, rapid reduction in the ability to perform movements, reduced consciousness of surroundings, as well as other symptoms that are included in the MSDS (Material Safety Data Sheet) available upon request from the Gas Supplier. It is recommended that pressurized nitrogen only be released into a well-ventilated area.

2.1.2 When using pressurized nitrogen, there are no risks related to fire, reactivity, or other special hazards. Nitrogen is not listed as a carcinogen by NTP, IARC, or OSHA.

2.2 Compressed Air – The use of nonflammable pressurized compressed air (Atmospheric Air), either from a cylinder / bottle or air compressor, presents no safety concerns.

2.2.1 Air is nontoxic and necessary to support life. There are no ventilation concerns.

2.2.2 Compressed Air at high pressures does present an unusual fire and explosive hazard in that it will accelerate the burning of materials to a greater rate than they would burn at normal atmospheric pressure.

2.2.3 When using pressurized air, there are no risks related to fire, reactivity, or other special hazards. Air is not listed as a carcinogen by NTP, IARC, or OSHA. An MSDS (Material Safety Data Sheet) is available upon request from the Gas Supplier.

2.3 Pressurized Gas Cylinders / Bottles – Transporting and handling pressurized gas cylinders presents several safety concerns.

2.3.1 Any pressurized gas cylinder is dangerous if damaged. Gas bottles must be properly capped when being transported and stored. Gas bottles must be secured in a stable bottle dolly or chained to structure when uncapped for use.

2.3.2 A full size 300 cubic foot volume gas bottle weighs approximately 160 lbs. Two personnel should accomplish any manual lifting or moving of

a bottle. Exercise care and use proper lifting techniques.

3.0 Reference Documents

3.1 Sumitomo Recommended Procedure, *FutureFLEX Blowing Equipment Set-up Procedure*, SRP SP-F04-001.

3.2 Sumitomo Recommended Procedure, *FutureFLEX Fiber Bundle Installation Procedure*, SRP SP-F04-002.

3.3 Sumitomo Recommended Procedure, *FutureFLEX Tube Obstruction Testing Procedure*, SRP SP-F04-004.

3.4 Sumitomo Recommended Procedure, *FutureFLEX Plenum-Rated Jacketed Tube Cable Installation Procedures,* SRP SP-F04-029.

4.0 Equipment / Tools Required
The following equipment and tools are required to complete this procedure.

4.1 Nitrogen Cylinder (Installer provided)
- Industrial Grade Nitrogen; preferred pressure source
- Inert (nonflammable) gas
- Dry or with no more than 4 ppm moisture content (H_2O)
- Oil / contaminant free output
- 300 cu. ft. (approx.) volume bottle size recommended
- 2200-to-2500 psi (approx.) pressure charge

4.2 One Pressure Regulator Assembly with male quick-release 8mm Tubing Adapter (BEREG01 Two-Stage or BEREG02 Single-Stage).

Note: *If a Blowing Head Equipment Kit (BE200RM, BE200RS, or BE200RY) is available, use Pressure Regulator with 8mm Tubing Adapter supplied with the Kit to perform Pressure Testing. However, if <u>not</u> available, the Pressure Regulator with 8mm Tubing Adapter should be purchased separately in order to support testing requirements.*

4.3 Tube Test Kit (BEPT001) includes the following items:
One Bypass Switch (BEPT0S)
- One 0-200 psi range Hand-Held Pressure Gage (BEPTGA)
- One hundred (100) 5mm OD plastic beads (BEBB01)

Note: 4mm plastic beads (BEBB4OP) must be ordered separately for routes with plenum. Further described in SRP SP-F04-029.

Note: *Tube Test Kit (BEPT001) is <u>not</u> part of Blowing Head Equipment Kit (BE200RM, BE200RS, or BE200RY) <u>and</u> must be purchased separately.*

4.4 Large Adjustable Wrench (Installer provided); at least 10” suggested.

4.5 Tubing Cutter (BETC001).

4.6 8mm tubing (any type) for miscellaneous connections (Installer provided); 10’ - 20’ suggested.

