BICSI's Handbook of ICT Codes, Standards, Regulations, and Organizations

Version 1.0

A collection of ICT-specific codes, standards, regulations, and related development enforcement organizations.

advancing the information and communications technology profession

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We welcome all comments about BICSI's *Handbook of ICT Codes, Standards, Regulations, and Organizations*. If you have any questions about BICSI and its services, please contact our office at 800.242.7405 (USA/Canada toll free); +1 813.979.1991; fax +1 813.971.4311; e-mail bicsi@bicsi.org; website www.bicsi.org.

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Handbook of ICT Codes, Standards, Regulations, and Organizations

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Codes, Standards, Regulations, and Organizations

Introduction

Since the advent of the telegraph, codes, standards, and regulations have been adopted to define the safe production, installation, best practices and use of ICT systems. Nothing impacts the design and construction of an ICT system more than codes, standards, and regulations.

In recent years, national, regional, and international standards-making bodies have joined efforts to harmonize the standards affecting ICT. These efforts, along with the technological developments that impact standards, codes, and regulations, maintain the dynamic nature of the documents.

Continuous standards harmonization efforts do not guarantee that all the unique requirements for a specific design work area are covered. ICT professionals must be familiar with the electrical, communications, safety, and building codes, standards, and regulations for the nation, region, and municipality in which the work is performed. This also includes personal health and safety practices, including the selection and use of PPE on work sites. They must also be aware of the critical importance of compliance with codes, standards, and regulations.

Design and Construction

In the United States, Canada, and most other countries, building codes and standards regulate the design and construction industry. Installation methods and products must conform to local code, standards, and regulatory requirements. The designated AHJ normally enforces the codes and legal regulations for the jurisdiction.

ICT professionals must have a thorough knowledge of the applicable sections of these codes that affect ICT infrastructure. Be aware that these codes and standards are updated regularly. It is the responsibility of the ICT professional to ensure that the current in-effect version is obtained, reviewed, and referenced, if necessary, in order to follow the changes and comply with the current codes and standards that are in effect within the applicable jurisdiction.

NOTE: While every effort has been made to identify the applicable codes, standards, and regulations that exist on a national, regional, or global basis for ICT design and installation activities, the ICT professional should not consider the information in this handbook to be the sole source of details and applicability concerning these documents. The ICT professional is responsible for understanding and complying with all applicable codes, standards, and regulations that apply to their specific projects, both those required contractually and those enforced by the AHJ.

Codes, Regulations, and Directives

A code can be defined as a rule or set of rules intended to ensure safety during the installation and the use of materials, components, fixtures, systems, premises, and related subjects.

Codes typically are invoked and enforced through government regulation. A code ensures the:

- Practical safeguarding of persons and property from hazards.
- Quality of construction.

Codes typically pertain to a particular construction trade or design discipline (e.g., electrical, building/architectural, mechanical, fire protection) and may cover other safety issues.

For the ICT professional, the code most often encountered is the electrical code. The *National Electrical Code*® (*NEC*®) in the United States and the *Canadian Electrical Code* (*CEC*) in Canada are issued to provide the criteria for minimizing the risk of electrical shock, fires, and explosions from electrical installations.

In most cases, codes are developed by recognized organizations (e.g., the National Fire Protection Association (NFPA) in the U.S., and the Canadian Standards Association (CSA) in Canada. This process, whether for the production of a new code or review and update of an existing code, typically involves generation, review, and editing of the content of the code. This is followed by a public comment period, and an organization voting process for approval for publication and issuance of the particular code.

Once a code is adopted or ratified by a government or other formally authorized body, it can be legally enforced by an AHJ. An AHJ may be a specific code authority (e.g., electrical inspector, building inspector, fire marshal). Typically, more than one AHJ will be involved on the project site because of different aspects requiring review and approval. The ICT professional must research to determine the appropriate AHJ and comply with their specific code requirements and concerns.

State, provincial, municipal, and local codes may be more restrictive than national codes and regulations and, therefore, take precedence. The order or hierarchy of code compliance should be in full conformance to local, state, and national codes.

ICT professionals must realize that as part of AHJ enforcement of a particular code, compliance paperwork such as inspection reports may be issued. If an AHJ finds a violation, compliance documents such as a Notice of Violation may be issued. Work pertaining to the violation can be stopped by the AHJ, based on its severity, until the violation is corrected. This may require an additional AHJ inspection visit for approval of the corrective action and closing of the Notice of Violation.

In the European Union (EU), a set of regulations titled directives take precedence. Some examples of these regulations are the European Union Construction Products Regulation (305/2011 EC) and the Electromagnetic Compatibility Directive (2014/30/EU).

Within each country, building regulations and other government-mandated regulations are enforced.

State Regulations

At the state level in the United States, many governmental bodies, such as public utility and service commissions, issue their own rules. State rules are generally in accordance with federal regulations issued by agencies such as the Federal Communications Commission (FCC).

The state commissioned rules are available to the public. Certain sections of these rules deal with installing ICT elements on private and public property.

Municipal/County/Local Regulations

Other regulations that may affect ICT systems include:

- Licensing of designers/engineers, contractors, and installation/trade personnel.
- General or task-specific permitting required to perform work.

These may involve additional costs or fees within the state/province or county/municipality to meet the criteria for implementation of the project. ICT professionals must research and understand what licenses and/or permit(s) are required. The penalties for not obtaining the required licenses and/or permits or paying fees can be severe, including fines, being barred from performing future work and loss of currently issued licenses.

Special Applications

ICT professionals must be aware of any special restrictions or conditions in specialized environments such as:

- Manufacturing and industrial areas:
  - Hazardous environments.
  - Corrosive environments (e.g., chemicals).
  - Explosive and combustible material environments.
  - Electromagnetic systems, RF systems, and EMC environments.
- Life safety areas:
  - Health care facilities.
  - First responder facilities and public safety access points.
- Government, military, and other secure facilities.
- Natural environments:
  - Seismically active.
  - Flood zones.

NOTE: The ICT professional must ensure that the correct code version that is in effect by the AHJ at the time of the design and/or installation work is being performed is applied. It is not uncommon for an earlier version of a code to be in effect in a particular jurisdiction rather than the most current version issued by the organization responsible for developing and updating that specific code.

Standards

A standard is an accepted collection of requirements and recommendations for the defining, construction, evaluation, application, or comparison of materials, equipment, products, and services.

Standards may define processes, procedures, best practices, or methods and are developed to improve the quality, function, performance, repeatability or some other facet of the item being defined. A standard is typically developed and approved by consensus or a group of individuals, and may be developed by entities such as businesses, organizations, industry groups, or governments. Compliance to a standard is a voluntary act, unless otherwise specified by law, contract, or other binding article.

One of the purposes of a standard is to ensure a minimal level of acceptable performance. While codes and safety standards address the safety of persons and property in the installation or use of a system, codes do not ensure the system functionality. In some design and installation contracts, failure to follow the referenced standards may require the ICT designer or installer to correct the deficiency at no cost to the client or owner.

NOTE: Codes may reference numerous standards to ensure the minimum functional requirements of a given material or component.

Safety standards provide the criteria for safety testing of a component or system. Performance and safety standards are typically test standards. Test standards provide uniform rules for the object, methods, and acceptable results of testing. For example, UL 1479, *Fire Tests of Through-Penetration Firestops*, defines several test methods to determine the performance of a firestop assembly during a fire.

This listing is given to the material that meets a specific safety test standard of minimum acceptable requirements for:

- Flammability.
- Smoke generation.
- Smoke density.
- Toxic gasses generated under flame.

Other standards are not written for safety requirements, but they are written for product performance or conformance.

As with most standards, ICT standards are typically voluntarily adopted, but can be enforced by inclusion into project contract documents (drawings and specifications) by reference. They represent industry consensus on requirements and best practices. A significant benefit of standards in the ICT industry is the ensured interoperability of components and systems by multiple manufacturers.

For example, if a manufacturer of network interface cards does not adhere to standards such as IEEE 802.3, then the product may not properly function with other standards-compliant products.

Standards, continued

Interpretation of Directive Language in Codes, Standards, and Regulations

ICT professionals need to be fully aware of and understand the requirements and recommendations contained within the applicable codes and standards. While not universal, many SDOs have adopted common verbiage that indicates mandatory, recommended, or permissible directive actions (i.e., shall, should, may) and related elements. This same verbiage can also be present in other documents used by the ICT professional (e.g., contract documents including drawings and specifications, installation and design manuals).

The definitions below provide specifics on this common verbiage.

- **Shall**–Indicates a statement of required, mandatory, or a specifically prohibitive practice regarding an action, procedure, or other activity.
- **Should**–Indicates a statement of recommended practice, but not mandatory, in typical situations, with deviations allowed if professional/engineering judgment or study indicates the deviation to be appropriate.
- **May**–Indicates a statement of practice that is a permissive condition and carries no requirement or recommendation.

NOTE: It is imperative for ICT professionals to fully understand and apply the standards or code requirements that are in place for a design or installation project. If this information is missing or incomplete, the ICT professional must ensure that this information is obtained from the appropriate personnel (e.g., AHJ, client/owner, project manager architect/engineer/designer) prior to proceeding with the work.

Standardization Efforts

United States (U.S.) Standards Development

In the U.S., the Telecommunications Industry Association (TIA) is a major SDO for ICT elements. Most TIA standards that govern ICT cabling infrastructure are accredited through American National Standards Institute (ANSI). As such, they have a broad industry acceptance throughout the United States.

Other SDOs, such as the Alliance for Telecommunications Industry Solutions (ATIS), BICSI®, and Society of Cable Telecommunications Engineers (SCTE), have developed standards that further define aspects of ICT design and installation.

International Standards Development

The Organisation Internationale de Normalization, also known as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) jointly oversee global standardization of ICT infrastructure. These organizations form a specialized system for global standardization.

National SDO bodies that are members of the ISO or IEC participate in the development of global standards through committees that deal with specific technical fields. ISO and IEC committees collaborate with other international governmental and non-governmental organizations to develop harmonized global requirements.

In the field of ICT, ISO and IEC have established a joint technical committee (TC), which is known as International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1).

International Codes and Standards

Overview

Several independent organizations specialize in establishing, certifying, and maintaining standards. Many industry trade organizations and national and international standards-setting bodies develop standards and are listed on the following pages.

American Society for Industrial Security (ASIS) International

Founded in 1955, ASIS International is a global community of security practitioners, each of whom has a role in the protection of assets–people, property, and/or information. Publications include:

- ASIS PAP.1, *Security Management Standard: Physical Asset Protection.*

Building Industry Consulting Services International (BICSI)®

The BICSI international standards program produces standards for the ICT industry, covering the design, construction, installation, and operation of ICT infrastructure and related systems for both indoor and OSP applications and premises. BICSI's standards include:

- ANSI/BICSI 001, *Information and Communications Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities*.
- ANSI/BICSI 002, *Data Center Design and Implementation Best Practices*.
- ANSI/BICSI 003, *Building Information Modeling (BIM) Practices for Information Communication Technology Systems.*
- ANSI/BICSI 004, *Information Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities*.
- ANSI/BICSI 006, *Distributed Antenna System (DAS) Design and Implementation Best Practices.*
- ANSI/BICSI 007, *Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises*.
- ANSI/BICSI 008, *Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices*.
- BICSI 009, *Data Center Operations and Maintenance Best Practices.*
- BICSI G1, *ICT Outside Plant Construction and Installation: General Practices*.
- ANSI/BICSI N1, *Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure*.
- ANSI/BICSI N2, *Practices for the Installation of Telecommunications and ICT Cabling Intended to Support Remote Power Applications*.
- ANSI/BICSI N3, *Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure*.

Broadband Forum

The Broadband Forum is a global group of network service providers, network and customer premises equipment manufacturers, regulatory bodies, and other parties that develop standards and specifications in the following areas:

- End-to-end architecture.
- Optical fiber and DSL transmission and testing.
- Connected home and broadband business management solutions.
- Core and network aggregation.
- Policy and service control.
- Service innovation and market requirements.

One of the many technical reports is TR-178, *Multi-service Broadband Network Architecture and Nodal Requirements*.

Common Ground Alliance (CGA)

CGA creates damage prevention tools and resources to help protect vital utilities and those who dig around them. CGA has created targeted damage prevention toolkits to assist associations and companies of any size in promoting safe digging practices.

One of the important publications is the *CGA Best Practices Guide.*

Institute of Electrical and Electronic Engineers (IEEE)®

IEEE® is a nonprofit technical professional association and authority in computer engineering, telecommunications engineering [e.g., LAN, WAN], power systems engineering, and consumer electronics.

IEEE publishes many documents that affect ICT elements. Some important electrical performance and safety related standards are:

- IEEE C2, *National Electrical Safety Code®* (*NESC®*).
- IEEE C62.39, *IEEE Standard for Test Methods and Preferred Values for Self-Restoring Current-Limiter Components Used in Telecommunication Surge Protection*.
- IEEE C62.41.1, *IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.*
- IEEE C62.41.2, *IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits*.
- IEEE C62.41.3, *IEEE Guide for Interactions between Power System Disturbances and Surge-Protective Devices.*
- IEEE C62.42, *Guide for the Application of Component Surge-Protective Devices for Use in Low-Voltage (Equal to or Less than 1000 V (ac) or 1200 V (dc)) Circuits.*
- IEEE C62.42.1, *Guide for the Application of Surge-Protective Components in Surge Protective Devices and Equipment Ports–Part 1: Gas Discharge Tubes (GDTs)*.
- IEEE C62.42.3, *IEEE Guide for the Application of Surge Protective Components in Surge Protective Devices and Equipment Ports–Part 3: Silicon PN Junction Clamping Diodes.*
- IEEE C62.43, *Guide for the Application of Surge Protectors Used in Low-Voltage (Equal to or Less than 1000 Voltage, rms, or 1200 V, DC) Data, Communications, and Signaling Circuits.*
- IEEE C62.43.0, *IEEE Guide for Surge Protectors and Protective Circuits Used in Information and Communications Technology (ICT) Circuits, Including Smart Grid Data Networks–Overview.*
- IEEE C62.43.1, *IEEE Guide for Surge Protectors and Surge Protective Circuits Used in Information and Communication Technology Circuits (ICT), Including Smart Grid–Part 1: Applications.*
- IEEE C62.45, *IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits*.
- IEEE C62.50, *IEEE Standard for Performance Criteria and Test Methods for Plug-in (Portable) Multiservice (Multiport) Surge-Protective Devices for Equipment Connected to a 120 V/240 V Single Phase Power Service and Metallic Conductive Communication Line(s)*.
- IEEE C62.55, *IEEE Guide for Surge Protection of DC Power Feeds to Remote Radio Heads.*
- IEEE C62.64, *IEEE Standard Specifications for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits.*
- IEEE C62.69, *IEEE Standard for the Surge Parameters of Isolating Transformers Used in Networking Devices and Equipment.*

IEEE®, continued

- IEEE C62.69a, *IEEE Standard for the Surge Parameters of Isolating Transformers Used in Networking Devices and Equipment–Amendment 1: Addition of Saturated Core Secondary Winding Parameters.*
- IEEE 81, *IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System*.
- IEEE 142, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems–Green Book*.
- IEEE 241, *IEEE Recommended Practice for Electric Power Systems in Commercial Buildings–Gray Book.*
- IEEE 446, *IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications–Orange Book*.
- IEEE 1100, *IEEE Recommended Practice for Powering and Grounding Electronic Equipment–Emerald Book*.
- IEEE 1184, *IEEE Guide for Batteries for Uninterruptible Power Supply Systems.*
- IEEE 1428, *IEEE Guide for Installation Methods for Fiber Optic Cables in Electric Power Generating Stations and in Industrial Facilities.*
- IEEE 1584, *IEEE Guide for Performing Arc Flash Hazard Calculations.*

Project 802

ICT professionals should be familiar with the physical layer signaling and connectivity for LAN standards under the IEEE Project 802.

