FIBER OPTICS TECHNICIAN – OUTSIDE PLANT (FOT-OSP)

Competency Requirements

This competency listing is an identification of subject topics in which Fiber Optics Technician – Outside Plant (**FOT-OSP**) individuals are expected to obtain knowledge in order to prepare for the ETA® International **FOT-OSP** certification examination. This includes a full understanding of Passive Optical Networks (PON), of skillfully performing splices and closures, and of Optical Time Domain Reflectometer (OTDR) use. A knowledge of the concepts of fiber optics troubleshooting and service applicable to all of the functions is required to safely and completely analyze FTTx signatures, measure reflectance, test splitters, and identify faults in fiber optics communications and transmission cabling.
This certification is designed for technicians working in the Outside Plant field studying the "physical layer" of the OSI model. An **FOT-OSP** must be knowledgeable in the following technical areas:

1.0 PRINCIPLES OF LIGHT AND FIBER OPTIC TRANSMISSION THEORY

- 1.1 List the types of light sources used in single-mode fiber systems
- 1.2 Describe common transmission wavelengths used in single-mode fiber systems
- 1.3 List the wavelengths used in these fiber systems:
  - 1.3.1 Fiber to the Home (FTTH)
  - 1.3.2 Passive optical networking (PON)
  - 1.3.3 Active Ethernet
- 1.4 Explain how optical power levels are measured (dBm)
  - 1.4.1 Explain how to express gain and loss using the decibel (dB)
- 1.5 List types of optical reflections
- 1.6 Explain Index of Refraction
- 1.7 Describe causes of Fresnel reflections
- 1.8 Describe the wavelength (or frequency) bands and spacing used in Coarse and Dense Wavelength Division Multiplexing (CWDM/DWDM) systems

2.0 SINGLE-MODE FIBER, CHARACTERISTICS, CONSTRUCTION AND THEORY

- 2.1 Describe an ITU-T G.652 / G.652.D single-mode fiber
- 2.2 Describe an ITU-T G.655 single-mode fiber
- 2.3 Describe an ITU-T G.657 single-mode fiber
- 2.4 Describe the light transmission area for single-mode fiber operation
- 2.5 Explain the purpose of a fiber's cladding
- 2.6 Describe the two common coating diameters used in single-mode fibers
- 2.7 Describe how different manufacturing techniques can affect system performance
- 2.8 Describe 'chromatic dispersion'
- 2.9 Describe 'material dispersion'
- 2.10 Describe 'waveguide dispersion'
- 2.11 Describe the term 'optical windows'
- 2.12 Describe 'optical bands'
- 2.13 Describe the term 'microbending'
- 2.14 Describe the term 'macrobending' and compare it with microbending
- 2.15 Identify standard tensile strength load value (pound-force, newton) for single-mode fiber optic cable

3.0 TERMINOLOGY, DEFINITIONS AND ABBREVIATIONS USED IN OSP FIBER OPTICS

- 3.1 Define the following acronyms and terms:
  - 3.1.1 ITU, ANSI, TIA, NEC, NESC, IEC
  - 3.1.2 FTTH/PON, FTTx
  - 3.1.3 LAN, WAN and MAN
  - 3.1.4 WIC coupler
  - 3.1.5 FOTP (Fiber Optic Test Procedure), i.e., TIA-455-
  - 3.1.6 ODN and OSP
  - 3.1.7 MSDS
  - 3.1.8 FDU
  - 3.1.9 FDH
  - 3.1.10 FAT
  - 3.1.11 MST
  - 3.1.12 Hardened
  - 3.1.13 OLT and ONT/ONU
  - 3.1.14 dB, dBm and dB/km

