FIBER OPTIC STANDARDS

I. ENGINEERING

I.1. ENGINEERING DEFINITIONS

I.1.1. Fiber Optic Cable:

A cable that contains individual glass fibers, designed for the transmission of digital information, using light pulses.

I.1.2. All Dielectric Self Support (ADSS) Cable:

A cable designed and constructed with non-metallic components, that is designed for aerial applications and does not require a separate cable messenger.

OTDR:

I.1.3. Optical Time Domain Reflectometer.

A device used for characterizing a fiber, wherein an optical pulse is transmitted through the fiber and the resulting backscatter and reflections are measured as a function of time.

I.1.4. Single-mode Fiber:

An optical fiber with a small core diameter in which only a single mode of light is capable of propagation.

I.1.5. Multi-mode Fiber:

An optical fiber whose core diameter is large compared with the optical wavelength and which, consequently, a large number of light modes are capable of propagation.

I.1.6. Splicing:

A permanent junction between optical fibers. May be thermally fused or mechanically applied.

Minimum Bend Radius: The minimum radius a fiber may be bent before optical losses are induced.

I.2. FIBER OPTIONS:

I.2.1. The following plates are used to order/issue the fiber optic cable itself.

C.FIBER24 (24 Count Single-Mode Fiber, ADSS)

C.FIBER36 (36 Count, 30 Single-Mode/6Mulit-Mode, ADSS)

*For Special DOT Projects.

C.FIBER48 (48 Count Single-Mode Fiber, ADSS)

C.FIBER72 (72 Count Single-Mode Fiber, ADSS)

C.FIBERTR24 (ADSS, Track resistant, 24 count)

C.FIBERTR48 (ADSS, Track resistant, 48 count)

C.FIBERTR72 (ADSS, Track resistant, 24 count)

I.2.2. The plate RC.FIBER is used for relocating any fiber optic cable from one location to another. It should be plated for each cable once per station, not per foot.

I.3. JEA fiber optic cable should be located at least 40 inches from any other utility. Field conditions will vary, so the actual location of the FO cable on the pole must be considered by the person designing the project. Typically, the FO cable is installed on or near the neutral location, on the birthmark face of the pole.

I.4. Included at the end of this Section are the cable specifications and some installation guidelines from the manufacturer.

II. JEA FIBER OPTIC CABLE STANDARDS

JEA has standardized on two types of fiber optic cable designs. One type is for aerial installations and the other for underground. JEA has standardized on All Dielectric Self Support (ADSS) fiber cables for aerial installations and Cable-in-Conduit type for underground applications.

II.1. REQUIREMENTS FOR UNDERGROUND FIBER CABLE:

The cable-in-conduit cable shall be a fiber optic cable with a one-inch diameter polyethylene conduit extruded around it. The cable shall be a telecommunications grade, all dielectric optical cable designed for the high speed transmission of voice and data communications. The cable shall combine a loose tube fiber cable with a UV rated outer jacket and be designed for underground installations. The optical cable shall be furnished with twelve (12) single-mode, glass fibers. The glass fibers in the cable shall be distributed such that there are six (6) fibers per buffer tube. The glass fibers shall be manufactured by Corning Glass Company, SMF-28 CPC3. The annealed polyethylene conduit shall be formed by continually extruding it as a pipe over the fiber optic cable. There shall be no adhesion between the fiber cable jacket and the conduit's inner surface. The installed cable in the conduit shall be lubricated for easy pulling, if required in the future.

II.2. REQUIREMENTS FOR AERIAL FIBER CABLE:

JEA has standardized on four fiber cables for aerial applications. All the cables are Telecommunications grade fiber optic, all dielectric, self-supporting cables, designed for aerial installation on electric transmission structures. The cables are round and constructed according to the loose tube concept. The cables utilize standard utility hardware for installation. The cables shall combine a loose tube fiber cable with a UV rated outer jacket that reduces corona and tracking problems. The cables shall have sufficient jacket dielectric strength and resistance to tracking such that it can be located in a radial and axial electric field of 12 kV per meter. The cable designs provided shall be shown to exhibit zero fiber strain at maximum load. The optical cables shall be furnished with 16 single-mode glass fibers. The glass fibers in the cable shall be distributed such that there are four (4) fibers per buffer tube. The glass fibers shall be manufactured by Corning Glass Company, SMF-28 CPC3. The different cables are classified by the installation requirements:

II.2.1. <u>Short Span Cable (CAI-FO-S24):</u>

This cable is primarily for installation on distribution poles or short transmission lines. The cable is designed for a pole line span of 350 feet with a 3.5 foot nominal sag. The cable is a 24 fiber single-mode ADSS fiber cable, with a nominal cable diameter of .52 inches. Alcoa # FE924211C8.

II.2.2. <u>Medium Span Cable (CAI-FO-001):</u>

This cable is primarily for installation on transmission lines. The cable is designed for a pole line span of 600 feet with a 4 foot nominal sag. The cable is a 16 fiber, single mode, ADSS fiber cable with a nominal cable diameter of .52 inches. Alcoa # FE816211K3.

II.2.3. Long Span Cable (CAI-FO-003):

This cable is primarily for installation on long span transmission lines. The cable is designed for a pole line span of 1200 feet with a 10 foot nominal sag. The cable is a 16-fiber, single-mode, ADSS fiber cable with a nominal cable diameter of .54 inches. Alcoa # FE816211L5.

II.2.4. Long Span Cable (CAI-FO-L46):

This cable is primarily for installation on long span transmission lines. The cable is designed for a pole line span of 1000 feet with a 8 foot nominal sag. The cable is a 46 fiber, single-mode, ADSS fiber cable with a nominal cable diameter of .594 inches. This cable is used for AAV contracts. Alcoa # FE946211L4.

II.2.5. Track Resistant ADSS (CAI FOT 24)

II.2.6. Track Resistant ADSS (CAI FOT 48)

II.2.7. Track Resistant ADSS (CAI FOT 72)

III. JEA FIBER OPTIC AERIAL HARDWARE STANDARDS

III.1. FIB-SU-001:

All dielectric tangent attachment for distribution or transmission line spans up to 400’. For use with JEA standard fiber cable CAI-FO-001 & CAI-FO-S24 (.52” diameter), may be used for angles up to 15 degrees.

III.2. FIB-SU-002:

All dielectric tangent attachment for distribution or transmission line spans up to 400’. For use with JEA standard fiber cable CAI-FO-003 (.54” diameter), may be used for angles up to 15 degrees.

III.3. FIB-SU-003:

Armor Grip Suspension tangent attachment for transmission line spans over 400’. For use with JEA standard fiber cable CAI-FO-001 (.52” diameter), may be used for angles up to 30 degrees.

III.4. FIB-SU-004:

Armor Grip Suspension tangent attachment for transmission line spans over 400’. For use with JEA standard fiber cable CAI-FO-003 (.54” diameter), may be used for angles up to 30 degrees.

III.5. FIB-SU-005:

Armor Grip Suspension tangent attachment for transmission line spans over 400’. For use with JEA standard fiber cable CAI-FO-L46, CAI-FI-T24, CAI-FO-T48 (.594” diameter), may be used for angles up to 30 degrees.

III.6. FIB-SU-006:

All dielectric tangent attachment for distribution or transmission line spans over 400’. For use with JEA standard fiber cable CAI-FO-L72, CAI-FO-T72 (0.701” diameter), may be used for angles up to 15 degrees.

III.7. FIB-DE-001:

Armor Grip Suspension dead-end attachment, for distribution or transmission lines. For use with JEA standard fiber cable CAI-FO-001 & CAI-FO-S24 (.52" diameter).

III.8. FIB-DE-002:

Armor Grip Suspension dead-end attachment for distribution or transmission lines. For use with JEA standard fiber cable CAI-FO-003 (.54" diameter).

III.9. FIB-DE-003:
Armor Grip Suspension dead-end attachment for distribution or transmission lines. For use with JEA standard fiber cable CAI-FO-L46, CAI-FO-T24, CAI-FO-T48 (0.594" diameter).

III.10. FIB-DE-007:
Armor Grip Suspension dead-end attachment for distribution or transmission lines. For use with JEA standard fiber cable CAI-FO-L72, CAI-FO-T72 (0.701" diameter).

III.11. FIB-CR-001:
Corona Ring for use when engineering analysis indicates it is required on 25kV track resistant ADSS cable. CAI-FO-T24, CAI-FO-T48 (0.549" diameter).

III.12. FIB-CR-002
Corona Ring for use when engineering analysis indicates it is required on 25kV track resistant ADSS cable. CAI-FO-T72 (0.701" diameter).

IV. INSTALLATION

IV.1. PLANNING

IV.1.1. General planning guidelines to be considered prior to the installation of the cable

IV.1.1.1. Number of 90 Degree Turns:

The number of 90 degree turns on a pull shall not exceed 6 for aerial cables and 4 for underground cable-in-conduit.

IV.1.1.2. Attachment Point:

The attachment location and method, drill, band, etc., shall be selected based on the type of structure to which the cable is to be attached. The attachment point will be established based on electric field predictions (< 12 kV/meter), blow out characteristics of the fiber cable in relation to energized lines, sag, tension and congestion on the Transmission and/or Distribution structures.

IV.2. AERIAL FIBER OPTIC CABLE PULLING GUIDELINES

IV.2.1. Bend Radius:

The main risk of damage to the fiber optic cable is by overlooking the minimum bending radius. It is important to know that the damage occurs more easily when the cable is bent under tension, so when the installation is in the process be sure to allow for a 13 inch bending radius. This is a problem when the cable drapes over the pulling blocks because of improper back tensioning, or during pulls around corners.

IV.2.2. Turns and Tangents:

Twenty-three inch diameters stringing blocks or the special fiber optic blocks, should be used on all turns or angles, however, seven inch stringing blocks may be used on tangent pulls if the pull remains taut at all times and the spans are less than 600'. Smaller stringing blocks are not be used. Pulling block assemblies from Sherman & Reilly (constructed of three seven inch dollies) must be used at all turns in the route that exceed 20 degrees and for spans that are greater than 700'.

IV.2.3. Reel Placement:

Have the reel set back from the first pole by 70 or more feet or use a pulling block assembly from Sherman & Reilly (constructed of three seven inch dollies) at the first structure. Use the breaking system on the drum feeder at all times, damage will occur if the cable sags severely off any of the dollies.

IV.2.4. Strength:

IV.2.4.1. The fibers in the cable will shatter under considerable impact, pressure or if pulling tensions exceed 1900 lbs., although from the outside of the cable this will not be apparent.

IV.2.4.2. With fiber optic cable, the jacket of the cable and the Kevlar layer directly beneath give the cable its strength; so please be sure to note and repair all nicks and cuts.

IV.2.5. Hardware:

Note that the cable strength is designed for each route's requirements and that hardware may change with each cable although some hardware appears identical. The substitution of attachment hardware is not acceptable under any circumstances. Contact the project engineer if there are any questions about the hardware. All dead-ended assemblies should be grounded to the structure ground. Install a spiral vibration unit at all spans that exceed 440 feet. One damper per span for spans 450 to 550 feet, two dampers per span for spans 560 to 1100 feet and four dampers per span for spans above 1200 feet.

IV.2.6. Installation:

Use a swivel, the tightening tool provided for the all-dielectric small span tangent units, the fiber optic dead-end fully wrapped and clipped in for tensioning the cable.

IV.2.7. Precautions:

Please review the manufacturer's installation instructions prior to commencing with the installation. If any questions arise during installation, please refer to the manufacturer's installation instructions, or notify the project engineer. Always ground a cable that is installed prior to handling. If the fiber cable is to be installed closer than 6' away from an energized line of 138 kV or higher, a slip ground should be used during pulling.

IV.2.8. Testing:

Perform OTDR test on each fiber in the installed cable, to verify that the parameters of each fiber meet the system design criteria.

IV.3. JEA GUIDELINES FOR PULLING UNDERGROUND FIBER OPTIC CABLE

IV.3.1. Bend Radius:

The main risk of damage to the fiber optic cable is by overlooking the minimum bending radius. It is important to know that the damage occurs more easily when the cable is bent under tension, so when the installation is in process, be sure to allow for a 13 inch bending radius.

IV.3.2. Turns and Tangents:

Special fiber optic blocks should be used on all turns or angles.

Reel Placement:

Have the reel set back from the manhole and use a fiber optic manhole pulling block assembly from Sherman & Reilly.

IV.3.3. Strength:

The fibers in the cable will shatter under considerable impact, pressure or if pulling tensions exceed 600 lbs., although from the outside of the cable this will not be apparent. With fiber optic cable the jacket of the cable and the Kevlar layer directly beneath give the cable its strength so please be sure to not and repair all nicks and cuts.

IV.3.4. Installation:

When installing use a swivel eye for pulling the fiber optic cable and conduit system.

IV.3.5. Precautions:

Please review the manufacturer's installation instructions prior to commencing with the installation. If any questions arise during installation, please refer to the manufacturer's installation instructions, or notify the project engineer.

IV.3.6. Testing:

Perform OTDR test on each fiber in the installed cable to verify that the parameters of each fiber meet the system design criteria.

V. SAFETY

V.1. The fiber optic cables used by JEA, being constructed entirely of non-conducting, all-dielectric materials are designed for installation around high voltage lines. In this application the fiber cable is classified as a fiber supply cable, and can only be installed, maintained and handled by electric utility employees trained and equipped to work on an around electric supply lines.

V.2. Although the fiber cable is made entirely of non-conducting materials, under certain conditions it is still capable of having induced or static charges on its surface. These fields can, however, induce a static surface charge that can be dangerous if touched bare handed. To ensure the safety of field operations personnel, it is recommended that all fiber cable installed near and around JEA electric facilities, be treated as an energized conductor and that it be grounded prior to handling. It should be made clear that fiber cable is more susceptible to crushing than regular conductors, so proper grounding techniques should be observed. See cable manufacturer's literature in Section III.

VI. INSTALLATION LOCATIONS

VI.1. Distribution

The fiber optic cables may be attached to distribution poles at various elevations, as determined by the appropriate process owner within Utility Service Capacity (USC). This attachment location may be in the supply space of the pole, as determined by NESC rules. Installation and maintenance of cable facilities in this location must be performed by qualified electric utility personnel, or an approved electric utility contractor.

VI.2. JEA Transmission Poles

The fiber cables may be installed on JEA transmission line poles at locations as determined by the appropriate process owner within USC. The attachment of communication cables to transmission line poles is limited to JEA owned fiber optic cables only. The installation and maintenance of cable facilities in this location must be performed by qualified transmission line utility personnel, or approved transmission line contractors.

VI.3. JEA Conduits and Building Entrances

The installation of fiber cable in JEA's downtown underground conduit system and building entrances is determined by USC. As a general guideline, if 3 or more spare power conduits are available between any two manholes in the downtown underground conduit system, one of the spare conduits may be reserved for JEA fiber communications. USC is responsible for determining what constitutes a spare conduit. The installation and maintenance of fiber cable in JEA's underground conduit system, must be performed by qualified electric utility personnel, or approved electric utility contractors.

VI.4. Location of Fiber Optic Attachments for Joint Use Agreements:

All fiber optic facilities associated with Joint Use applications must be capable of being installed in the JEA Communication Use Location as it is determined by USC. In addition, joint use requests in the JEA underground conduit system, will be subject to the following additional requirements:

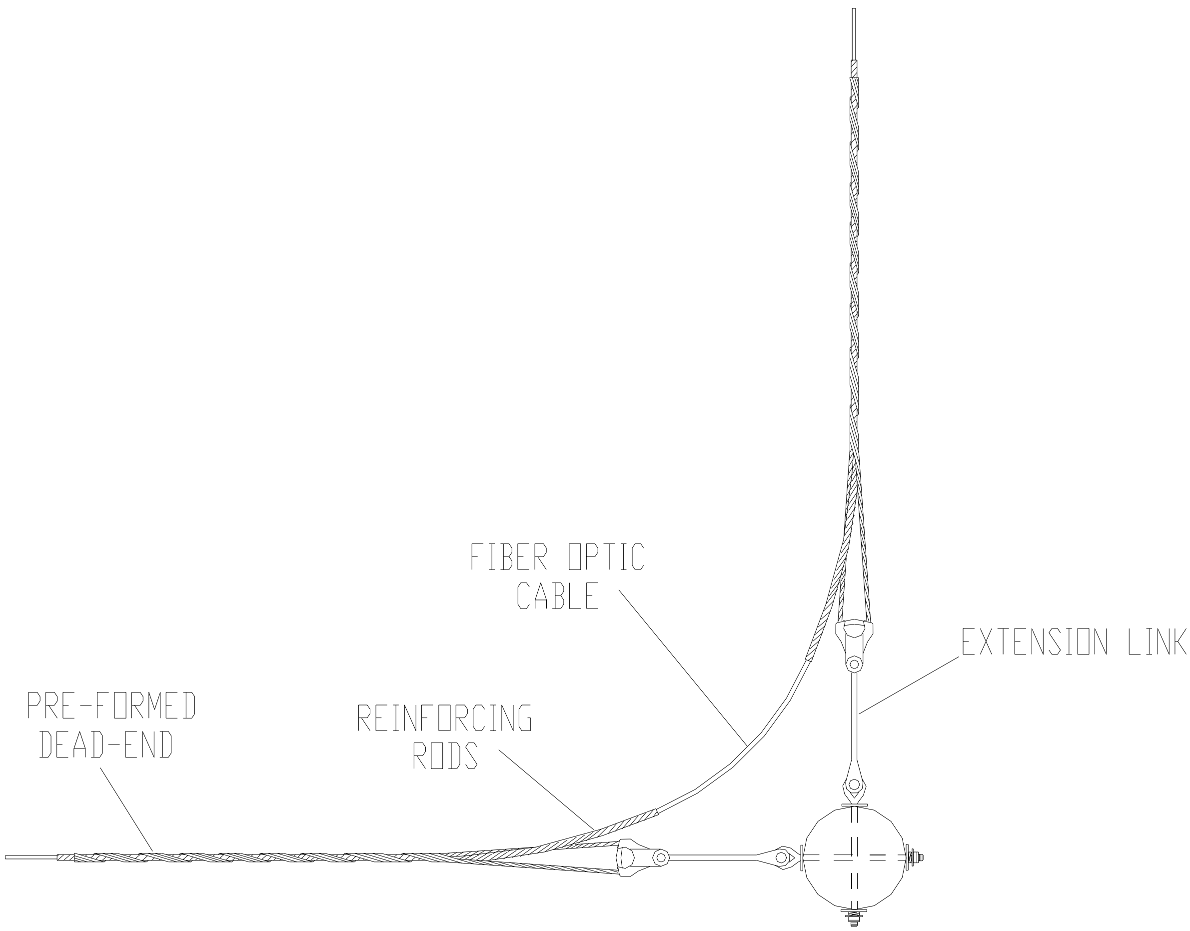
VI.4.1. Joint Use Conduit Requirements:

If a joint use request is granted, the first joint use party, in addition to bearing all costs for the installation of the fiber cable, shall bear all the costs of installing a 5-way inner-duct system in the spare conduit reserved for JEA communications. The 5-way inner-duct system shall be used for the JEA fiber cable, the first joint use party and any other future joint use parties.