Project 802 was organized specifically for the development of LAN and MAN standards. The IEEE LAN/MAN Standards Committee (LMSC) develops LAN and MAN standards primarily for the lowest two layers of the OSI Reference Model.

The LMSC coordinates with other national and international standards groups with some standards published by ISO as international standards. The objective of the LMSC is to develop standards that will be accepted by organizations using LANs as well as LAN hardware and software vendors. This encourages customers to ask for and manufacturers to develop standardized products, ensuring interoperability among products obtained from different vendors. Reporting to the 802 LMSC executive committee are:

- Working groups.
- Technical advisory groups.
- Executive committee study groups.

The working groups under the LMSC are identified as:

- Active–Standards published, continuing work.
- Hibernating–Standards published, but inactive.
- Disbanded.

The LMSC working groups of most import to ICT professionals and some of their respective standards (including drafts) within IEEE 802 are described in the following sections.

IEEE®, continued

802.1 Higher Layer LAN Protocols Working Group

The IEEE 802.1 working group is chartered to develop standards and recommended practices in the following areas: 802 LAN/MAN architecture, internetworking among 802 LANs, MANs, and other WANs, 802 security, 802 overall network management, and protocol layers above the MAC and LLC layers.

Current standards are:

- IEEE 802.1AB, *IEEE Standard for Local and Metropolitan Area Networks–Station and Media Access Control Connectivity Discovery.*

  Current projects to the IEEE 802.1AB standard include:

  – IEEE P802.1ABcu*, Draft Standard for Local and Metropolitan Area Networks–Station and Media Access Control Connectivity Discovery Amendment: YANG Data Model.*

  – IEEE P802.1ABdh*, Draft Standard for Local and Metropolitan Area Networks–Station and Media Access Control Connectivity Discovery Amendment: Support for Multiframe Protocol Data Units.*

- IEEE 802.1AC, *IEEE Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Service Definition*.
- IEEE 802.1AC/COR1*, IEEE Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Service Definition–Corrigendum 1: Logical Link Control (LLC) Encapsulation EtherType.*

  Current project to the IEEE 802.1AC standard includes:

  – IEEE P802.1ACct, *Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Service Definition Amendment Support for IEEE Std 802.15.3.*

- IEEE 802.1AE, *IEEE Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Security.*

  – IEEE 802.1AE/COR1, *Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Security–Corrigendum 1: Tag Control Information Figure.*

  Current project to the IEEE 802.1AE standard includes:

  – IEEE P802.1AEdk, *Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Security Amendment 4: MAC Privacy Protection.*

- IEEE 802.1AR, *IEEE Standard for Local and Metropolitan Area Networks–Secure Device Identity.*
- IEEE 802.1AS, *IEEE Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks.*
- IEEE 802.1AS/COR1, *IEEE Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks–Corrigendum 1: Technical and Editorial Corrections.*

IEEE®, continued

Current project to IEEE 802.1AS includes:

– IEEE P802.1AS, *IEEE Draft Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications.*

– IEEE P802.1AS-2020/Cor 1, *Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications–Corrigendum 1: Technical and Editorial Corrections.*

– IEEE P802.1ASdm, *Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications Amendment: Hot Standby.*

– IEEE P802.1ASdn, *Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications Amendment: YANG Data Model.*

– IEEE P802.1ASdr*, Standard for Local and Metropolitan Area Networks–Timing and Synchronization for Time-Sensitive Applications Amendment: Inclusive Terminology.*

- IEEE 802.1AX, *IEEE Standard for Local and Metropolitan Area Networks–Link Aggregation.*

Current project to the IEEE 802.1AX standard includes:

– IEEE P802.1AX*, IEEE Draft Standard for Local and Metropolitan Area Networks–Link Aggregation.*

- IEEE 802.1BA, *IEEE Standard for Local and Metropolitan Area Networks–Audio Video Bridging (AVB) Systems.*
- IEEE 802.1BA/COR1, *IEEE Standard for Local and Metropolitan Area Networks–Audio Video Bridging (AVB) Systems–Corrigendum 1: Technical and Editorial Corrections.*
- IEEE 802.1BR, *IEEE Standard for Local and Metropolitan Area Networks–Virtual Bridged Local Area Networks–Bridge Port Extension.*
- IEEE 802.1CB, *IEEE Standard for Local and Metropolitan Area Networks–Frame Replication and Elimination for Reliability.*

Current projects to the IEEE 802.1CB standard include:

– IEEE P802.1CBcv*, Draft Standard for Local and Metropolitan Area Networks–Frame Replication and Elimination for Reliability Amendment: Information Model, YANG Data Model and Management Information Base Module.*

– IEEE P802.1CBdb, *Draft Standard for Local and Metropolitan Area Networks–Frame Replication and Elimination for Reliability–Amendment: Extended Stream Identification Functions.*

- IEEE 802.1CF, *IEEE Recommended Practice for Network Reference Model and Functional Description of IEEE 802® Access Network.*
- IEEE 802.1CM, *IEEE Standard for Local and Metropolitan Area Networks–Time-Sensitive Networking for Fronthaul.*

IEEE®, continued

Current project to the IEEE 802.1CM standard includes:

– IEEE P802.1CMde*, Standard for Local and Metropolitan Area Networks–Time-Sensitive Networking for Fronthaul Amendment 1: Enhancements to Fronthaul Profiles to Support New Fronthaul Interface, Synchronization, and Synchronization Standards.*

Current projects to the IEEE 802.1C standard include:

– IEEE P802.1CQ*, Draft Standard for Local and Metropolitan Area Networks: Multicast and Local Address Assignment.*

– IEEE P802.1CS, *IEEE Draft Standard for Local and Metropolitan Area Networks–Link-local Registration Protocol.*

• IEEE 802.1D, *IEEE Standard for Local and Metropolitan Area Networks–Media Access Control (MAC) Bridges.*

Current projects to the IEEE 802.1D standard include:

– IEEE P802.1DC, *Draft Standard for Local and Metropolitan Area Networks–Quality of Service Provision by Network Systems.*

– IEEE P802.1DF*, Draft Standard for Local and Metropolitan Area Networks–Time-Sensitive Networking Profile for Service Provider Networks.*

– IEEE P802.1DG*, Draft Standard for Local and Metropolitan Area Networks–Time-Sensitive Networking Profile for Automotive In-Vehicle Ethernet Communications.*

– IEEE P802.1DP, *Draft Standard for Local and Metropolitan Area Networks–Time-Sensitive Networking for Aerospace Onboard Ethernet Communications.*

• IEEE 802.1Q, *IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks.*

Amendments to the IEEE 802.1Q standard include:

– IEEE 802.1Qcc, *IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks–Amendment 31: Stream Reservation Protocol (SRP) Enhancements and Performance Improvements.*

– IEEE P802.1Qcj, *Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Automatic Attachment to Provider Backbone Bridging (PBB) services.*

– IEEE 802.1Qcp, *IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks–Amendment 30: YANG Data Model.*

– IEEE 802.1Qcr, *Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment 34: Asynchronous Traffic Shaping.*

– IEEE P802.1Qcw, *Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: YANG Data Models for Scheduled Traffic, Frame Preemption, and Per-Stream Filtering and Policing.*

IEEE®, continued

– IEEE 802.1Qcx, *IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment 33: YANG Data Model for Connectivity Fault Management.*

– IEEE 802.1Qcy, *IEEE Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment 32: Virtual Station Interface (VSI) Discovery and Configuration Protocol (VDP) Extension to Support Network Virtualization Overlays Over Layer 3 (NVO3).*

Current projects to the IEEE 802.1Q standard include:

– IEEE P802.1Qcj*, Draft Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Automatic Attachment to Provider Backbone Bridging (PBB) Services.*

– IEEE P802.1Qcw, *Draft Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: YANG Data Models for Scheduled Traffic, Frame Preemption, and Per-Stream Filtering and Policing.*

– IEEE P802.1Qcz*, IEEE Draft Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Congestion Isolation.*

– IEEE P802.1Qdd*, Draft Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Resource Allocation Protocol.*

– IEEE P802.1Qdj*, Draft Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Configuration Enhancements for Time-Sensitive Networking.*

– IEEE P802.1Qdq, *Standard for Local and Metropolitan Area Networks–Bridges and Bridged Networks Amendment: Shaper Parameter Settings for Bursty Traffic Requiring Bounded Latency.*

• IEEE 802.1X, *IEEE Standard for Local and Metropolitan Area Networks–Port-Based Network Access Control.*

802.3 Ethernet Working Group

The IEEE 802.3 working group is responsible for developing standards and recommended practices for access control and physical signaling in the CSMA/CD form of network communications.

This group originally specifies the physical and data link layer standards for LANs using a CSMA/CD access method, bus topology, and repeaters hubs. Such LANs include 5 and 10 Mb/s PMD sublayer. Modern Ethernet deployments such as Fast Ethernet, Gigabit Ethernet, 2.5 Gigabit Ethernet, 5 Gigabit Ethernet, 10 Gigabit Ethernet, 25 Gigabit Ethernet, 40 Gigabit Ethernet, 100 Gigabit Ethernet, 200 Gigabit Ethernet, and 400 Gigabit Ethernet employ full duplex architecture at the (PMD) sublayer.

IEEE®, continued

- IEEE 802.3, *IEEE Standard for Ethernet*, defines the physical layer implementations utilizing copper or fiber media operating with data rates ranging from 1 Mb/s to 400 Gb/s. It also contains specifications for such items as PoE and Power over Data Lines.

  Amendments to the 802.3 standard include:

  – IEEE 802.3bt, *IEEE Standard for Ethernet Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs*.

  – IEEE 802.3ca, *IEEE Standard for Ethernet Amendment 9: Physical Layer Specifications and Management Parameters for 25 Gb/s and 50 Gb/s Passive Optical Networks.*

  – IEEE 802.3cb, *IEEE Standard for Ethernet Amendment 1: Physical Layer Specifications and Management Parameters for 2.5 Gb/s and 5 Gb/s Operation over Backplane*.

  – IEEE 802.3cd, *IEEE Standard for Ethernet Amendment 3: Media Access Control Parameters for 50 Gb/s and Physical Layers and Management Parameters for 50 Gb/s, 100 Gb/s, and 200 Gb/s Operation.*

  – IEEE 802.3cg, *IEEE Standard for Ethernet Amendment 5: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors.*

  – IEEE 802.3ch, *IEEE Standard for Ethernet Amendment 8: Physical Layer Specifications and Management Parameters for 2.5 Gb/s, 5 Gb/s, and 10 Gb/s Automotive Electrical Ethernet.*

  – IEEE 802.3cm, *IEEE Standard for Ethernet Amendment 7: Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber.*

  – *IEEE 802.3cn, IEEE Standard for Ethernet Amendment 4: Physical Layers and Management Parameters for 50 Gb/s, 200 Gb/s, and 400 Gb/s Operation over Single-Mode Fiber.*

  – IEEE 802.3cq, *IEEE Standard for Ethernet Amendment 6: Maintenance #13: Power over Ethernet over 2 pairs.*

  – IEEE 802.3cr, *IEEE Standard for Ethernet Amendment 10: Maintenance #14: Isolation.*

  – IEEE 802.3cu, *IEEE Standard for Ethernet Amendment 11: Physical Layers and Management Parameters for 100 Gb/s and 400 Gb/s Operation over Single-Mode Fiber at 100 Gb/s per Wavelength.*

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Current projects to the IEEE 802.3c standard include:

– IEEE P802.3, (IEEE 802.3dc) *Revision to IEEE Std 802.3-2018 Maintenance #16 Task Force.*

– IEEE P802.3ck, *Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling.*

– IEEE P802.3cp, *IEEE Draft Standard for Ethernet Amendment 14: Bidirectional 10 Gb/s, 25 Gb/s, and50 Gb/s Optical Access PHYs.*

– IEEE P802.3cs, *Standard for Ethernet Amendment: Physical Layers and Management Parameters for Increased-reach Point-to-Multipoint Ethernet Optical Subscriber Access (Super-PON).*

– IEEE P802.3ct, *Standard for Ethernet Amendment: Physical Layers and Management Parameters for 100 Gb/s Operation over DWDM (dense wavelength division multiplexing) systems.*

– IEEE P802.3cv, *Standard for Ethernet Amendment: Maintenance #15: Power over Ethernet*.

– IEEE P802.3cw, *Standard for Ethernet Amendment: Physical Layers and Management Parameters for 400 Gb/s Operation over DWDM (dense wavelength division multiplexing) systems.*

– IEEE P802.3cx, *Standard for Ethernet Amendment: Media Access Control (MAC) service interface and management parameters to support improved Precision Time Protocol (PTP) timestamping accuracy.*

– IEEE P802.3cy, *Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for greater than 10 Gb/s Electrical Automotive Ethernet.*

– IEEE P802.3cz, *Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for Multi-Gigabit Optical Automotive Ethernet.*

– IEEE P802.3da, *Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for Enhancement of 10 Mb/s Operation over Single Balanced Pair Multidrop Segments.*

– IEEE P802.3db, *Standard for Ethernet Amendment: Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Operation over Optical Fiber using 100 Gb/s Signaling.*

– IEEE P802.3dd, *Standard for Ethernet Amendment: Maintenance #17: Power over Data Lines of Single Pair Ethernet.*

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Additional standards include:

- IEEE 802.3.1, *IEEE Standard for Management Information Base (MIB) Definitions for Ethernet.* This standard includes the Structure of Management Information Version 2 MIB module specifications. These modules are intended for use with the SNMP, commonly used to manage Ethernet.
- IEEE 802.3.2, *IEEE Standard for Ethernet–YANG Data Model Definitions.* This standard defines YANG modules for various Ethernet devices specified in IEEE Std 802.3.

