FIBER CONNECT

FIBER OPTIC SPLICING AND TESTING METHODS

ISSUING DIVISION: SVP Fiber Engineering **Signed by Joseph Pâté**

SVP SPONSOR: Ted Salazar, Program Manager **Date Signed 07/20/21**

SECTION: Underground Construction FO-1901

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1. Scope of Standard

This standard describes the fiber optic splicing and testing requirements used for City owned fiber managed by Fiber Connect. In most cases, this standard describes the work done by Fiber Connect Splicers but this standard will also apply to developers and/or contractors if they provide fiber splicing and/or testing services for the Fiber Connect fiber optic network.

2. Purpose of Revision

a. Not Applicable. This is a new document with Fiber Connect.

3. References

a. City of Santa Clara Public Works standards
   i. Current standards location - (www.santaclaraca.gov)
   ii. Search for Technical Documents or go to Engineering and Technical Documents in the menus
b. SVP Fiber Lease Agreement - Exhibit 7
c. NEC (National Electric Code)
d. BICSI Standards
e. EIA-455-53
f. California MUTCD Document
g. California 2010 Code of Safe Practices
h. California CPUC General Order 95
i. California CPUC General Order 128

4. Rescissions

a. SVP 0403. This document deprecates all previous versions of SVP 0403 – FIBER OPTIC CABLE AND SPLICE TESTING.

5. Definition of Terms

a. **Building Inspector**: City of Santa Clara Building Dept. Inspector, responsible for verifying proper installation and repair of all private building facilities. This includes the electric service entrance and meter service panel.

b. **Contractor**: The person or persons, firm, partnership, corporation or combination thereof, who has entered into a contract with the City of Santa Clara.

c. **City**: City of Santa Clara or the City Council of the City of Santa Clara.

d. **City Engineer**: City Engineer of the City of Santa Clara.

e. **Developer**: Any person or legal entity who causes land to be divided into two or more parcels for himself or others; or is engaged in the development of property, in whole or in part, by the placing of any improvements thereon, whether the property was previously developed in whole, in part, or at all.

f. **Demarcation Point:** the access point, within the requested service location where FOI connects to Lessee's Infrastructure.

g. **Extended Demarcation For Cable (EDFC):** a cable that is extended past the FOI structure demarcation point and has its own cable demarcation point.

h. **Fiber Connect**: Fiber Connect is Division within Silicon Valley Power. Fiber Connect specializes in the design and installation of fiber systems and supporting infrastructure.

i. **Fiber Connect Inspector**: Silicon Valley Power Fiber Inspector responsible for verifying proper installation of Fiber substructures installed for use by Fiber Connect.

j. **Fiber Connect Splicer**: Silicon Valley Power Fiber Splicer responsible for splicing and testing of fiber cables and strands.

k. **Fiber Optic Infrastructure (FOI):** Fiber Optic Infrastructure is defined as unlit fiber optic strands, cable, splices, and associated structures owned and maintained by the City such as conduits, handholes, manholes, vaults, messenger and any structure installed by, or on behalf of City. Examples of the FOI line of demarcation is a patch panel, cable 1 foot from a City owned structure or a splice point.

l. **Inside Plant** – Refers to all cables, structures and materials used to install and support cable installations that are located inside a building. These cables are usually not subjected to exposure to Ultraviolet radiation from the Sun. Also, should the cables or structures become exposed to flames and release gases, the fumes may travel in the building exposing occupants to their fumes and thus, will need to be riser, plenum or Low Smoke Zero Halogen rated.

m. **Meet Me Box (MMB):** A customer owned vault, handhole, manhole or equivalent structure that is often the tie in point from structures owned and maintained by Fiber Connect. The MMB often serves as the tie in point for conduits that access into the building.

n. **Point of Presence (PoP):** an access point, location, facility or another location as specified by City established to connect with an Internet Service Provider (“ISP”) or other communications entity.

o. **OLTS** – Optical Loss Test Set – Fiber optic test sets that measure the fiber loss between two points.