VI.4.2. Joint Use Building Entrances Requirements:

If a joint use request is granted, the first joint use party in addition to bearing all costs for the installation of the fiber cable, shall bear all the costs of installing a 5-way inner-duct system in the spare conduit reserved for JEA communications. The 5-way inner-duct system shall be used for the JEA fiber cable, the first joint use party and any other future joint use parties. In all cases, the joint use party must submit with their joint use request written documentation from the Owner of the building or facility that the joint use party is granted access to the building via the JEA power entrance

FO-A (MAINTENANCE ONLY)
90 DEGREE ANGLE
OPTIONS:24, 36, 48, 72
BOLT PLATE: NONE

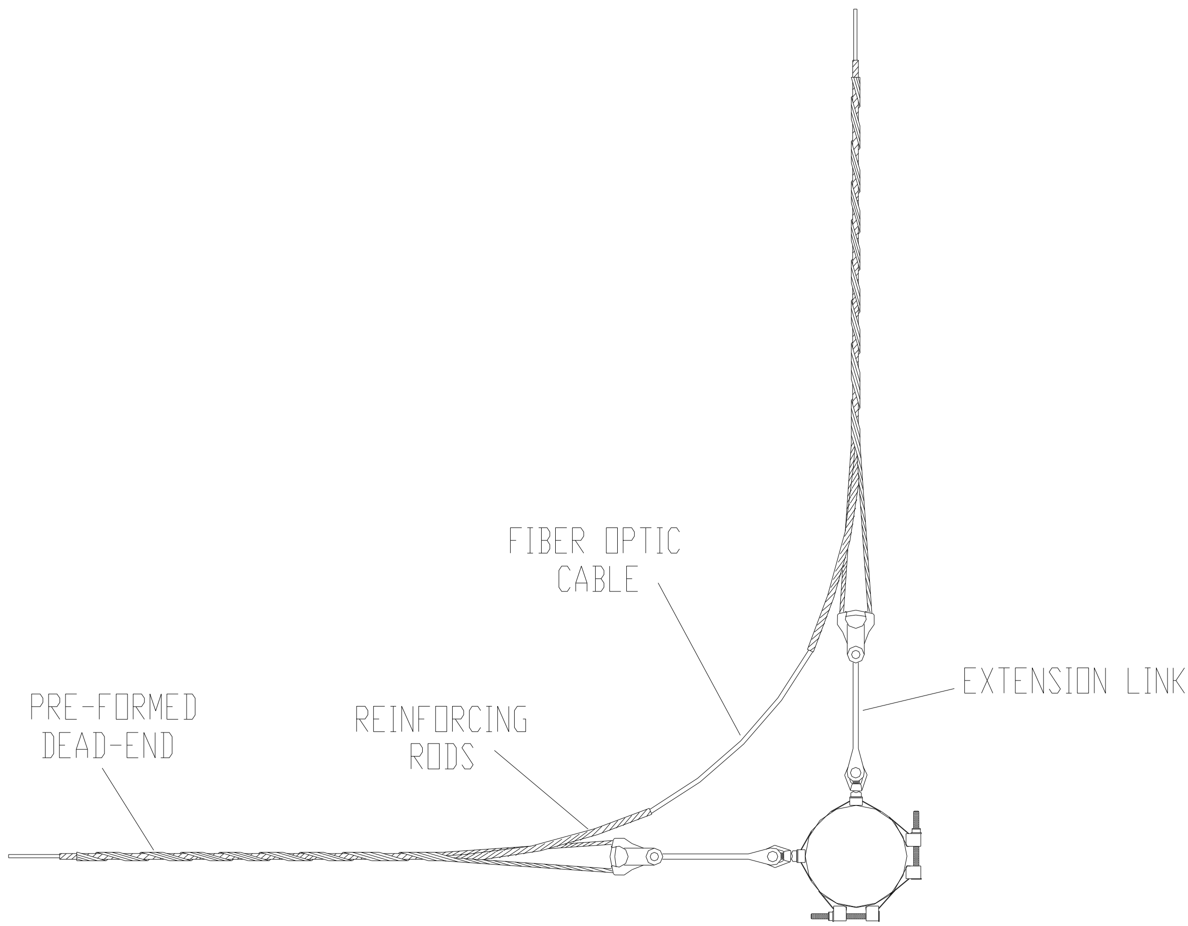


NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 005	2	BOLT, EYE, 5/8 X 16
2	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
3	FIB DE ***	2	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
4	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
5	WAS RD 004	2	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
6	WAS SF 002	4	WASHER, SQUARE, FLAT, 2-1/4”, FOR 5/8 IN. DIA. BOLT
7	WAS SP 002	2	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT

FO-ABD (MAINTENANCE ONLY)

90 DEGREE ANGLE, BANDED

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

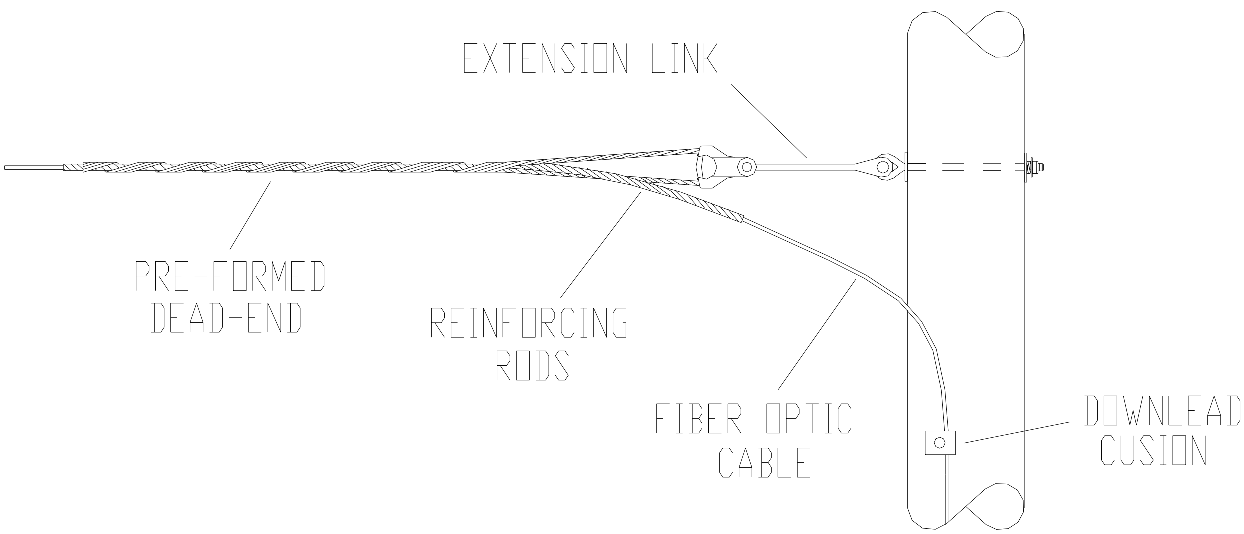


NO.	ITEM ID	QTY	DESCRIPTION
1	FIB BD 001	12	1.25 IN. STAINLESS STEEL BANDING
2	FIB BK 002	4	BOLTED RETAINER FOR S.S. BANDING
3	FIB DE ***	2	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
4	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
5	FIB MT 001	2	FIBER OPTIC MOUNTING PLATE
6	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
7	NUT EY 002	2	NUT, EYE, 5/8 IN.

FO-D (MAINTENANCE ONLY)

DEAD-END

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

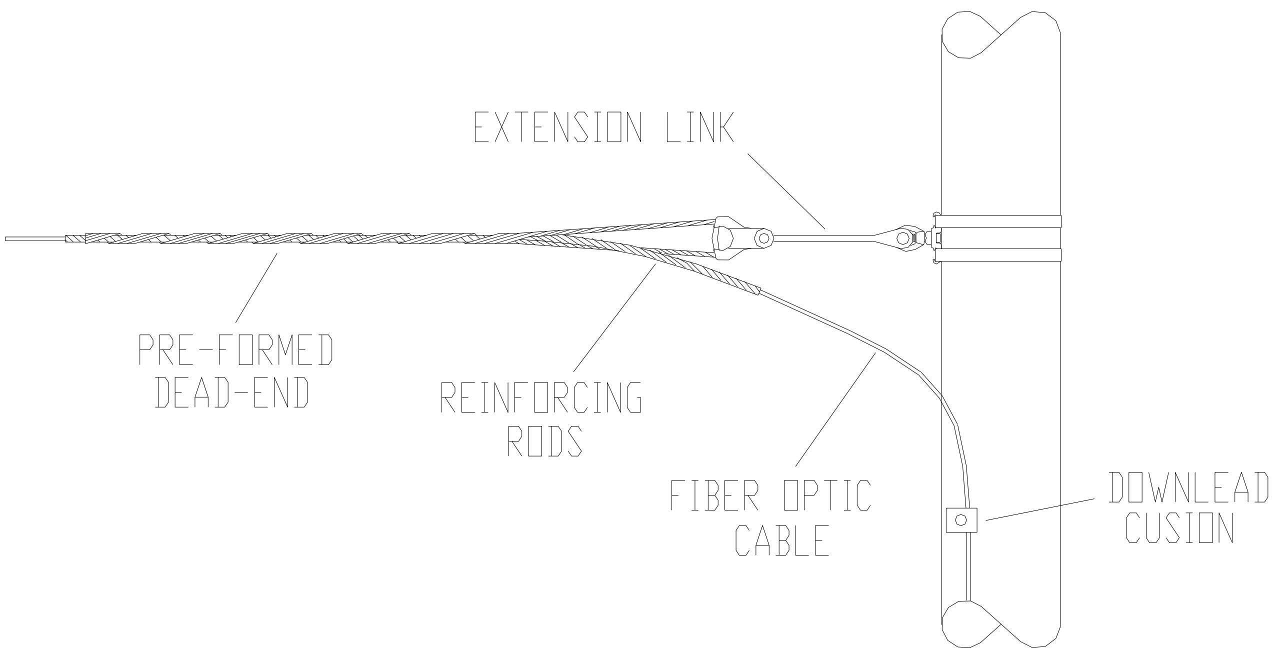


NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 005	1	BOLT, EYE, 5/8 X 16
2	FIB CL 001	1	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
3	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
4	FIB DE ***	1	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
5	LIK EX 002	1	LINK, EXTENSION, CLEVIS EYE
6	WAS RD 004	1	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
7	WAS SF 002	2	WASHER, SQUARE, FLAT, 2-1/4”, FOR 5/8 IN. DIA. BOLT
8	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT

FO-DBD (MAINTENANCE ONLY)

DEAD-END, BANDED

OPTIONS: 4, 36, 48, 72
BOLT PLATE: NONE

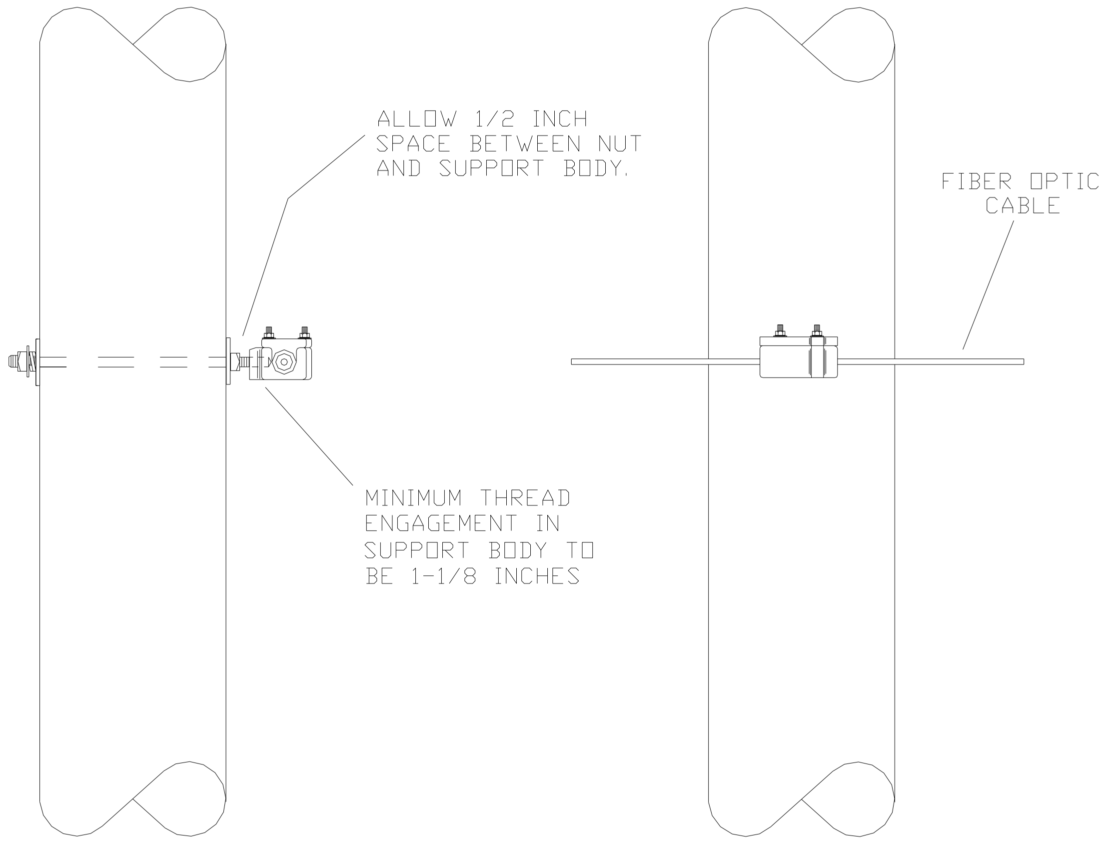


NO.	ITEM ID	QTY	DESCRIPTION
1	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
2	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
3	FIB CL 001	1	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
4	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
5	FIB DE ***	1	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
6	FIB MT 001	1	FIBER OPTIC MOUNTING PLATE
7	LIK EX 002	1	LINK, EXTENSION, CLEVIS EYE
8	NUT EY 002	1	NUT, EYE, 5/8 IN.

FO-T (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

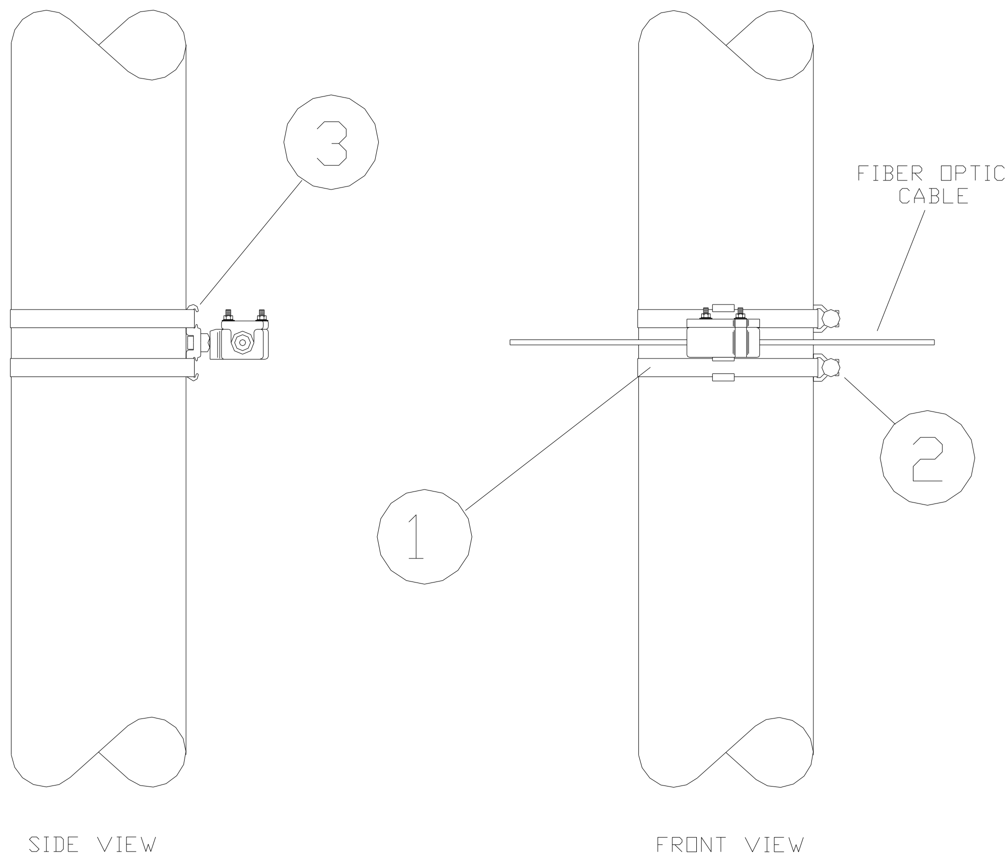


NO.	ITEM ID	QTY	DESCRIPTION
1	BOL DA 003	1	BOLT, DOUBLE ARMING, 5/8 X 16
2	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT
3	WAS RD 004	1	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
4	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT
5	WAS SF 003	2	WASHER, SQUARE, FLAT, 3 IN., FOR 3/4 IN. DIA. BOLT