802.11 Wireless Local Area Networks Working Group

IEEE 802.11, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications* provides the basis of wireless LAN connectivity. Wireless LAN equipment is often termed 802.11 a, b, g, n, ac, or ax compliant, which reflects a particular amendment of the 802.11 standard. Like all IEEE 802 standards, 802.11 periodically incorporates previously published amendments into the primary document every four to five years.

Amendments to the IEEE 802.11 standard include:

- IEEE 802.11ah, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Sub 1 GHz License Exempt Operation.*
- IEEE 802.11ai, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Fast Initial Link Setup.*
- IEEE 802.11aj, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput to Support Chinese Millimeter Wave Frequency Bands (60 GHz and 45 GHz).*
- IEEE 802.11ak, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer(PHY) Specifications Amendment 4: Enhancements for Transit Links Within Bridged Networks.*
- IEEE 802.11aq, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Preassociation Discovery.*
- IEEE 802.11ax, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment Enhancements for High Efficiency WLAN.*

IEEE®, continued

Current projects to the IEEE 802.11 standard include:

- IEEE P802.11, *Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless Local Area Network (LAN) Medium Access Control (MAC) and Physical Layer (PHY) Specifications.*
- IEEE P802.11ay*, IEEE Approved Draft Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks– Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications–Amendment: Enhanced Throughput for Operation in License-Exempt Bands Above 45 GHz.*
- IEEE P802.11az*, IEEE Draft Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications–Enhancements for Positioning.*
- IEEE P802.11ba*, IEEE Approved Draft Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks– Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Wake-up radio operation.*
- IEEE P802.11bb*, Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Light Communications.*
- IEEE P802.11bc, *Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhanced Broadcast Service.*
- IEEE P802.11bd*, Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Next Generation V2X.*
- IEEE P802.11be, *Standard for Information technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Extremely High Throughput (EHT).*
- IEEE P802.11bf, *Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific Requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Wireless Local Area Network (WLAN) Sensing.*
- IEEE P802.11bi, *Standard for Information Technology–Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks–Specific requirements–Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhanced Service with Data Privacy Protection.*

IEEE®, continued

802.15 Wireless Personal Area Networks (WPANs)

IEEE 802.15 is a collection of specifications governing short distance personal networks. These standards include IEEE 802.15.1, the original source of what is commonly known as Bluetooth®, and IEEE 802.15.4, which is often known as ZigBee™. The IEEE 802.15.7 standard specifies Li-Fi, a free-space optical communication utilizing visible light waves.

802.15 standards include:

- IEEE 802.15.3, *IEEE Standard for High Data Rate Wireless Multi-Media Networks.*

  Amendments to the 802.15.3 standard include:

  – IEEE 802.15.3d, *IEEE Standard for High Data Rate Wireless Multi-Media Networks Amendment 2: 100 Gb/s Wireless Switched Point-to-Point Physical Layer.*

  – IEEE 802.15.3e, *IEEE Standard for High Data Rate Wireless Multi-Media Networks– Amendment 1: High-Rate Close Proximity Point-to-Point Communications.*

  – IEEE 802.15.3f, *IEEE Standard for High Data Rate Wireless Multi-Media Networks Amendment 3: Extending the Physical Layer (PHY) Specification for Millimeter Wave to Operate from 57.0 GHz to 71 GHz.*

- IEEE 802.15.4, *IEEE Standard for Low-Rate Wireless Networks*.

  Amendments to the 802.15.4 standard include:

  – IEEE 802.15.4z, *IEEE Standard for Low-Rate Wireless Networks Amendment 1: Enhanced Ultra Wideband (UWB) Physical Layers (PHYs) and Associated Ranging Techniques.*

  Current projects to the IEEE 802.15.4 standard include:

  – IEEE P802.15.4, *Standard for Low-Rate Wireless Networks.*

  – IEEE P802.15.4-2020/Cor, *Standard for Low-Rate Wireless Networks–Corrigendum 2: Correction of Errors Preventing Backward Compatibility.*

  – IEEE P802.15.4aa, *Standard for Low-Rate Wireless Networks Amendment: Higher Data Rate Extension to IEEE 802.15.4 Smart Utility Network (SUN) Frequency Shift Keying (FSK) Physical layer (PHY).*

  – IEEE P802.15.4w, *Standard for Low-Rate Wireless Networks Amendment 2: Low Power Wide Area Network (LPWAN) extension to the Low Energy Critical Infrastructure Monitoring (LECIM) Physical layer (PHY).*

  – IEEE P802.15.4y, *IEEE Draft Standard for Low-Rate Wireless Networks Amendment: Defining Support for Advanced Encryption Standard (AES)-256 Encryption and Security Extensions.*

- IEEE 802.15.6, *IEEE Standard for Local and Metropolitan Area Networks–Part 15.6: Wireless Body Area Networks*.
- IEEE 802.15.7, *IEEE Standard for Local and Metropolitan Area Networks–Part 15.7: Short-Range Wireless Optical Communication Using Visible Light.*

IEEE®, continued

Current IEEE 802.15.7 project includes:

– IEEE P802.15.7a, *Standard for Local and Metropolitan Area Networks–Part 15.7: Short-Range Optical Wireless Communications Amendment: Higher Speed, Longer Range Optical Camera Communication (OCC).*

- IEEE 802.15.8, *IEEE Standard for Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Peer Aware Communications (PAC).*
- IEEE 802.15.9, *IEEE Recommended Practice for Transport of Key Management Protocol (KMP) Datagrams.*

Current IEEE 802.15.9 project includes:

– IEEE P802.15.9ma, *IEEE Draft Standard for Transport of Key Management Protocol (KMP) Datagrams.*

- IEEE 802.15.10, *IEEE Recommended Practice for Routing Packets in IEEE 802.15.4 Dynamically Changing Wireless Networks.*

Amendments to the IEEE 802.15.10 standard include:

– IEEE 802.15.10a, *IEEE Recommended Practice for Routing Packets in IEEE 802.15.4 Dynamically Changing Wireless Networks–Amendment 1: Fully Defined Use of Addressing and Route Information Currently in IEEE Std 802.15.10.*

– IEEE P802.15.10/D07, *IEEE Draft Recommended Practice for Routing Packets in 802.15.4 Dynamically Changing Wireless Networks.*

- IEEE 802.15.13, *Standard for Multi-Gigabit per Second Optical Wireless Communications (OWC) with Ranges up to 200 meters, for both Stationary and Mobile Devices*.
- IEEE 802.15.22.3, *IEEE Standard for Spectrum Characterization and Occupancy Sensing.*

Current projects to the WPANs standard include:

– IEEE P802.15.12, *Upper Layer Interface (ULI) for IEEE 802.15.4 Low-Rate Wireless Networks.*

802.16 Broadband Wireless Metropolitan Area Networks (WMANs)

IEEE 802.16 defines requirements for larger networks, often on the order of size of a city and is the foundation of WiMAX. Currently, the IEEE 802.16 working group is hibernating.

802.16 standards include:

- IEEE 802.16, *IEEE Standard for Air Interface for Broadband Wireless Access Systems.*
- IEEE 802.16.1, *IEEE Standard for Wireless MAN-Advanced Air Interface for Broadband Wireless Access Systems.*

IEEE®, continued

Amendments to the 802.16.1 standard include:

– IEEE 802.16.1a, *IEEE Standard for Wireless MAN-Advanced Air Interface for Broadband Wireless Access Systems–Amendment 2: Higher Reliability Networks.*

– IEEE 802.16.1b, *IEEE Standard for Wireless MAN-Advanced Air Interface for Broadband Wireless Access Systems Amendment 1: Enhancements to Support Machine-to-Machine Applications.*

• IEEE 802.16.3, *Telecommunications and Information Exchange Between Systems–LAN/MAN Specific Requirements–Air Interface for Fixed Broadband Wireless Access.*

Current projects to the WMANs standard include:

– IEEE P802.16t, *Standard for Air Interface for Broadband Wireless Access Systems Amendment–Fixed and Mobile Wireless Access in Narrowband Channels.*

802.18 Radio Regulatory Technical Advisory Group (RR-TAG)

IEEE 802 LMSC has six working groups with projects on standards for radio-based systems: 802.11 (WLANs), 802.15 (WPANs), 802.16 (WMANs), 802.20 (wireless mobility), 802.21 (handoff/interoperability between networks), and 802.22 (WRANs). The task of RR-TAG is to monitor and participate in the activities of these groups.

802.19 Coexistence Technical Advisory Group (TAG)

The IEEE 802.19 Coexistence TAG develops and maintains policies defining the responsibilities of 802 standards developers to address the issues of coexistence with the existing standards and other standards under development. In addition, the TAG may develop coexistence documentation of interest to the technical community outside 802.

The following was developed in conjunction with the Mobile Broadband Wireless Access (MBWA) working group:

• IEEE 802.19.1, *IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks–Specific Requirements–Part 19: Wireless Network Coexistence Methods.*

• IEEE 802.19.1a*, IEEE Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks–Specific Requirements–Part 19: TV White Space Coexistence Methods Amendment: Coexistence Methods for Geo-Location Capable Devices Operating Under General Authorization.*

• IEEE 802.19.3*, IEEE Recommended Practice for Local and Metropolitan Area Networks–Part 19: Coexistence Methods for 802.11 and 802.15.4 based systems operating in the Sub-1 GHz Frequency Bands.*

IEEE®, continued

Current IEEE 802.19 projects include:

- IEEE P802.19.1, *IEEE Draft Standard for Information Technology–Telecommunications and Information Exchange Between Systems–Local and Metropolitan Area Networks–Specific Requirements–Part 19: Wireless Network Coexistence Methods.*
- IEEE P802.19.3/D0.08, *IEEE Draft Recommended Practice for Local and Metropolitan Area Networks–Part 19: Coexistence Methods for 802.11 and 802.15.4 based systems operating in the Sub-1 GHz Frequency Bands.*

802.21 Media Independent Handover Services Working Group

The Media Independent Handover Services working group developed an extensible MIS framework (i.e., function and protocol) that enables the optimization of services including handover service when performed between heterogeneous IEEE 802 networks. It also facilitates these services when networking between IEEE 802 networks and cellular networks. Currently the IEEE 802.21 working group is hibernating.

802.21 standard includes:

- IEEE 802.21, *IEEE Standard for Local and Metropolitan Area Networks–Part 21: Media Independent Services Framework.*
- IEEE Std 802.21, *IEEE Standard for Local and Metropolitan Area Networks–Part 21: Media Independent Services Framework–Corrigendum 1: Clarification of Parameter Definition in Group Session Key Derivation.*
- IEEE Std 802.21.1, *IEEE Standard for Local and Metropolitan Area Networks–Part 21.1: Media Independent Services*.

  Current IEEE 802.21 project includes:

  – IEEE P802.21, *IEEE Approved Draft Standard for Local and Metropolitan Area Networks–Part 21: Media Independent Services Framework.*

802.22 Wireless Regional Area Network (WRAN) Working Group

The WRAN working group is responsible for policies and procedures for wireless operation in established TV bandwidths. WRAN specifies a cognitive air interface for fixed point-to-multipoint wireless LANs (WLANs) that operate on unused channels in the VHF/UHF TV bands between 54 and 862 MHz. Currently, the IEEE 802.16 working group is hibernating.

802.22 standards include:

- IEEE 802.22, *IEEE Standard–Information Technology–Telecommunications and Information Exchange between Systems–Wireless Regional Area Networks–Specific Requirements–Part 22: Cognitive Wireless RAN MAC and PHY specifications: Policies and Procedures for Operation in the Bands that Allow Spectrum Sharing where the Communications Devices May Opportunistically Operate in the Spectrum of Primary Service.*
- IEEE 802.22.2, *IEEE Recommended Practice for Information Technology–Telecommunications and Information Exchange Between Systems Wireless Regional Area Networks (WRAN)–Specific Requirements–Part 22.2: Installation and Deployment of IEEE 802.22 Systems.*

International Code Council (ICC)

The ICC was established in 1994 as a nonprofit organization committed to developing a single set of all-inclusive and coordinated national model construction codes. The ICC was founded by the International Conference of Building Officials, Building Officials and Code Administrators International, and Southern Building Code Congress International.

The ICC has developed a number of international codes and standards, including:

- ICC/ANSI A.117.1–Accessible and Useable Buildings and Facilities.
- ICC Performance Code™.
- International Building Code®.
- International Energy Conservation Code®.
- International Existing Building Code®.
- International Fire Code®.
- International Mechanical Code®.
- International Property Maintenance Code®.
- International Residential Code®.

International Electrotechnical Commission (IEC)

IEC is a leading global organization that prepares and publishes international standards for electrical, electronic, optical fiber, and related technologies. These standards serve as a basis for national standardization and as reference for drafting international tenders and contracts.

Through its members, IEC promotes international cooperation regarding electrotechnical standardization and related matters (e.g., standards, conformity assessment).

Within IEC, various TCs are responsible for developing and maintaining applicable standards within their assigned areas.

The TC 20, *Electric Cables*, ratifies standards linked to cable characteristics, such as:

- IEC 60332, *Tests on electric and optical fibre cables under fire conditions*.