4.0 SINGLE-MODE FIBERS IN WAN, MAN, FTTx AND PREMISES NETWORKS

- 4.1 List the types of single-mode fiber used in premises applications
- 4.2 Describe acceptable methods of terminating single-mode fiber
- 4.3 List the types of fiber used in metropolitan area networks (MANs)
- 4.4 Describe the type of fiber used for Wavelength Division Multiplexing (WDM):
  - 4.4.1 Dense WDM (DWDM)
  - 4.4.2 Coarse WDM (CWDM)
  - 4.4.3 Shortwave WDM (SWDM)
- 4.5 List the International Telecommunication Union (ITU) specification for the two common single-mode fiber types
- 4.6 Compare different techniques used in fiber manufacturing
- 4.7 List different types of fiber optic cable tolerances
- 4.8 List the fiber types specified in the ITU FTTH standards
- 4.9 Describe the different types of dispersion in single-mode applications

5.0 FIBER OPTIC CABLES

- 5.1 In a cross-section drawing of a stranded fiber optic cable, explain the purposes of each segment
- 5.2 Identify the segments in the drawing of a cross section of a central tube fiber optic cable
- 5.3 Explain why and where loose tube cable is used
- 5.4 Compare tight-buffered cable with other types of fiber cable
- 5.5 Explain the differences between the strength member in both stranded and central tube fiber optic cables
- 5.6 Name the cable jacket material used in common types of outside plant cables
- 5.7 Explain the purpose of installation specifications
- 5.8 Define an indoor distribution cable structure and compare it with loose tube and central tube fiber optic cables
- 5.9 List reasons for utilizing armored fiber cables
- 5.10 Describe the purpose of cable ribbons and how they are used in fiber optic cables
- 5.11 Explain the purpose and indicate where the TIA-598 color code is used
- 5.12 Describe manufacturer markings on cable jackets and how they are used
- 5.13 Explain the use of sequential cable markings
  - 5.13.1 Describe helical lay fiber length with respect to marked cable length
- 5.14 Describe the two types of outdoor style cable structures
- 5.15 Compare indoor and outdoor cables, their applications and benefits
- 5.16 Describe the use of cable gels, powders and tapes for cable protection
- 5.17 Define tensile strength of a fiber cable
- 5.18 Describe the dynamic load of a fiber cable
- 5.19 Define ‘static load’ as it refers to fiber cabling
- 5.20 Describe the detrimental effects of exceeding the minimum dynamic bend radius of a fiber cable
- 5.21 Compare static versus dynamic bend radius in fiber optic cabling
- 5.22 Describe the differences between fiber optic trunk, distribution and drop cables used in FTTx installations
- 5.23 Explain the importance of the attenuation specification in fiber optic cables and how it is used
- 5.24 Define microducts and microduct cables
- 5.25 Explain the role(s) of feeder cables
- 5.26 Explain the role(s) of distribution cables
- 5.27 Explain the role(s) of drop cables

6.0 ACTIVE DEVICES

- 6.1 Name the types of active optical devices used in fiber optic-communication systems
- 6.2 Explain the purposes and differences in the safety classifications for light sources used in fiber communications
- 6.3 Name the types of light sources used in OSP applications
- 6.4 List the common wavelengths used in single-mode fiber communications systems and the advantages and disadvantages of each
- 6.5 Explain how to measure the output power of a light source
- 6.6 Explain dBm and its role in testing transmit and receive optical power levels
- 6.7 Explain the impact of Fresnel reflections on laser transmission
- 6.8 Explain the impact of proper optical fiber cleaning materials and their effect on transmission quality

6.9 Describe the basic role of the photodiode in fiber optic communications
6.10 Describe the function and relationship of optical attenuators to detectors