p. **OTDR** – Optical Time Domain Reflectometer – Fiber optic test unit that sends a pulse into a fiber and measures reflections that appear on the fiber. The level of

reflections determine the length of the fiber and the type of damages there is on the fiber.

q. **Outside Plant** – Refers to all cables, structures and materials used to install and support cable installations that are located outside a building. These cables may be exposed to Ultraviolet radiation from the Sun or prolonged submersion in water in conduits or manholes.

r. **Public Works Inspector**: City of Santa Clara Public Works Dept. Inspector, responsible for verifying proper installation and repair of all facilities within City right of ways and easements.

s. **Service Entrance**: The underground electric service conductors and duct(s) between the customer's main switch and the utility connection point.

t. **Silicon Valley Power (SVP)**: Municipal Electric Department of the City of Santa Clara.

u. **SVP Inspector**: Silicon Valley Power Electric Inspector responsible for verifying proper installation of communication substructures installed for use by Fiber Connect.

v. **Utility Electric (UE)**: All conduits and structures owned and maintained by Fiber Connect. The Utility Electric network also includes systems for alarm and control circuits, fire alarm, SCADA, fiber optic cable, protection circuits, etc.

7. Materials

a. Fiber Connect will provide all cable and splice materials for fiber cable installations. Should an install occur where the fiber cable or splice materials are provided by the developer, refer to other standards for details for those installations.

8. Cable Criteria

a. Only singlemode fibers will be used for fiber circuits.
b. Fiber strands will have a core and cladding size of 9 µm and 125 µm.
c. Fiber strands will not have more cable loss than 0.35 dB/km @1310 nm and 0.25 dB/km @ 1550 nm.
d. Each fiber splice will be no more than 0.05 dB of flat loss.

e. Fiber strands will correspond to TIA-598 color scheme shown below:

Blue (BL)	Orange (OR)	Green (GN)	Brown (BR)	Slate (SL)	White (WH)	Red (RD)	Black (BK)	Yellow (YL)	Violet (VI)	Rose (RO)	Aqua (AQ)
1	2	3	4	5	6	7	8	9	10	11	12

f. Bend Radius – During installation, cable pulling tension should not exceed cable manufacture's rating and not less than 20 x outside diameter of the cable unless otherwise specified. For coiling purposes, no less than 10 x outside diameter should be maintained.
g. The cable shall be able to withstand a short-term longitudinal load (during installation) of not less than 2700N (608 lbs.) with maximum elongation of less than 0.5%. The cable shall be able to withstand a long-term longitudinal load of not less than 1350N (304 lbs.).

h. The minimum static or no load (0-130 lbs.) bending radius for the cable shall be no less than ten (10) times the cable diameter. The minimum dynamic or loaded (131-600 lbs.) bending radius shall be no less than twenty (20) times the cable diameter. The cable shall be able to withstand being flexed at the minimum static bending radius +/- 90 degrees for at least 20 cycles at 20-40 cycles per minute at 20 degrees C.

i. The contractor shall provide both the swivel and the break-away pin. The swivel break-away pin must be replaced every cable pull by the contractor.

j. The cable shall be able to withstand twisting of +/-360 degrees over a length of 2 meters for at least 10 cycles at 10 cycles per minute.

k. Cable installations should follow or exceed National Electrical Code criteria for the purposes of bonding, support and conduit fill.

l. Ensure slack coils of fiber are neat, tidy and secure from movement.

m. Properly label cables with tags or labels that will not fade, disintegrate or become unusable for at least 20 years. Labels must be visible in junction boxes or racks and not hidden inside of conduits or walls.