4.7 Tube Couplings (DE08MC2) (Installer provided).

4.8 Cylinder Adapter (BEREGCA) (Installer provided); required if using Compressed Air Cylinders as pressure source.

4.9 Means of communicating across tube span (e.g.: two-way radios or similar).

4.10 Alternate Pressure Source – Although bottled Nitrogen is the preferred pressure source because of its cleanliness, general convenience, inexpensive cost, and ease of portability, compressed air from either a Compressed Air Cylinder or an Air Compressor can be used as an alternate pressure source.

4.11 Compressed Air Cylinder (Installer provided)
- “Dry Grade” Compressed Air
- Nonflammable gas (atmospheric air)
- Dry or with no more than 10 ppm moisture content (H_2O)
- Oil / contaminant free
- 300 cu. ft. (approx.) volume bottle size recommended
- 2200-to-2500 psi (approx.) pressure charge

Note: *Different types or "grades" of Compressed Air are available. The "purer" grades with such names as Zero Grade, Vehicle Emission Grade, Scientific Grade, and Accurate Grade undergo additional refining processes so they contain fewer impurities (hydrocarbons) and have less moisture content. It is <u>not</u> necessary to use these "purer" more costly grades of air for testing operations.*

Note: *Performance-wise, Compressed Air supplied in a Cylinder performs the same as Nitrogen. There are no differences in the blowability of fiber bundle nor testing of tubes.*

Important Note: *Compressed Air Cylinders are supplied with a Female left-hand thread Bottle fitting (CGA-590). Pressure Regulators BEREG01 or BEREG02 supplied in the Blowing Head Equipment Kit have a Male right-hand thread Nut (CGA-580). A CGA-590 Industrial Air Cylinder-to-CGA-580 Nitrogen Regulator Cylinder Adapter is therefore required to connect the Pressure Regulators to the Bottle fitting. One (1) Cylinder Adapter is required for each Pressure Regulator used.* ***See Fig. 1.***

4.12 Air Compressor (Installer provided)

- Output dry or with no more than 10 ppm moisture content (H_2O); often requires use of a Secondary Dryer
- Output oil / contaminant free
- Output flow rate (capacity) at least 12 scfm
- Output pressure at least 200 psi

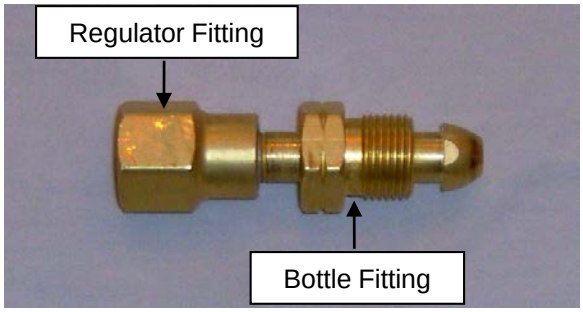

Figure 1
CGA-590 Industrial Air Cylinder-to-CGA-580 Nitrogen Regulator Cylinder Adapter

Note: *If an Air Compressor is to be used, additional Air and Coalescer Filters <u>and</u> a secondary Desiccant-type Dryer are strongly recommended <u>and</u> must be of compatible output flow and pressure ratings with the Air Compressor. Also consider the following potential issues first. Power source / requirements? Physical size of Compressor? Portability? Distance Compressor must be set up from tube test point? Fittings necessary to connect Compressor output to a Pressure Regulator? Noise if use indoors?*

5.0 Equipment Layout

5.1 **See Fig. 2** for Pressure Test Equipment layout.