The TC 23, *Electrical Accessories*, ratifies standards linked to pathway types, such as:

- IEC 61537, *Cable Management–Cable Tray Systems and Cable Ladder Systems.*

The TC 40, *Electrical Cables*, ratifies standards such as:

- IEC 61034-2, *Measurement of Smoke Density of Cables Burning Under Defined Conditions–Part 2: Test Procedure and Requirements.*

The TC 46, *Cables, Wires, Waveguides, RF Connectors, RF and Microwave Passive Components and Accessories*, ratifies standards linked to copper cables, such as:

- IEC 61156-xx series*, Multicore and Symmetrical Pair/Quad Cables for Digital Communications.*
- IEC 61935-1-x series, *Specification for the Testing of Balanced and Coaxial Information Technology Cabling–Part 1: Installed Balanced Cabling as Specified in ISO/IEC 11801 and Related Standards.*
- IEC 61935-2-x series, *Specification for the Testing of Balanced and Coaxial Information Technology Cabling–Part 2: Cords as specified in ISO/IEC 11801 and Related Standards.*
- IEC 61935-3, *Testing of Balanced and Coaxial Information Technology Cabling–Part 3: Installed Cabling as Specified in ISO/IEC 15018 and Related Standards*
- IEC 62153-x-x series, *Metallic Communication Cable Test Methods.*
- IEC 62807-x series, *Hybrid Telecommunications Cables.*

The TC 48, *Electrical Connectors and Mechanical Structures for Electrical and Electronic Equipment*, ratifies standards linked to copper connectors and cabinets, such as:

- IEC 60352-xx series, *Solderless Connections.*
- IEC 60512-xx series, *Connectors for Electronic Equipment–Tests and Measurements.*
- IEC 60512-99-xxx series, *Test Schedules for Unmating Under Electrical Load.*

International Electrotechnical Commission (IEC), continued

- IEC 60603-7-x series*, Connectors for Electronic Equipment.*
- IEC 61076-1, *Connectors for Electronic Equipment–Product Requirements–Part 1: Generic Specification.*
- IEC 61076-2, *Connectors for Electrical and Electronic Equipment–Product Requirements Part 2: Circular Connectors.*
- IEC 61076-3-xxx series, *Connectors for Electrical and Electronic Equipment–Product Requirements Part 3: Rectangular Connectors.*
- IEC 63171 series*, Connectors for Electronic Equipment–General Requirements: 2-way, Shielded or Unshielded Free and Fixed Connectors for Data Transmission with Current Carrying Capacity.*

The TC 64, *Electrical Installations and Protection Against Electric Shock*, ratifies standards linked to aspects, such as:

- IEC 60364-1, *Low-Voltage Electrical Installations–Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions.*
- IEC 60364-4-41, *Low-Voltage Electrical Installations–Part 4-41: Protection for Safety–Protection Against Electric Shock.*
- IEC 60364-4-42, *Low-Voltage Electrical Installations–Part 4-42: Protection for Safety–Protection Against Thermal Effects.*
- IEC 60364-4-43, *Low-Voltage Electrical Installations–Part 4-43: Protection for Safety–Protection Against Overcurrent.*
- IEC 60364-4-44, *Low-Voltage Electrical Installations–Part 4-44: Protection for Safety–Protection Against Voltage Disturbances and Electromagnetic Disturbances.*
- IEC 60364-5-51, *Electrical Installations of Buildings–Part 5-51: Selection and Erection of Electrical Equipment–Common Rules.*
- IEC 60364-5-52, *Low-Voltage Electrical Installations–Part 5-52: Selection and Erection of Electrical Equipment–Wiring Systems.*
- IEC 60364-5-53, *Low-Voltage Electrical Installations–Part 5-53: Selection and Erection of Electrical Equipment–Devices for Protection for Safety, Isolation, Switching, Control and Monitoring.*
- IEC 60364-5-54, *Low-Voltage Electrical Installations–Part 5-54: Selection and Erection of Electrical Equipment–Earthing Arrangements and Protective Conductors.*
- IEC 60364-7-715, *Low-Voltage Electrical Installations–Part 7-715: Requirements for Special Installations or Locations–Extra-Low Voltage Lighting Installations.*
- IEC 61140, *Protection Against Electric Shock–Common Aspects for Installations and Equipment.*
- IEC 62305-x series, *Protection Against Lightning.*

International Electrotechnical Commission (IEC), continued

The TC 70, *Degrees of Protection Provided by Enclosures*, ratifies standards such as:

- IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code).*

The TC 77, *Electromagnetic Compatibility*, ratifies standards linked to electromagnetic effects between products and systems, such as:

- IEC 61000-x-x series, *Electromagnetic Compatibility (EMC).*

The TC 86, *Fibre Optics*, ratifies standards linked to fiber optic components and systems, such as:

- IEC 60793-1-x series, *Optical Fibres–Part 1: Measurement Methods and Test Procedures*.
- IEC 60793-2-x series, *Optical Fibres–Part 2: Product Specifications*.
- IEC 60794-xx series, *Optical Fibre Cables.*
- IEC 60874-x series, *Fibre Optic Interconnecting Devices and Passive Components.*
- IEC 61073-1 *Fibre Optic Interconnecting Devices and Passive Components–Mechanical Splices and Fusion Splice Protectors for Optical Fibres and Cables–Part 1: Generic Specification.*
- IEC 61280-x series, *Fibre Optic Communication Subsystem Basic Test Procedures.*
- IEC 61282-xx series, *Fibre Optic Communications System Design Guidelines.*
- IEC 61300-x series*, Fibre Optic Interconnecting Devices and Passive Components–Basic Test and Measurements Procedures.*
- IEC 61753-x series, *Fibre Optic Interconnecting Devices and Passive Components–Performance Standard.*
- IEC 61754-x series, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Connector Interfaces*.
- IEC 61755-x series, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Connector Optical Interfaces.*
- IEC 61756-x series, *Fibre Optic Interconnecting Devices and Passive Components–Interface Standard for Fibre Management Systems.*
- IEC 61757-x series, *Fibre Optic Sensors.*
- IEC 61977, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Fixed Filters.*
- IEC 62077, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Circulators.*
- IEC 62496-x series, *Optical Circuit Boards–Basic Test and Measurement Procedures.*
- IEC 62614-x series, *Fibre Optics–Multimode Launch Conditions.*
- IEC 62664-s series, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Connector Product Specifications.*
- IEC 63267-x series, *Fibre Optic Interconnecting Devices and Passive Components–Fibre Optic Connector Optical Interfaces.*

International Electrotechnical Commission (IEC), continued

The TC 100, *Audio, Video and Multimedia Systems and Equipment*, ratifies standards linked to multimedia systems, such as:

- IEC 61938, *Multimedia Systems–Guide to the Recommended Characteristics of Analogue Interfaces to Achieve Interoperability.*
- IEC 62680-xx series, *Universal Serial Bus Interfaces for Data and Power.*

International Municipal Signal Association (IMSA)

IMSA is comprised of persons employed by governmental organizations (e.g., city, county, state, federal, provincial) and private corporations who are interested in promoting public safety. Its objectives are to improve the efficiency, installation, construction, and maintenance of public safety equipment and systems by increasing the knowledge of its members on traffic controls, fire alarms, radio communications, roadway lighting, work zone traffic control, emergency medical services, and other related systems.

One of the applicable IMSA publications is:

- *IMSA Official Wire and Cable Specifications*.

International Organization for Standardization (ISO)

ISO, through its membership representing more than 160 countries, produces documents and standards that affect telecommunications and is responsible for many standards, such as the OSI model. The OSI model provides criteria for product development that is interoperable. ICT professionals should be familiar with the standardized signaling and connection interface for various network-accessing protocols. Standards related to the OSI model are now joint ISO/IEC standards and are covered in the ISO/IEC listing in this handbook.

Some of the applicable ISO standards include:

- ISO 7240-x series, *Fire Detection and Alarm Systems*.
- ISO 20345, *Personal Protective Equipment–Safety Footwear*.
- ISO 21500, *Project, Programme and Portfolio Management–Context and Concepts*.
- ISO 21502, *Project, Programme and Portfolio Management–Guidance on Project Management*.
- ISO 21503, *Project, Programme and Portfolio Management–Guidance on Programme Management*.
- ISO 22301, *Security and Resilience–Business Continuity Management Systems–Requirements*.
- ISO 31000, *Risk Management–Guidelines*.

International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1)

In 1988, the ISO and the IEC created a Joint Technical Committee on Information Technology (ISO/IEC JTC 1). ISO/IEC JTC 1 produces standards that affect telecommunications.

The *Interconnection of Information Technology Equipment* subcommittee (SC) 25, is responsible for development and maintenance of structured cabling standards from a systems approach.

The most relevant standards for ICT professionals are:

- ISO/IEC 7498-x series, *Information Processing Systems–Open Systems Interconnection–Basic Reference Model.*
- ISO/IEC 11801-1, *Information technology–Generic cabling for customer premises–Part 1: General requirements.*
- ISO/IEC 11801-2*, Information technology–Generic cabling for customer premises–Part 2: Office premises.*
- ISO/IEC 11801-3*, Information technology–Generic cabling for customer premises–Part 3: Industrial premises.*
- ISO/IEC 11801-4*, Information technology–Generic cabling for customer premises–Part 4: Single-tenant homes.*
- ISO/IEC 11801-5*, Information technology–Generic cabling for customer premises–Part 5: Data centres.*
- ISO/IEC 11801-6*, Information technology–Generic cabling for customer premises–Part 6: Distributed building services.*
- ISO/IEC 14709-1, *Information technology–Configuration of customer premises cabling (CPC) for applications–Part 1: Integrated Services Digital Network (ISDN) basic access.*
- ISO/IEC 14709-2, *Information technology–Configuration of customer premises cabling (CPC) for applications–Part 2: Integrated Services Digital Network (ISDN) primary rate.*
- ISO/IEC 14763-2, *Information technology–Implementation and operation of customer premises cabling–Part 2: Planning and installation.*
- ISO/IEC 14763-3, *Information technology–Implementation and operation of customer premises cabling–Part 3: Testing of optical fibre cabling.*
- ISO/IEC 14763-4, *Information technology–Implementation and operation of customer premises cabling–Part 4: Measurement of End-to-End (E2E) Links, Modular Plug Terminated Links (MPTLs) and Direct Attach Cabling.*
- ISO/IEC 18598, *Information technology–Automated Infrastructure Management (AIM) systems–Requirements, data exchange and applications.*
- ISO/IEC 22237-x series*, Information technology–Data centre facilities and infrastructures.*
- ISO/IEC 30129, *Information technology–Telecommunications bonding networks for buildings and other structures.*

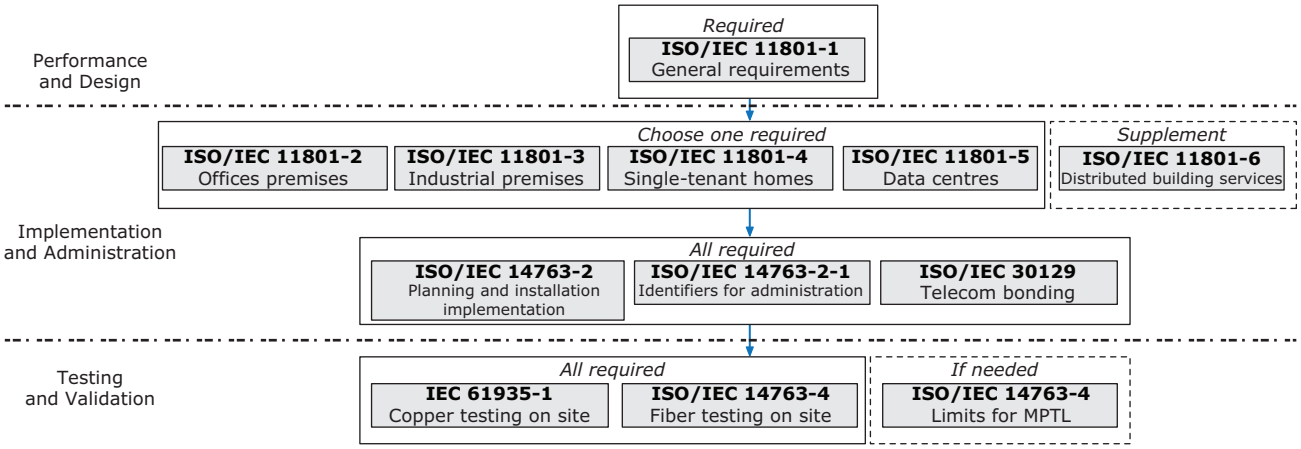
International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1), continued

- ISO/IEC TR 11801-9901, *Information technology–Generic cabling systems for customer premises–Part 9901: Guidance for balanced cabling in support of at least 40 Gbit/s data transmission.*
- ISO/IEC TR 11801-9902, *Information technology–Generic cabling for customer premises–Part 9902: Specifications for end-to-end link configurations.*
- ISO/IEC TR 11801-9904*, Information technology–Generic cabling systems for customer premises–Part 9904: Guidelines for the use of installed cabling to support 2,5GBASE-T and 5GBASE-T applications.*
- ISO/IEC TR 11801-9905, *Information technology–Generic cabling systems for customer premises–Part 9905: Guidelines for the use of installed cabling to support 25GBASE-T application.*
- ISO/IEC TR 11801-9906, *Information technology–Generic cabling for customer premises–Part 9906: Balanced 1-pair cabling channels up to 600 MHz for single pair Ethernet (SPE).*
- ISO/IEC TR 11801-9907*, Information technology–Generic cabling systems for customer premises–Part 9907: Specifications for direct attach cabling.*
- ISO/IEC TR 11801-9908, *Information technology–Generic cabling for customer premises–Part 9908: Guidance for the support of higher speed applications over optical fibre channels.*
- ISO/IEC TR 11801-9909, *Information technology–Generic cabling systems for customer premises–Part 9909: Evaluation of balanced cabling in support of 25 Gbit/s for reach greater than 30 metres.*
- ISO/IEC TR 11801-9910, *Information technology–Generic cabling for customer premises–Part 9910: Specifications for modular plug terminated link cabling.*
- ISO/IEC TR 14763, *Information technology–Implementation and operation of customer premises cabling–Part 2-1: Planning and installation–Identifiers within administration systems.*
- ISO/IEC TR 24704, *Information technology–Customer premises cabling for wireless access points.*
- ISO/IEC TR 24746*, Information technology–Generic cabling for customer premises–Mid-span DTE power insertion.*
- ISO/IEC TR 24750, *Information technology–Assessment and mitigation of installed balanced cabling channels in order to support of 10GBASE-T.*
- ISO/IEC TR 29106, *Information technology–Generic cabling–Introduction to the MICE environmental classification.*
- ISO/IEC TS 11801-9903, *Information technology–Generic cabling systems for customer premises–Part 9903: Matrix modelling of channels and links.*
- ISO/IEC TS 29125, *Information technology–Telecommunications cabling requirements for remote powering of terminal equipment.*

International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1), continued

Below are schematics of the relationships between standards.

