Certified Data Cabling Installer (DCI)
Instalador Certificado en Cableado de Datos
Competency Requirements

Data Cabling Installers (**DCI**) are expected to obtain knowledge of basic concepts of copper cabling installation and service, which are then applicable to all the functions required to safely and competently install communications cabling and low voltage premises cabling. Network cabling has many options now and is being used for many applications in addition to data. Copper cabling is also combined with other media applications to create these networks. Once a **DCI** has acquired these skills, abilities and knowledge and with minimal training, the **DCI** should be able to enter employment in the telecommunications cabling field.

Data Cabling Installers must be knowledgeable and have abilities in the following technical areas:

1.0 SAFETY
Seguridad en el lugar de trabajo

1.1 Describe the various forms of personal protective equipment (PPE) that data cabling technicians have at their disposal
1.2 Explain the safety best practices associated with the work area
1.3 Provide an overview of emergency response information and techniques for the workplace that can be found in Material Safety Data Sheets (MSDS or SDS) described in the Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, and detailed in Appendix D of 29 CFR 1910.1200

2.0 BASIC ELECTRICITY
Electricidad básica

2.1 Describe the relationships between voltage, current, resistance and power
2.2 Identify components called resistors and also non-component types of resistance in cabling technology
2.3 Use Ohm's law to calculate power usage and power losses in cabling circuits
2.4 Explain how noise may be generated onto communications cabling and components
2.5 Define impedance and compare impedance with resistance
2.6 Explain Signal-to-Noise Ratio (SNR or S/R)
2.7 Explain the difference between inductance and inductive reactance; capacitance and capacitive reactance
2.8 Explain the importance of grounding cabling and electronics communications products also found in multiple categories and competencies below
2.9 Identify wire sizes needed for grounding also found in competency 5.1.23
2.10 Describe the types of conductor insulation used for communications wiring
2.11 Differentiate between Alternating Current (AC) and Direct Current (DC) circuits

3.0 DATA CABLING INTRODUCTION
Introducción al cableado de datos

3.1 Provide a brief history of telephone and wireless communications
3.2 Describe the basic operation of the telephone system in the United States
3.3 Describe the differences between analog and digital communications signals
3.4 Identify the different categories of balanced twisted-pair cabling and components to include:
- 3.4.1 Category 3 (Cat or CAT 3)
- 3.4.2 Category 5e (Cat or CAT 5e – '5 enhanced')
- 3.4.3 Category 6 (Cat or CAT 6)
- 3.4.4 Category 6_A (Cat or CAT 6_A - Augmented Cat 6)
- 3.4.5 Category 7 and 7A (not recognized by TIA, no true IEEE application)
- 3.4.6 Category 8 (Cat or CAT 8)

3.5 Understand the different types of unshielded twisted-pair (UTP) cabling
3.6 Understand the different types of shielded twisted-pair (STP) cabling
3.7 Differentiate between the uses of plenum and riser rated cabling

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4.0 DATA COMMUNICATIONS BASICS
Conceptos básicos de comunicación de datos

- 4.1 Define audio and radio or Radio Frequency (RF) frequencies
- 4.2 Explain the term bandwidth
- 4.3 Explain the difference between frequency, bit rate and baud rate
- 4.4 Trace the history of the BEL and decibel and explain how and why these terms are used
- 4.5 Convert signals from voltage levels to their corresponding decibel equivalents decibel levels to their corresponding voltage or current levels
- 4.6 Convert signal gains or losses to comparative decibel readings
- 4.7 Define attenuation
- 4.8 Define crosstalk and explain how it occurs in communications cabling
- 4.9 Discuss how the industry has developed a comprehensive set of crosstalk measurements to ensure that permanent link cabling systems meet their intended applications in accordance with ANSI/TIA-568.2-D, section 6.3 including:
  - 4.9.1 Near-End Crosstalk (NEXT)
    - 4.9.1.1 Alien Near End Crosstalk (ANEXT)
  - 4.9.2 Power Sum Near-End Crosstalk (PSNEXT)
  - 4.9.3 Attenuation to Crosstalk Ration, Far-End (ACRF)
  - 4.9.4 Power Sum Attenuation to Crosstalk Ration, Far-End (PSACRF)
  - 4.9.5 Power Sum Alien Near-End Crosstalk (PSANEXT)
  - 4.9.6 Power Sum Attenuation to Alien Crosstalk Ratio, Far-End (PSAACRF)