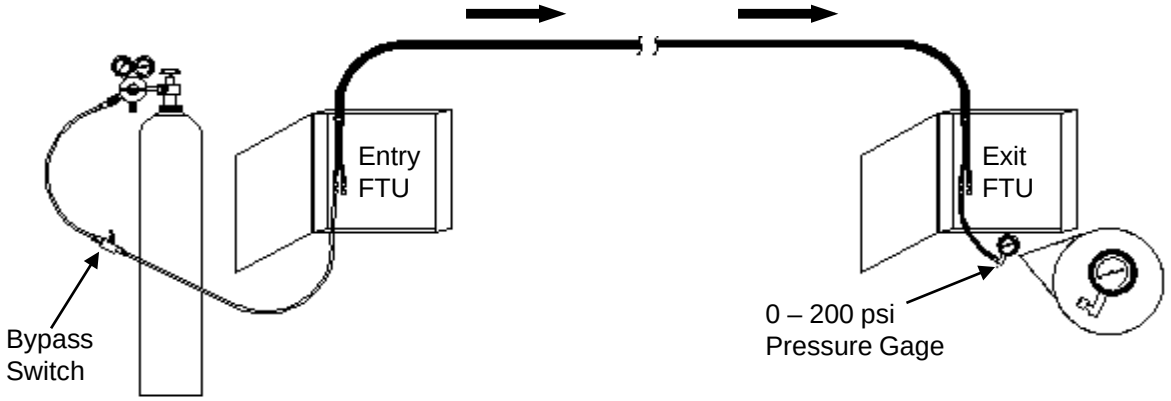

Figure 2
Pressure Test Equipment Layout

6.0 Pressure Source Set-up

6.1 Begin Pressure Test procedures with both Installers at entry point Fiber Termination Unit (FTU) location.

6.2 Ensure Gas Bottle is securely chained in place and remove valve cap.

6.3 Thread Pressure Regulator fitting onto bottle valve housing and tighten with large adjustable wrench.

Note: *Do not use a serrated jaw tools (e.g.: pipe wrench, vise grips, channel locks, etc.) to tighten brass fitting of Pressure Regulator.*

6.4 Open Bottle Supply Valve and check for leakage around fitting. If leakage is detected, close Bottle Supply Valve and see Sumitomo Recommended Procedure SRP SP-F04-001. Retightening is usually required with wrench.

6.5 Close Bottle Supply Valve.

6.6 Install male quick-disconnect 8mm Tubing Adapter into female quick-disconnect fitting on Pressure Regulator. **See Fig. 3.**

Figure 3
8mm Tubing Adapter Installed to Pressure Regulator

7.0 Test Equipment Set-up

7.1 Locate numbers #1, #2, and #3 stamped on body of Bypass Switch (#1 and #2 are located under 8mm push-fit couplings and #3 is on bottom of valve). #1 is Inlet port. #2 is Outlet port. #3 port is "Bypass" or vent port. **See Fig. 4.**

CAUTION: *Inlet and Outlet tubing must be connected to correct push-fit couplings (#1 Inlet and #2 Outlet) or Bypass Switch will not function properly and can be damaged.*

Note*: Inspect tubing ends before connecting to push-fit couplings. Use Tubing Cutter (Installer provided) to trim tubing ends with straight, clean cut for best seat and seal in push-fit couplings.*

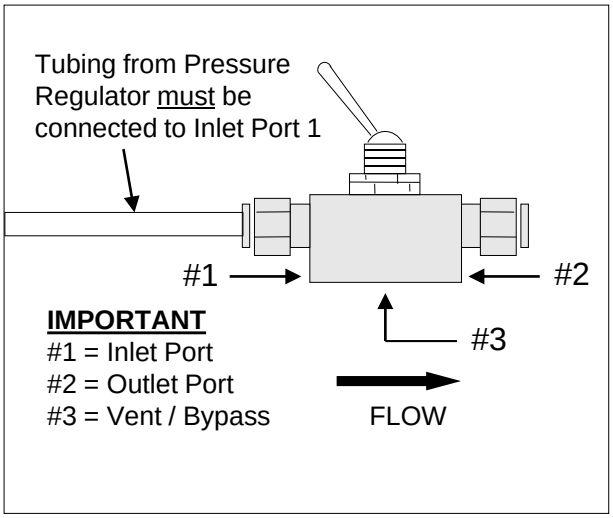

Figure 4
Bypass Switch

7.2 Push-fit Installer-provided length of 8mm tubing between 8mm Tubing Adapter on Pressure Regulator and #1 Inlet coupling on Bypass Switch. **See Fig. 5.**