FO-TBD (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE, BANDED

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

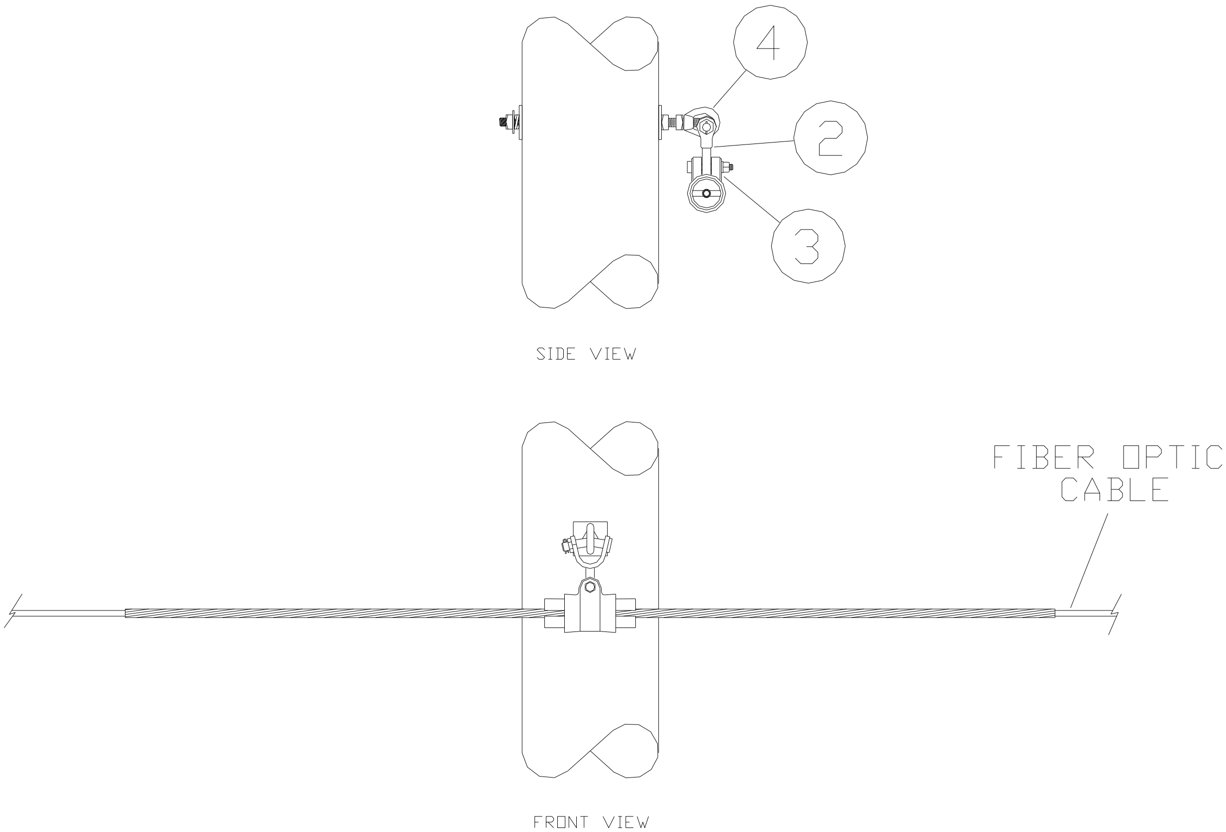


NO.	ITEM ID	QTY	DESCRIPTION
1	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
2	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
3	FIB MT 001	1	FIBER OPTIC MOUNTING PLATE
4	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT

FO-TL (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE – LONG SPAN

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

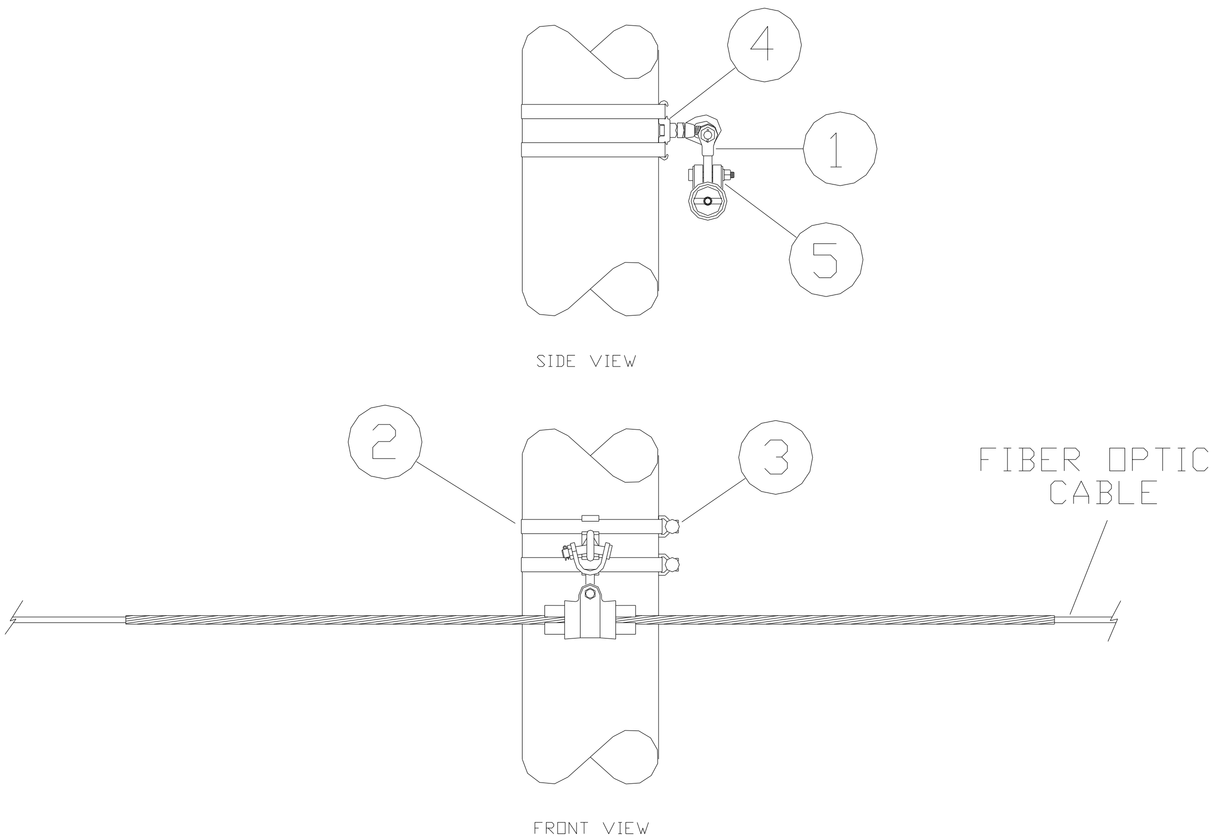


NO.	ITEM ID	QTY	DESCRIPTION
1	BOL DA 003	1	BOLT, DOUBLE ARMING, 5/8 X 16
2	CLE TE 004	1	CLEVIS, TOWER EYE, 90 DEGREE
3	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT
4	NUT EY 002	1	NUT, EYE, 5/8 IN.
5	WAS RD 004	1	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
6	WAS SF 003	2	WASHER, SQUARE, FLAT, 3 IN., FOR 3/4 IN. DIA. BOLT
7	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT

FO-TLBD (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE, LONG SPAN, BANDED

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

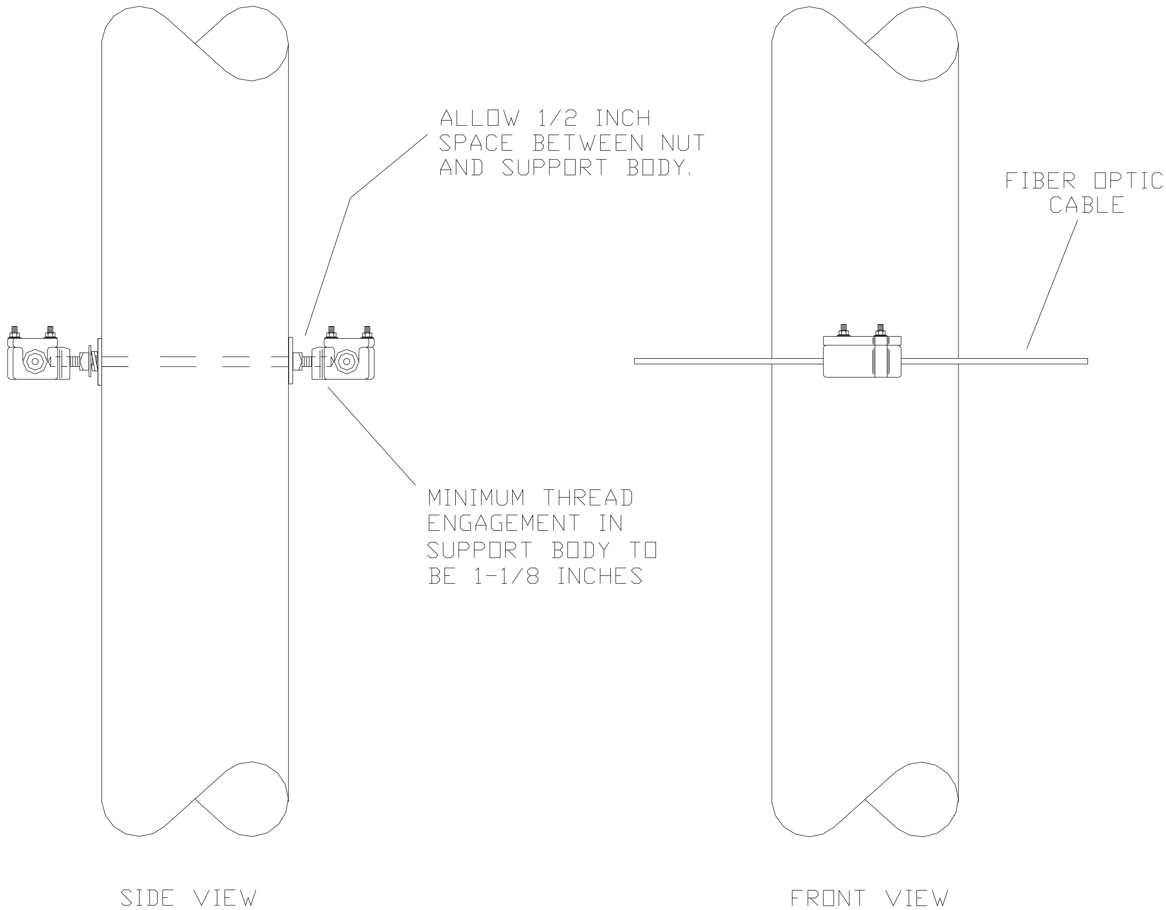


NO.	ITEM ID	QTY	DESCRIPTION
1	CLE TE 004	1	CLEVIS, TOWER EYE, 90 DEGREE
2	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
3	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
4	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT
5	FIB MT 001	1	FIBER OPTIC MOUNTING PLATE
6	NUT EY 002	1	NUT, EYE, 5/8 IN.

FO-TP (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE, PARALLEL

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

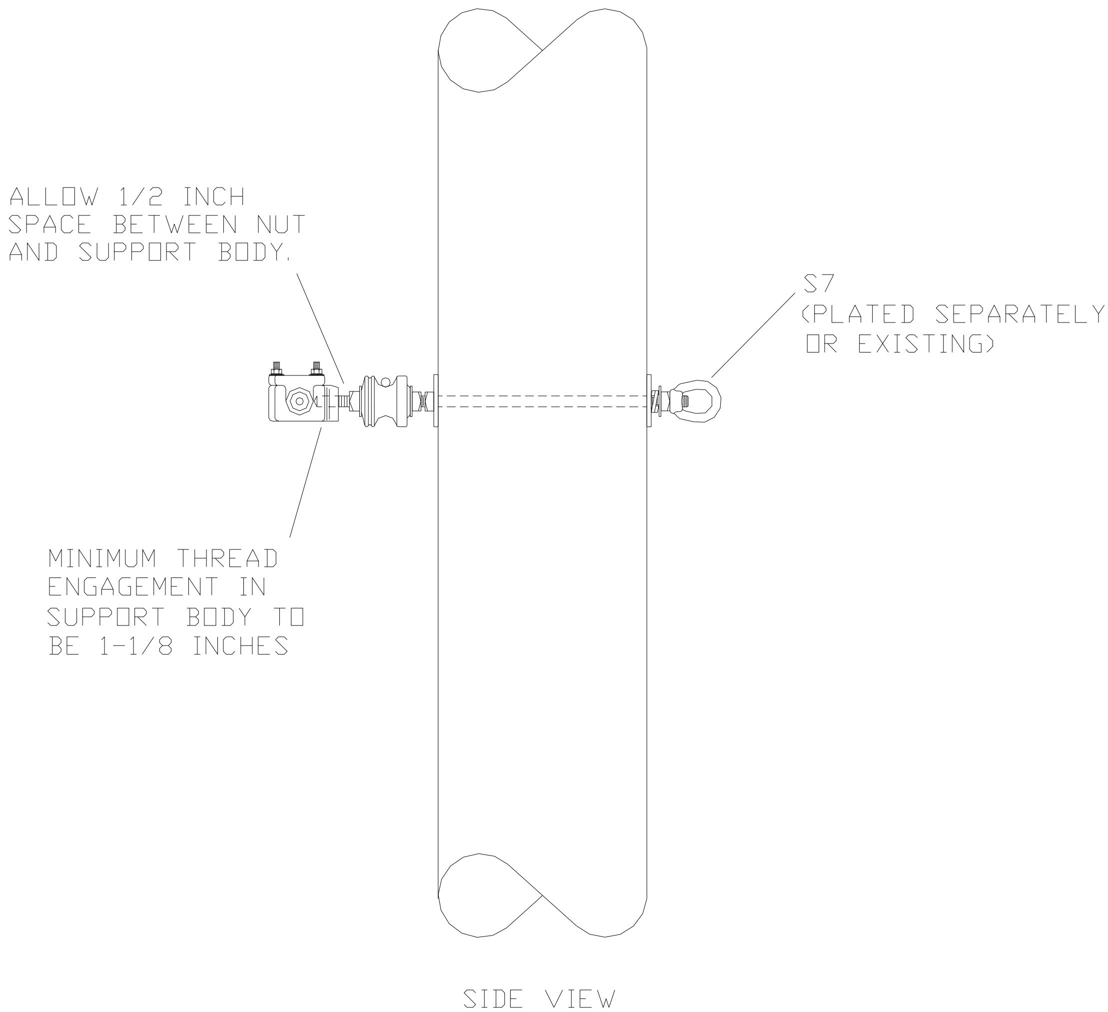


NO.	ITEM ID	QTY	DESCRIPTION
1	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT

FO-TN (MAINTENANCE ONLY)

0 TO 15 DEGREE ANGLE AT NEUTRAL

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

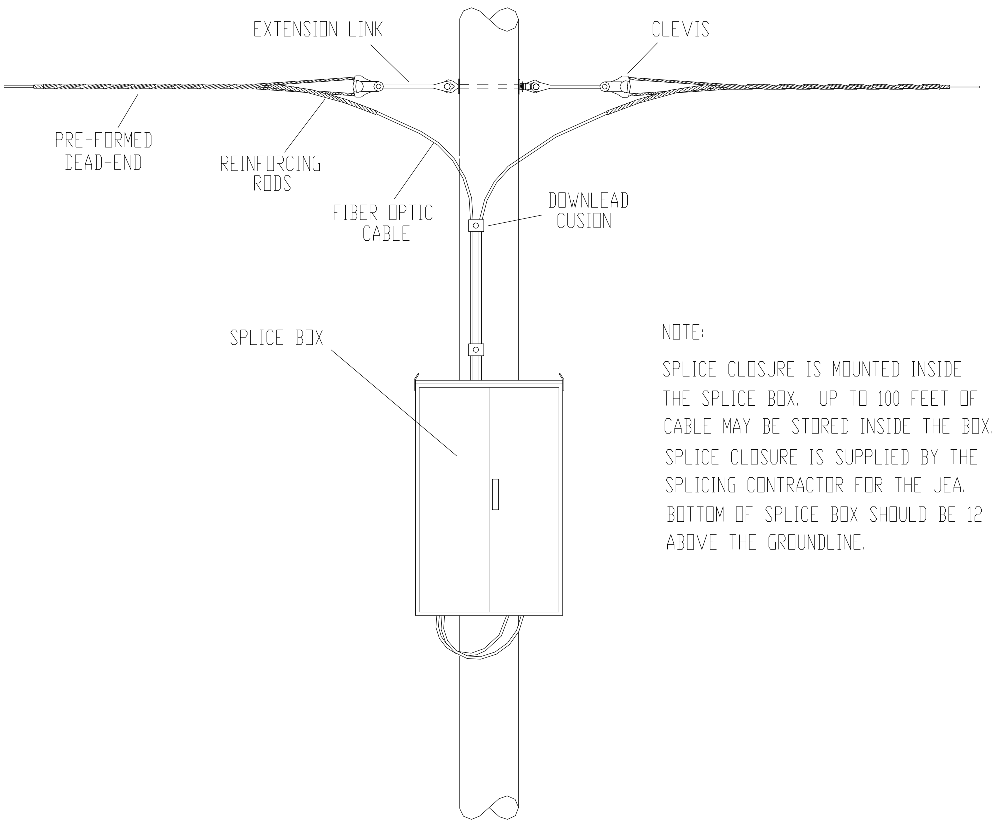


NO.	ITEM ID	QTY	DESCRIPTION
1	FIB SU ***	1	GENERAL CODE FOR FIBER OPTIC CABLE SUPPORT

FO-SB (MAINTENANCE ONLY)

FIBER OPTIC SPLICE BOX

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONEFO-CS



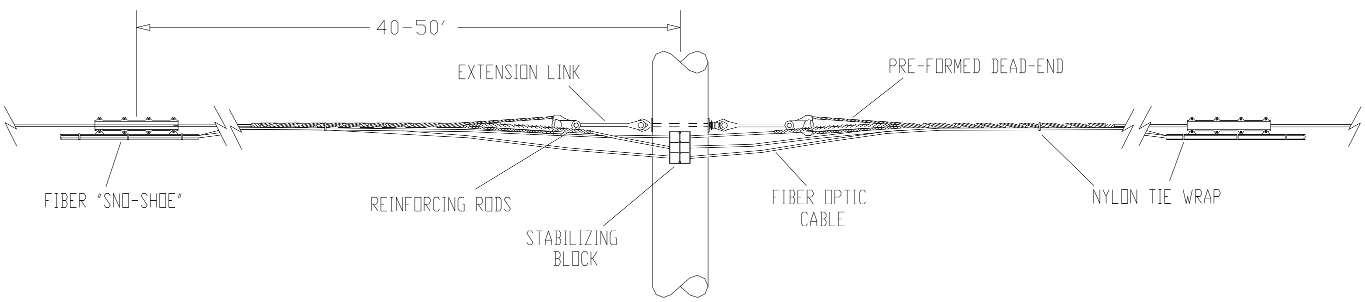
NOTE:
SPLICE CLOSURE IS MOUNTED INSIDE THE SPLICE BOX. UP TO 100 FEET OF CABLE MAY BE STORED INSIDE THE BOX.
SPLICE CLOSURE IS SUPPLIED BY THE SPLICING CONTRACTOR FOR THE JEA.
BOTTOM OF SPLICE BOX SHOULD BE 12 FEET ABOVE THE GROUNDLINE.