5.0 CABLING SPECIFICATIONS AND STANDARDS
Especificaciones y estándares de cableado

- 5.1 Identify key industry standards necessary to specify, install, and test network cabling to include:
  - 5.1.1 ANSI/TIA-568.0-E, Generic Telecommunications Cabling for Customer Premises
  - 5.1.2 ANSI/TIA-568.1-E, Commercial Building Telecommunications Cabling Standard
  - 5.1.3 ANSI/TIA-568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standard
  - 5.1.4 ANSI/TIA-568.3-D, Optical Fiber Cabling Components Standard
  - 5.1.5 ANSI/TIA-569-E -, Commercial Building Standard for Telecommunications Pathways and Spaces
  - 5.1.6 ANSI/TIA-570-D, Residential Telecommunications Cabling Standard
  - 5.1.7 ANSI/TIA-606-C, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - 5.1.8 J-STD/TIA-607-D, Commercial Building Grounding/Bonding Requirements for Telecommunications
  - 5.1.9 ANSI/TIA-942-B, Telecommunications Infrastructure Standard for Data Centers
  - 5.1.10 ANSI/TIA-1005-A, Telecommunications Infrastructure for Industrial Premises
  - 5.1.11 ISO/IEC 11801, Generic Cabling for Customer Premises
  - 5.1.12 ISO 11801 Class E (Augmented Category 6) Standard
  - 5.1.13 IEEE 802.3af, Power over Ethernet (PoE) Standard
  - 5.1.14 IEEE 802.3at, Power over Ethernet+ (Plus) Standard (Level 3)
    - 5.1.14.1 IEEE 802.3bt, Power over Ethernet++ (Plus Plus), published 2018 (Level 4)
  - 5.1.15 IEEE 802.3an, Physical Layer and Management Parameters for 10 Gbps Operation, Type 10GBASE-T
  - 5.1.16 ANSI/TIA-568.2-D Augmented Category 6 or ISO 11801 Class E Cables
  - 5.1.17 IEEE 802.3ba Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation
  - 5.1.18 IEEE 802.11, Wireless Standard
  - 5.1.19 NFPA® 70, National Fire Protection Association®, and the National Electrical Code® (NEC®)
  - 5.1.20 Canadian Electrical Code (CEC)
  - 5.1.21 IEEE 1100
  - 5.1.22 ISO/IEC 30129
  - 5.1.23 American Wire Gauge (AWG) also found in ASTM B258

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6.0 BASIC NETWORK DESIGN: ARCHITECTURE AND IMPLEMENTATION
Diseño básico de red: Arquitectura e implementación

- 6.1 Describe the architectural divisions of the ISO/IEC Open Systems Interconnect (OSI) reference model layers, specifically the IEEE 802.3 Ethernet standard relationship:
  - 6.1.1 Data Link Layer
    - 6.1.1.1 Logical Link Control (LLC) sublayer
    - 6.1.1.2 Media Access Control (MAC) sublayer
  - 6.1.2 Physical Layer
  - 6.1.3 Explain how IEEE 802.3 Ethernet is organized into two parts comprising the MAC sublayer and the Physical layer
- 6.2 Describe network design implementation by three topologies:
  - 6.2.1 Bus
  - 6.2.2 Ring
    - 6.2.2.1 Describe how a Token Ring network operates
  - 6.2.3 Hierarchical star
    - 6.2.3.1 Explain that in accordance with ANSI/TIA-568.0-E generic cabling shall be installed in a hierarchal star topology
  - 6.2.4 Explain why other topologies (mesh, tree, hybrid) complicate designs
- 6.3 Define Fiber Distributed Data Interface (FDDI) networking specification produced by ANSI X3T9.5 committee
- 6.4 Explain Asynchronous Transfer Mode (ATM) designed as a high-speed communications protocol that does not depend on any specific LAN technology