7.0 CONNECTORS

7.1 Identify standard fiber optic cable connector types
7.2 Explain intrinsic factors applicable to losses in fiber connectors
7.3 Explain extrinsic factors that cause attenuation in a fiber optic connection
7.4 Describe how interconnection losses can be identified using common measuring equipment
7.5 Explain how reflections can be identified in a completed cable link
7.6 Describe a PC polish
7.7 Describe a UPC polish
7.8 Describe an APC polish
7.9 Describe how and where pigtails are used in fiber optic cabling systems
7.10 List steps taken to properly perform a visual inspection of an optical plug (connector)
7.11 Describe proper cleaning of a single-mode plug and sleeve
7.12 Describe contaminated or damaged connector ferrules
7.13 Name common contaminants found in fiber cabling systems
7.14 Describe common types and causes of fiber damage at the ferrule
7.15 Describe a small form factor (SFF) connector as used in fiber optic transmission systems
7.16 Describe the type of bonding techniques optimized for FTTx single fiber terminations
7.17 Describe what an array connector is and its common applications
7.18 Describe a “hardened” connector
7.19 List two types of “Splice-On” connectors
7.20 Explain how to use the ANSI/TIA-568- color code to identify multimode and single-mode connectors and adapters

8.0 PASSIVE COMPONENTS

8.1 Explain the uses and benefits as well as disadvantages of using fiber optic signal splitters
8.2 Describe where optical splitters are used in FTTx applications
8.3 Explain wavelength division multiplexing (WDM)
8.4 Explain how WDM is used in FTTH/PON systems
8.5 Explain the differences between WDM and DWDM
8.6 Explain the differences between WDM and CWDM
8.7 Describe a wavelength independent coupler (WIC) and its characteristics
8.8 Describe how an insertion loss test is conducted for optical splitters
8.9 List the theoretical attenuation values for 1:2, 1:4, 1:16 and 1:32 splitters
8.10 Explain how to test and compare measured versus theoretical losses of splitters
8.11 Explain why an optical attenuator may be required in a fiber optics system

9.0 TYPES OF SPLICING

9.1 Explain the differences between intrinsic factors and extrinsic factors when splicing optical fibers
9.2 List extrinsic factors important in fiber splicing
9.3 Describe correct fiber cable preparation
9.4 Explain the purpose of index matching gel and where it is used
9.5 Explain the benefit of index matching fluids
9.6 Describe Telcordia GR-20 performance specification standards for mechanical and fusion splices
9.7 Explain the purposes of the splice closure
9.8 Describe the correct cleaving operation for a fiber optic splice
9.9 Explain the purpose and the correct method of applying a splice protector
9.10 Describe splice trays and their usage
    9.10.1 Identify the proper color code sequence for splice tray management
9.11 Explain the role and benefits of pigtail splices in a single-mode system
9.12 List the two coatings used in single-mode pigtail splicing
9.13 Explain where mechanical splices are used in single-mode systems

10.0 CABLE INSTALLATION

10.1 Define ‘dynamic tensile loading’ of a fiber optic cable
10.2 Explain ‘static tensile loading’ and compare with dynamic tensile loading
10.3 Compare the dynamic bend radius minimums for common OSP fiber cables
10.4 Describe the effects of exceeding minimum bend radius limitations

10.5 Explain when and where bonding to ground is required
10.6 Describe a pulling grip and explain its usage
10.7 Describe where conduit should be installed to protect fiber optic cables
10.8 Describe the National Electrical Code® (NEC®) Article 770 rules pertaining to indoor cabling
10.9 Describe the role of the National Electric Safety Code® (NESC®) for aerial and buried installations
10.10 Explain why a mid-entry into an OSP cable may be required
10.11 Explain the tension ratings of drop and feeder cables
10.12 List the minimum depth for burial of a fiber optic cable drop
10.13 Name cable management products used for cable slack in aerial installations
10.14 Name cable management products used for slack cable in hubs and vaults
10.15 List the maximum tension level (pound-force, Newton) for a fiber optic drop cable