Figure 1
Schematic of the relationships between standards



International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1), continued

The technical reports and technical specifications are not standards and were previously identified with the initial TR and TS respectively. All new such documents are now under the series 11801-99xx. The principal documents are:

- ISO/IEC TR 11801-9901, *Generic cabling systems for customer premises–Part 9901: Guidance for balanced cabling in support of at least 40 Gbit/s data transmission*.
- ISO/IEC TR 11801-9902, *Information technology–Generic cabling for customer premises–Part 9902: Specifications for end-to-end link configurations.*
- ISO/IEC TR 11801-9903, *Information technology–Generic cabling for customer premises–Part 9903: Matrix modelling of channels and links*.
- ISO/IEC TR 11801-9904, *Information technology–Generic cabling for customer premises–Part 9904: Guidelines for the use of installed cabling to support 25GBASE-T and 5GBASE-T applications*.
- ISO/IEC TR 11801-9905, *Information technology–Generic cabling for customer premises–Part 9905: Guidelines for the use of installed cabling to support 25GBASE-T application*.
- ISO/IEC TR 11801-9906*, Information technology–Generic cabling for customer premises–Part 9906: Balanced 1-Pair Cabling Channels up to 600 MHz for Single Pair Ethernet (SPE).*
- ISO/IEC TR 11801-9907, *Information technology–Generic cabling for customer premises–Part 9907: Specifications for direct attach cabling.*
- ISO/IEC TR 11801-9908, *Information technology–Generic cabling for customer premises–Part 9908: Guidance for the support of higher speed applications over optical fibre channels.*
- ISO/IEC TR 11801-9909, *Information technology–Generic cabling for customer premises–Part 9909: Evaluation of balanced cabling in support of 25 Gbit/s for reach greater than 30 Metres.*
- ISO/IEC TR 11801-9910, *Information technology–Generic cabling for customer premises–Part 9910: Specifications for modular plug terminated link cabling.*
- ISO/IEC TR 24750, *Information technology–Assessment and mitigation of installed balanced cabling channels in order to support 10GBASE-T*.
- ISO/IEC TR 29106, *Information technology–Generic cabling–Introduction to the MICE environmental classification*.
- ISO/IEC TS 29125, *Information technology–Telecommunications cabling requirements for remote powering of terminal equipment*.

International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1 (ISO/IEC JTC 1), continued

The ISO/IEC covers two main aspects of remote powering:

- Implementation on existing cabling—Found in the TS 29125 standard, which explains how to evaluate the maximum power that can be implemented depending on current conditions.
- Design of a new cabling compliant to PoE—This is an amendment to the installation standard ISO/IEC 14763-2. It explains that all new installations should be of type RP3, which allows maximum PoE current (480 mA) on all wires in all cables. It also provides all tools necessary to evaluate the temperature increase depending on design.

Other ISO/IEC JTC1 working groups with applicable standards to ICT professionals are:

- ISO/IEC 18598*, Information technology–Automated infrastructure management (AIM) systems–Requirements, data exchange and applications.*
- ISO/IEC 23916, *Telecommunications and information exchange between systems–Corporate telecommunication networks–Signalling interworking between QSIG and SIP–call transfer.*
- ISO/IEC 27001, *Information technology–Security techniques–Information security management system–Requirements.*

International Organization for Standardization Technical Committee 21 (ISO/TC 21)

In 1996, the ISO created ISO TC 21 which produces standards related to gaseous media and firefighting systems using gas extinguishing compounds that affect telecommunications. The most relevant standard for ICT professionals is:

- ISO 14520-x series, *Gaseous fire-extinguishing systems–Physical Properties and System Design.*

International Safety Equipment Association (ISEA)

ISEA is the association responsible for safety equipment and technologies. This includes equipment and systems that enable people to work safely in hazardous environments. Where government standards are in effect, ISEA provides important industry counsel to regulatory bodies, including the National Institute of Occupational Safety and Health (NIOSH), the Mine Safety and Health Administration (MSHA), and the Occupational Safety and Health Administration (OSHA) in the U.S.

The association also works to influence international standards and conformity assessment for safety products, working through the ISO.

International Safety Equipment Association (ISEA), continued

Some of the ISEA standards applicable to PPE requirements which may be in place at ICT work sites include:

- ANSI/ISEA Z87.1, *American National Standard for Occupational and Educational Eye and Face Protection Devices.*
- ANSI/ISEA Z89.1, *American National Standard for Industrial Head Protection.*
- ANSI/ISEA Z308.1, *American National Standard–Minimum Requirements for Workplace First Aid Kits and Supplies.*
- ANSI/ISEA Z358.1, *American National Standard for Emergency Eyewash and Shower Equipment.*
- ANSI/ISEA 105, *American National Standard for Hand Protection Classification.*
- ANSI/ISEA 107, *American National Standard for High-Visibility Safety Apparel.*
- ANSI/ISEA 138, *American National Standard for Performance and Classification for Impact-Resistant Gloves.*

International Society of Automation (ISA)

The ISA is a non-profit professional association of engineers, technicians, and management engaged in industrial automation. The ISA/IEC 62443 series of standards, developed by the ISA99 committee and adopted by the IEC, provides a flexible framework to address and mitigate current and future security vulnerabilities in IACSs.

The committee draws on the input and knowledge of IACS security experts from across the globe to develop consensus standards that are applicable to all industry sectors and critical infrastructure.

- ISA/IEC 62443-x series, *Security for Industrial Automation and Control.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T)

The ITU is a United Nations specialized agency for ICT.

Founded in 1865 to facilitate international connectivity in communications networks, the ITU allocates global radio spectrum and satellite orbits, develops the technical standards that ensure networks and technologies seamlessly interconnect, and strives to improve access to ICT worldwide. ITU covers the entire ICT sector, from digital broadcasting to the Internet and from mobile technologies to three-dimensional TV.

ITU's Telecommunication Standardization Sector (ITU-T), formerly known as the Consultative Committee on International Telegraphy and Telephony (CCITT), assembles experts from around the world to develop international standards known as ITU-T Recommendations which act as defining elements in the global infrastructure of ICT. Some of their standards include:

G-series; Transmission systems and media, digital systems and networks

- ITU-T G.650-1, *Definitions and Test Methods for Linear, Deterministic Attributes of Single-Mode Fibre and Cable.*
- ITU-T G.650-2, *Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable.*
- ITU-T G.650-3, *Test methods for installed single-mode optical fibre cable links.*
- ITU-T G.651*, Characteristics of a 50/125 Micrometer Multimode Graded Index Optical Fibre Cable–Series G: Transmission Systems and Media, Digital Systems and Networks–Transmission Media Characteristics–Optical Fibre Cables.*
- ITU-T G.652*, Characteristics of a Single-Mode Optical Fibre and Cable.*
- ITU-T G.653*, Characteristics of a Dispersion-Shifted Single-Mode Optical Fibre and Cable.*
- ITU-T G.654*, Characteristics of a Cut-Off Shifted Single-Mode Optical Fibre and Cable.*
- ITU-T G.655*, Characteristics of a Non-Zero Dispersion-Shifted Single-Mode Optical Fibre and Cable.*
- ITU-T G.656, *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.*
- ITU-T G.657*, Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network.*
- ITU-T G.664, *Optical safety procedures and requirements for optical transmission systems.*
- ITU-T G.693, *Optical interfaces for intra-office systems.*
- ITU-T G.701, *Vocabulary of digital transmission and multiplexing, and pulse code modulation (PCM) terms.*
- ITU-T G.702, *Digital hierarchy bit rates.*
- ITU-T G.703, *Physical/electrical characteristics of hierarchical digital interfaces.*
- ITU-T G.704*, Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44,736 kbit/s hierarchical levels.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

- ITU-T G.711*, Pulse Code Modulation (PCM) of Voice Frequencies.*
- ITU-T G.723.1*, Dual Rate Speech Coder for Multimedia Communications Transmitting at 5.3 and 6.3 kbit/s.*
- ITU-T G.726, *40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM).*
- ITU-T G.729*, Coding of Speech at 8 kbit/s Using Conjugate-Structure Algebraic-Code-Excited Linear Prediction* (*CS-ACELP*).
- ITU-T G.764, *Voice packetization–Packetized voice protocols.*
- ITU-T G.769/Y.1242, *Circuit multiplication equipment optimized for IP-based networks.*
- ITU-T G.872, *Architecture of the optical transport network.*
- ITU-T G.983.1, *Broadband optical access systems based on Passive Optical Networks (PON).*
- ITU-T G.983.2*, ONT Management and Control Interface Specification for B-PON.*
- ITU-T G.984.1*, Gigabit-Capable Passive Optical Networks (GPON): General Characteristics.*
- ITU-T G.984.2*, Gigabit-Capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) Layer Specification*.
- ITU-T G.984.3*, Gigabit-Capable Passive Optical Networks (GPON): Transmission Convergence Layer Specification*.
- ITU-T G.984.4, *Gigabit-Capable Passive Optical Networks (G-PON): ONT Management and Control Interface Specification.*
- ITU-T G.987.1*, 10-Gigagit-Capable Passive Optical Network (XG-PON) Systems: General Requirement.*
- ITU-T G.989-40, *Gigabit-Capable Passive Optical Networks (NG-PON2): Definitions, Abbreviations and Acronyms.*
- ITU-T G.1000, *Communications Quality of Service: A framework and definitions.*
- ITU-T G.1001, *End-user multimedia QoS categories.*
- ITU-T G.9803, *Radio over fibre systems.*
- ITU-T G.9807-1, *10-Gigabit-capable symmetric passive optical network (XGS-PON).*
- ITU-T G.9970, *Generic home network transport architecture.*

H-series; Audiovisual and multimedia systems

- ITU-T H.225*, Call Signalling Protocols and Media Stream Packetization for Packet-Based Multimedia Communication Systems*.
- ITU-T H.245*, Control Protocol for Multimedia Communication.*
- ITU-T H.261*, Video Codec for Audiovisual Services at p × 64 kbit/s.*
- ITU-T H.263*, Video Coding for Low Bit Rate Communication.*
- ITU-T H.264, *Advanced Video Coding for Generic Audiovisual Services.*
- ITU-T H.265, *High Efficiency Video Coding.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

- ITU-T H.266, *Versatile Video Coding.*
- ITU-T H.310, *Broadband Audiovisual Communication Systems and Terminals.*
- ITU-T H.320*, Narrow-Band Visual Telephone Systems and Terminal Equipment.*
- ITU-T H.323*, Packet-Based Multimedia Communications Systems*.
- ITU-T H.361, *End-to-end Quality of Service (QoS) and Service Priority Signalling in H.323 Systems.*
- ITU-T H.550, *Architecture and Functional Entities of Vehicle Gateway Platforms.*
- ITU-T H.560, *Communications Interface Between External Applications and a Vehicle Gateway Platform.*
- ITU-T H.623, *Web of Things Service Architecture.*
- ITU-T H.641, *SNMP-based Sensor Network Management Framework.*
- ITU-T H.720, *Overview of IPTV Terminal Devices and End Systems.*
- ITU-T H.780, *Digital Signage: Service Requirements and IPTV-based Architecture.*
- ITU-T H.781, *Digital Signage: Functional Architecture.*

I-series; Integrated services digital network

- ITU-T I.120, *Integrated Services Digital Networks (ISDNs).*
- ITU-T I.211-B*, ISDN Service Aspects.*
- ITU-T I.312, *Principles of Intelligent Network Architecture.*
- ITU-T I.313-B, *ISDN Network Requirements.*
- ITU-T I.350, *General aspects of quality of service and network performance in digital networks, including ISDNs.*
- ITU-T I.351, *Relationships among ISDN, IP-based network and physical layer performance recommendations.*
- ITU-T I.411, *ISDN user-network interfaces–Reference configurations.*
- ITU-T I.413-B, *ISDN user-network interface.*
- ITU-T I.430*, Integrated Services Digital Network (ISDN) User-Network Interfaces–Basic User-Network Interface–Layer 1 Specification.*
- ITU-T I.431*, Primary Rate User-Network Interface–Layer 1 Specification.*

J-series; Cable networks and transmission of television, sound programme and other multimedia signals

- ITU-T J.1210, *Requirements of IP video broadcast (IPVB) for cable TV networks.*
- ITU-T J.1211, *Specifications of IP video broadcast (IPVB) for cable TV networks.*

K-series; Protection against interference

- ITU-T K.6, *Protection at Crossings.*
- ITU-T K.10, *Low frequency interference due to unbalance about earth of telecommunication equipment.*
- ITU-T K.11, *Principles of protection against overvoltages and overcurrents.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

- ITU-T K.19, *Joint use of trenches and tunnels for telecommunication and power cables.*
- ITU-T K.26*, Protection of telecommunication lines against harmful effects from electric power and electrified railway lines.*
- ITU-T K.29, *Coordinated protection schemes for telecommunication cables below ground.*
- ITU-T K.36*, Selection of protective devices.*
- ITU-T K.47*, Protection of telecommunication lines against direct lightning flashes.*
- ITU-T K.50*, Safe limits for operating voltages and currents of telecommunication systems powered over the network.*
- ITU-T K.64, *Safe working practices for outside equipment installed in particular environments.*
- ITU-T K.66, *Protection of customer premises from overvoltages.*
- ITU-T K.69, *Maintenance of protective measures.*
- ITU-T K.73, *Shielding and bonding for cables between buildings.*
- ITU-T K.98, *Overvoltage protection guide for telecommunication equipment installed in customer premises.*
- ITU-T K.108*, Joint use of poles by telecommunication and solidly earthed power lines.*
- ITU-T K.109, *Installation of telecommunication equipment on utility poles.*
- ITU-T K.112, *Lightning protection, earthing and bonding: Practical procedures for radio base stations.*

L-series; Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant

- ITU-T L.1, *Construction, installation and protection of telecommunication cables in public networks.*
- ITU-T L.9, *Methods of terminating metallic cable conductors.*
- ITU-T L.11*, Joint use of tunnels by pipelines and telecommunication cables, and the standardization of underground duct plans.*
- ITU-T L.18, *Sheath closures for terrestrial copper telecommunication cables.*
- ITU-T L.76, *Copper loop requirements for various technologies including indoor and structured cabling.*
- ITU-T L.100, *Optical fibre cables for duct and tunnel application.*
- ITU-T L.101, *Optical fibre cables for buried application.*
- ITU-T L.102, *Optical fibre cables for aerial application.*
- ITU-T L.103, *Optical fibre cables for indoor applications.*
- ITU-T L.105, *Optical fibre cables for drop applications.*
- ITU-T L.106, *Optical fibre cables: Special needs for access networks.*
- ITU-T L.108, *Optical fibre cable elements for microduct blowing installation application.*
- ITU-T L.150, *Installation of optical fibre cables in the access network.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

- ITU-T L.152*, Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation.*
- ITU-T L.153, *Mini-trench installation technique.*
- ITU-T L.154, *Micro-trench installation technique.*
- ITU-T L.155, *Low impact trenching technique for FTTx networks.*
- ITU-T L.156, *Air-assisted installation of optical fibre cables.*
- ITU-T L.158, *Installation of optical fibre cables along railways.*
- ITU-T L.162, *Microduct technology and its applications.*
- ITU-T L.200, *Passive node elements for fibre optic networks–General principles and definitions for characterization and performance evaluation.*
- ITU-T L.203, *Electric power supply for equipment installed as outside plant.*
- ITU-T L.250, *Optical access network topologies for broadband service.*
- ITU-T L.253*, Access facilities using hybrid fibre/copper networks.*
- ITU-T L.259*, Methods for inspecting and repairing underground plastic ducts.*
- ITU-T L.261, *Design of suspension wires, telecommunication poles and guy-lines for optical access networks.*
- ITU-T L.300*, Optical fibre cable network maintenance.*
- ITU-T L.330, *Telecommunication infrastructure facility management.*
- ITU-T L.340, *Maintenance of cable tunnels.*
- ITU-T L.341*, Management of poles carrying overhead telecommunication lines.*
- ITU-T L.390, *Disaster management for outside plant facilities.*
- ITU-T L.400, *Optical fibre splices.*
- ITU-T L.401, *Optical fibre attenuators.*
- ITU-T L.402, *Single-mode fibre optic connectors.*
- ITU-T L.403, *Optical branching components (non-wavelength selective).*
- ITU-T L.1200, *Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment.*
- ITU-T L.1201, *Architecture of power feeding systems of up to 400 VDC.*
- ITU-T L.1203, *Colour and marking identification of up to 400 VDC power distribution for information and communication technology systems.*
- ITU-T L.1204, *Extended architecture of power feeding systems of up to 400 VDC.*
- ITU-T L.1205*, Interfacing of renewable energy or distributed power sources to up to 400 VDC power feeding systems.*
- ITU-T L.1210, *Sustainable power-feeding solutions for 5G networks.*
- ITU-T L.1301**,** *Minimum data set and communication interface requirements for data centre energy management.*
- ITU-T L.1370, *Sustainable and intelligent building services.*
- ITU-T L.1700, *Requirements and framework for low-cost sustainable telecommunications infrastructure for rural communications in developing countries.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

T-series; Terminals for telematic service

- ITU-T T.38*, Procedures for Real-Time Group 3 Facsimile Communication Over IP Networks.*
- ITU-T T.120*, Data Protocols for Multimedia Conferencing*.