7.0 CABLE CONSTRUCTION
Construcción de cables

- 7.1 Explain the requirements in accordance with ANSI/TIA-568.2-D for 100-ohm Category 3, 5, 5e, 6, 6_A and 8 balanced twisted-pair cabling and components
- 7.2 Describe broadband coaxial cabling, cords and connecting hardware to support CATV (cable television), and satellite television supported by ANSI/TIA-568.0-E star topology in accordance with ANSI/TIA-568.4-D Broadband Coaxial Cabling and Components Standard
- 7.3 Describe the differences between twisted-pair data cable constructions
- 7.4 Distinguish that horizontal cable shall consist of four balanced twisted-pairs of 22 AWG to 24 AWG thermoplastic insulated solid conductors enclosed by a thermoplastic jacket
- 7.5 State that the diameter of the insulated conductor shall be 1.53 mm (0.060 in) maximum
- 7.6 Define the ultimate breaking strength of the cable, measured in accordance with ASTM D4565, shall be 400 N (90 lbf – foot pounds) minimum
- 7.7 Define the pulling tension (tensile rating) for a 4-pair balanced twisted-pair cable shall not exceed 110 N (25 lbf) during installation
- 7.8 Relate how twisted-pair cables shall withstand a bend radius of 4x cable diameter for UTP constructions and 8x cable diameter for screened constructions
- 7.9 Explain that the minimum inside bend radius for 4-pair balanced twisted-pair cord cable shall be one-times the cord cable diameter

8.0 CABLE PERFORMANCE CHARACTERISTICS
Características de rendimiento del cable

- 8.1 Describe the transmission characteristics of twisted-pair cabling in accordance with ANSI/TIA-568.2-D to include the following:
  - 8.1.1 Category 3: This designation applies to 100 ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 16 MHz
  - 8.1.2 Category 5e: This designation applies to 100 ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 100 MHz
  - 8.1.3 Category 6: This designation applies to 100 ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 250 MHz
  - 8.1.4 Category 6_A: This designation applies to 100 ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 500 MHz
  - 8.1.5 Category 8: This designation applies to 100 ohm balanced twisted-pair cabling and components whose transmission characteristics are specified from 1 to 2000 MHz

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8.2 Point out that Category 1, 2, 4, and 5 cabling and components are not recognized as part of the new standards and, therefore, their transmission characteristics are not specified
8.3 Explain the transmission characteristics of 75-ohm coaxial cable
8.4 Explain the mechanical performance characteristics of twisted pair and coaxial cables
8.5 Describe cabling transmission performance requirements (permanent link and channel) for Category 3, 5e, 6, 6_A and Category 8 100-ohm balanced twisted pair cabling as specified in ANSI/TIA-568.2-D

9.0 NATIONAL ELECTRICAL CODE® and UNDERWRITERS LABORATORIES® REQUIREMENTS Requisitos de NEC® y UL®

9.1 Associate the history of the National Fire Protection Association® (NFPA®) with the National Electrical Code® (NEC®)
9.2 Describe that Underwriters Laboratories (UL®) is a nonprofit product safety testing and certification organization and explain the following key UL® standards:
  9.2.1 UL 444 Communications Cables
  9.2.2 NFPA 262 (formerly UL 910) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for use in Air-Handling Spaces
  9.2.3 UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords
  9.2.4 UL 1666 Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
  9.2.5 UL 1863 Standard for Communications-Circuit Accessories
9.3 Summarize the information in the NFPA® 70's NEC® to include the following:
  9.3.1 Chapter 1 – General Requirements
  9.3.2 Chapter 2 – Wiring and Protection
  9.3.3 Chapter 3 – Wiring Methods and Materials
  9.3.4 Chapter 5 – Special Occupancies
  9.3.5 Chapter 7 – Special Conditions
  9.3.6 Chapter 8 – Communications Systems
9.4 Relate the similarities between the Canadian Electrical Code (CEC) and the NEC®
9.5 Summarize how the NEC® and IEEE PoE standards coordinate network cabling/wiring compliance

10.0 TELECOMMUNICATIONS CABLING SYSTEM STRUCTURE

Estructura del sistema de cableado de telecomunicaciones

10.1 Describe a representative model of the functional elements that comprise a generic hierarchal star topology cabling system
10.2 Point out that the hierarchal star topology specified by ANSI/TIA-568.0-E was selected because of its acceptance and flexibility
10.3 Explain that the functional elements are equipment outlets, distributors, and cabling (subsystems) total system
10.4 Explain that in a typical commercial building where ANSI/TIA-568.1-E applies, Distributor C represents the main cross-connect (MC), Distributor B represents the intermediate cross-connect (IC), Distributor A represents the horizontal cross-connect (HC), and the equipment outlet (EO) represents the telecommunications outlet/connector
10.5 Describe that equipment outlets (EOs) provide the outermost location to terminate the cable in a hierarchal star topology
10.6 Explain that distributors provide a location for administration, reconfigurations, connection of equipment and for testing
10.7 Discuss how distributors can be configured as interconnections or cross-connections
10.8 Explain that the function of a cabling subsystem is to provide a signal path between distributors
10.9 Identify that the recognized media in a hierarchal star topology, which shall be used individually or in combination in accordance with ANSI/TIA-568.0-E are:
  10.9.1 100-ohm balanced twisted-pair cabling
  10.9.2 Multimode optical fiber cabling
  10.9.3 Single-mode optical fiber cabling