11.0 HARDWARE

11.1 Explain common practices for fiber optic splice closures
11.2 Explain the role of the Fiber Distribution Unit (FDU)
11.3 Explain the role of the Fiber Distribution Hub (FDH) in FTTx applications
11.4 Explain the role of the Fiber Access Terminal (FAT) in FTTx applications
11.5 Explain the role of the Multiport Service Terminal (MST) in FTTx applications
11.6 Describe how the mid-entry splice cables are routed through a splice enclosure
11.7 Describe the different types of cable management products that are used at the hub locations
11.8 Compare the options for cable routing in a hub location
11.9 Explain the NEC® requirement for outdoor cable entry into a building
11.10 List the different types of innerduct products commonly used in fiber optic cabling
11.11 Describe how a loose tube cable is installed and spliced at an entrance cabinet
11.12 Describe the products, applications and options used in the Optical Distribution Network (ODN) for FTTx installations
11.13 Describe the five installation/termination options for the FTTx drop cables

12.0 FIBER OPTIC LINK

12.1 List the three basic parts of a fiber optics system
12.2 Explain how to prepare a basic optical link power budget
12.3 Explain the purpose of a basic “not to exceed” OSP loss budget
12.4 Explain how to measure the receive power levels of a fiber optics receiver
12.5 Describe how to use an optical attenuator and calculate the proper reduction of signal output light intensity
12.6 Describe the topologies used in MAN applications
12.7 Describe the topology used in an FTTx installation
12.8 Describe the role of the OLT (Optical Line Terminal) in FTTx systems
12.9 Describe the role of the ONT/ONU (Optical Network Terminal or Unit) in FTTx systems

13.0 OPTICAL FIBER MEASUREMENT AND TESTING

13.1 List the types of attenuation in fiber optics cables
13.2 Explain how to properly use an Optical Loss Test Set
13.3 Explain when 2 kHz modulation of the fiber optic light source would be used
13.4 Explain the proper use of the fiber optic power meter (OPM)
13.5 Describe how to locate a fault using an Optical Time Domain Reflectometer (OTDR)
13.5.1 Explain an OTDR’s pulse: width, power, number of
13.6 Compare fusion and mechanical splice, connector, and splitter signatures when using the OTDR
13.7 Describe a micro/macrobend at a splice closure
13.8 Describe the ‘Fiber Identifier’ and its operation
13.9 Explain how to measure Fresnel reflections at patch panels
13.10 Explain why bi-directional tests are performed
13.11 Explain the reasons for dual wavelength testing
13.12 Explain when to test using a light source and power meter
13.13 Explain what tests the OTDR is used for
13.14 Describe the causes of ghost reflections
13.15 Explain how the fiber optic talk set is used
13.16 Describe when and where the visual laser (visual fault locator-VFL) is commonly used
13.17 Identify wavelength assignments for next generation PON systems

13.18 Identify the wavelength the ITU L.301 standard has specified for testing and maintenance of single-mode fiber optic communication systems (formerly ITU-T L.41)
13.19 Identify other PON standards of ITU-T G.983, G.984, with IEEE 802.3ah and ANSI/SCTE 174
13.20 Explain how to test the attenuation of a 1:N splitter using dBm

14.0 LINK AND CABLE TESTING

14.1 Explain why an end-to-end optical loss test is performed
14.2 Describe the transmitter power test using the optical power meter
14.3 Describe the receiver optical power test using the optical power meter
14.4 Explain the purpose of an acceptance test to verify fiber optic cable values using an OTDR
14.5 Explain how an acceptance test for a mechanical splice is made
14.6 Describe the OTDR's 'deadzone'
14.7 Compare fusion and mechanical splice loss requirements per TIA-758-, TIA-568-, Telcordia GR-20, GR-765, ITU-T G.652, G.671, IEC 60793-2-50
  14.7.1 List the ANSI/TIA-568- maximum insertion and return loss values for multimode and single-mode mated connector pairs
  14.7.2 List the ITU-T G.671 maximum insertion loss and reflectance values for single-mode single-fiber mated connector pairs
14.8 Explain how to measure a fusion splice
14.9 Explain how to find the actual fault location of a non-reflective break
14.10 Explain how to perform a bi-directional test on a fiber span
14.11 Describe documentation of the values of component losses
14.12 Describe how to document the end-to-end attenuation value of a fiber span
14.13 Describe what tests Tier 1 and Tier 2 testing involves