7.3 Push-fit a short piece (6" - 12" length suggested) of Installer-provided 8mm tubing between #2 Outlet coupling on Bypass Switch and 0-200 psi Hand-Held Pressure Gage. **See Fig. 5.**

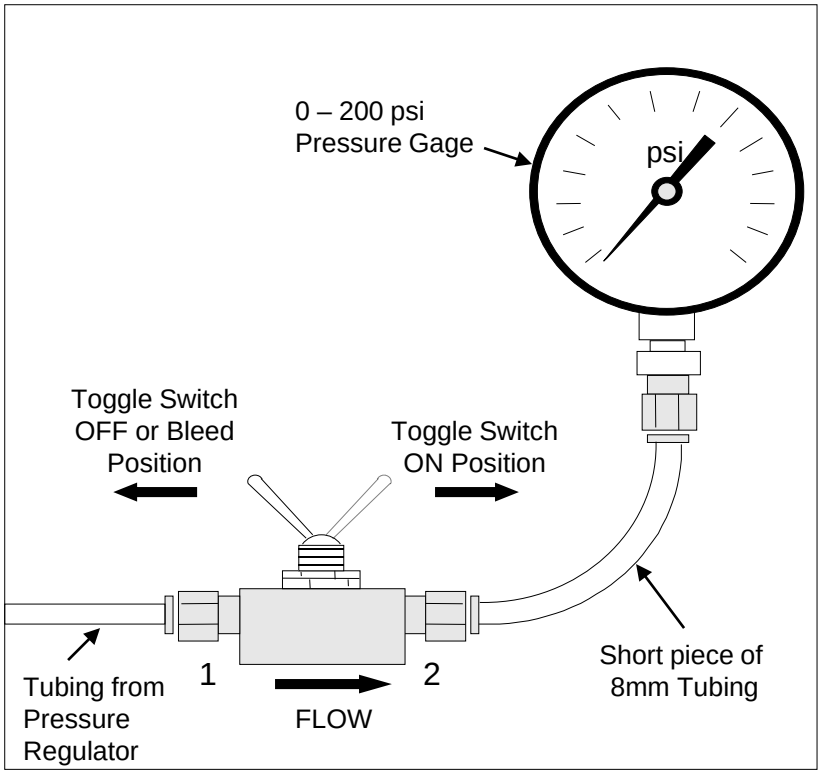

Figure 5
Bypass Switch Positions and Pressure Gage

Note: *Bypass Switch is "OFF" when toggle switch / handle is positioned back towards #1 Inlet coupling or pressure source (Bleed Position). Bypass Switch is "ON" when toggle switch / handle is positioned forward towards #2 Outlet coupling or tube span (Pressurizing Position).*

7.4 Open Bottle Supply Valve and turn Bypass Switch ON.

7.5 Slowly adjust Pressure Regulator Valve, increasing output pressure until 0-200 psi Hand-Held Pressure Gage reads 150 psi.

Note: *The Pressure Regulator's (0-400 psi) Pressure Gage and the 0-200 psi Hand-Held Pressure Gage readings may be different at this point. This is not unusual due to the differences in accuracy between the two Gages. Use the more accurate 0-200 psi Hand-Held Pressure Gage reading.*

7.6 Once 150 psi reading is obtained on 0-200 psi Hand-Held Pressure Gage, do <u>not</u> move / adjust Pressure Regulator Valve from its (now) "pre-set" position. Maintaining a constant 150 psi pressure setting will ensure better test accuracy throughout remainder of Pressure Test.