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11.0 DATA CABLING INSTALLER TOOLS
Herramientas del instalador de cableado de datos

11.1 Explain the purpose and proper usage of twisted-pair and coaxial wire strippers
11.2 Demonstrate how wire cutters and cable preparation tools are used properly to prepare cable for installation
11.3 Demonstrate the proper methods of using both twisted-pair and coaxial cable crimpers
11.4 Demonstrate a punch-down tool and show where and how it is used in cross-connect blocks (66 block), patch panels (110 block), or modular jacks that use insulation displacement connectors (IDCs)
11.5 Explain the purpose and demonstrate proper use of fish tape and pull/push rod devices used in cable installation
11.6 Identify the tools for basic cable testing
11.7 Discuss the technology of pulling lubricants
11.8 Identify cable marking supplies and labels that make cable installations easy

12.0 TRANSMISSION MEDIA FOR NETWORKING AND TELECOMMUNICATIONS
Medios de transmisión para redes y telecomunicaciones

12.1 Identify the three common bounded media types used for data transmission
  12.1.1 Twisted-pair
  12.1.2 Coaxial
  12.1.3 Fiber Optic
12.2 Discuss the common types of copper cabling and the applications that run on them
12.3 Describe the different types of twisted-pair cables and expand on their performance characteristics:
  12.3.1 Category 3
  12.3.2 Category 5e
  12.3.3 Category 6
  12.3.4 Category 6_A
  12.3.5 Category 7 and 7_A (not recognized by TIA, no true IEEE application)
  12.3.6 Category 8
12.4 Describe the different types coaxial cable and expand on their performance characteristics:
  12.4.1 RG-59
  12.4.2 RG-6
  12.4.3 RG-62
  12.4.4 RG-11
12.5 Explain the terms hybrid and composite cable types
12.6 Describe the best practices for copper installation including following standards, not exceeding distance limits, and good installation techniques
12.7 Explain that when pulling copper cable (or wire), tension must be applied to all elements of the cable
12.8 Describe that pulling solely on the core can pull it out of the sheath and care must be taken to avoid damage to the conductors
12.9 Define the maximum allowable pulling tension is the greatest pulling force that can be applied to a cable during installation without risking damage to the conductors
12.10 Identify the minimum bend radius and maximum pulling tension in accordance with ANSI/TIA-568.0-E section 5.3
12.11 Explain that copper data cabling and wiring systems are divided into categories or classes by the cabling standards organizations and use bandwidth needs to determine the proper customer application of each category of cabling
12.12 Discuss the importance of any telecommunications cabling system supporting data is the 110 block
12.13 Explain the usage of cross connects using punch downs in the telecommunications rooms, more common on telephone wires (66-block) than data (110-block)
12.14 Explain that the 110 block has two primary components: the 110 wiring block and the 110 connecting block
12.15 Identify the other 110 block styles including a 110-block with RJ-45 connectors and 110-blocks on the back of patch panels
12.16 Examine the different 110-block possible scenarios for use in a structured cabling system
12.17 Be aware of other proprietary block technologies such as BIX and GigaBIX
12.18 List the common usages of the 66-block in cross-connect systems

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12.19 Explain that the 66-block was used with telephone cabling for many years, but is not used in modern structured wiring installations
12.20 Describe how a 66-block is assembled using the punch-down (impact) tool and how it is terminated using a metal bridging clip
12.21 Recall that the most common type of cable connected to a 66-block is the 25-pair cable
12.22 Explain that a minimum of Category 3 cable is used for voice applications (mostly legacy application); however, Category 5e or higher is used for both data and voice
12.23 Explain that every cable run must receive a minimum level of testing and the minimum tests should determine continuity and ascertain that the wire map is correct
12.24 Demonstrate the cable testers that are used to perform the basic level of testing:
- 12.24.1 Tone generator
- 12.24.2 Continuity tester
- 12.24.3 Wire-map tester
- 12.24.4 Cable certifier