V-series; Data communications over the telephone network

- ITU-T V.24, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment.*

X-series; Data networks, open system communications and security

- ITU-T X.7, *Technical characteristics of data transmission services.*
- ITU-T X.21*, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Synchronous Operation on Public Data Networks.*
- ITU-T X.25, *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit.*
- ITU-T X.27, *Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s.*
- ITU-T X.75, *Packet-switched signalling system between public networks providing data transmission services.*
- ITU-T X.200*, Information technology–Open Systems Interconnection–Basic Reference Model: The basic model.*
- ITU-T X.207, *Information technology–Open Systems Interconnection–Application layer structure.*
- ITU-T X.210*, Information technology–Open Systems Interconnection–Basic Reference Model: Conventions for the definition of OSI services.*
- ITU-T X.211*, Information technology–Open Systems Interconnection–Physical service definition.*
- ITU-T X.212*, Information technology–Open Systems Interconnection–Data Link service definition.*
- ITU-T X.213*, Information technology–Open Systems Interconnection–Network service definition.*
- ITU-T X.214*, Information technology–Open Systems Interconnection–Transport service definition.*
- ITU-T X.215*, Information technology–Open Systems Interconnection–Session service definition.*
- ITU-T X.216*, Information technology–Open Systems Interconnection–Presentation service definition.*
- ITU-T X.222*, Use of X.25 LAPB-compatible Data Link procedures to provide the OSI connection-mode Data Link service.*
- ITU-T X.223*, Use of X.25 to provide the OSI connection-mode Network service for ITU-T applications.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

Y-series; Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

- ITU-T Y.1001, *IP framework–A framework for convergence of telecommunications network and IP network technologies.*
- ITU-T Y.1231, *IP Access Network Architecture.*
- ITU-T Y.1261, *Service requirements and architecture for voice services over Multi-Protocol Label Switching.*
- ITU-T Y.1306, *Architecture of Ethernet layer networks.*
- ITU-T Y.1308.1*, Interfaces for the Ethernet transport network.*
- ITU-T Y.4000, *Overview of the Internet of things.*
- ITU-T Y.4050, *Terms and definitions for the Internet of things.*
- ITU-T Y.4051, *Vocabulary for smart cities and communities.*
- ITU-T Y.4100, *Common requirements of the Internet of things.*
- ITU-T Y.4101*, Common requirements and capabilities of a gateway for Internet of things applications.*
- ITU-T Y.4102*, Requirements for Internet of things devices and operation of Internet of things applications during disasters.*
- ITU-T Y.4103*, Common requirements for Internet of things (IoT) applications.*
- ITU-T Y.4112*, Requirements of the plug and play capability of the Internet of things.*
- ITU-T Y.4113, *Requirements of the network for the Internet of things.*
- ITU-T Y.4200, *Requirements for the interoperability of smart city platforms.*
- ITU-T Y.4201*, High-level requirements and reference framework of smart city platforms.*
- ITU-T Y.4401*, Functional framework and capabilities of the Internet of things.*

International Telecommunication Union (ITU) Handbooks

- *Earthing and Bonding*
- *Mitigation measures for telecommunications installations–Part 1.*
- *Mitigation measures for telecommunications installations–Part 2.*
- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume I: Design, construction and operational principles of telecommunication, power and electrified railway facilities.*
- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume IV: Inducing currents and voltages in electrified railway systems.*
- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume V: Inducing currents and voltages in power transmission and distribution systems.*

International Telecommunication Union–Telecommunication Standardization Sector (ITU-T), continued

- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume VI: Danger, damage and disturbance.*
- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume VII: Protective measures and safety precautions.*
- *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines–Volume VIII: Protective devices.*
- *The Protection of Telecommunication Lines and Equipment Against Lightning Discharges–Chapters 1 to 5.*
- *The Protection of Telecommunication Lines and Equipment Against Lightning Discharges–Chapters 6, 7 and 8.*
- *The Protection of Telecommunication Lines and Equipment Against Lightning Discharges–Chapters 9 and 10.*
- *Optical Transport Networks from TDM to Packet.*
- *Outside Plant Technologies for Public Networks.*
- *Security in Telecommunications and Information Technology.*

Internet Engineering Task Force (IETF)

IETF is an open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

Some of their standards include:

- IETF RFC 1075*, Distance Vector Multicast Routing Protocol*.
- IETF RFC 2328, *OSPF Version 2*.
- IETF RFC 3031*, Multiprotocol Label Switching Architecture*.
- IETF RFC 3261, *SIP: Session Initiation Protocol.*
- IETF RFC 3376*, Internet Group Management Protocol, Version 3*.
- IETF RFC 3666, *Session Initiation Protocol (SIP) Public Switched Telephone Network (PSTN) Call Flows.*
- IETF RFC 4822*, RIPV2 Cryptographic Authentication*.
- IETF RFC 5059*, Bootstrap Router* (*BSR*) *Mechanism for Protocol Independent Multicast* (*PIM*).
- IETF RFC 5367*, Subscriptions to Request-Contained Resource Lists in the Session Initiation Protocol* (*SIP*).
- IETF RFC 5415*, Control and Provisioning of Wireless Access Points* (*CAPWAP*) *Protocol Specification*.
- IETF RFC 5416*, Control and Provisioning of Wireless Access Points* (*CAPWAP*) *Protocol Binding for IEEE 802-11*.

Internet Engineering Task Force (IETF), continued

- IETF RFC 5417*, Control and Provisioning of Wireless Access Points* (*CAPWAP*) *Access Controller DHCP Option*.
- IETF RFC 5853, *Requirements from Session Initiation Protocol (SIP) Session Border Control (SBC) Deployments.*
- IETF RFC 6405, *Voice over IP (VoIP) SIP Peering Use Cases.*
- IETF RFC 7540, *Hypertext Transfer Protocol Version 2 (HTTP/2).*
- IETF RFC 8200, *Internet Protocol, Version 6 (IPv6) Specification.*
- IETF RFC 8633, *Network Time Protocol Best Current Practices.*
- IETF RFC 9006, *TCP Usage Guidance in the Internet of Things (IoT).*

Regional Codes and Standards

Australia/New Zealand Codes and Standards

Standards Australia and Standards New Zealand jointly develop standards that promote an integrated trans-Tasman economy. Joint standards are identified as AS/NZS standards.

When standards are applicable to and released in one country only, the standard will be identified as either an AS (Australia) or NZS (New Zealand) standard. In the absence of an AS/NZS standard, in New Zealand the AS or ISO/IEC equivalent standard may also be used.

ICT standards used in Australia and New Zealand include:

- AS 11801-2*, Information technology–Generic cabling for customer premises–Part 2: Office premises.*
- AS 11801-3*, Information technology–Generic cabling for customer premises–Part 3: Industrial premises.*
- AS 11801-4, *Information technology–Generic cabling for customer premises–Part 4: Single-tenant homes.*
- AS 11801-5*, Information technology–Generic cabling for customer premises–Part 5: Data centres.*
- AS 11801-6*, Information technology–Generic cabling for customer premises–Part 6: Distributed building services.*
- AS 30129, *Information technology–Telecommunications bonding networks for buildings and other structures.*
- AS/NZS 2878, *Timber–Classification into strength groups.*
- AS/NZS 2967, *Optical fibre communication cabling systems safety*.
- AS/NZS 3084, *Telecommunications installations–telecommunications pathways and spaces for commercial buildings.*
- AS/NZS 3085.1, *Telecommunications installations–administration of communications cabling systems–basic requirements.*
- AS/NZS 11801-1, *Information Technology–Generic cabling for customer premises, Part 1: General requirements.*
- AS/NZS 14763.3, *Information technology–Implementation and operation of customer premise cabling, Part 3: Testing of optical fibre cabling.*
- AS/NZS ISO/IEC 14763.2, *Information technology–Implementation and operation of customer premise cabling, Part 2 Planning and installation.*
- AS/NZS ISO/IEC 61935.1, *Specification for the testing of balanced and coaxial information technology cabling.*
- NZS 4219, *Seismic performance of engineering systems in buildings.*

Caribbean Region Codes and Standards

The Caribbean region of nations, territories, and colonies contains a unique mix of applicable codes, standards, and regulations. ICT designers and installers working in this region may encounter codes and standards that are of U.S., Canadian, European, or United Kingdom (UK) origin in effect by the applicable AHJ (e.g., National Fire Protection Association [NFPA] 70, CSA C22.1, IEC 60364 series, British Standards [BS] 7671).

Caribbean Telecommunications Union (CTU)

The CTU is an intergovernmental organization which was established by the Heads of the Caribbean Community in 1989. The CTU is dedicated to facilitating the development of the telecommunications sector of its Member States and manages several regional projects in areas such as spectrum management and Internet governance.

Caribbean Region Codes and Standards, continued

Table 1
Key elements of the legal and regulatory framework of telecommunications sectors in select countries

Country	State of Liberalization	Monopoly Segments	Telecommunications Regulatory Agency	Overarching Legislation
Anguilla			Public Utilities Commission	Telecommunications Act, 2003 as amended
Antigua & Barbuda	Partial		Telecommunications Division, Government of Antigua & Barbuda	Telecommunications Act, 1951 as amended (CAP 423)
Aruba			Netherlands Radiocommunications Agency	Communications Act of 1934, as amended
Bahamas	Full	Nil	Utilities Regulation and Competition Authority	Communications Act, 2009 as amended
Barbados	Full	Nil	Telecommunications Unit, Government of Barbados	Telecommunications Act, 2001 as amended (Cap 282B)
Belize	Partial	Mobile/ cellular	Public Utilities Commission	Telecommunications Act, 2002
Bermuda			Regulatory Authority	Electronic Communications Act, 2011
Cayman Islands	Full	Nil	Information and Communications Technology Authority	Information & Communications Technology Authority Law (2011 Revision)
Curacao	Full		Bureau Telecommunicatie and Post	
Dominica	Full	Nil	National Telecommunications Regulatory Commission	Telecommunications Act, 2000, as amended
Dominican Republic	Full	Nil	Instituto Dominicano de las Telecomunicaciones	
Grenada	Full	Nil	National Telecommunications Regulatory Commission	Telecommunications Act, 2000
Guyana	Partial	Mobile/ cellular	Public Utilities Commission	Public Utilities Commission, 1999 as amended
Haiti	Full	Nil	Conseil National des Telecommunications	Décret du 27 Septembre, 1969

Caribbean Region Codes and Standards, continued

Table 1, continued
Key elements of the legal and regulatory framework of telecommunications sectors in select countries

Country	State of Liberalization	Monopoly Segments	Telecommunications Regulatory Agency	Overarching Legislation
Jamaica	Full	Nil	Office of the Utilities Regulation	Telecommunications Act, 2000 as amended
Montserrat			Montserrat Info-Communications Authority	Telecommunications Act, 1949 as amended
St. Kitts & Nevis	Full	Nil	National Telecommunications Regulatory Commission	Telecommunications Act, 2000 as amended
St. Lucia	Full	Nil	National Telecommunications Regulatory Commission	Telecommunications Act, 2000 as amended
St. Vincent and the Grenadines	Full	Nil	National Telecommunications Regulatory Commission	Telecommunications Act, 2001
Suriname			Telecommunicatie Autoriteit Suriname	Telecommunications Act, 2004
Trinidad & Tobago	Full	Nil	Telecommunications Association of Trinidad and Tobago	Telecommunications Act, 2001 as amended (Chap 47.31)
Turks and Caicos Islands	Full	Nil	Turks and Caicos Islands Telecommunications Commission	Telecommunications Ordinance, Chap 14.02

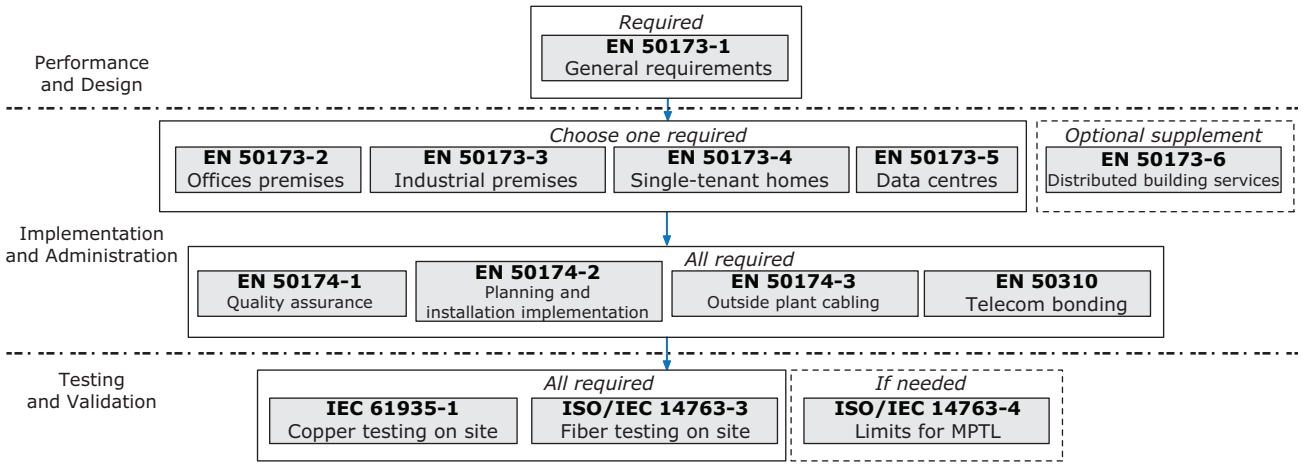
European Codes and Standards

Comité Européen de Normalisation Electrotechnique (CENELEC)

While every country in the EU has adopted CENELEC standards, there may be local standards that provide guidance or are specific to a country application for the CENELEC standards.