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 005	1	BOLT, EYE, 5/8 X 16
2	BOL MS 006	2	BOLT, MACHINE, 1/2”x16”
3	FIB BX 001	1	FIBER OPTIC CABLE STORAGE CLOSURE
4	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
5	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
6	FIB DE ***	2	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
7	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
8	NUT EY 002	1	NUT, EYE, 5/8 IN.
9	WAS RD 003	2	WASHER, ROUND, 1-3/8 INCH, FOR 1/2 IN. DIA. BOLT
10	WAS RD 004	1	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
11	WAS SF 002	2	WASHER, SQUARE, FLAT, 2-1/4”, FOR 5/8 IN. DIA. BOLT
12	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT
13	WAS SP 003	2	WASHER, SPRING, 1/2”

FO-CS (MAINTENANCE ONLY)

CABLE STORAGE

OPTIONS: 24, 36, 48, 72
BOLT PLATE: NONE

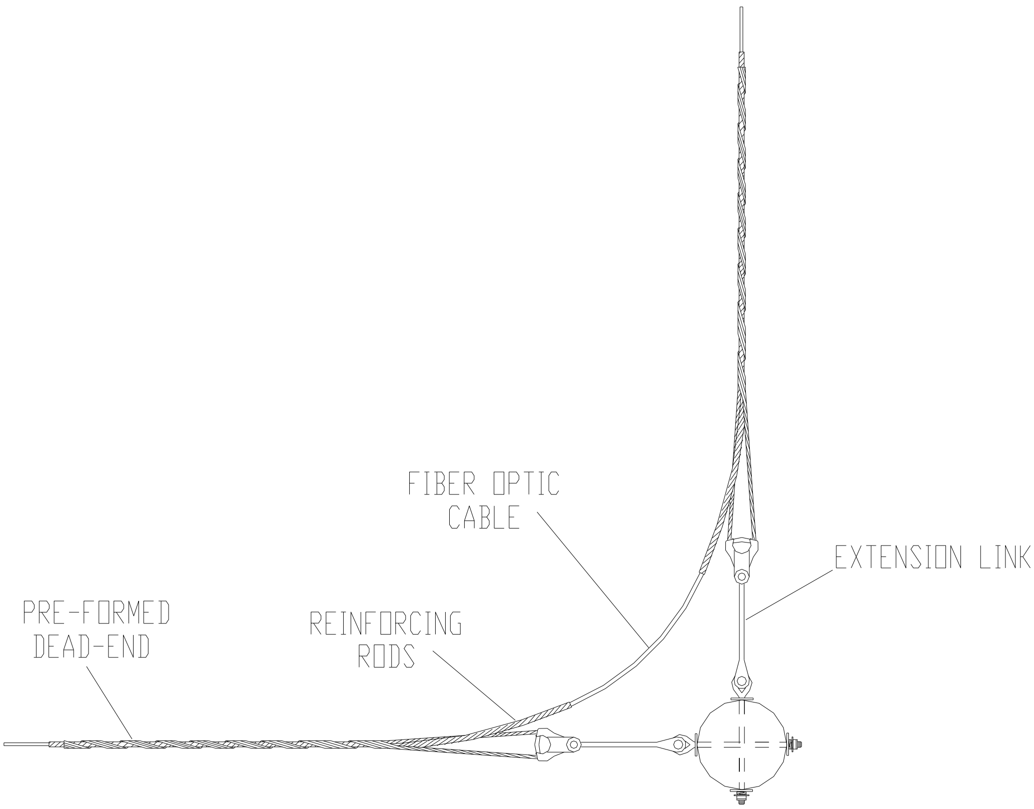


NO.	ITEM ID	QTY	DESCRIPTION
1	BOL DA 003	1	BOLT, DOUBLE ARMING, 5/8 X 16
2	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
3	FIB CS ***	1	FIBER OPTIC CABLE STORAGE SYSTEM
4	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
5	FIB DE ***	2	DEAD-END, PREFORMED FOR FIBER OPTIC CABLE
6	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
7	NUT EY 002	2	NUT, EYE, 5/8 IN.
8	TIE CA 001	40	TIE, CABLE, HEAVY DUTY, 28”-33” LONG
9	WAS RD 004	1	WASHER, ROUND, 1-3/4 INCH, FOR 5/8 IN. DIA. BOLT
10	WAS SF 002	2	WASHER, SQUARE, FLAT, 2-1/4”, FOR 5/8 IN. DIA. BOLT
11	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4 IN. DIA. BOLT

FO-TX-A

90 DEGREE ANGLE

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-A Base

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 015	2	BOLT, EYE, $^5/_8$"X 36"
	CNN VG 003	2	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	20	CONDUCTOR, #4 SOLID
2	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
4	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	2	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
	NUT EY 002	2	NUT, EYE, $^5/_8$"
5	WAS RD 004	2	WASHER, ROUND, $1^3/_4$ ", FOR $^5/_8$" DIA. BOLT
6	WAS SF 002	4	WASHER, SQUARE, FLAT, $2^1/_4$ " FOR $^5/_8$" DIA. BOLT
7	WAS SP 002	2	WASHER, SPRING, DOUBLE HELIX, FOR $^3/_4$" DIA. BOLT

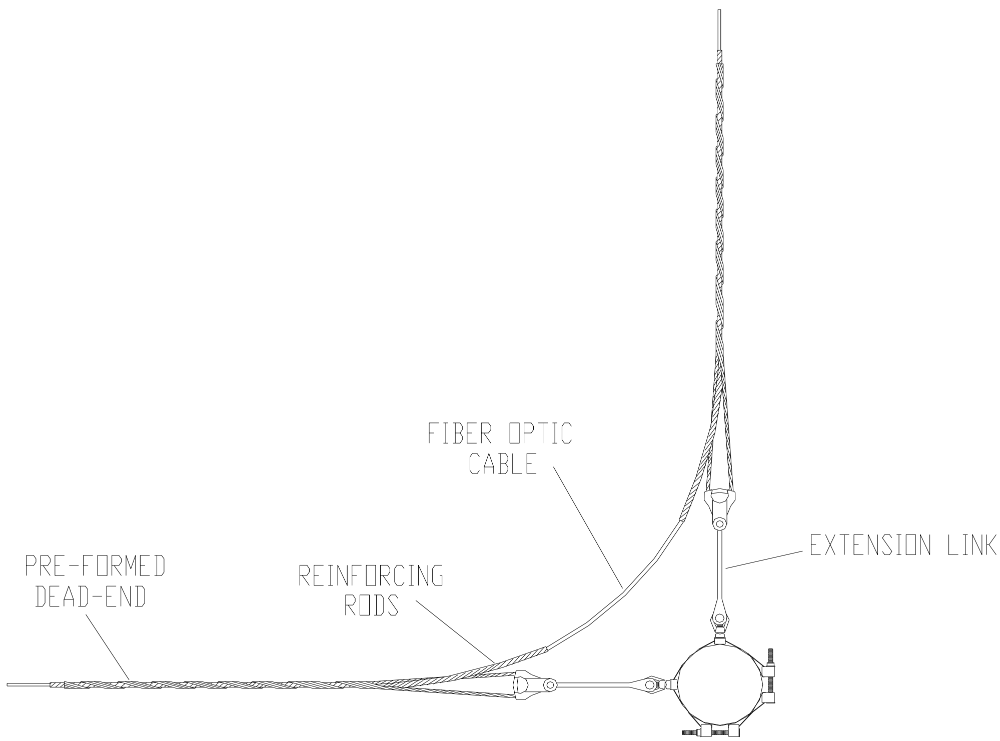
FO-TX-A* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
48	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-ABD

90 DEGREE ANGLE, BANDED

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-ABD Base

NO.	ITEM ID	QTY	DESCRIPTION
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
1	FIB BD 001	12	1.25" STAINLESS STEEL BANDING
2	FIB BK 002	4	BOLTED RETAINER FOR S.S. BANDING
4	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
5	FIB MT 001	2	FIBER OPTIC MOUNTING PLATE
6	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
7	NUT EY 002	2	NUT, EYE, $^{5}/_{8}$"
	WAS RD 004	2	WASHER, ROUND, 1$^{3}/_{4}$ ", FOR $^{5}/_{8}$"DIA. BOLT

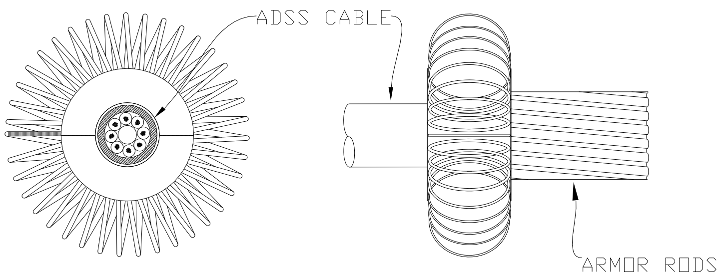
FO-TX-ABD* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
48	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-CR

CORONA RING

OPTIONS: 24, 48, 72



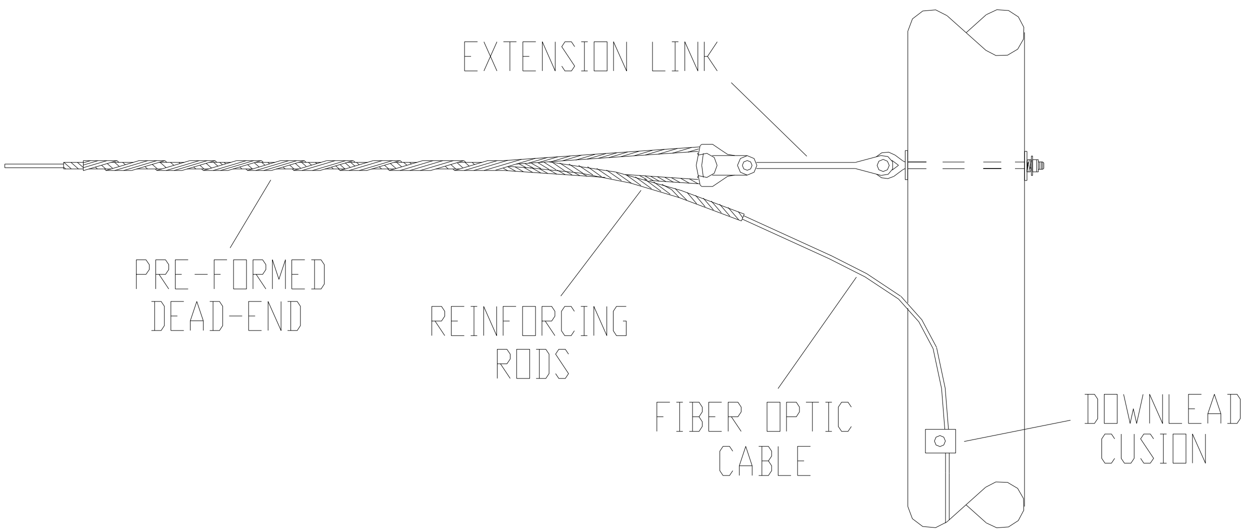
FO-TX-CR* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB CR 001	1	CORONA RING, FIBER OPTIC, FOR 0.549 INCH DIAMETER CABLE.
48	FIB CR 001	1	CORONA RING, FIBER OPTIC, FOR 0.549 INCH DIAMETER CABLE.
72	FIB CR 002	1	CORONA RING, FIBER OPTIC, FOR 0.701 INCH DIAMETER CABLE.

FO-TX-D

DEAD-END

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-D Base

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 015	1	BOLT, EYE, 5/8" X 36"
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
2	FIB CL 001	1	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
3	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
5	LIK EX 002	1	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
	NUT SQ 003	1	NUT, SQUARE, 5/8"
6	WAS RD 004	1	WASHER, ROUND, 1 3/4 ", FOR 5/8"DIA. BOLT
7	WAS SF 002	2	WASHER, SQUARE, FLAT, 2 1/4", FOR 5/8"DIA. BOLT
8	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR 3/4" DIA. BOLT

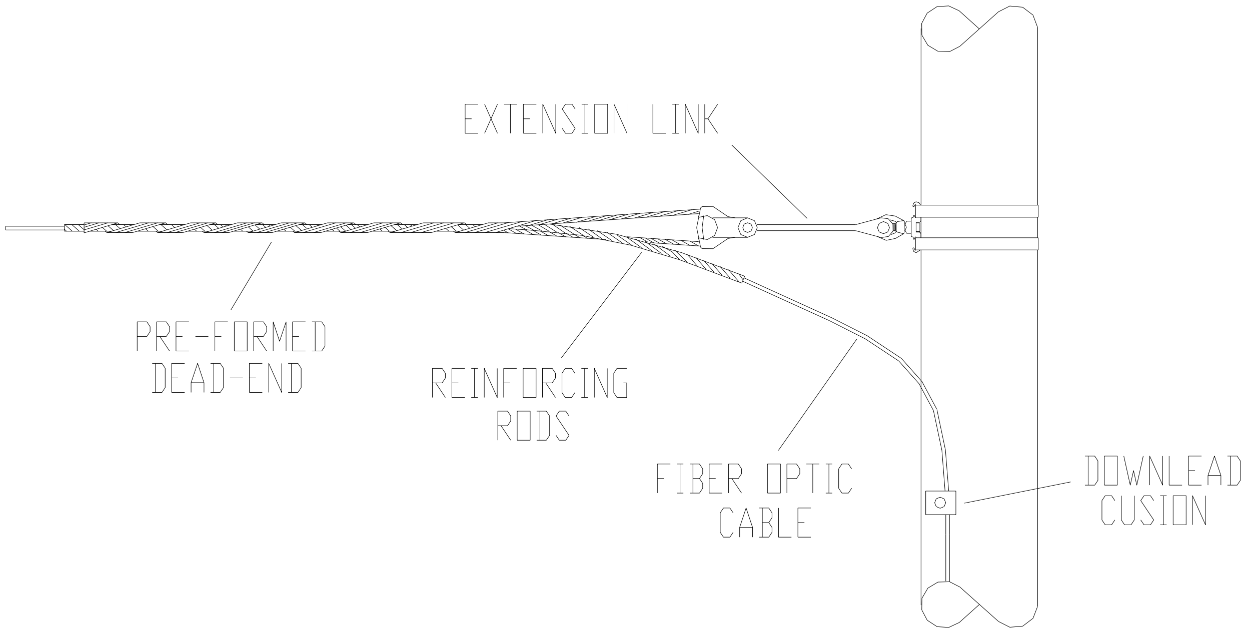
FO-TX-D* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	1	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
48	FIB DE 003	1	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
72	FIB DE 007	1	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-DBD

DEAD-END, BANDED

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-DBD Base

NO.	ITEM ID	QTY	DESCRIPTION
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
1	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
2	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
3	FIB CL 001	1	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
4	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
6	FIB MT 001	1	FIBER OPTIC MOUNTING PLATE
7	LIK EX 002	1	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
8	NUT EY 002	1	NUT, EYE, $^5/_8$"
	WAS RD 004	2	WASHER, ROUND, $1^3/_4$ ", FOR $^5/_8$"DIA. BOLT

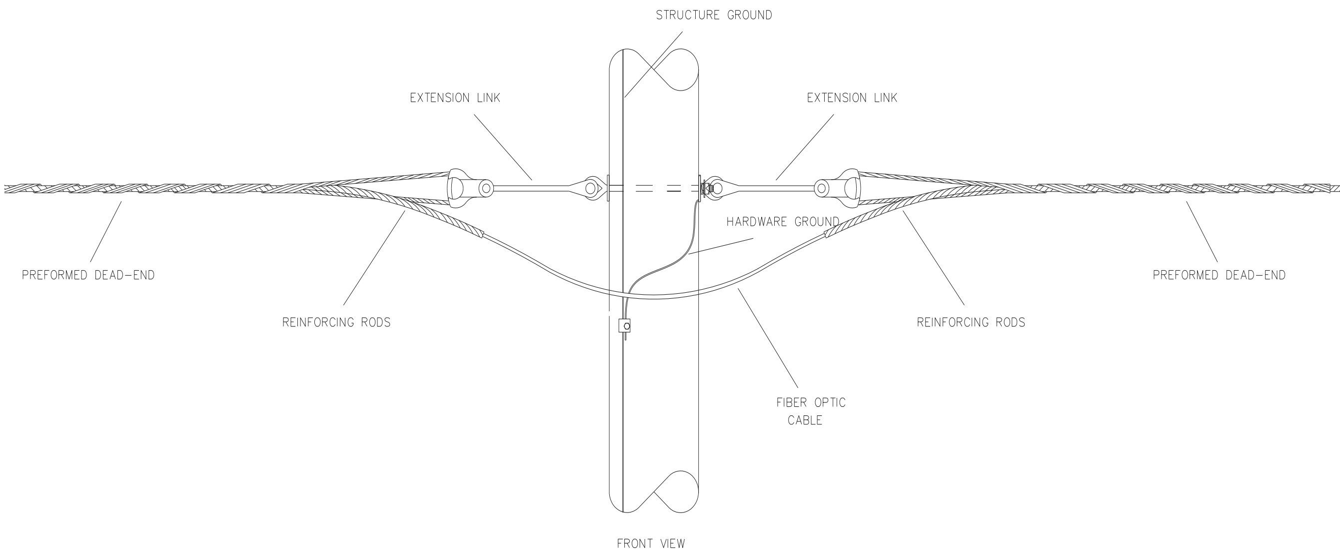
FO-TX-DBD* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	1	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
48	FIB DE 003	1	DEADEND, FIBER OPTIC CABLE FOR .594" DIAMETER FIBER CABLE
72	FIB DE 007	1	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-DDE

DOUBLE DEAD-END

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-DDE Base

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 015	1	BOLT, EYE, $^{5}/_{8}$" X 36"
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
2	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
5	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMPRESSI
	NUT EY 002	1	NUT, EYE, $^{5}/_{8}$"
6	WAS RD 004	2	WASHER, ROUND, 1$^{3}/_{4}$ ", FOR $^{5}/_{8}$"DIA. BOLT
7	WAS SF 002	2	WASHER, SQUARE, FLAT, 2$^{1}/_{4}$", FOR $^{5}/_{8}$"DIA. BOLT
8	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR $^{3}/_{4}$" DIA. BOLT

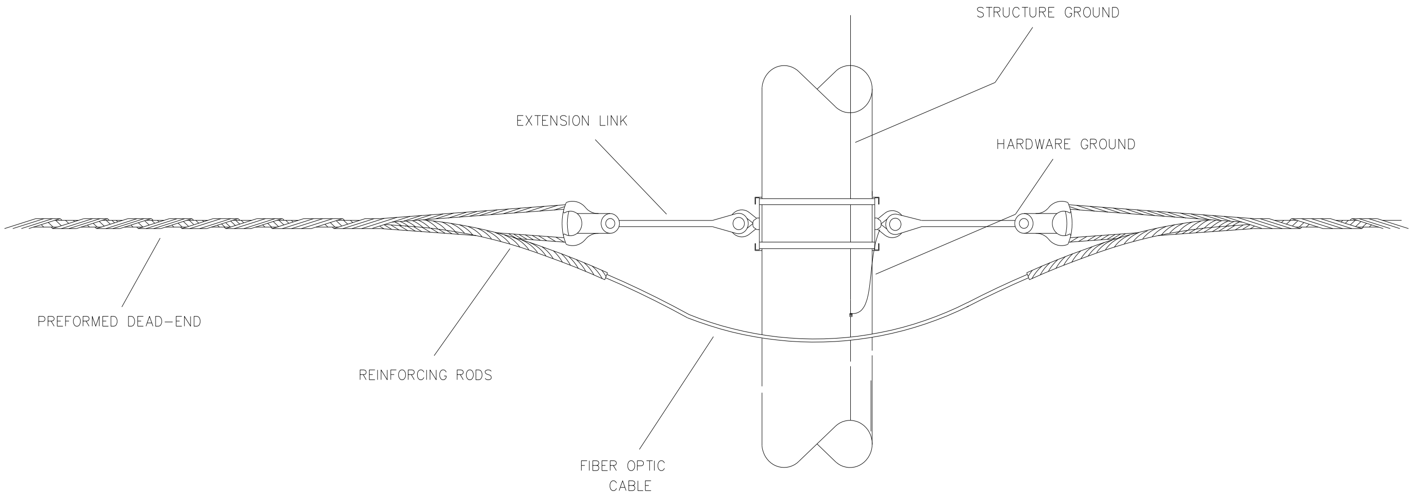
FO-TX-DDE* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
48	FIB DE 003	2	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-DDEBD