13.0 WORK AREA TELECOMMUNICATIONS OUTLET AND CONNECTORS
Área de Trabajo Toma de Telecomunicaciones y Conectores

13.1 Explain that in accordance with ANSI/TIA-568.2-D each four-pair horizontal cable shall be terminated in an eight-position modular jack at the work area
13.2 Explain that the telecommunications outlet/connector shall meet the requirements of clause 5.7 and the terminal marking and mounting requirements specified in ANSI/TIA-570-D Residential Telecommunications Infrastructure Standard
13.3 Describe the proper wiring scheme (pin/pair assignments) necessary to accommodate certain cabling systems to include the following:
- 13.3.1 Bell Telephone Universal Service Order Code (USOC)
- 13.3.2 ANSI/TIA-568.2-D T568A and T568B
- 13.3.3 ANSI X3T9.5 TP-PMD

13.4 Identify the different types of coaxial connector styles to include:
- 13.4.1 F-Type RG-6 crimp-on method
- 13.4.2 F-Type RG-6 twist-on method
- 13.4.3 F-Type RG-6 compression method
- 13.4.4 BNC RG-59

13.5 Describe the key wall plate designs
13.6 Explain the most common wall plate mounting methods in commercial applications
13.7 Describe the difference between a fixed design and modular wall plate design installation
13.8 Describe how to mount networking cables to a wall with a RJ45 (8P8C) surface mount biscuit jack
13.9 Describe the use of a floor-mounted communications outlet that provides point-of-use connectivity for a broad range of applications where convenience or building requirements dictate this installation
13.10 Explain that open office design practices use multi-user telecommunications outlet assemblies (MUTOAs), consolidation points (CPs), or both to provide flexible layouts
13.11 Explain the Modular Plug Terminated Link (MPTL) methods of applications in accordance with ANSI/TIA-568.2-D standard

14.0 LOCAL AREA NETWORK INTERCONNECTION AND INTERNETWORKING
Interconexión de redes de área local e interconexión de redes

14.1 Explain the basic active components of a hierarchical star network for commercial buildings and networks to include the following:
- 14.1.1 Network interface card (NIC)
- 14.1.2 Media converter
- 14.1.3 Repeater
- 14.1.4 Hub
- 14.1.5 Bridge
- 14.1.6 Switch
- 14.1.7 Server
- 14.1.8 Router

14.2 Describe the differences between a blocking and non-blocking workgroup switch and affects with the effective bandwidth performance of the switch
14.3 Identify the differences between various types of transceiver modules

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15.0 WIRELESS HETEROGENEOUS CABLING NETWORKS
Redes de cableado heterogéneas inalámbricas

15.1 Discuss how wireless switches and routers are usually connected to the core network with some type of copper cabling media
15.2 Explain how infrared wireless systems work
15.3 Define the types of Radio Frequency (RF) wireless networks
15.4 Explain how microwave communication works

16.0 CABLING SYSTEM COMPONENTS
Componentes del sistema de cableado

16.1 Explain that the entrance facility (EF), sometimes referred to as the demarcation point, consists of cables, connecting hardware, protection devices, and other equipment that connect to access provider (AP) cabling in accordance with ANSI/TIA-568.1-E
16.2 Explain that the equipment rooms (ERs) are considered to be distinct from telecommunications rooms (TRs) and telecommunications enclosures (TEs) because of the nature and complexity of the equipment they contain in reference to TIA-569-E Telecommunications Pathways and Spaces standard in Competency 5.1.5
16.3 Explain the main cross-connect (MC; Distributor C) of a commercial building are normally located in the ER
16.4 Explain that intermediate cross-connects (ICs; Distributor B), horizontal cross-connects (HCs; Distributor A), or both, of a commercial building may also be located in an ER
16.5 Describe that an ER houses telecommunications equipment, connecting hardware, splice closures, grounding and bonding facilities, and local telephone company service terminations, and premises network terminations
16.6 Explain that telecommunications rooms (TRs) and telecommunications enclosures (TEs) provide a common access point backbone and building pathways
16.7 Recognize that the TR and any TE should be located on the same floor as the work areas served
16.8 Explain that TEs may be used in addition to one TR per floor and in addition to an additional TR for each area up to 1000 m^2 (10,000 ft^2)
16.9 Explain that the horizontal cross-connect (HC; Distributor A) of a commercial building is located in a TR or TE
16.10 Describe backbone cabling as the portion of the commercial building telecommunications cabling system that provides interconnections between entrance facilities (EFs), access provider (AP) spaces, telecommunications rooms (TRs) and telecommunications enclosures (TEs)
16.11 Explain that the horizontal cabling includes horizontal cable, telecommunications outlet/connectors in the work area, patch cords or jumpers located in a telecommunications room (TR) or telecommunications enclosure (TE)
16.12 Explain that the work area (WA) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the WA equipment