The organization of the CENELEC cabling-related standards is shown in Figure 2.

Figure 2
Schematic of the relationships between CENELEC standards



European Codes and Standards, continued

EN 50098 Series

EN 50098 ***Customer Premises Cabling for Information Technologies***

This European standard defines the requirements for the design and configuration of customer premises cabling for the connection of basic access ISDN equipment. It also defines:

- Design requirements for ISDN basic access with point-to-point and point-to-multipoint cabling configurations.
- Minimum cabling requirements for the installation of new cabling.
- Criteria for the use of generic cabling.
- Criteria for the use of existing cabling.

EN 50173 Series

EN 50173 is a series of standards detailing generic cabling systems for general practice and office, industrial, residential, and data center applications.

EN 50173-1, ***Information Technology–Generic Cabling Systems–Part 1: General Requirements***

EN 50173-1 contains those specifications that are common to generic cabling systems irrespective of the type of premises. It specifies generic balanced twisted-pair, unbalanced coaxial, singlemode, multimode, and plastic optical fiber cabling components for use within premises, which may comprise single or multiple buildings on a campus.

This European standard is optimized for premises where the maximum distance over which telecommunications services are distributed is ≈10,000 m (32,800 ft). The principles of this standard may also be applied to larger installations.

This standard specifies the:

- Structure and configuration for generic cabling.
- Cabling performance requirements.
- Implementation options.
- Applications supported by application and by media type.

European Codes and Standards, continued

EN 50173-2, *Information Technology–Generic Cabling Systems–Part 2:* Office Premises

This European standard is based upon and references the requirements of EN 50173-1. This standard contains additional requirements that are appropriate to office premises in which the maximum distance over which communications services may be distributed is ≈2000 m (6500 ft).

EN 50173-3, *Information Technology–Generic Cabling Systems–Part 3: Industrial Premises*

This European standard recognizes the benefit of generic cabling to interconnect several pieces of apparatus within industrial premises (within and between structures and buildings) and is to be read in conjunction with EN 50173-1.

EN 50173-4, *Information Technology–Generic Cabling Systems–Part 4: Residential Premises*

This European standard specifies generic cabling in homes, which is installed to support one or more of the following groups of applications and is based upon balanced and coaxial cabling as appropriate:

- ICT.
- Broadcast and communications technologies.
- Commands, controls, and communications in buildings.

EN 50173-5, *Information Technology–Generic Cabling Systems–Part 5: Data Centres*

Cabling within data centers comprises both application-specific and multi-purpose networks that are mission critical to the enterprise. This European standard recognizes the benefit of generic cabling to provision multiple services and to connect large quantities of equipment within the limited space of data center premises and is to be used in conjunction with EN 50173-1.

EN 50173-6, *Information Technology–Generic Cabling Systems–Part 6: Distributed Building Services*

This standard specifies generic cabling for distributed building services and can be used in conjunction with all the space-specific standards of the EN 50173 series. It covers balanced cabling and optical fiber cabling. This standard specifies directly or via reference to EN 50173-1 the:

- Structure and minimum configuration for generic cabling for distributed building services.
- Interfaces at the service outlet.
- Performance requirements for cabling links and channels.
- Implementation requirements and options.
- Performance requirements for cabling components.
- Conformance requirements and verification procedures.

This standard has taken into account requirements specified in application standards listed in EN 50173-1.

European Codes and Standards, continued

EN 50174 Series

EN 50174 series of standards addresses the specification, installation, and operational aspects of network and ICT systems that use balanced twisted-pair and optical fiber cabling.

This European standard is applicable to:

- Cabling designed to support particular analog and digital telecommunications services, including voice services.
- Generic cabling systems designed in accordance with EN 50173 and intended to support a wide range of telecommunications services.

Information in this standard is intended for those involved in the procurement, installation, and operation of IT cabling.

EN 50174 is applicable to certain hazardous environments, but it does not exclude additional requirements, which are applicable in specific circumstances (e.g., those defined by electrical supply and electrified railways).

This European standard is in three parts and addresses the specification, installation, and operational aspects. The EN 50173 series and other application standards cover design issues. EN 50174-1 is used during the specification phase and addresses:

- Installation specification, quality assurance documentation, and procedures.
- Documentation and administration.
- Operation and maintenance.

EN 50174-2 is applicable inside buildings, and EN 50174-3 is applicable outside buildings.

European Codes and Standards, continued

EN 50174-1, *Information Technology–Cabling Installation–Part 1: Installation Specification and Quality Assurance*

This European standard provides guidance on the preparation and agreement of an installation specification covering the IT cabling, its accommodation, and associated building services.

It also defines installation and acceptance testing practices, enabling the agreement of a quality plan used to demonstrate conformance with the installation specification.

EN 50174-2, *Information Technology–Cabling Installation–Part 2: Installation Planning and Practices Inside Buildings*

EN 50174-2 is concerned with the planning and installation of IT cabling using metallic cabling and optical fiber cabling inside buildings. It provides guidance as to the responsibilities of those involved and is intended to be referenced in relevant contracts.

EN 50174-2 contains requirements and recommendations relating to the installation planning and practices by defining:

- Planning strategy (road map) and guidance, depending on the application, electromagnetic environment, building infrastructure, facilities, and other factors.
- Planning and installation requirements for metallic and optical fiber IT cabling, depending on the application, electromagnetic environment, building infrastructure, facilities, and other factors.
- The practices and procedures to be adopted to ensure that the cabling is installed in accordance with the specification.

European Codes and Standards, continued

EN 50174-3, *Information Technology–Cabling Installation–Part 3: Installation Planning and Practices Outside Buildings*

This European standard establishes requirements for satisfactory installation and operation of IT cabling outside buildings–it is not restricted to campus areas.

EN 50174-3 contains detailed requirements and guidance relating to the installation planning and practices by defining:

- Planning strategy (road map) and guidance, depending on the application and physical environment (e.g., climatic, mechanical, electromagnetic).
- Design and installation rules for metallic and optical fiber cabling, depending on the application, electromagnetic environment, and physical environment.
- Requirements on satisfactory operation of the cabling, depending on the application, electromagnetic environment, and physical environment.
- The practices and procedures to be adopted to ensure that the cabling is installed in accordance with the specification.

EN 50600 Series

EN 50600, *Information Technology–Data Centre Facilities and Infrastructures*

EN 50600 is the designation assigned to a collection of standards focused on data centers. EN 50600 currently has four major divisions, with most having additional standards within each division. The divisions are:

- EN 50600-1, *Information Technology–Data Centre Facilities and Infrastructures–General requirements.*
- EN 50600-2-xx-series, *Data Centre Facilities and Infrastructures–Design Standards*.
- EN 50600-3-xx-series, *Data Centre Facilities and Infrastructures–Operational Standards*.
- EN 50600-4-xx-series, *Data Centre Facilities and Infrastructures–Reportable Metrics and Key Performance Indicators*.

European Codes and Standards, continued

Other CENELEC Standards

EN 50310, *Telecommunications Bonding Networks for Buildings and Other Structures*

This European standard specifies minimum requirements for earthing networks and connections (bonds) in buildings in which IT equipment is intended to be installed to protect that equipment and interconnecting cabling from electrical hazards.

This standard also specifies requirements and provides recommendations for earthing networks and connections (bonds) in order for the IT installation to achieve:

- Reliable signal reference.
- Adequate immunity from electromagnetic interference carried by the earthing network.

EN 50575, *Power, control, and communication cables–Cables for general applications in construction works subject to reaction to fire requirements*

The Construction Products Regulation is a European law ratified to harmonize conditions for the marketing of construction products in the European Union. Compliance is mandatory for products carrying the CE mark.

EN 50575 is the applicable standard for power, control, and communications cables. It covers communications cables fixed in the building, but not removable items (e.g., patch cords, user cords).

European Codes and Standards, continued

EN 62305, *Protection Against Lightning*

CENELEC has adopted IEC 62305 as a European standard.

EN 62305-1 provides general guidelines in the lightning protection of:

- Structures, including their installations, contents, and occupants.
- Services connected to a structure.

The applicable standards include:

- EN 13501-6, *Fire classification of construction products and building elements–Part 6: Classification using data from reaction to fire tests on electric cables.*
- EN 50399, *Common test methods for cables under fire conditions–Heat release and smokeproduction measurement on cables during flame spread test–Test apparatus, procedures, results.*
- EN 50575, *Power, control, and communication cables–Cables for general applications in construction works subject to reaction to fire requirements.*
- EN 60754-2, *Test on gases evolved during combustion of materials from cables–Part 2: Determination of acidity (by pH measurement) and conductivity.*
- EN 62305-2, *Protection against lightning–Part 2: Risk Management*.
- EN 62305-3, *Protection against lightning–Part 3: Physical Damage to Structure and Life Hazard.*
- EN 62305-4, *Protection against lightning–Part 4: Electrical and Electronic Systems within Structures.*
- EN 62305-5, *Protection against lightning–Part 5: Services*.

National Codes and Standards

Australian Codes and Standards

Australian Communications and Media Authority (ACMA)

The ACMA is a government authority that oversees telecommunications, broadcasting, radio communication, and the Internet within Australia. For telecommunications and ICT, the ACMA serves as an AHJ for inspecting and approving cabling installations and as a licensing body for ICT installers and technicians. Applicable regulation issued by this agency include:

- *Telecommunications (Labelling Notice for Customer Equipment and Customer Cabling) Instrument.*
- *Telecommunications (Types of Cabling Work) Declaration.*

Communications Alliance (CA)

The CA provides a forum for the communications industry to take the lead on initiatives which grow the Australian communications industry and foster the highest standards of business behavior. Within their activities, the CA develops and approves technical standards and codes of practice for the communications industry. Some of the most relevant codes and standards for ICT include:

- AS/CA S008, *Requirements for Authorised Cabling Products.*
- AS/CA S009, *Installation Requirements for Customer Cabling (Wiring Rules).*
- C524, *External Telecommunications Cable Networks.*
- G538, *Interconnection Model.*
- G571, *Building Access Operations and Installation.*
- G591, *Telecommunications in Road Reserves–Operational Guidelines for Installation.*
- G645, *Fibre Ready Pit and Pipe Specification for Real Estate Development Projects.*

Standards Australia

Standards Australia serves as the Australian representative within regional and international standards development efforts. In addition to the development of regional standards, Standards Australia also produces standards and documents specific to Australia. For ICT, these include:

- AS EN 301 549, *Accessibility requirements suitable for public procurement of ICT products and services.*
- SA TR ISO/IEC 11801.9902, *Information technology–Generic cabling for customer premises, Part 9902: Specifications for end-to-end link configurations.*
- SA TS 29125, *Information technology–Telecommunications cabling requirements for remote powering of terminal equipment.*

Brazilian Codes and Standards

Associacão Brasileira de Normas Técnicas (ABNT)

ABNT produces standards that affect telecommunications in Brazil. Some of the most relevant are:

- ABNT NBR 5410, *Instalações elétricas de baixa tensão* (Low Voltage Electrical Installations).
- ABNT NBR 6814, *Fios e cabos elétricos–Ensaio de resistência elétrica* (Cables and Wires–Electrical Resistance Test and Measurement).
- ABNT NBR 9130, *Fios e cabos telefônicos–Ensaio de desequilíbrio resistivo* (Telephone Cables and Wires–Resistance Unbalance Test).
- ABNT NBR 9133, *Cabos telefônicos–Ensaio de atenuação de sinal de transmissão–Método de ensaio* (Telephone Cables–Signal Transmission Attenuation–Methods of Test).
- ABNT NBR 13989, *Cabo óptico subterrâneo–Determinação do desempenho quando submetido ao ensaio de coeficiente de atrito estático–Método de ensaio* (Underground Optical Cable–Performance Evaluation of Static Friction Coefficient–Method of Test).
- ABNT NBR 13990, *Cabo óptico subterrâneo–Determinação do desempenho quando submetido à vibração–Método de ensaio* (Underground Optical Cable–Performance Evaluation under Vibration Conditions–Method of Test).
- ABNT NBR 14103, *Cabo óptico dielétrico para aplicação enterrada* (Direct-Buried Dielectric Optical Cable).
- ABNT NBR 14159, *Cabo óptico com núcleo geleado protegido por capa APL–Especificação* (APL-Insulated Optical Cable Loose Tube Filled with Gel–Specification).
- ABNT NBR 14160, *Cabo óptico aéreo dielétrico auto-sustentado* (Aerial Self-Sustained Dielectric Optical Cable).
- ABNT NBR 14433, *Conectores montados em cordões ou cabos de fibras ópticas e adaptadores–Especificação* (Optical Connectors and Adapters Assembled in Patch Cords or Optical Fiber Cables–Specification).
- ABNT NBR 14565, *Cabeamento de telecomunicações para edifícios comerciais* (Telecommunications Cabling for Commercial Buildings).
- ABNT NBR 14584, *Cabo óptico com proteção metálica para instalações subterrâneas–Verificação da suscetibilidade a danos provocados por descarga atmosférica–Método de ensaio* (Optical Cable with Metallic Protection for Underground Installations–Evaluation of Damage Caused by Atmospheric Discharge–Method of Test).
- ABNTNBR 14702, *Cabos coaxiais flexíveis com impedância de 75 ohms para redes de banda larga–Especificação* (75-ohm Flexible Coaxial Cables for Broadband Applications–Specification).