DOUBLE DEAD-END, BANDED

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-DDEBD Base

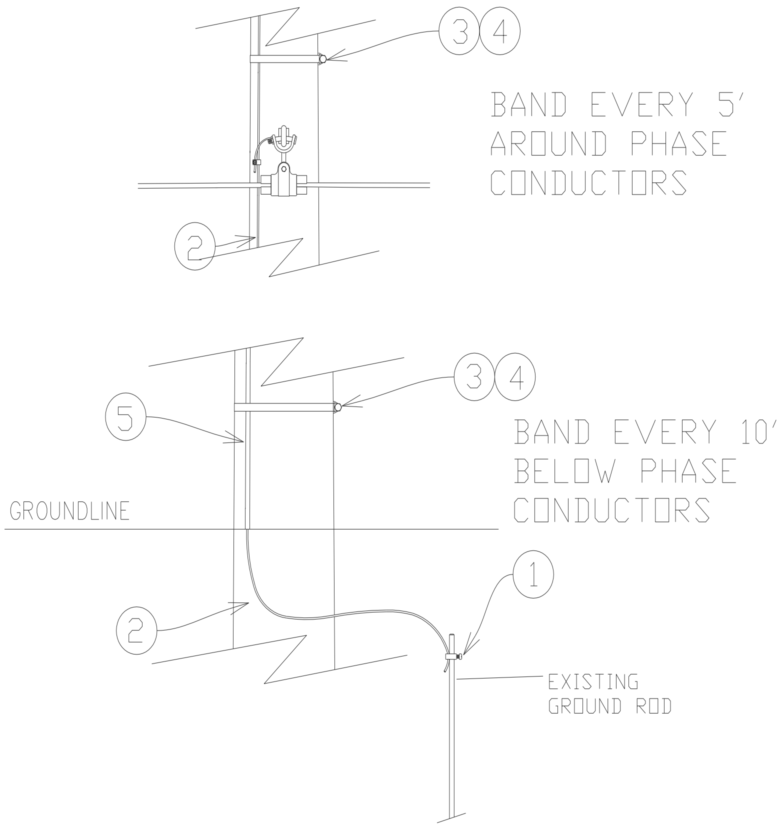
NO.	ITEM ID	QTY	DESCRIPTION
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
1	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
2	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
3	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
6	FIB MT 001	2	FIBER OPTIC MOUNTING PLATE
7	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 002	1	LUG, 4 SOLID, ¾”
8	NUT EY 002	2	NUT, EYE, $^{5}/_{8}$”
	WAS RD 004	1	WASHER, ROUND, 1$^{3}/_{4}$ “, FOR $^{5}/_{8}$”DIA. BOLT

FO-TX-DDEBD* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
48	FIB DE 003	2	DEADEND, PREFORMED, FOR .594" DIAMETER FIBER OPTIC CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-GRD

REPLACEMENT GROUND

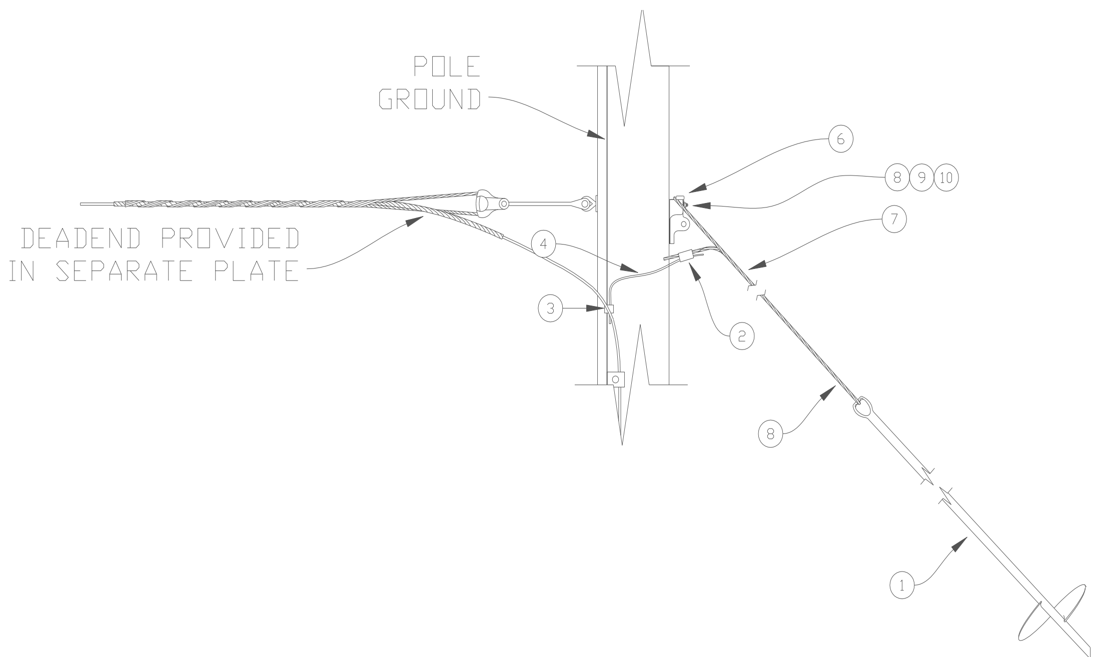


FO-TX-GRD

NO.	ITEM ID	QTY	DESCRIPTION
1	CLA GR 002	1	CLAMP, GROUND ROD, 5/8", 8 SOL - 1/0 STR. "WEDDING BAND"
2	COB CO 028	50	CONDUCTOR, #4 SOLID
3	FIB BD 001	40	1.25 IN. STAINLESS STEEL BANDING
4	FIB BK 002	6	BOLTED RETAINER FOR S.S. BANDING
5	GUA GW 001	2	GUARD, GROUND WIRE, 1/2" X 1/2" X 96", GRAY PLASTIC

FO-TX-GUY

FIBER OPTIC GUY

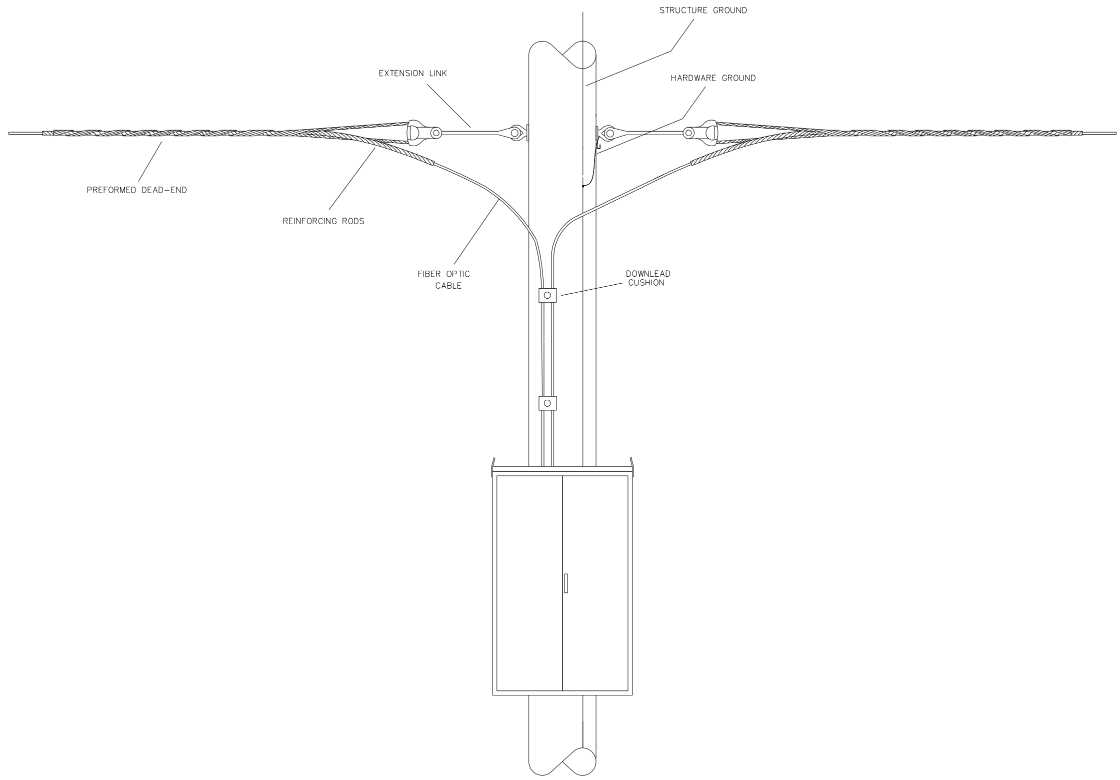


NO.	ITEM ID	QTY	DESCRIPTION
1	ANC SS 002	1	ANCHOR, SINGLE HELIX, 8 FOOT LENGTH
2	CLA PJ 001	1	CLAMP, PARALLEL JUMPER
3	CNN VG 003	1	CONNECTOR, VISE TYPE, #6- #2 SOL., #10- #2 SOL.
4	COB CO 028	3	CONDUCTOR, BARE COPPER, #4 SOL.
5	GUY AT 008	1	GUY ATTACHMENT (COMBINATION) 20,000 POUNDS
6	GUY GR 001	2	GUY GRIP, FOR $^{3}/_{8}$" GUY STRAND
7	GUY ST 005	50	GUY STRAND, $^{3}/_{8}$"
8	NUT SQ 003	1	NUT, SQUARE, $^{5}/_{8}$"
9	WAS RD 004	1	WASHER, ROUND, $^{5}/_{8}$" BOLT SIZE X $1^{3}/_{4}$" DIAMETER, GALVANIZED
10	WAS SP 001	1	WASHER, SPRING, $^{5}/_{8}$" BOLT SIZE, DOUBLE COIL HELICAL TYPE

FO-TX-SB

FIBER OPTIC SPLICE BOX

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



FO-TX-SB Base

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL EY 010	1	BOLT, EYE, $^5/_8$" X 26"
2	BOL MS 028	2	BOLT, MACHINE, $^5/_8$"x 30"
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
3	FIB BX 001	1	FIBER OPTIC CABLE STORAGE CLOSURE
4	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
5	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
7	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
8	NUT EY 002	1	NUT, EYE, $^5/_8$"
	NUT SQ 003	2	NUT, SQUARE, $^5/_8$"
10	WAS RD 004	3	WASHER, ROUND, $1^3/_4$" FOR $^5/_8$" DIA. BOLT
11	WAS SF 002	2	WASHER, SQUARE, FLAT, $2^1/_4$", FOR $^5/_8$" DIA. BOLT
12	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR $^3/_4$" DIA. BOLT

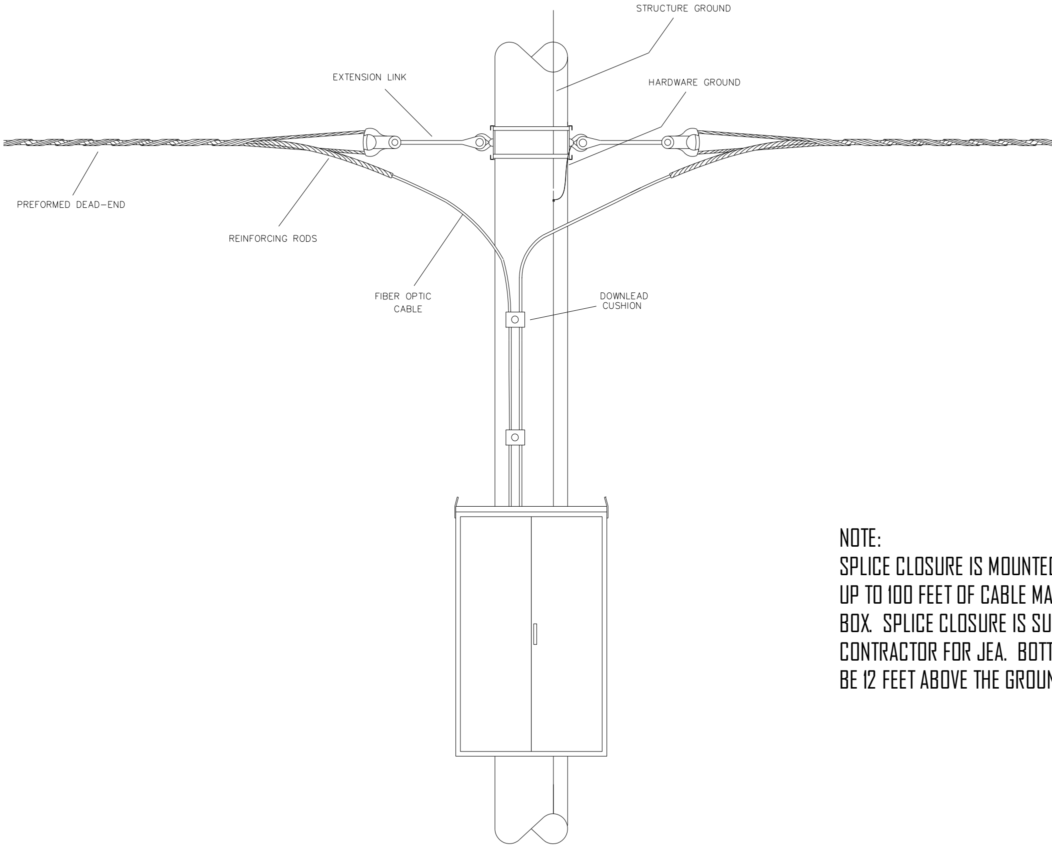
FO-TX-SB* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE "FOR .594" DIAMETER FIBER CABLE
48	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE "FOR .594" DIAMETER FIBER CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-SBBD

FIBER OPTIC SPLICE BOX, BANDED

OPTIONS: 24, 48, 72
BOLT PLATE: NONE



NOTE:
SPLICE CLOSURE IS MOUNTED INSIDE THE SPLICE BOX. UP TO 100 FEET OF CABLE MAY BE STORED INSIDE THE BOX. SPLICE CLOSURE IS SUPPLIED BY THE SPLICING CONTRACTOR FOR JEA. BOTTOM OF SPLICE BOX SHOULD BE 12 FEET ABOVE THE GROUNDLINE.

FO-TX-SBDB Base

NO.	ITEM ID	QTY	DESCRIPTION
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
	FIB BD 001	12	1.25 IN. STAINLESS STEEL BANDING
	FIB BK 002	6	BOLTED RETAINER FOR S.S. BANDING
	FIB BX 001	1	FIBER OPTIC CABLE STORAGE CLOSURE
	FIB CL 001	2	CLEVIS, THIMBLE (FOR FIBER OPTIC CABLE)
	FIB CU 001	3	CUSHION, FIBER OPTIC CABLE DOWNLEAD
	FIB MT 001	4	FIBER OPTIC MOUNTING PLATE
	LIK EX 002	2	LINK, EXTENSION, CLEVIS EYE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
	NUT EY 002	2	NUT, EYE, $^5/_8$"
	NUT SQ 003	2	NUT, SQUARE, $^5/_8$"
	WAS RD 004	2	WASHER, ROUND, $1^3/_4$", FOR $^5/_8$" DIA. BOLT

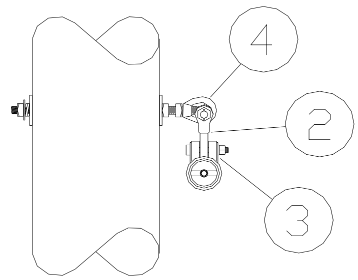
FO-TX-SBBD* 24, 48, 72

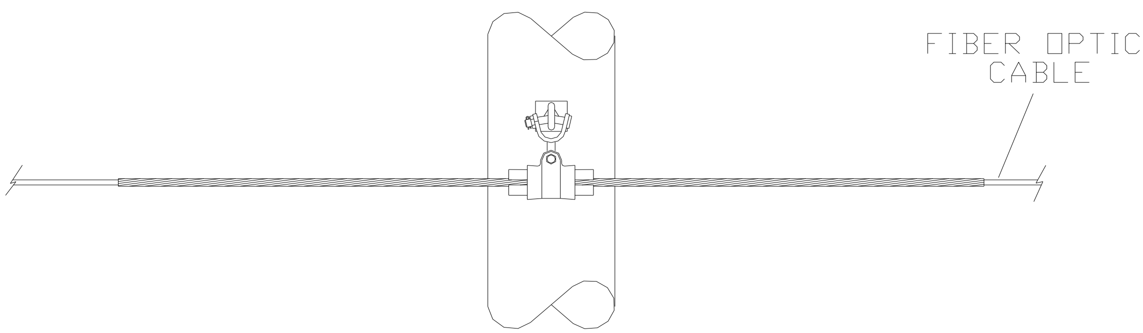
OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE "FOR .594" DIAMETER FIBER CABLE
48	FIB DE 003	2	DEADEND, FIBER OPTIC CABLE "FOR .594" DIAMETER FIBER CABLE
72	FIB DE 007	2	DEADEND, PREFORMED, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-TL

0 TO 15 DEGREE ANGLE – LONG SPAN

OPTIONS: 24, 48, 72
BOLT PLATE: NONE





FO-TX-TL Base

NO.	ITEM ID	QTY	DESCRIPTION
1	BOL DA 013	1	BOLT, DOUBLE ARMING, $^5/_8$" X 36'
2	CLE TE 004	1	CLEVIS, TOWER EYE, 90 DEGREE
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
4	NUT EY 002	1	NUT, EYE, $^5/_8$"
	NUT SQ 003	1	NUT, LOCK, SQUARE, $^5/_8$"
5	WAS RD 004	1	WASHER, ROUND, 1$^3/_4$", FOR $^5/_8$" DIA. BOLT
6	WAS SF 002	2	WASHER, SQUARE, FLAT, 2$^1/_4$", FOR $^5/_8$" DIA. BOLT
7	WAS SP 002	1	WASHER, SPRING, DOUBLE HELIX, FOR $^3/_4$", DIA. BOLT