15.0 SAFETY

15.1 Describe laser classifications (per CDRH – Center for Devices & Radiological Health)
15.2 Describe SDS / MSDS (Material Safety Data Sheets) regulations and the OSP products for which they would be required
15.3 Describe basic fiber optic safety practices in regard to eyes, skin and lungs, as well as safe fiber disposal methods
15.4 Describe safe cabling operations when working in confined spaces
15.5 Explain the role of UPS (uninterrupted power supply) at ONTs

End of FOT – OSP Knowledge Competencies

Find An ETA Approved Fiber Training School and Test Site: **http://www.eta-i.org/test_sites.html**

Suggested Study Materials and Resources for Fiber Optics Technician – OSP Certification:

Troubleshooting Optical Fiber Networks: Understanding and Using Optical Time-Domain Reflectometers, 2E; Duwayne Anderson, Larry Johnson, Florian Bell; ISBN 978-0120586615; Elsevier Academic Press; May 2004; 437 ppg; 800-545-2522

Technology Series DVDs and CDs; The Light Brigade, 800-451-7128, www.lightbrigade.com. Available through ETA 800-288-3824, www.eta-i.org

Cabling: The Complete Guide to Copper and Fiber-Optic Networking, 5E; Andrew Oliviero, Bill Woodward; ISBN 978-1-118-80732-3; Sybex, Inc; March 2014; paperback; 1284 ppg**.** —Available through ETA at 800-288-3824, www.eta-i.org

Fiber Optic Installer and Technician Guide; Bill Woodward, Emile Husson; ISBN 978-0782143904; Sybex, Inc; July 2005; hardcover; 496 ppg; Available through ETA 800-288-3824, www.eta-i.org

Fiber to the Home: The New Empowerment; Paul E. Green, Jr; ISBN 978-0471742470; Wiley-Interscience; Oct.2005; hardcover; 144 ppg

FTTX Concepts and Applications; Gerd Keiser; ISBN 978-0471704201; Wiley-IEEE Press; Jan.2006; 312 ppg

FTTx PON Technology and Testing; Andre Girard, PhD; EXFO Electro-Optical Engineering, Inc.; www.exfo.com; 2005; paperback, 200 ppg.

Understanding Fiber Optics, 5E; Jeff Hecht; ISBN: 978-0131174290; Prentice-Hall; April 2005; 800 ppg

National Electrical Code®, 2020; National Fire Protection Assn., Nov.,2019; www.nfpa.org