17.0 CABLING SYSTEM DESIGN
Diseño del sistema de cableado

17.1 Describe the basics of the hierarchical star, bus, ring and mesh topologies
17.2 Explain that the backbone cable length extends from the termination of the media at the main cross-connect (MC) to an intermediate cross-connect (IC) or horizontal cross-connect (HC)
17.3 Explain that the backbone cable lengths are dependent upon the application and upon the specific media chosen in accordance with ANSI/TIA-568.0-E Annex D and specific application standard
17.4 Explain the maximum horizontal cable length shall be 90 m (295 ft), independent of media type
17.5 Describe how the telecommunications room is wired to include:
- 17.5.1 Local area network (LAN) wiring
- 17.5.2 Telephone wiring
- 17.5.3 Power requirements
- 17.5.4 HVAC considerations

17.6 Explain the concept of cabling management to include the following:
- 17.6.1 Physical protection
- 17.6.2 Electrical protection
- 17.6.3 Fire protection

17.7 List the lengths of the cross-connect jumpers and patch cords in the MC, IC, HC and WA in accordance with ANSI/TIA-568.1-E to include:

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17.7.1 MC or IC should not exceed 20 m (66 ft)
17.7.2 HC should not exceed 5 m (16 ft)
17.7.3 WA should not exceed 5 m (16 ft)

17.8 Explain that for each horizontal channel, the total length allowed for cords in the work area (WA), plus patch cords or jumpers, plus equipment cords in the telecommunications room (TR) or telecommunications enclosure (TE) shall not exceed 10 m (33 ft)

17.9 Describe the purpose, construction and usage of telecommunications pathways and spaces in accordance with ANSI/TIA-569-E Commercial Standard for Telecommunications Pathways and Spaces to include:
17.9.1 Entrance facility
17.9.2 Equipment room
17.9.3 Telecommunications rooms
17.9.4 Horizontal pathways
17.9.5 Backbone pathways
17.9.6 Work areas

17.10 Define the term, location and usage of both the main distribution frame (MDF) and Intermediate distribution frame (IDF)

18.0 CABLING INSTALLATION
Instalación de cableado

18.1 Describe the steps used in installing communications cabling
18.2 Explain cable stress and the precautions for aerial construction; underground, ducts (conduit) and plenum installation; define pulling tension and bend radius
18.3 Describe cabling dressing and methods of securing cabling
18.4 Explain proper labeling of cables in accordance with ANSI/TIA-606-C Administration Standard for Commercial Telecommunications Infrastructure
18.5 Identify the insulated conductor color code for 4-pair horizontal cables in accordance with ANSI/TIA-568.2-D
18.6 Demonstrate proper cable stripping for both twisted-pair and coaxial cable
18.7 Explain safety precautions for underground construction
18.8 Define Fire stopping and the different applications and types
18.9 Define the components of a grounding and bonding system for telecommunications and their purpose per J-STD/TIA-607-D Commercial Building Grounding and Bonding Requirements for Telecommunications and NEC® Article 250 Grounding and Bonding
18.10 Explain that for multipair backbone cables with more than 25 pairs, the core shall be assembled in units or sub-units of up to 25 pairs and shall be identified by a color-coded binder in accordance with ANSI/ICEA S-80-576
18.11 Explain how ducts (conduit) are used for cabling installations
18.12 Outline and understand the need for firestopping
18.13 Introduce the fire-related considerations associated with installing cable runs
18.14 Describe the different components used to minimize the spread of smoke and fire throughout the structure

19.0 CONNECTOR INSTALLATION
Instalación del conector

19.1 Demonstrate proper installation of balanced twisted pair connectors (including 8P8C and other Registered Jacks)
19.2 Demonstrate proper installation of coaxial cable connectors
19.3 Describe the 4-pair color code for telecom cabling and the pin/pair assignments
19.4 Explain the maximum pair un-twist for the balanced twisted pair cable termination shall be in accordance with ANSI/TIA-568.0-E 5.3.3.1 Table 1