9. Cable Shipment Testing

a. Prior to installation and handling, all fiber cables (one fiber per tube) should be tested before getting installed. Testing cables while still on the reel or in the packaging ensures that all cables were received in proper condition free of defects.

b. Pre-Terminated Cables

   i. Cables terminated by the cable vendor are a convenient means to receive fiber cables since they can be installed directly for use without the need to splice connectors onto the fibers.

   ii. Industry changes must be compatible with LC type fiber connectors. If a cable is equipped with connectors other than LC, an adapter must be provided such as an MTP to LC adapter panel.

iii. If pre-terminated cables have connectors on both ends then an OLTS power loss test can be made with any vendor test sets provided the sets have been calibrated within two years of the test.
    i. Record power loss test results at both 1310nm and 1550 nm.
    ii. Losses of the test should not exceed the combined loss of the cable length per km using 0.35 dB/km @1310 nm or 0.25 dB/km @1550 nm.

iii. Pre-terminated cables should also be tested with an OTDR to ensure that the cables are free of defects or anomalies. Tests should be saved for record keeping and produced upon request. The OTDR to perform the test must have the correct settings for the fiber under test and should have been calibrated within the last two years.

c. Unterminated Reel Cables
    i. Fiber cables that are used in outside plant construction often are shipped on a reel without connectors on the end of the fiber. Inside plant cables that are larger in size may also arrive in a reel configuration. Prior to installation, fibers should be tested using an OTDR and bare fiber connector test set. The OTDR to perform the test must have the correct settings (index of refraction) for the fiber under test and should have been calibrated within the last two years.
    ii. Fiber Coefficient Test – Compare the distance noted by the OTDR from step 9.c.i. above against the distance noted on the sheath of the cable. The distance noted with this test should be longer than the cable by about 3%. Record both distances and save the OTDR file for later review.

8. Fiber Cable Testing after Installation

a. The fiber strands inside the fiber cable may become damaged even with no visible damage to the cable outer jacket. Damage to the fiber strands is most likely caused by the following common problems:

   i. The cable tension was exceeded by pulling too hard on the cable without using a breakaway or tensiometer to limit cable tension.

   ii. The cable was pulled around corners or over edges which exceeded the minimum bend radius of the cable.

   iii. The cable was crushed, kinked or compressed beyond a safe level by driving over or walking on the cable during installation.

b. Testing the fiber cable after installation by Fiber Connect Splicers is necessary to ensure that the fiber cable was installed correctly. Records of the test and OTDR also provide a means to troubleshoot the line in the event of failure of the fiber in the future.

c. With fibers terminated in panels or with connectors, an OLTS power loss test can be made with any vendor test sets provided the sets have been calibrated within two years of the test.

   i. Record power loss test results at both 1310nm and 1550 nm.

   ii. Losses of the test should not exceed the combined loss of the cable length per km using 0.35 dB/km @1310 nm or 0.25 dB/km @1550 nm, 0.05 dB per splice and 0.3db per connector.

d. Cables connected to a patch panel at both ends must also be tested with an OTDR at both ends.

   i. No single event in the resulting waveform may exceed 0.06 dB.

   ii. The cable cannot exceed 0.35 dB/km @1310 nm or 0.25 dB/km @1550 nm, 0.05dB per splice and 0.3db per connector.

   iii. Save all OTDR traces for later review.

9. Guarantee

a. It shall be the responsibility of the Contractor to repair and correct any defects or deficiencies due to workmanship or material, which are discovered within one year from date of acceptance by the City. Repairs and corrections will be made at no charge to Fiber Connect or the City of Santa Clara.

b. In the event that Fiber Connect must make repairs before the Contractor can be notified, or when Fiber Connect determines that it is not practical for the Contractor to make the necessary repairs, Fiber Connect reserves the right to make the necessary repairs or replacements at the expense of the Contractor. Fiber Connect will make every effort to preserve the available evidence of cause of the failure for examination by the Contractor.

c. In most installations, the City's FOI is a true demarcation point for both cable and structures however, when an EDFC is required, the cable may extend outside of the FOI structure boundaries due to passing through structures owned by other entities such as conduits. For these installations, the City owns and maintains the cable, splice points and patch panels. The customer is responsible for maintenance and repair of the structures up to the city's FOI.

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