National Electrical Safety Code®, 2017; IEEE Standards Assn.; www.ieee.org

ETA Fiber Optics Committee

Committee Chairman,	**Bill Woodward, P.E.,FOD**	wrwoodward@outlook.com
Agard, Rich, FOI, RESIma	Phila. Fiber Optic Training, (PA)	ragard@aol.com
Alicto, Al, FOI		alalicto@gmail.com
Arndt, David, FOI	Casper College, (WY)	darndt@caspercollege.edu
Bonner, Dr. Tommy	VIAVI, (MS, TN)	
Booth, Richard, FOI, FOT	ETA International, (AZ)	richard.w.booth@gmail.com
Burch, Glenn, SAEFAB, FOT	Kitco Fiber Optics, (VA)	glenn.burch@kitcofo.com
Casbeer, Chuck, FOD	Infotec, ECPI University, (VA)	ccasbeer@infotecpro.com
Dadaian, Scott	Kitco Fiber Optics, (VA))	scott.dadaian@kitcofo.com
Dominique, Jeffrey, FOI, FOT	Fiber Network Training, (AZ)	jeffdominique@f-n-t.com
Dover, Tom	Dover Telecom.Serv., (UT)	
Engebretson, David, ESNT, TTT	SlaytonSolutions, Ltd/SNI, (IL)	slaytonsolutions@sbcglobal.net
Farmer, Jonathan, FOI	US Army CECOM	
Forrest, Jr., Ed	RaceMarketingServices, (GA)	edwforrest@gmail.com
Giordano, Timothy, FOT, CETsr	USMC, (CA)	gio0905@gmail.com
Gosnay, Greg, FOI, FOT	Yeager Career Ctr, (WV)	ggosnay@access.k12.wv.us
Goudy, J. Joe, FOI, CETsr	IHCC, (IA)	
Graeser, Steven T., SFF	Boeing, (FL)	
Gray, Renelle, FOI, CETa, CSS	Texas State Tech., (TX)	
Groves, JB, FOI, FOT, et al	WCJC Ft. Bend Tech. Ctr., (TX)	jbgroves@wcjc.edu
Guadalupe, Felipe	Kitco Fiber Optics, (VA)	felipe.guadalupe@kitcofo.com
Johnson, Larry	The Fiber Story, (WA)	fiberstory@gmail.com
Keller, Chuck, CETma, RCDD	APT College, (CA)	ckeller@aptc.edu
Kellett, Lee	Light Brigade, (WA)	
Knapp, Greyson, FOT-OSP	APEX Optics, ((TX)	greysonk@gmail.com
Kostner, Paul, FOT-OSP, FOI	WITC.edu, (WI)	
Limtiaco, John, FOI, DCI	L & K Communications, (Guam)	anital@teleguam.net
Milione, Dr. Ron, CETma, FOD	PSEG-Wireless Comm, (NY)	
Morris, Rohan, FOT-OSP	Vector Tech. Institute, (FL, Jam)	rohmor@cwjamaica.com
Neukam, Paul, FOI, FOT-OSP, RCDD	SiteWise Systems, (IN)	paul@sitewisesystems.com
O'Shay, L. Celeste	FOIRandD, Ltd, (WA)	w47lton@frontier.com
Osvatic, John, CETsr, FOT,	Light Brigade, (WI)	josvatic@lightbrigade.com
Proudley, Dr. Geoff, SFF	AVOptics, Ltd, (Yeovil, UK)	geoff.proudley@avoptics.com
Rivera, Kenneth, FOT	J M Fiber Optics, (CA)	krivera@jmfiberoptics.com
Sheedy, Sean, FOT-OSP, FOI	Optical Resources, Light Brigade, (ID)	
Shirk, Brian, FOI,FOT	Amphenol, (TX)	bshirk@fibersystems.com
Shoemaker, Phil, FOT-OSP	Light Brigade, (TX)	pshoemaker@lightbrigade.com
Siahmakoun, Dr. Azad	Rose-Hulman Inst.Tech., (IN)	siamako@rose-hulman.edu
Smith, Joe, FOI	Telecom Training Div-TEEX, (TX)	joe.smith@teexmail.tamu.edu
Stone, Don, SAEFAB,FOT,CFODE	Kitco Fiber Optics, (VA)	dstone@kitcofo.com
Spears, CJ "Buck"	S S Solutions, LLC, (AZ)	Buck@SSSolutions.us.com
Starnes, Dede,	Corning, (NC)	
Stover, Robert, FOI, FOT, DCI	Advanced Tech. Ctr. (VA)	rstover@vbschools.com
Taha, Khalid, FOD,FOT,FOI	ECPI University (VA)	ktaha@ecpi.edu
Taylor, Mike, FOI, PVI, CSM	Metronet, (IL, IN)	
Teague, Brian,	MicroCare-Sticklers, (CT)	brianteague@microcare.com
Thiam, Boon Kwee, FOI, FOT	FiberOpto Asia, PTE, Ltd	thiambk@fiberopto.com
Van Wemmer, Keith, FOI, FOT-OSP	VanTek Consulting, LLC (AZ)	SocialNet@VanTekConsulting.net
Veloz Perez, Rodolfo, CETms(F)	Brainamics, (Chile)	Rodolfo@brainamics.net
Wasser, Leonard, FOI	Tool Pouch Training, (CA)	
Wheeler, Larry, FOI, FOT-OSP	Light Brigade, (WA)	lwheeler@lightbrigade.com

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