7.7 Close Bottle Supply Valve and turn Bypass Switch OFF. Any pressure in tubing and 0-200 psi Hand-Held Pressure Gage will vent to atmosphere through #3 vent port on bottom of Bypass Switch (a hissing sound will be heard).

7.8 Verify 0-200 psi Hand-Held Pressure Gage reads zero.

7.9 Uncouple 0-200 psi Hand-Held Pressure Gage from short 8mm tubing <u>and</u> uncouple short 8mm tubing from #2 Outlet coupling on Bypass Switch.

8.0 Pressure Test Set-up

8.1 Installer #1 remains at entry point FTU location.

8.2 Installer #2 takes 0-200 psi Hand-Held Pressure Gage to exit point FTU location.

8.3 Establish communications between Installers located at both ends of tube span.

8.4 Evaluate fiber bundle entry and exit point locations. Ensure they are well ventilated to disperse nitrogen gas released during Pressure Test operations. If necessary, use jumper tubing to extend entry and exit point FTU tubes to ventilated area. If required, provide auxiliary means of ventilation.

8.5 At entry and exit point FTUs, locate, identify, and verify correct tube span to be tested.

8.5.1 At entry point FTU, push-fit 8mm jumper tubing and a Tube Coupling between #2 Outlet on Bypass Switch and first tube to be tested.

8.5.2 When Installer #2 indicates ready, open Bottle Supply Valve and turn Bypass Switch ON to pressurize tube span.

8.5.3 At exit point FTU, verify pressure flows from correct tube; i.e.: do a "Continuity Check."

8.5.4 At entry point FTU, turn Bypass Switch OFF, close Bottle Supply Valve, and allow tube span to de-pressurize.

9.0 Pressure Testing

9.1 At exit point FTU, connect 0-200 psi Hand-Held Pressure Gage to first tube to be tested. If space is limited, push-fit 8mm jumper tubing and a Tube Coupling between first tube to be tested and 0-200 psi Hand-Held Pressure Gage to extend tube span and gage to a convenient working area.

9.2 At entry point FTU, ensure Bypass Switch is OFF and open Bottle Supply Valve.

9.3 When Installer #2 indicates ready to receive pressure, turn Bypass Switch ON to pressurize tube span.

Note: *Depending on tube span length, pressure build-up on the 0-200 psi Hand-Held Pressure Gage will be gradual. "Rule of Thumb," on average, it takes about 20 - 30 seconds to fully charge a 1000' length of tubing.*

9.4 When 0-200 psi Hand-Held Pressure Gage reading steadies out at 150 psi (gauge needle stops moving), tube span has reached full pressure. Installer #2 then directs Installer #1 to close Bottle Supply Valve.

9.5 After Bottle Supply Valve is closed, Installer #1 instructs Installer #2 to begin 10 second time count while observing 0-200 psi Hand-Held Pressure Gage reading.

Note: *The "10 second test period" is an approximate time value only and should be considered a minimum requirement.*

10.0 Pressure Test Completion

10.1 Pressure Test results are considered satisfactory if 0-200 psi Hand-Held Pressure Gage reading holds between 146 - 150 psi for 10 seconds.

10.1.1 Leakage exists if 0-200 psi Hand-Held Pressure Gage reading drops below 145 psi within 10 second test period.

10.1.2 All leakage problems must be located and repaired. See Troubleshooting recommendations in Para. 11.0.

10.2 At conclusion of 10 second test period, Installer #2 directs Installer #1 to turn Bypass Switch OFF and de-pressurize tube span.

Note: *Pressure Test results must be recorded. See Addendum A (Pressure Test Data Sheet) for a "suggested" format. Revise to suit specific needs.*

10.3 When tube span has de-pressurized, disconnect Bypass Switch and 0-200 psi Hand-Held Pressure Gage and repeat testing steps for remaining tube spans.