20.0 CABLING TESTING AND CERTIFICATION
Pruebas y certificación de cableado

20.1 Explain the purpose of installation testing
20.2 Describe the purpose and methods of certifying the cable plant
20.3 Define the ANSI/TIA-568-D standard performance requirements for horizontal and backbone cabling
20.4 Explain the differences between the two types of horizontal links used in copper cable certification: permanent link and channel link

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20.5 Show the proper selection and use of cable testing tools and equipment
20.6 Describe both cabling requirements (permanent link and channel) for Category 3, 5e, 6, 6_A and Category 8 100 ohm balanced twisted-pair cabling as specified in ANSI/TIA-568.2-D (defined in competency 7.1, also described in 8.1 and 8.5)
20.7 Explain the minimum required tests (wire map, length, insertion loss and near-end crosstalk) for all Category 5e installations
20.8 Demonstrate how the data cabling installer thoroughly tests the newly installed cabling according to the specifications contained in the ANSI/TIA-568.2-D standard to include:
- 20.8.1 Near-End Crosstalk (NEXT)
  - 20.8.1.1 Alien Near End Crosstalk (ANEXT)
- 20.8.2 Power Sum Near-End Crosstalk (PSNEXT)
- 20.8.3 Attenuation to Crosstalk Ratio, Far-End (ACRF)
- 20.8.4 Power Sum Attenuation to Crosstalk Ratio, Far-End (PSACRF)
- 20.8.5 Power Sum Alien Near-End Crosstalk (PSANEXT)
- 20.8.6 Power Sum Attenuation to Alien Crosstalk Ratio, Far-End (PSAACRF)

20.9 Describe how Power over Ethernet must be checked to ensure proper wattage (up to 15.4 watts) is provided to the end device at 100 meters per the IEEE 802.3af PoE standard
20.10 Describe DC Resistance Unbalance Testing complying with IEEE 802.3 - 2012; and especially as defined in IEEE 802.3bt PoE++ standard
20.11 Describe Shield Integrity Testing for Category 6_A and Category 8 cabling

21.0 CABLING TROUBLESHOOTING
Solución de problemas de cableado

21.1 Explain how to establish a baseline for testing or repairing a cabling system
21.2 Demonstrate a method of locating a cabling defect or problem
21.3 Describe commonly encountered cable problems and the methods used to resolve them including:
- 21.3.1 Wire-map faults
- 21.3.2 Excessive length
- 21.3.3 Opens and shorts
- 21.3.4 Excessive attenuation
- 21.3.5 Excessive crosstalk
- 21.3.6 Excessive noise

21.4 Explain that for a communications installer, the effects of the earth's magnetic field is the possibility of what is known as a ground loop and how it effects copper cabling
21.5 Define a ground fault
21.6 Explain that a troubleshooter must possess good communication skills and be able to accomplish the following:
- 21.6.1 Read technical manuals, instructions, catalogs, etc.
- 21.6.2 Verbal communication
- 21.6.3 Understand blueprints and drawings

22.0 DOCUMENTATION
Documentación

22.1 Point out that the process of troubleshooting can be greatly eased when appropriate documentation is available including:
- 22.1.1 Cabling diagrams
- 22.1.2 Description and functioning of the equipment attached to the cabling system
- 22.1.3 Certification test data for the network

22.2 Explain the purpose of documenting a cabling installation
22.3 Explain the required ingredients of the installation documents
- 22.3.1 Describe following the TIA-606-C accordance defined in competency 5.1.7, described in competency 18.4, including the 4 classes of administration

22.4 Explain that the request for proposal is essential to the success of a telecommunications infrastructure project
22.5 Prepare a sample cable documentation record that meets industry standards

End of Data Cabling installer Competencies Listing:
(22 major knowledge categories)

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Find an ETA approved training organization: **https://www.etai.org/course_approvals.html**
(Listing by State, or by Military, or Internationally)

Find an ETA approved test site (approved training): **https://www.etai.org/test_sites.html**
(Listing by map)

Suggested Additional Study Materials and Resources for ETA Data Cabling Installer Certification:

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.etai.org

Cabling: The Complete Guide to Network Wiring, 3E; Jim McBee, David Groth, David Barnett; ISBN 978-0782143317; Sybex, Inc 2004; Paperback; 693 pg**.** - Available through ETA at 800-288-3824, www.eta-i.org

Premises Cabling, 3E; Donald J. Sterling, Les Baxter; ISBN 978-1401898205; Delmar Cengage Learning; December 2005; Paperback; 320 ppg**.** - Available through ETA at 800-288-3824, www.etai.org

Installer's Guide to Local Area Networks; Buddy Shipley; ISBN 978-0766833746; Thompson Delmar Learning; September 2003; Paperback; 300 ppg**.** - Available through ETA at 800-288-3824, www.etai.org

Commercial Low-Voltage Wiring: Installing Structured Wiring (for Data Cabling Installers); Charles J. Brooks, Ray Stroud; ISBN 978-1581220858; Marcraft, Educational Technologies; 2012; Paperback; 539 pg

Telecommunications and Data Communications Handbook; Ray Horak; ISBN 978-0470041413; Wiley-Interscience; September 2007; Paperback; 791 ppg**.**

Four Years of Broadband Growth; The White House; June 2013; 28 ppg; http://www.whitehouse.gov/sites/default/files/broadband_report_final.pdf

2018 Broadband Deployment Report; Federal Communications Commission; Feb.2,2018; 89 ppg; https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report

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; hardcover; 437 ppg; 800-545-2522

Technology Series Videos and CDs; The Light Brigade,2013; 800-451-7128, www.lightbrigade.com

Technicians Guide to Fiber Optics, 4E; Donald J. Sterling; ISBN 1-4018-1270-8; Delmar Learning; Dec 2003; hardcover; 384 ppg; - Available through ETA at 800-288-3824, www.etai.org

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

Understanding Fiber Optics, 5E; Jeff Hecht; ISBN: 978-0131174290; Prentice-Hall; Apr 2005; hardcover; 800p

Introduction to Fiber Optics, 3E; John Crisp, Barry Elliott; ISBN 978-0750667562; Newnes; Dec 2005; paperback; 245 ppg

Fiber Optic Theory & Applications, Rev.2; Jeffrey Dominique, FOT; 2005; FNT Publ.; Available: paperback www.f-n-t.com; contact FNT for version updates; (formerly Fiber Optic Theory & Applications; the FNT Fiber Optic Installer; Rev.3 will be available 2016)

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

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

Also contact ETA at www.etai,org or 1-800-288-3824 for more information, numerous links, locations for training sites, additional white papers, articles and the latest Fiber updates.

ETA certification programs are accredited through ICAC, complying with the ISO/IEC 17024 standard.

ICAC International Certification Accreditation Council

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ETA Data Cabling and Fiber Optics Installer Certification 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
Baker, Steven G, FOT	Sheppard AFB, (TX)	
Barks, Kevin W., SFF	Kitco Fiber Optics, (VA)	
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
Cruz, CW3 Mickael, FOT, CETsr	U.S. Army, (KY)	
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)	
Gray, Renelle, FOI, CETa, CSS	Retired., (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	AmeriSkills, (CA)	
Kelly, Sean, RCDD	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
Majcher, CW5 David, FOT, GROL	U.S.Army, (GA)	
Milione, Dr. Ron, CETma, FOD	PSEG-Wireless Comm, (NY)	
Neukam, Paul, FOI, FOT-OSP, RCDD	SiteWise , (IN)	paul@sitewiseinc.com
O'Shay, L. Celeste	FOIRandD, Ltd, (WA)	w47lton@frontier.com
Osvatic, John, CETsr, FOT,	Retired, (WI)	
Proudley, Dr. Geoff, SAFF	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)	1625nm@gmx.com
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
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
Teague, Brian,	Senko, (SC)	brian.teague@senko.com
Thiam, Boon Kwee, FOI, FOT	FiberOpto Asia, PTE, Ltd	thiambk@fiberopto.com
Tyquiengco, Ricky S., FOI, DCI	Guam Comm College, (GU)	ricky.tyquiengco1@guamcc.edu
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	Retired, (ID)	
Wilson, Doug	FiberQA, (CT)	dwilson@fiberqu.com
Wolszczak, Steve	Midwest Lightwave, (IN)	steve@MidwestLightwave.com
Wood, Larry, AFT, FEEC	Spirit AeroSystems, (KS)	

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