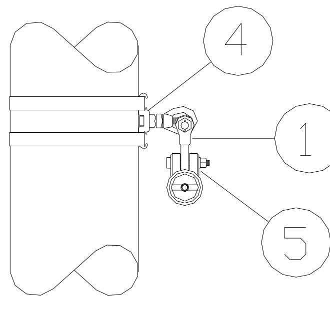
FO-TX-TL* 24, 48, 72

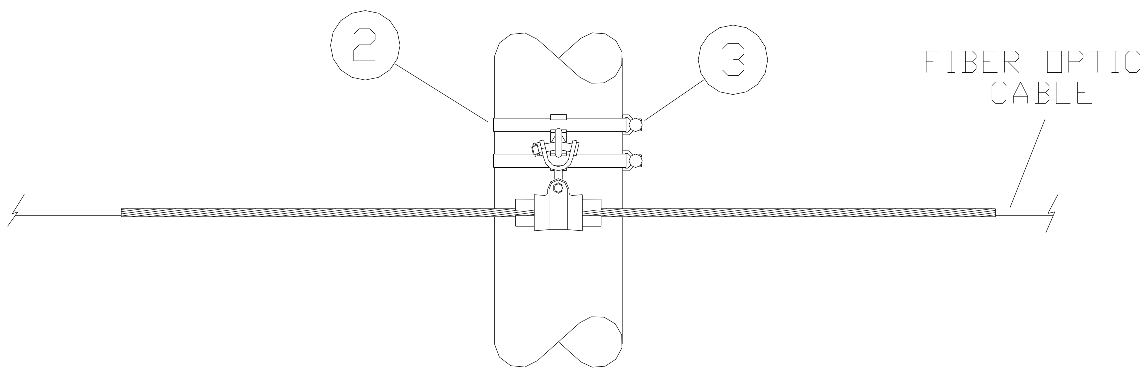
OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB SU 005	1	SUPPORT, LONG SPAN TANGENT, FOR .594" DIAMETER FIBER OPTIC CABLE
48	FIB SU 005	1	SUPPORT, LONG SPAN TANGENT, FOR .594" DIAMETER FIBER OPTIC CABLE
72	FIB SU 006	1	SUPPORT, LONG SPAN TANGENT, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-TLBD

0 TO 15 DEGREE ANGLE, LONG SPAN, BANDED

OPTIONS: 24, 48, 72
BOLT PLATE: NONE





FO-TX-TLBD Base

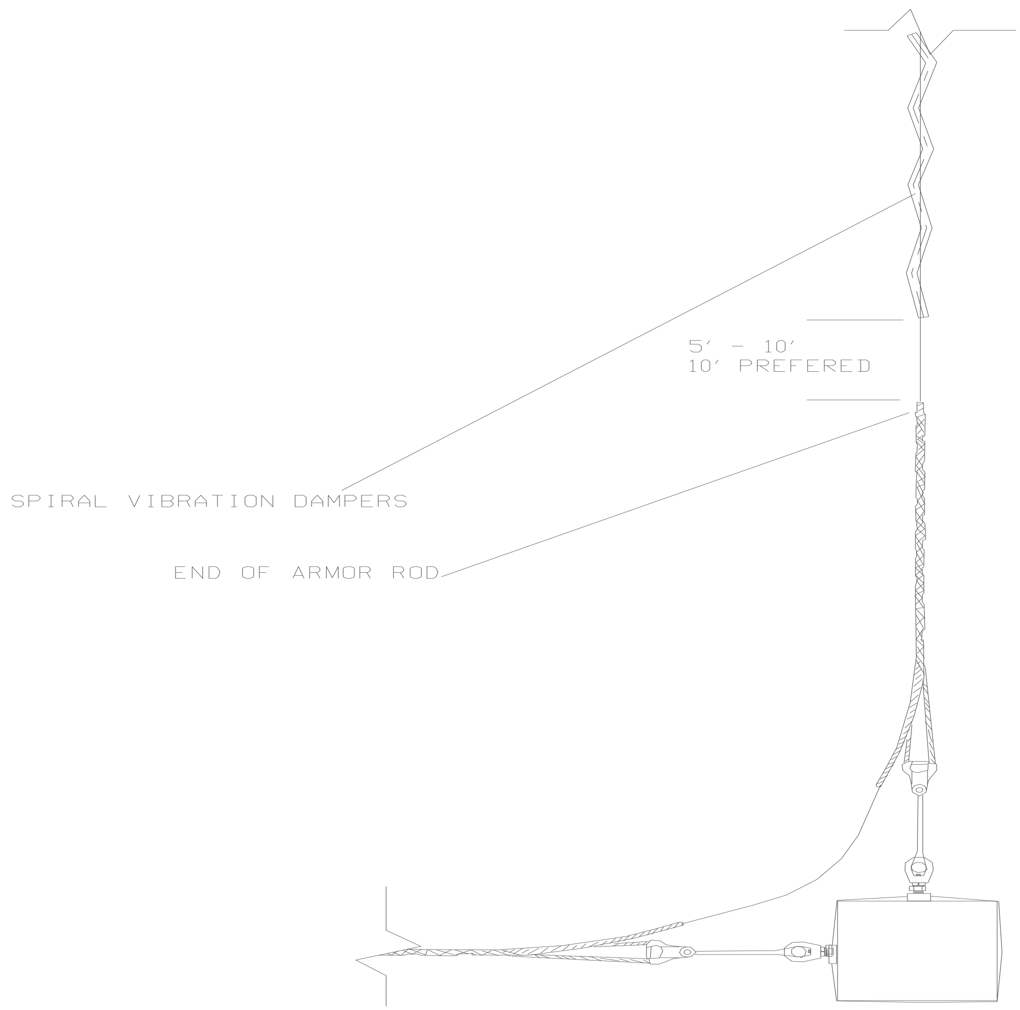
NO.	ITEM ID	QTY	DESCRIPTION
1	CLE TE 004	1	CLEVIS, TOWER EYE, 90 DEGREE
	CNN VG 003	1	CONNECTOR, 6-2 SOL/10-2 SOL, VISE GRIP PARALLEL
	COB CO 028	10	CONDUCTOR, #4 SOLID
2	FIB BD 001	6	1.25 IN. STAINLESS STEEL BANDING
3	FIB BK 002	2	BOLTED RETAINER FOR S.S. BANDING
5	FIB MT 001	1	FIBER OPTIC MOUNTING PLATE
	LUG GR 001	1	LUG, 4 SOLID WIRE SIZE, 3/4" BOLT SIZE, TIN PLATED COPPER COMP
6	NUT EY 002	1	NUT, EYE, $^5/_8$"
	WAS RD 004	2	WASHER, ROUND, 1$^3/_4$ ", FOR $^5/_8$"DIA. BOLT

FO-TX-TLBD* 24, 48, 72

OPTION.	ITEM ID	QTY	DESCRIPTION
24	FIB SU 005	1	SUPPORT, LONG SPAN TANGENT, FOR 0.594" DIAMETER FIBER OPTIC CABLE
48	FIB SU 005	1	SUPPORT, LONG SPAN TANGENT, FOR 0.594" DIAMETER FIBER OPTIC CABLE
72	FIB SU 006	1	SUPPORT, LONG SPAN TANGENT, FOR 0.701" DIAMETER FIBER OPTIC CABLE

FO-TX-VIB

FIBER OPTIC VIBRATION DAMPER



FO-TX-VIB

NO.	ITEM ID	QTY	DESCRIPTION
	FIB VD 002	1	DAMPER, SPIRAL VIBRATION, FOR .564" - .760" FIBER OPTIC CABLE

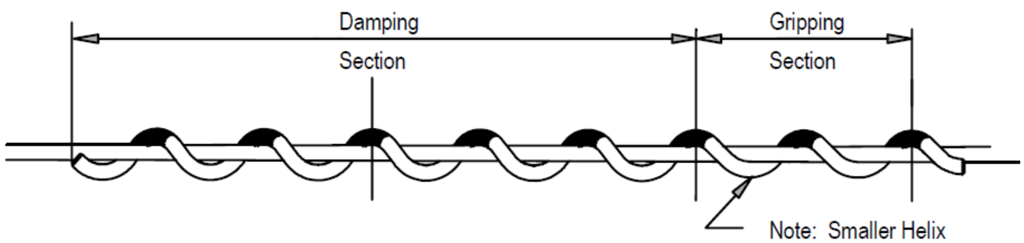
GENERAL GUIDELINES FOR THE USE OF VIBRATION DAMPERS ON AFL-ADSS CABLES

The table below is a general guideline for the application of spiral-shaped dielectric dampers on AFL ADSS cable. To use this matrix, take the initial sagging tension and divide by the cable's rated breaking strength (RBS) to determine the percentage ratio of the initial sagging tension to rated breaking strength. Then look in the column for the appropriate span range of the application, then move across the row to the appropriate tension percentage to find the recommended total number of dampers per span. Follow the guidelines after the table for the proper installation of the dampers.

	Initial Tension as % of Cable RBS				
Span Length(ft)	**0-10%**	**11-15%**	**16-20%**	**21-25%**	**25+%**
< 350	0	1/s	1/s	2/s	2/s
351-600	1/s	1/s	2/s	2/s	4/s
601-1000	1/s	2/s	2/s	4/s	4/s
1001-1500	2/s	2/s	4/s	4/s	6/s
1501-2000	2/s	4/s	4/s	6/s	6/s
2001-2500	4/s	4/s	6/s	6/s	8/s

1/s = 1 damper per span (either end)
2/s = 2 dampers per span, one on each end of the span
4/s = 2 dampers in tandem on each end of the span
6/s = 3 dampers in tandem on each end of the span
8/s = 2 dampers in tandem + 2 dampers in tandem on each end of the span

The term "in tandem" means that the dampers are "nested" or "stacked" together in a bundle. To achieve this orientation, the first damper is wrapped onto the cable. The second damper is then wrapped inside the first damper. So essentially the two dampers are "side-by-side" as opposed to "end-to-end". This can be repeated for up to three dampers being mounted in tandem.



VII. FREE-SPAN AERIAL ALL DIELECTRIC SELF-SUPPORTING FIBER OPTIC CABLE INSTALLATION

VII.1. GENERAL

VII.1.1. This practice provides general information for design engineers and construction forces on the methods for placement of aerial, all-dielectric, self-supporting, FREE-SPAN fiber optic cable. These methods and instructions are intended as guidelines, as each installation will be influenced by local conditions, customer's existing procedures and requirements.

VII.1.2. Information such as minimum separation and clearance, sag tables, and specific cable data are found in other documents. This information is generally provided to customers based on specific application of FREE-SPAN fiber optic cable.

VII.1.3. Installation equipment not mentioned in this practice is not approved for use with FREE-SPAN and its use without specific approval by Superior Optics, Inc. shall be at the risk of the customer.

VII.1.4. Methods used for placement of aerial, all-dielectric, self-supporting, FREE-SPAN fiber optic cable are essentially the same as those used for placing power utility phase conductors. Refer to ANSI/IEEE Std. 524-1980, IEEE Guide to the Installation of Overhead Transmission Line Conductors, for additional detail on installation techniques.

VII.2. PRECAUTIONS

VII.2.1. Upon receipt of the cable reels, remove all reel lagging and packing material from the reel and inspect the reel and outer coils of cable carefully. Check the inside edges of the reel for any sharp edges or obstructions that may have occurred during shipment and could potentially damage the cable sheath, or interfere with turning the reel and the cable deployment.

VII.2.2. Prior to starting construction, use an optical time domain reflectometer (OTDR) to verify that the cable has not been damaged during shipment. Readings obtained may be useful later for comparison with test acceptance data and as part of a records package that will assist in emergency restoration.

VII.2.3. FREE-SPAN fiber optic cable is very strong and robust. However, care must be taken to assure that the cable is not mishandled or installed improperly causing subsequent damage. Ensure that the cable is not kinked or that the minimum bend radius (typically 20 times the cable diameter) is not exceeded. Take all precautions that the cable is never crushed or twisted. Any such damage will alter the transmission characteristic of the fiber and may require replacement of that cable section.

VII.2.4. Prior to starting construction, survey the proposed cable route to assure that he right-of-way is clear of obstructions that may interfere with the installation. During installation, be sure that the cable jacket is not damaged due to abrasion. Do not drag the cable over obstructions in the span or on the ground. It is recommended that if obstructions are observed, they should be removed, or a series of hold-down blocks be used to prevent contact with the obstruction. Before installing the cable, be sure all installation personnel understand the cable parameters such as handling requirements, minimum bend diameters and maximum pull tensions.

VII.2.5. When placing FREE-SPAN, all precautions and safety requirements of the respective company shall be followed. When required, use of warning signs and traffic warning cones shall clearly define the work area to safely channel the traffic. On streets or highways, always place the cable in the same direction as the traffic flow and use flagmen to control traffic.

VII.2.6. Do not allow the cable to twist as it is pulled through travelers or sheaves. Observe the cable markings of the cable as it is first pulled through the traveler or sheave. If continuous twist in a constant direction is observed, stop the installation immediately, ease off the tension, and readjust the traveler. Due to the light weight of FREE-SPAN and relative low stringing tensions, the traveler may require support at the base to help prevent the cable from riding out of the traveler or excessive twisting during installation. Proper feed of the cable through travelers or sheaves is diagrammed in Figure 1.

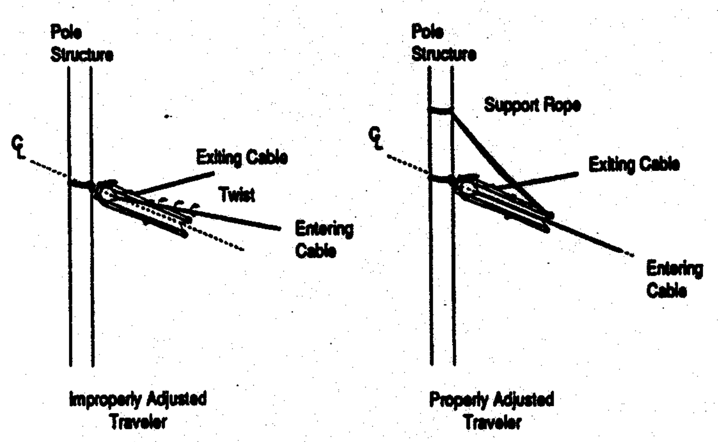


Figure 1. Proper Traveler Adjustment.

VII.2.7. Control the rotation of the pay off reel to prevent over running. Apply only a minimal amount of braking. Braking should be applied to the reel through the support shaft, and not by methods such as wedging a 2 x 4 under the reel flange. As the reel empties, the tension will have to be periodically adjusted.

VII.2.8. Do not cut the cable under any circumstances without prior approval of the engineer responsible for the transmission of the project. Changes to the total number of spice points can potentially degrade quality of transmission of the system. The number and location of splices are usually determined in the initial design.

VII.2.9. Do not allow vehicles to pass over the cable. At road crossings, the cable should be suspended above roads, driveways, etc. during installation. Travelers or blocks placed on a temporary slack span of rope, or steel strand, may be used to suspend the cable above such road crossings.

VII.2.10. When placing FREE-SPAN on active structures, or structures involving power crossings, observe the safety precautions outlined in your company's applicable procedures. When pulling up and tensioning self-supporting cable, observe the same precautions used when pulling up and tensioning metallic phase conductors. When aerial lift equipment is used for placing self-support cable, all precautions outlined for placing phase conductors, as well as the instructions covering the equipment must be observed.

VII.2.11. Permanent or temporary guys must be used when needed at any location where self-supporting cable is tensioned to avoid placing any unbalanced load on those support structures.

VII.2.12. Use only approved gripping and pulling devises when tensioning, or temporarily holding fully tensioned self-support cable. Wire mesh grips are intended only for pulling the cable through the system. Do not use wire mesh grips to tension or to hold cable under tension.

VII.2.13. Adequate electrical protection must be established at all work sites. The method required, and the equipment used, will be determined by the degree of exposure to electrical hazards and the soil conditions at the site. All metallic equipment, hardware, anchors and structures within such work sites must be common bonded together, and then grounded to assure worker safety.

VII.3. SAFETY ISSUES

VII.3.1. Although FREE-SPAN is an all-dielectric cable, some conductivity can result from moisture on the cable and in the surrounding air. As a precaution, it is recommended that the installed cable is grounded prior to touching it. The precautions in the following paragraphs must be observed to assure safety during and after the cable installation.

VII.3.2. Choosing Cable Location:

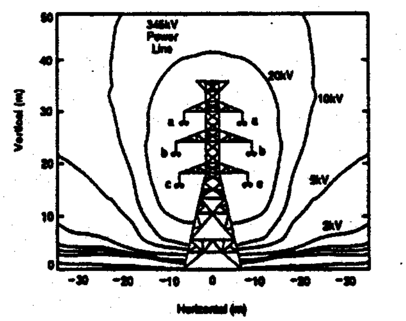


Figure 2. Equipotential Contours Surrounding Power Lines.

VII.3.2.1. It is recommended that Superior Optics suggest the desired mounting location of FREE-SPAN in relation to the phase conductors at the structure. Superior Optics has developed a computer program to determine the optimum position for FREE-SPAN cable. The program investigates the physical relationship of the structure and the electrical phenomena of the phase conductors and provides a profile with plotted equipotential contours, as shown in Figure 2.

VII.3.2.2. Careful selection of the suspension position of the FREE-SPAN cable prevents dangerous scintillation. Scintillation is a surface arc that may pose a cable and personnel hazard. These scintillations occur mainly at the suspension position of the cable; therefore, minimum clearance between the cable and phase conductors should be determined at this joint. This is determined by considering the FREE-SPAN cable a grounded metallic conductor, and using currently acceptable methods for determining its placement.

VII.3.2.3. The recommended position must be such that there will be no contact between the FREE-SPAN cable and the phase conductors or static wires, either during installation or under maximum environmental load conditions. If during a rare case of galloping conductors contact should occur, there may be a potential for scintillation. However, the potential for subsequent cable damage is minimal.

VII.3.3. During Installation:

VII.3.3.1. Leakage current can be induced onto FREE-SPAN even when the cable is a relatively long distance from the phase conductors. Superior Optics can calculate the leakage current based upon the cable position relative to the phase conductors and to the ground, the transmission voltage and the surface resistivity of the cable jacket. The cable surface resistivity is dependent on the moisture and contaminants on the cable. Since a clean, dry cable has a surface resistance of 1014 Ω/ft and a dirty, wet cable has a surface resistance of 106 Ω/ft., do not install cables on active towers during wet environmental conditions.

VII.3.3.2. When the cable is too close to the phase conductors, scintillation can occur through the air from phase conductors to the cable. This scintillation from a phase conductor to FREE-SPAN cable can occur only when the resistance of the cable sheath to the grounding location is low enough to lower the induced voltage. In the worse case condition, the cable resistance is zero, at which time it will be similar to a grounded metal rod. A grounded rod configured in air has a flashover voltage of 15kV/in. for large gaps. Hence, the distance to keep the phase conductors away from the FREE-SPAN cable can be calculated by:

$$SD = E/15$$

Where: SD = distance (inches)
E = phase to ground (kilovolts)

Note: The work rules of the NESC Section 43 and 44 should be used to determine safe approach to live systems.

VII.3.3.3. Specific safe approach distance to active phase conductors are defined in the National Electrical Safety Code (NESC) Work Rules Sections. The safe approach distance is different for electrical personnel and telecommunications personnel. These should be the minimum safe approach distances to active phase conductors.