CAUTION: *When securing from Pressure Testing operations, always de-pressurize / vent the Pressure Regulator by turning its valve counterclockwise until the Output Pressure Gage reads zero. This step is vital to prevent damaging the Regulator's internal diaphragm.*

10.4 When Pressure Testing operations are concluded, close Bottle Supply Valve and open Pressure Regulator Valve to vent Regulator until its Output Pressure Gage reads zero.

11.0 Troubleshooting Leakage Problems

11.1 Troubleshooting pressure leaks in a tube span first requires finding where the leak points are located and then making repairs.

11.2 Basic Troubleshooting Method
The basic troubleshooting method is to apply 150 psi pressure to the faulty tube span and, with pressure left on, inspect the tube route. Listen for escaping air (a hissing sound).

11.3 Common Leak Point Locations
The most common locations for pressure leaks to occur are at Tube Coupling connections found in or near Tube Distribution and Fiber Termination Units (TDUs and FTUs).

11.4 Common Causes for Leaks
The most common causes for pressure leaks are listed below along with suggested repair techniques.

CAUTION: *Always ensure tube span is de-pressurized before attempting to disconnect any Tube Coupling.*

11.4.1 Tube is not fully seated in Tube Coupling
De-pressurize tube span and firmly push tube into Tube Coupling until it fully seats.

11.4.2 Tube end has slanted or jagged cut
De-pressurize tube span, disconnect tube, and trim end using Tubing Cutter (BETC001) to obtain straight, clean cut. Firmly push tube back into Tube Coupling. **See Fig. 6.**

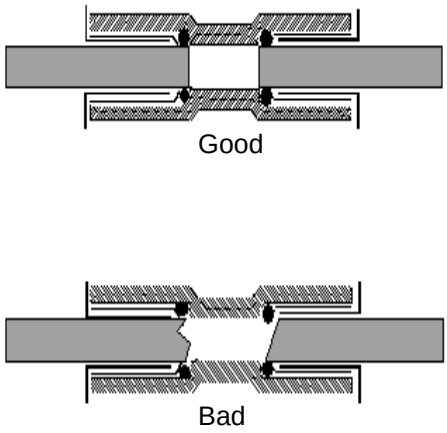

Figure 6
Importance of Good, Straight Tubing Cuts for Best Seat and Seal Inside Tube Couplings

11.4.3 Inside of Tube Coupling blocked
Contamination (dirt) or shavings build-up inside Tube Coupling (resulting from numerous tube coupling disconnect / re-connect cycles performed during troubleshooting) preventing good seat / seal with coupling O-rings. Clean out or replace Tube Coupling.

11.4.4 Tube is cut / nicked at end of tube cable outer jacket / sheath
This condition is typically caused by improper techniques used during tube cable jacket removal. More specifically, the outer jacket was scored too deeply and outer tubes were cut / nicked during the process. Repair is possible only if there is enough slack available to cut the bad tube off below where it is damaged and remove more outer jacket correctly. Install additional Tube Couplings and 8mm jumper tubing to restore original tube length.

11.5 Another Troubleshooting Method
Another effective troubleshooting method to help find pressure leaks is to “isolate” a long tube span into shorter segments / sections.

11.5.1 For example, at a mid-point TDU, disconnect Tube Coupling in faulty tube span and connect 0-200 psi Hand-Held Pressure Gage to front half of span.

11.5.2 Perform normal pressure testing steps.

11.5.3 If front half of tube span holds 150 psi for about 10 seconds, leakage is located in the back half of tube span. Further troubleshooting efforts should be concentrated in this area.

11.6 After repairs have been made, always conduct another Pressure Test to verify the total end-to-end airtight integrity of the tube span.

12.0 Alternate Pressure Test Method

12.1 The standard Tube Pressure Test procedure checks one tube span at a time. A “time-saving” method involves testing two tube spans at the same time. This method can be used provided the two spans under test run between the same end-to-end points.

12.2 The basic procedure to test two tube spans at the same time is identical to testing one tube span with the following exceptions.

12.2.1 At exit point FTU, use 8mm jumper tubing and Tube Couplings to connect the two span ends together. **See Fig. 7.**

12.2.2 At entry point FTU, connect Bypass Switch to one tube span (serves as supply leg) and 0-200 psi Hand-Held Pressure Gage to other tube span (serves as return leg). **See Fig. 7.**

12.2.3 Conduct Pressure Test following normal test procedures.

Note: *It is recommended to limit “multiple” tube testing to just two (2) tube spans at the same time. In the event there are pressure leaks, troubleshooting efforts can quickly become more complex and time consuming when dealing with multiple tube spans.*

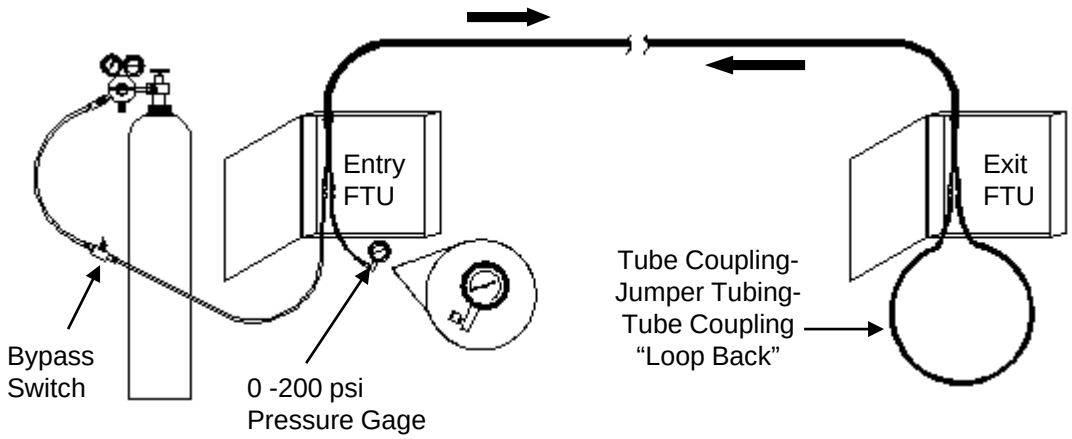

Figure 7
Alternate Pressure Test Method
To Test Two (2) Tubes at Same Time

13.0 Pressure Testing TCxxTP2 Plenum-Rated Tubes

13.1 Sumitomo Recommended Procedure *FutureFLEX Plenum-Rated Jacketed Tube Cable Installation Procedures,* SRP SP-F04-029 requires that TCxxTP2 tubes be tested with only 100 psi test pressure. Refer to SRP SP-F04-029.

13.2 If a particular tube span consists of TCxxTP2 tube cables and any other tube cable type or types (General Purpose-rated TGX, Riser-rated TRC, or any OSP TOX, TOD, or MSOS) that have a 6mm ID tube dimension, Obstruction Test the entire span with 100 psi pressure only.

Note: 4mm plastic beads (BEBB4OP) must be ordered separately for routes with plenum. Further described in SRP SP-F04-029.

FUTUREFLEX®

TUBE PRESSURE TEST DATA SHEET

Test Date:	**SEL Tube Cable Part Number (TCxxYYY):**
Test Event:	**Tube Cable Span or Segment ID Number**
Test Personnel:	**From:** **To:**
End-User Rep:	***Note: Tube Cable Part Numbers and Span / Segment ID numbers must match As-Built Drawing documentation***

Ref Doc = Sumitomo Recommended Procedure SRP SP-F04-003
Test Criteria = Hold 146 psi - 150 psi for 10 seconds

	Tube Cable Span or Segment ID Number	Tube Number (IN)	Tube Number (OUT)	Test Pressure (psi)	Time Held (secs)	Comments
1						
2						
3						
4						
5						
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