VII.3.4. During Splicing:

When splicing FREE-SPAN cable during rain conditions near active phase conductors, it is advised to ground the cable between the work area and the spans. This will prevent dangerous leakage currents and transients from flowing through personnel. In dry weather, there is little induced charge on the cable; however, as a personnel safety practice, the cable should be grounded between the work area and the spans.

VII.3.5. During Routine Maintenance:

Dry Weather Conditions: When the cable is suspended by insulators or on wooden poles, a voltage potential may be induced in the metal suspension grips and support hardware. To avoid dangerous electrical shock, ground the metal grips before touching. The cable can be touched anywhere when it is dry, because there is little charge induced on the small area that is touched.

VII.3.6. Wet Weather Conditions

When the cable is wet, the resistance to ground is low near the tower or grounded structure, so there is little voltage potential on the metal grips or cable at these points. However, at distances of 10 to 15 feet or further from the metal grips, a voltage potential may exist. To avoid dangerous electrical hazards, ground the cable within 3 to 5 feet on both sides of the area to be touched.

VII.4. INSTALLATION EQUIPMENT

VII.4.1. FREE-SPAN fiber optic cable is normally supplied on non-returnable wooden reels. The cable is covered with protective covering and the cable reels are lagged with 2 x 4 lagging to provide additional protection during transportation. The following Table 1 provides dimensions and un-cabled weight of the standard reel sizes:

Table 1. Dimensions of Standard Reels

Flange Diameter (in.)	Drum Diameter (in.)	Width Inside (in.)	Width Outside (in.)	Shaft Hole Diameter (in.)	Uncabled Weight (lbs.)
72	36	36	41	2 ¾	480
60	36	36	41	2 ¾	320
48	24	30	35	2 ¾	160
36	18	18	23	2 ¾	75
Note: Custom reel sizes can be provided per customer request.					

VII.4.1.1. Reel Handling:

The type and construction of the reel stand determines the method and tools for handling. Reels are constructed so that they must be supported either on an axle, supported from above, or by the reel flange. When the reels are lifted by an axle supported from above, a spreader bar must be employed to maintain smooth payoff and to prevent damage to the cable or reel, or both, by inward pressure on the reel flange. Proper equipment rated for the maximum load must be available to lift the reel. If the reel stand is not self-loading, a crane, forklift or other suitable equipment should be used to load the cable reel into the stand.

VII.4.1.2. Reel Stands:

Reel stands are designed to be used with tensioners to supply the necessary hold-back tension to the cable. The stand(s) should be selected to accommodate the cable reel dimensions and gross weight. Superior Optics standard reels are not designed to withstand the forces developed by braking during high tension stringing operations. Direct tension stringing from the reel at cable installationstringing tensions should not be attempted. The cable may be pulled directly from the reel stand only when employing slack stringing methods that allow minimal tension to be applied directly to the reel of cable.

VII.4.2. Pulling Machines:

Both bullwheel and reel type pulling machines may be used to install FREE-SPAN fiber optic cable. Availability and previous experience with a particular type of pulling machine should be a factor when determining the type of pulling machine to be utilized.

VII.4.2.1. Bullwheel Characteristics:

he depth and flare of grooves in the bullwheels are not critical; however, there are some recommended guidelines. Semicircular grooves with depths of 50% or more than the cable diameter, and with a flare angle of 5 degrees to 15 degrees from the vertical center line reference, generally have been found to be satisfactory. The minimum diameter at the bottom of the groove should be at least 35 times the diameter of the cable. Tandem bullwheels should be aligned with the offset approximately one-half the groove spacing. The material and finish of the grooves should not mar the surface of the cable. Elastomer lined grooves are recommended.

VII.4.2.2. Puller and Tensioner Operating Characteristics:

The pulling and braking system should be operated smoothly to prevent any sudden jerking or bouncing of the cable during deployment. Each system should be readily controllable and capable of maintaining a constant and even tension. Pullers and tensioners should be equipped with tension indicating tension and the actual cable weight and length to be installed. Tensioner bullwheels should be retarded so that the cable maintains a constant hold-back tension at various pulling speeds. Positive braking systems are required for pullers and tensioners to maintain cable tension when pulling is stopped. Fail safe type braking systems are recommended.

VII.4.3. Travelers/Stringing Blocks:

VII.4.3.1. Sheave Diameter:

The diameter of the sheave should not be less than 20 inches at mid-span suspension points, see Figure 3. Where the cable line makes an angle of 45 degrees or greater, and at the first position after the pay-off reel and the final position before the take-up reel, the minimum diameter of the sheave should not be less than 24 inches. Sheave diameters that are larger than those specified are acceptable, and offer some advantages by reducing the load applied to the cable.

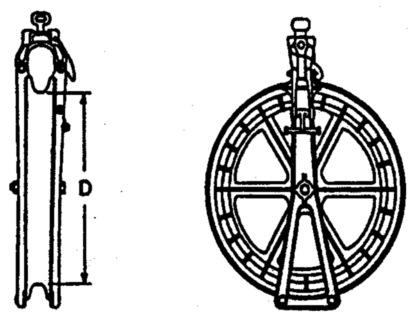


Figure 3. Sheave Diameter

VII.4.4. Travelers/Stringing Blocks:

VII.4.4.1. Sheave Groove Configuration:

The minimum radius of the sheave groove is recommended to be 55% greater than the diameter of the cable. The minimum depth of the groove should be 25% greater than the diameter of the cable. The sides of the groove should flare between 15 degrees to 20 degrees from the vertical, to facilitate passage of grips, swivels, etc. and to contain the cable within the groove, see Figure 4.

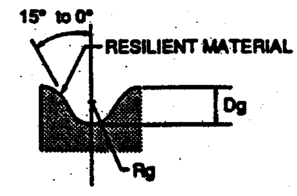


Figure 4. Sheave Groove

VII.4.4.2. Traveler Construction and Material:

Travelers may be made of any suitable material, such as heat treated aluminum, with consideration for the weight. It is recommended that the safe working load and suitable margin be matched with the maximum installation load of the fiber cable. The traveler should be in good working order and properly lubricated. The cable release should work smoothly with minimal pressure. It is recommended that the traveler be lined with an elastomeric liner that will provide cushioning and minimizes abrasion to the cable jacket. Elastomers of neoprene or urethane are acceptable. The liner should not be torn or loose.

VII.4.4.3. Traveler Grounds:

Grounding attachments are recommended when stringing fiber optic cable under active phase conductors. As a minimum, the first and last traveler of a pull should be equipped with a traveler ground attached to the structure grounding system.

VII.4.5. Uplift and Hold Down Blocks:

At positions where uplift may occur, it is recommended that uplift rollers or hold down blocks be used. This will minimize any potential for scintillation during installation on active systems and protect the cable jacket from abrasion on non-active systems. A series of travelers 12 inches to 14 inches in diameter will maintain minimum bend radius. These devises should have a cable breakaway feature to easily remove the blocks.

VII.4.6. Running Grounds:

When installing FREE-SPAN fiber optic cable under active power systems, a running ground should be used to protect personnel from electrical hazards. The running ground shall provide constant contact with the moving cable without excessive tension. It should be located prior to first support structure. The spring tension on the running ground should be adjustable, and the rollers should be sized for the diameter of the cable.

VII.4.7. Chain Hoist:

Chain hoists are used to tension and sag each cable span. The hoist should be rated for the maximum installation load of the FREE-SPAN cable, plus a desired safety factor. It shall be in good working order and properly maintained. Assure the chain is not deformed, twisted, or corroded. Inspect release levers and cam action for proper operation. Any suspect unit should not be used.

VII.4.8. Dynamometers:

Dynamometers are used to measure the tension at each cable span. The dynamometer should be rated above the maximum installation load of the FREE-SPAN cable. Typically, the accuracy of the dynamometer is .5% of the full scale rating. If the full scale rating is too high above the installation load, the degree of accuracy is questionable. To assure a high degree of accuracy, two comparable dynamometers can be attached in tandem, and the two readings averaged.

VII.4.9. Grips:

Wire mesh grips are utilized to pull the fiber optic cable through the travelers. The grip should be a double or triple weave design and be rated to match the cable diameter. The load rating shall match the maximum anticipated load on the cable during cable pull-in. This is typically well under the sagging tension, but is dependent on cable design. The grip should have a swivel link that will minimize cable twisting and is rated to separate prior to the wire mesh grip breaking, see Figure 5. Grips can be banded or un-banded and shall be applied per the manufacturer's instructions. Do not use the wire mesh grip to tension or to hold cable under tension.

Figure 5. Wire Mesh Grip With Swivel Link

VII.5. INSTALLATION METHODS

VII.5.1. Methods used for placement of aerial, all-dielectric, self-supporting, FREE-SPAN fiber optic cable are essentially the same as those utilized to place power utility phase conductors. However, there are handling and bend radius requirements that are more restrictive for FREE-SPAN. The two basic methods for the placement of FREE-SPAN fiber optic cable are: the stationary reel, sometimes called the "Back-pull Method," and the moving reel, sometimes called the "Drive-off Method". The drive-off method is acceptable but is rarely used.

VII.5.1.1. Drive-off Method:

As stated in previous paragraphs, this method is not utilized very frequently. Its primary application is in construction of new lines with clear right-of-way and no obstacles. This method is not very economical in urban areas where traffic hazards and obstacles would slow cable deployment.

VII.5.1.1.1. Place cable reel in a reel trailer or line truck equipped with reel carrier, supported by the arbor holes. The cable should pay off the top of reel from the back for reel trailers and off the bottom of the reel to the front quadrant for the line trucks. A braking device, set on minimum, is utilized to brake the reel rotation by friction to the arbor shaft. This is used to prevent overrun of the reel when stopping at the support structures.

VII.5.1.1.2. Holes are drilled and machine bolts, or comparable hardware, are placed on the structures at the appropriate mounting height. At dead-end and tensioning locations, down-guys of an appropriate loading factor are placed.

VII.5.1.1.3. Travelers are placed above or below the desired framing location of each support structure and the cable is dead-ended at the starting location.

VII.5.1.1.4. With minimal tension applied to the reel brake, the reel of cable is transported along the construction route and the cable is played out. As the reel empties, the back tension will have to be periodically adjusted to account for the difference in reel mass.

VII.5.1.1.5. As the moving reel passes a support structure, the pulling is stopped and the cable is placed into the traveler attached to the structure at the desired framing height.

VII.5.1.1.6. The reel proceeds on to the next support structure where the process is continued until the cable is completely deployed.

VII.5.1.1.7. With the cable deployed, starting at the end location, each span can be sagged and tensioned and support hardware applied according to the installation requirements. An alternative procedure would sag and tension each span and install permanent hardware as the cable is being deployed.

VII.5.1.2. <u>Back-pull Method:VIII.5.1.2</u>

This method of cable installation is most frequently used for FREE-SPAN fiber optic cable. Its primary application is for long spans on EHV power facilities. It also is most effective for application on distribution facilities, where there are many obstacles such as lateral branches or taps. This method is very economical in urban areas and offers the fastest deployment of cable.

VII.5.1.2.1. The cable reel is placed on a reel stand or reel trailer, supported by the arbor holes at a stationary location. A braking device applies minimal tension to the reel to prevent overrun.

VII.5.1.2.2. At the same location as the cable reel, the tensioner is placed in-line between the cable reel and the first two structures. The FREE-SPAN cable is then fed through the tensioner.

VII.5.1.2.3. Holes are drilled, and machine bolts or comparable hardware are mounted to the structure at the appropriate mounting height. At dead-end and tangent locations, down-guys are placed at the desired framing location of each support structure.

VII.5.1.2.4. Travelers are placed just above or below the desired cable framing location of each support structure.

VII.5.1.2.5. Small pilot lines are run through the travelers at each support structure. The pulling line is pulled from the pulling location back through each traveler using the small pilot lines. After the pulling line is fed through the entire section to be pulled, it is attached to the FREE-SPAN cable with a swivel link and a wire mesh grip as seen in Figure 4.

VII.5.1.2.6. The FREE-SPAN cable is then pulled through the entire section with the puller and tensioner. Care must be exercised to keep the cable under minimal load.

VII.5.1.2.7. Several pulling stages may be required to place the cable through the entire system.

VII.5.1.2.8. With the cable deployed, starting at an end location, each span can be sagged and tensioned and support hardware applied according to the installation requirements.

VII.5.1.3. Communications:

Proper communications during fiber cable deployment are critical to assure safe and efficient installations.

VII.5.1.3.1. The Drive-off Method requires minimal communication between different personnel on the installation crew. It is recommended to have good communications between the operator of the vehicle used to deploy the cable, and the individual at the cable reel. If traffic control is necessary, the flagman shall also have communication with the vehicle operator to assure safe traffic routing.

VII.5.1.3.2. The Back-pull Method requires good communications between the operator of the tensioner and the operator of the puller. In addition, intermediate check points such as road crossing and obstacles, i.e.; power conflicts, should have spotters to inform the puller and tensioner of potential problems. The types of communication devices are dependent on local availability. Maintenance radio, cellular telephone and dedicated talk circuits over copper pair facilities with temporary station wire, are all viable alternatives. Systems such as civilian band radio or power line carrier systems are not recommended.

VII.6. INSTALLATION CONSIDERATIONS

VII.6.1. Pull, Tension, Anchor, and Splicing Sites:

The selection of pull, tension, anchor and splicing sites must consider many factors from system design issues to logistics and capability of equipment. In the Back-pull method, the reel is stationary, thus the cable for the system is pulled in several segments. These segment lengths are dependent on allowable splices, accessibility of the sites for vehicles, capability of the installation equipment, obstacles in the right-of-way, and cable reel length. Other factors that will affect the site selection are the maximum load the cable can handle, maximum structure load and availability of adequate grounding systems when necessary.

VII.6.2. Equipment Locations:

The location of the tensioner and puller relative to the structure must be selected so that the structure is not overloaded. Where possible, a pulling slope of four or five horizontal to one vertical is considered good practice. This ratio will minimize the load on the cable, traveler, and structure. Refer to ANSI/IEEE 524 for calculations of structure loads. It may also be necessary to place temporary guys to prevent overloading the structures. The tensioner and reel stand must be placed in-line with the first two structures to prevent twisting of the cable or any abrasion to the cable by rubbing on the sides of the traveler groove.

VII.6.3. Anchors and Hardware:

Anchors and support structure hardware shall be rated above the anticipated environmental load of the cable, plus a safety factor. The amount of the safety factor is dependent on the utilities' existing procedures. In applications where aeolian vibration becomes an issue, the safety factor shall be increased due to the potential for degradation of the hardware. At locations where the cable is tensioned to achieve proper cable sag, the structure may require a temporary down-guy and anchor to prevent unbalance of the structure. At these locations a minimum ration of two horizontal to one vertical for the slope of the guy is considered good practice. Anchor types shall match the soil conditions and loading considerations. All down-guys shall be properly tensioned or re-tensioned prior to starting the cable installation.

VII.6.4. Crossing Structures:

When crossing roads, highways, railroads, energized lines, etc., some supplemental support is necessary to prevent the minimum clearance from not being met, and posing a safety hazard. One method is to erect "H" frame structures on both sides of the crossing point. With these guard posts, the cable can be maintained above the minimum height. In some cases rope nets can be strung between the two structures to provide more positive protection. Another method is to string travelers on temporary ropes or guys at the crossing point, that will maintain clearance if tension should be lost. It is recommended that a spotter with communications to the puller and tensioner be at the crossing location, while the cable is being pulled into place.

VII.6.5. Terrain Considerations:

The terrain of each pull section must be analyzed to assure there are no potential conflict areas that would impair installation. In areas where ground clearance or minimum clearance under power facilities becomes a concern, a spotter with communications to the puller and tensioner should be utilized to assure no abrasion to the cable.

VII.6.6. Travelers Installation:

Travelers are typically attached directly to the structure. On pole structures, a standoff pole bracket may be considered to allow free movement of the traveler. The socket eyes, used to support the traveler, shall be consistent with ultimate working load and rating of the traveler. Shackles used on towers to support the traveler shall be rated above the ultimate working load, to assure a safety factor. The need for traveler grounds and required grounding locations must be based on the degree of exposure to electrical hazards. When hazards exist, observe local practices for the placement of traveler grounds. As a minimum, traveler grounds should be installed at the first and last tower between the tensioner and puller.

VII.6.7. Grip Installation:

The pulling grip, as described in the apparatus section, shall be rated above the maximum pulling tension anticipated. Use the manufacturer's instructions for the proper application. When installed properly, no special preparation of the cable end, or aramid yams, are required. It may be recommended by the grip manufacturer to band the end of the grip to prevent slippage. Apply vinyl tape over the banding to minimize damage to the traveler coatings.

A matched clevis type swivel is recommended to help prevent twisting of the cable during pulling. The swivel shall be at the rating of the grip, to assure breakaway prior to the grip failing. It is not recommended to pull the swivel through bullwheels under any significant tension. When removing the grip after the cable has been pulled in, cut off a minimum of twenty (20) feet past the end of the grip to assure no stressed cable is used.

VII.6.8. Cable Pulling:

Pulling rates of 2 to 5 miles per hour usually provide safe, smooth, efficient passage of cable. Once the cable movement has started, it should be maintained at a constant rate until the cable segment has been pulled into place. At all times during the pull, the tensioner operator should monitor the tensionometer to assure that the maximum pulling tension is not exceeded. The maximum tension during the pulling operation should not exceed that which is necessary to clear obstacles. In general, pulling tension should not exceed more than one-half the maximum initial sagging tension. If greater tensions are required, consideration must be given to the fact that when long lengths of cable are pulled, the tension at the pulling end may exceed the tension at the tensioner by significant amounts. This difference is due to the length of cable to be strung, changes in the line angle, number of travelers and differences in elevation of the route and structures. Light and steady back tension is required at the cable pay-off reel to prevent overrunning of the reel. It may be necessary to periodically loosen the brake on the pay-off reel as it empties. As the reel empties, the moment arm available to overcome the brake drag is reduced, and the tension rises.

VII.6.9. Aeolian Vibration:

Aeolian vibration is a resonant vibration caused by low velocity wind blowing across a cylindrical conductor under tension, see Figure 5. Although the vibration will not typically affect the optical or mechanical performance of the FREE-SPAN fiber optic cable, it can cause severe degradation to the cable support hardware. Vibration dampers can be very effective in controlling aeolian vibration when used on FREE-SPAN fiber optic cable. Both resonant and interference type vibration control systems will work when properly applied.

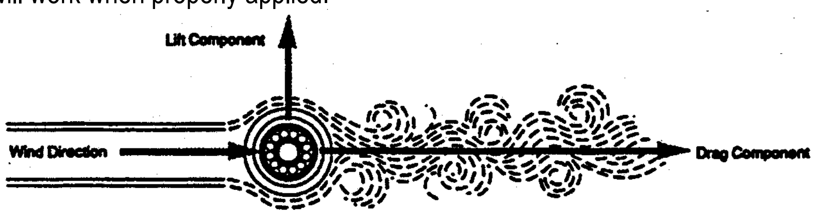


Figure 6. Aeolian Vibration Effect

Superior Optics recommends that vibration dampers be utilized to protect attachment hardware when the cable spans exceed 350 feet and/or the cable tension exceeds 15% of the calculated cable breaking strength, and there is a prevailing laminar wind between 2 and 20 mph.

VII.6.10. Splicing:

At the locations where a splice is required, additional cable must be provided to provide extra fiber and cable to physically accommodate the splicing process. In the outdoor environment, Superior Optics recommends that splicing be accomplished on the ground and not in an aerial bucket. Consideration must be made to the type of splicing, mechanical or fusion, and the respective environmental requirements of each. If fusion is the method, a splice vehicle may be required and subsequently enough cable will be required to reach the vehicle. In general, enough cable should be provided to reach the base of the structure and reach the intended splicing site. Do not forget to remove 20 feet of cable from the grip to remove any stressed cable. Superior Optics also recommends that the spare cable at splice points be stored in an enclosure, either mounted to the pole or in an underground housing, see Figure 7. Superior Optics also recommends cable guards along the entire height of the structure.

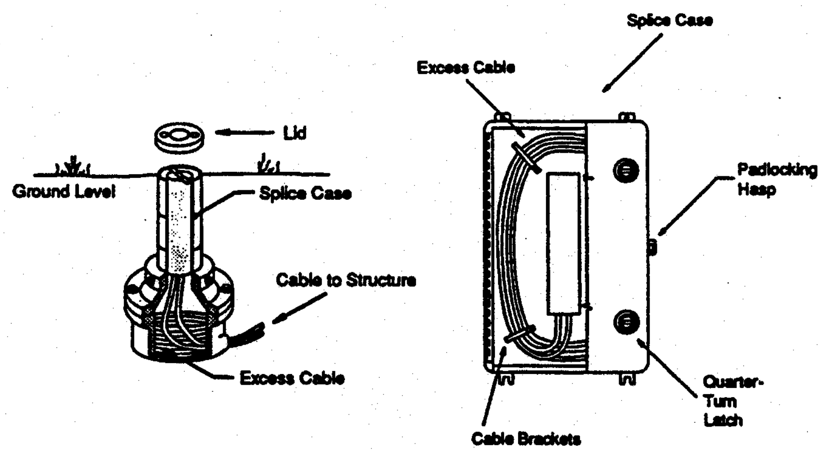


Figure 7. Underground and Pole Mounted Housing

After the excess cable length is determined, coil the cable and store at the structure until the splice housing has been installed. Be sure to place end caps on the exposed cable ends or seal with vinyl tape to prevent water penetration.

VII.7. CABLE SUPPORT HARDWARE

VII.7.1. Hardware Types:

The hardware used to support the cable at the structure is very similar in appearance and application to the type used for power utility metal conductors. This hardware is available from several different manufacturers that Superior Optics has coordinated the design requirements with. Dependent on the applications, Superior Optics can provide recommendations and, if required, procure the hardware for customers. In general, there are three basic types of supports: dead-ends, suspension and tangent assemblies.

VII.7.2. Dead-end Assemblies:

Dead-end assemblies are used at points of cable termination, or on structures where the line angle is greater than 25 degrees. The basic elements that are included in a dead-end assembly, refer to Figure 8, are the Structural Reinforcement Layer (SRL), the dead-end grip, the thimble clevis and an extension link.

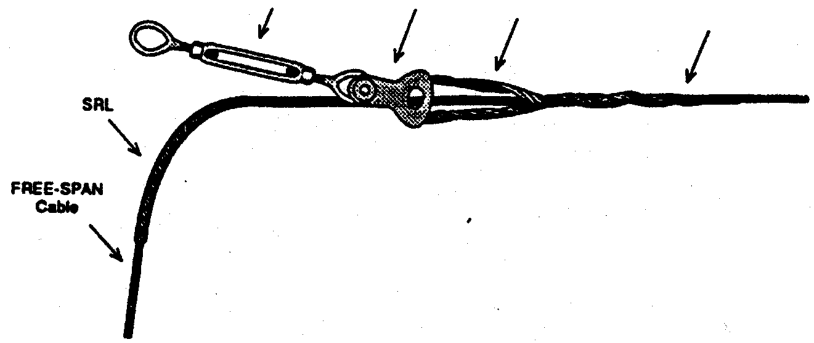


Figure 8. Dead-End Assembly

VII.7.3. Structural Reinforcement:

VII.7.3.1. Structural Reinforcement Layer (SRL):

The SRL is a straight subset of armor rod that is the first layer applied to the FREE-SPAN cable. They are spiraled in a precise twist lay to address the diameter and maximum anticipated load of a specific cable. Typically, they are grouped together in a sub-set of four to five individual rods, with grit applied to the inside for better slip resistance.

VII.7.3.2. Dead-end Grip:

The dead-end grip is a set of armor rods that have been formed with a loop in the center. It, too, has a precise twist lay that matches the diameter of the SRL and cable. Its length is dependent on the maximum anticipated load. It has grit applied to the inside and also has a color band 18 inches from the loop.

VII.7.3.3. Thimble Clevis:

The thimble clevis, sometimes called the clevis shackle, is a cast aluminum or steel piece of hardware used to maintain the seat diameter of the dead-end loop and attach the dead-end loop to the extension link, and ultimately the structure.

VII.7.3.4. Assembly:

The dead-end hardware is assembled by the following steps:

VII.7.3.4.1. There is a color band that is closer to one end of SRL. The rods should be installed with that made (at the attachment end of the span).

VII.7.3.4.2. Wind one subset of rods on the cable. Wind on subsequent sets of SRL by utilizing the color marker as a guide to proper alignment. The rods should be placed close together to assure room for all sets.

VII.7.3.4.3. At the end of the SRL, the rod tips should align. Do not use tools to snap the rod tips in place, as this may damage the cable jacket.

VII.7.3.4.4. Align the color band of the dead-end grip with the color band on the SRL, and wind one leg on approximately two feet.

VII.7.3.4.5. Insert the thimble clevis into the loop, by removing the pin and sliding the clevis arms into the loop.

VII.7.3.4.6. Align the color band of the second dead-end leg with the first that is already partially wound on the SRL. Wind the second leg over the SRL for approximately two feet.

VII.7.3.4.7. Continue winding on the legs of the dead-end, either one at a time or together. Snap the ends of the rods in place. Do not use a tool to snap them in.

VII.7.3.4.8. Apply a band of vinyl tape on both ends of the SRL to assure all SRL ends are seated properly.

VII.7.3.4.9. Secure the thimble clevis to the extension link and then secure the extension link to the structure.

VII.7.4. Suspension Assembly:

Suspension assemblies, sometimes called Armor Grip Suspensions (AGS) units, are used where the line angle is from 0 degrees to 25 degrees. The basic elements that are included in the suspension assembly, refer to Figure 9, are the Structural Reinforcement Layer (SRL), the AGS rods, the neoprene insert, the housing strap, and nuts/bolts. The suspension assembly is typically supported with an appropriately rated shackle.

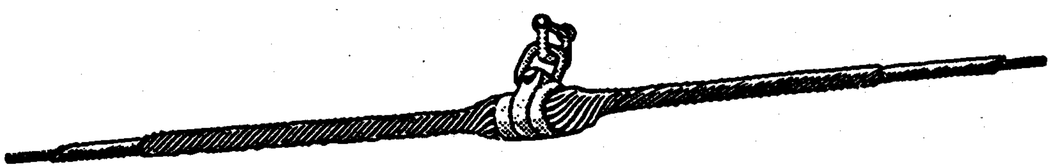


Figure 9. Suspension Assembly

VII.7.4.1. Structural Reinforcement Layer (SRL):

The SRL for the suspension assembly is very similar in function as the SRL for the dead-end. However, the color band is at the center of the rods.

VII.7.4.2. Armor Grip Suspension (AGS) Rods:

The AGS rods are individual rods that are typically larger in diameter than the SRL rods. They too have a color code band at the center of each rod.

VII.7.4.3. Insert, Housing, Strap and Nuts/Bolts:

The neoprene insert cushions the load transfer from the SRL to the AGS rods. The housing is a cast steel clamp that acts as the main support element with the strap, nuts and bolts completing the assembly.

VII.7.4.4. Assembly:

The AGS suspension unit is assembled by the following steps:

VII.7.4.4.1. There is a color band in the center of the SLR rods. Apply the SRL subunit from the center point, winding in both directions. Add each individual subunit by using the color marker as a guide to line the SRL subunits properly.

VII.7.4.4.2. Apply the neoprene insert at the center color band of the installed SLR rods. Ensure that the seam of the two halves is horizontal and not vertical. A band of vinyl tape at the center of insert will hold it in place.

VII.7.4.4.3. Center the AGS rod in the insert. Apply two wraps of rod on each side of the insert. The curvature of the rod should follow the curvature of the insert. The AGS rod should be parallel with the insert, not wrapped around the insert.

VII.7.4.4.4. Apply the remainder of the AGS rods on the insert. Make sure that no rods are crossed. They should all be parallel to the insert. Complete the application of the rods and assure the ends are snapped into place. Do not use tools, such as screwdrivers, to snap in place.

VII.7.4.4.5. Place the two halves of the AGS housing on either side of the center of the assembly and slide the AGS strap into place. Insert the bolt through the ears, and tighten. Do not over tighten the ears of the AGS housing against the suspension shackle or fitting.

VII.7.4.4.6. Attach suspension shackle or fitting to structure.

VII.7.4.5. Tangent Support Assemblies:

Tangent support assemblies come in several varieties, some as dielectric blocks and others as metal housing with an insert that pad and protect the cable. These units are in distribution applications where the span is less than 400 feet and the line angle is from 0 degrees to 15 degrees.

VII.8. SAGGING AND TENSIONING

VII.8.1. General:

After the cable has been placed throughout the entire length of the system, sagging and tensioning can now be started. Sagging and tensioning of a system is worked progressively from one end of the system towards the opposite end. Typically, the cable slack is worked back toward the payoff reel in order to recover as much cable as possible.

VII.8.2. Termination Point:

Pull enough cable into the building to assure that the termination location is reached and enough fiber optic cable is spared to facilitate cable splicing. The spare fiber required in the splice tray is dependent on type of fiber organizer and splicing method. Typically, four to six feet of fiber is required to facilitate splicing. Assure that 20 feet of cable is cut off at the wire mesh grip to assure that no damaged fiber is used. Some excess cable may also be required to provide sufficient cable to splice it on the ground, and not in the cable rack.

VII.8.3. Termination Structure:

At the last structure establish a dead-end assembly per the instruction paragraph 7. Assure that the bend radius requirements are maintained where the cable is run down the structure. If the FREE-SPAN fiber cable is run down the structure, it is recommended that cable riser guards are used to protect the cable as it makes the transition of aerial cable to the building entrance conduit.

VII.8.4. Remove all excess cable sack out of the span; or if in the case of several in-line structures, series of spans. This is not prestressing or even tensioning. This removal of excess cable slack is necessary to properly position the temporary dead-end pulling grip. To remove the slack, reverse the tensioner and pull the cable back toward the reel, being careful not to exceed the pulling criteria of one-half the maximum installation tension.

VII.8.5. With the cable slack removed, apply a temporary dead-end assembly 1.5 to 2 dead-end assembly lengths (approximately six to ten feet) from the structure. This will be utilized as a tensioning grip to achieve the proper span sag and tension, prior to installing the permanent dead-end assembly. Attach the tensioning rig, comprised of a sufficiently rated chain hoist, dynamometer and bull chain, to the structure and the temporary dead-end. Take up the load and begin to tension the span per the provided sag and tension charts.

VII.8.6. Typically, the cable is worked span by span back to the payoff reel. If several structures are in-line, then a series of spans may be tensioned at one time. After the spans are close to proper tension, the suspension or tangent hardware is installed and attached to the structures by working back to the temporary dead-end, a span at a time. The tension will have to be adjusted at the temporary dead-end to assure proper sag of each span. Superior Optics recommends that no more than 4 spans be attempted in this manner. If more spans are attempted at once, the temporary tensioning rig will have to be moved several times, costing time.

VII.8.7. The permanent dead-end can now be applied. Measure the length of the extension link, thimble clevis, and dead-end loop up to the color band. Keep this measurement as a reference to determine where to install the permanent dead-end. Once the span has been tensioned, measure the reference length from the structure and start applying the structural reinforcing layer at that point, with the color band at the measured location on the cable. Once the permanent dead-end is installed, and the hardware is attached to the structure, the tension can be released on the tensioning rig and the temporary dead-end removed. As the next permanent dead-end is installed on the adjacent span, make sure that the expansion loop under the dead-ends is properly formed, maintaining minimum bend radius. This means the cable is typically 14 inches lower than the cable framing location. This process is repeated until all spans are sagged and tensioned for the complete system.

VII.9. ROUTE IDENTIFICATION

VII.9.1. <u>General:</u>

Identification of the fiber optic cable and the cable route with warning signs helps prevent inadvertent cable damage caused by company personnel or the general public. This is most important on joint-use distribution pole lines where more than one company may have facilities on the structure. The proper warning signs should use industry accepted wording and visual indicators stating warnings.

VII.9.2. <u>Fiber Optic Cable Warning Signs:</u>

At each structure the cable should be tagged with a cable warning sign. These signs can be a snap around plastic tag in high visibility orange, sating “WARNING – FIBER OPTIC CABLE” or similar wording. The tags are typically applied to the expansion loop under the double dead-ends. Other types of cable warning signs are small plastic or painted metal signs with the same type of wording, but are affixed to the structure at the cable framing locations.

VII.9.3. <u>Fiber Optic Cable Route Warning Signs:</u>

At locations where the cable may go underground or change to adherent structure type, it is recommended to identify the cable route direction with a fiber optic cable route warning sign. This helps to identify the route during an emergency restoration and during preventative maintenance programs, when the cable route is periodically inspected. Again, the use of industry accepted wording and colors are recommended.

VII.10. RECORDS

VII.10.1. General:

Records are an integral part of the equipment required to maintain and restore a fiber optic system. During outage conditions, having a records package readily available eliminates unnecessary delays locating and accumulating information required for the restoration process.

VII.10.2. Coordination:

Due to the number of departments involved in the design, construction, turn-up, and maintenance of fiber optic systems, records can be lost or misplaced after the initial installation of the fiber optic system. This can be a catastrophe during a system outage, because this information is necessary for comparison against trouble-shooting information.

VII.10.3. Documentation

For each fiber optic system the following information should be included in the documentation package.

VII.10.3.1. Engineering Design Package

The Engineering Design Package typically includes some or all of the items below depending on the magnitude of the project. These include a Cover sheet & Key Map, Composite Schematic, Route Map Construction sheets, Construction Detail Sheets, Fiber Splice Plans, Circuit Diagrams and Manufacturer Provided Documentation.

VII.10.3.1.1. Cover Sheet & Key Map:

The Cover sheet & key map shows the project title along with a geographical map showing the system route in relation to roads and highways. Its purpose is to provide general bearings to quickly access key areas of the system, such as field splice points and major road crossings. Sheath meter marks should be indicated on the map for splice points, road crossings, river crossings, etc.

VII.10.3.1.2. Composite Schematic:

The composite schematic is a straight line schematic identifying the construction sequence of cable reels by reel number, meter markings to major construction points such as splice points, and major road crossings. The cable reel section length and a cumulative cable length should be marked at each of these points. In addition, the cable and fiber type and count shall be identified for each reel section.

VII.10.3.1.3. Route Map Construction Sheets:

The Route Map construction sheets identify the actual apparatus units at each structure. Other information such as the structure type and dimensions, cumulative distance to each termination point from the structure, any grounding or bonding detail, etc. Overhead route maps should typically be prepare at a scale of 1 inch to 100 feet. Underground route maps should typically be prepare at a scale of 1 inch to 50 feet or less when applicable.

VII.10.3.1.4. Construction Detail Sheets:

These sheets show details of JEA Fiber optic Standards as well as specific details for a particular location on the route map that may require greater clarity.

VII.10.3.1.5. Fiber Splice Plans:

These plans detail how individual fiber optic strands shall be Spliced (at field splices) or Terminated (at a Fiber Patch Panel). For Field splices, typically the buffer tubes and strands are shown in an assigned splice tray. For terminations, typically a preterm pigtail is shown with the applicable buffer tubes/strands/ splice tray on one side and the applicable Connector Panel Bulkhead position on the other side.

VII.10.3.1.6. Circuit Diagram:

The circuit diagram is a schematic that identifies the actual fiber circuits, system number, working and protect fibers, fiber/buffer colors, priority sequence during restoration and other pertinent information such as transposed fibers.

VII.10.3.1.7. Manufacturer Provided Documentation:

The manufacturer provided documentation would include cable data sheets of each cable reel, documentation provided on the fiber, equipotential plots of the field strength levels relative to different structure types, and sag and tension charts provided for construction.

VII.10.3.2. Contractor & JEA Crew Redline Mark-ups:

The Redline Mark-ups are produced during and finalized at the completion of construction. A copy of the Engineering Design Package is updated and corrected to reflect any changes during construction. Examples may include Overhead additions, deletions, revisions of attachment locations, Underground additions, deletions, revisions of conduit and vaults, slack loop and splice location changes. Specific cable jacket data should be added at this time. This shall include cable Manufacturer, Build

Year/Month, Cable designator, Footage/Meter markings at splice cases, patch panels, and slack loops.

A Contractor Stamp with the Forman's signature and Date of completion shall be include on the cover page in case follow-up is needed to produce the As built. Redline mark-ups are required documents for acceptance of work and receipt of payment.

VII.10.3.2.1. Splice Plan Redline Markup and Test Acceptance Sheets:

A different group than cable installation normally completes Fiber optic splicing work. However, Splice Plans should be Relined and stamped as described in the previous paragraph. . Splice plan Redline mark-ups are required documents for acceptance of work and receipt of payment.

The test acceptance sheets are the recorded values of the transmitter output power, receiver input power, and measured attenuation levels at the receiver. Other information to be included in the test acceptance package are the Optical Time Domain Reflectometer (OTDR) plots or photographs of each fiber and its terminated pigtail, shot in both directions at both 1300nm and 1550nm. Other recommended documentation includes the bi-directional average of the loss of each splice, including pigtail spices with connector insertion loss.

VII.10.3.3. Records Documentation Package "As-Built":

These sheets are typically the Engineering Design Package: that have been corrected to reflect any changes during construction. The As built should be prepared by the engineering group as part of the closing package.

VII.10.4. The original copy should be maintained by the engineering group and a copy (Both PDF and CAD Drawing) distributed to the maintenance group. One copy of the records package should be placed at each end of the termination points of the fiber optic system. When changes in the system are required due to supplemental construction or emergency restoration, the records package should be revised and redistributed.

VII.10.5. Annual System Check:

Periodically, the system attenuation level shall be verified against the turn-up attenuation measurement. If this attenuation level has changed more than 3db, it is recommended that the cause be investigated and corrective action taken.