Brazilian Codes and Standards, continued

- ABNT NBR 14703, *Cabos de telemática de 100 Ω para redes internas estruturadas–Especificação* (Telecommunications Cable for Structured Cabling, 100-ohm–Specification).
- ABNT NBR 14705, *Cabos internos de telecomunicações–classificação quanto ao retardo à propagação de chamas* (Indoor Telecommunications Cable–Fire Rating Classification).
- ABNT NBR 14770, *Cabos coaxiais rígidos com impedância de 75 ohms para redes debanda larga–especificação* (75-ohm Rigid Coaxial Cables for Broadband Applications–Specification).
- ABNT NBR 14771, *Cabo óptico interno–Especificação* (Indoor Optical Cable–Specification).
- ABNT NBR 14772, *Cabo óptico de terminação–Especificação* (Optical Cable for Connectors Termination–Specification).
- ABNT NBR 14774, *Cabo óptico dielétrico protegido contra ataque de roedores para aplicação enterrada–Especificação* (Corrugated-Metal Sheath Dielectric Optical Cable for Direct-Buried Distribution–Specification).
- ABNT NBR 15110, *Cabo óptico com núcleo dielétrico e proteção metálica para aplicação enterrada* (Optical Cable with Dielectric Core Protected by Metallic Insulated Sheath for Direct-Buried Installations).

Agência Nacional de Telecomunicações (ANATEL)

ANATEL publishes Resolucao 242, *Regulamento para certificação e homologação de produtos para telecomunicações* (Resolution 242, Regulation for Certification of Telecommunications Products).

Canadian Codes and Standards

Canadian Standards Association (CSA)

CSA produces several documents and standards that affect telecommunications. Among the most important are:

- CAN/CSA-B72, *Installation Code for Lightning Protection Systems.*
- CSA C22.1, *Canadian Electrical Code (CEC), Part I, Safety Standard for Electrical Installations.*
- CSA C22.3 No. 1, *Overhead Systems.*
- CSA C22.3 No. 5.1, *Recommended Practices for Electrical Protection–Electric Contact Between Overhead Supply and Communication Lines.*
- CSA C22.3 No. 7, *Underground Systems.*
- CSA Z195.1-16, *Guideline for Selection, Care, and Use of Protective Footwear.*
- CSA Z195-14*, Protective Footwear.*
- CSA Z462, *Workplace Electrical Safety.*

Canadian Electrical Code (CEC)–Part I

The CSA sponsors, controls, and publishes the *CEC, Part I*. The intent of this code is to establish safety standards for the installation and maintenance of electrical equipment, including telecommunications. Compliance with the requirements of this code and proper maintenance will ensure an essentially safe installation. The *CEC, Part I*, is a voluntary code for adoption and enforcement by the municipal, provincial, and territorial regulatory authorities.

All provinces and territories have adopted the *CEC, Part I*, as their standard, and some provinces, territories, and municipalities have introduced additional requirements.

The *CEC, Part I*, (revised every three years) is used by:

- Electrical and ICT contractors, electricians, and ICT installers to ensure code compliant installations.
- Architectural, engineering, and design organizations to design code compliant systems.
- Fire marshals and electrical inspectors in loss prevention and safety enforcement.
- Attorneys (barristers) and insurance companies to determine liability.

Designers and installers must be familiar with all sections of the *CEC, Part I*, when planning the installation of the telecommunications system within Canada and the Bahamas.

Canadian Codes and Standards, continued

Table 2 lists sections of the *CEC, Part I*, that are applicable to the ICT professional.

Table 2
Sections of the *Canadian Electrical Code* (*CEC*)

Section	Title	Contents
0	Definitions	Contains terms and their applicable definitions as to be used in the code.
2	General rules	Provides information on: • Permits. • Marking of cables. • Flame spread requirements for electrical wiring and cables.
10	Bonding and grounding	Contains detailed bonding and grounding (earthing) information and requirements for using and identifying bonding and ground (earth) conductors.
12	Wiring methods	Requirements for installing cabling systems. It outlines: • Raceway systems. • Boxes. • Other system elements.
16	Class 1 and Class 2 circuits	Requirements for installing Class 2 power and data communication circuits.
18	Hazardous locations	Applies to circuits placed within specific environments.
32	Fire alarm systems, fire pumps, and carbon monoxide systems	Requirements specific to fire alarm systems.
54	Community antenna distribution and radio and television installations	Applies to circuits employed to distribute video, radio, and other information frequency signals.
56	Optical fiber cables	Requirements for installing optical fiber cables.
60	Electrical communication systems	Requirements for installing communications circuits.

Canadian Codes and Standards, continued

Table 2, continued
Sections of the *Canadian Electrical Code* (*CEC*)

Section	Title	Contents
82	Closed-loop and pre-closed-loop power distribution	Requirements for controlling the signal between the energy controlling equipment and the utilization equipment.
Table 5A	Correction factors applying to Tables 1, 2, 3, 4, and 60	Ampacity correction factor for cables operating at an ambient temperature above 30 ºC (86 ºF)
Table 19	Cable classifications	Provides conditions of use and maximum allowed conductor temperatures for conductors
Table 59	Minimum size of protector grounding conductors for communications systems	Specifies the minimum grounding conductor size based on the number of fused or fuseless protected circuits.
Table 60	Allowable ampacities for copper, eight-conductor, Class 2 power and data communication circuit cables	Specifies the maximum ampacity of a cable based on number of cables in a bundle, conductor size, and ambient temperature.

Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC)

CSI and CSC jointly produce several publications for the building construction industry in Canada. The most notable is:

- *MasterFormat*®: A master list of numbers and titles classified by work results or construction practices that is used to organize project manuals, detail cost information, and relate drawing notations.

National Research Council of Canada, Institute for Research in Construction (NRC-IRC)

The NRC-IRC produces several documents and standards that affect telecommunications. Among the most important are:

- National Building Code of Canada for Buildings.
- National Energy Code of Canada for Buildings.
- National Fire Code of Canada.

Standards Council of Canada (SCC)

The SCC is a federal Crown corporation that serves to promote efficient and effective standardization in Canada. The SCC's mission is to facilitate the development and use of national and international standards and accreditation services. The SCC recognizes nine accredited standards development organizations and over 350 accredited laboratories.

Chilean Codes and Standards

Sub-Secretariat of Telecommunications (Subtel)

Undersecretary of State under the Ministry of Transport and Telecommunications is in charge of control and supervision in the exercise of telecommunications in the country.

- Degree N°157, *Regulates the form and conditions to guarantee free choice in the contracting and reception of telecommunications services in lots, building and co-tenancy real state.*
- Exempt Resolution N°575, *Regulation of the use of short-range telecommunications devices.*
- Exempt Resolution N°766, *Normative Technical Specification for routes and space for telecommunication wire in optical fiber and coaxial for lots, building and co-tenancy real state.*
- Law 18168, *General Telecommunications Law*.

Superintendency of Electricity and Fuels (SEC)

The SEC is the public agency, dependent on the Ministry of Energy, in charge of ensuring that people have safe and quality products and services in the electricity and fuels systems.

- RIC N°01, *Normative Technical Specification for electrical connection*.
- RIC N°02, *Normative Technical Specification for electrical power board.*
- RIC N°03, *Normative Technical Specification for electric linear.*
- RIC N°04, *Normative Technical Specification for Conductors, materials and canalization systems.*
- RIC N°05, *Normative Technical Specification for Protective measures against dangerous voltages and electric shock.*
- RIC N°06, *Normative Technical Specification for Grounding and equipotential bonding.*
- RIC N°07, *Normative Technical Specification for installation of equipment.*
- RIC N°08, *Normative Technical Specification for Emergency systems.*
- RIC N°09, *Normative Technical Specification for Self-generation systems.*
- RIC N°10, *Normative Technical Specification for General purpose facilities.*
- RIC N°11, *Normative Technical Specification for Special facilities.*
- RIC N°12, *Normative Technical Specification for Installations in explosive atmospheres.*
- RIC N°13, *Normative Technical Specification for Substations and electrical rooms.*
- RIC N°14, *Normative Technical Specification for Energy efficiency requirements for buildings.*
- RIC N°15, *Normative Technical Specification for Infrastructure for charging electric vehicles.*
- RIC N°16, *Normative Technical Specification for Distribution subsystems.*
- RIC N°17, *Normative Technical Specification for Operation and maintenance.*
- RIC N°18, *Normative Technical Specification for Project presentation.*
- RIC N°19, *Normative Technical Specification for Commissioning.*

Colombian Codes and Standards

Instituto Colombiano de Normas Técnicas y Certificación (ICONTEC)

ICONTEC publishes several regional standards called *Norma Técnica Colombiana*. These standards are related to the ICT industry:

- NTC 2050, *Colombia Electrical Code*.
- NTC 3608, *Technical Specifications For Dispersion Boxes, Cabinets And Pedestals For Telecommunications Networks*.
- NTC 5797, *Telecommunications. Common Telecommunications Infrastructure*.
- NTC 6181, *Optical Fibre Cables. Indoor Cables. Sectional Specification*.
- NTC 6264, *Information Technology. Generic Cabling For Homes*.
- NTC 6307, *System Earthing (System Grounding)*.
- NTC 6323, *Generic Telecommunications Cabling For Customer Premises*.
- NTC 6324, *Commercial Building Telecommunications Infrastructure*.

French Codes and Standards

Association Française de Normalisation (AFNOR)

All applicable European standards are translated into French and adopted with the NF prefix.

The French standards committees linked to information technology generally do not write component standards except for cabled fiber, generally used for FTTH, and country-specific residential copper cabling such as:

- XP C 93-531-16, *Câbles pour installations intérieures de télécommunications Partie 16: Câbles avec écran pour applications télévision radio fréquence incluant la bande intermédiaire satellite (DVB-S/S2)–Grade 2 TV* (Indoor communication cable–Part 16: Screened cables for radiofrequency television applications including satellite intermediate band (DVB-S/S2)–Class 2 TV).
- XP C 93-531-17, *Câbles pour installations intérieures de télécommunications Partie 17: Câbles avec écran pour applications télévision radio fréquence incluant la bande intermédiaire satellite (DVB-S/S2)–Grade 3 TV* (Indoor communication cable–Part 17: Screened cables for radiofrequency television applications including satellite intermediate band (DVB-S/S2)–Class 3 TV).

French Codes and Standards, continued

These two listings are based on category 5e and category 6 cables, but with one pair improved to category 8 specifications to allow transmission of TV signals up to satellite DVB-S 2150 MHz. They are linked to the design standards:

- XP C 90-483, *Systèmes de câblage résidentiel* « THD READY » *des réseaux de communication* («THD READY» residential cabling systems of communication network).
- XP C 90-486, *Les colonnes de communication (Réseau d'accès au logement ou au local à usage professionnel)* Telecom risers (access network to homes or office premises).

All standards starting with XP are experimental and are only valid for 3 years, renewable once. After this, they must either be adopted by CENELEC or become official French standards.

The standard to guide electricians in providing a compliant installation is:

- NF C 15-100, *Installations électriques* à *basse tension* (Low-voltage electrical installations).

Most of the requirements for structured cabling in these standards are linked to regulation "Arrêté du 3 août 2016 modifiant l'arrêté du 16 décembre 2011 relatif à l'application de l'article R. 111-14 du code de la construction et de l'habitation" which states that all new homes must include a communications technical cabinet and be cabled to allow a minimum of 1 Gb/s datarate as well as all AV signals up to DVB-S 2150 MHz to the outlets.

German Codes and Standards

German Product Safety Act (ProdSG)

The ProdSG replaced the German Equipment and Product Safety Act in 2011. It regulates the safety requirements for products, which are made available, exhibited, or used for the first time in the context of a commercial activity on the German or European market. It incorporates important rules for the protection of consumers that govern transparency, information, and market surveillance. This includes the provision that comprehensive information must be made available to consumers and that the manufacturer and/or the importer must be clearly identified.

The award of the GS mark is also regulated in the Product Safety Act. According to § 20 et seq. ProdSG, the GS mark shall ensure that the technical requirements with regard to the safety of a ready-to-use product are met and that they are monitored by an independent testing institution.

Deutsches Institut für Normung (DIN)

The DIN produces 4102-9, *Fire Behaviour of Building Materials and Elements; Seals For Cable Penetrations; Concepts, Requirements and Testing.*

Japanese Codes and Standards

Japanese Standards Association

The standard for residential cabling in Japan is JIS X 5150 (ISO/IEC 11801 Ed.2:2002+A1:2010), *Information Technology–Generic Cabling for Customer Premises.*

Korean Codes and Standards

Telecommunications Technology Association (TTA)

The TTA produces TTAK.KO-04.0225, *Design Basis for Information and Communication Facility.*

Mexican Codes and Standards

Normalización y Certificación (NYCE)

NYCE is the national organization of standardization (ONN) for México. They have the responsibility for publishing the standards of this country. Relevant standards are:

- NMX-I-108-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado–Puesta atierra en sistemas de telecomunicaciones*.
- NMX-I-132-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado–Especificaciones de las pruebas de cableado balanceado–Parte 1: Cableado instalado*.
- NMX-I-154-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado–Cableado genérico residencial*.
- NMX-I-248-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado– Cableado de Telecomunicaciones para edificios comerciales–Especificaciones y métodosde prueba*.
- NMX-I-279-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado–Canalizaciones y espacios para cableado de telecomunicaciones en edificios comerciales.*
- NMX-I-14763-1-NYCE, *Telecomunicaciones–Cableado–Cableado estructurado–Implementación y operación de cableado en edificios comerciales–Parte 1: Administración*.
- NMX-I-14763-2-NYCE, *Tecnologías de la información-Implementación y operaciónde cableado estructurado–Parte 2: Planeación e instalación*.
- NMX-I-24764-NYCE, *Tecnología de la información–Sistema de cableado genéricopara centros de datos*.
- NMX-J-C-I-489-ANCE-ONNCCE-NYCE, *Centros de datos de alto desempeñosustentable y energético–Requisitos y métodos de comprobación*.

Mexico has adopted the *NEC* NFPA 70 as its electrical code.

Peruvian Codes and Standards

Instituto Nacional de Calidad (INACAL)

INACAL is the governing body and highest technical-normative authority of the National System for Quality in Peru. Some of the most relevant standards to telecommunications are:

- ETP-ISO/IEC TS 22237-1*, Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 1: Conceptos generales. 1a Edición.*
- ETP-ISO/IEC TS 22237-2*, Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 2: Construcción de edificio. 1a Edición.*
- ETP-ISO/IEC TS 22237-3, *Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 3: Distribución de energía. 1a Edición.*
- ETP-ISO/IEC TS 22237-4, *Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 4: Control ambiental. 1a Edición.*
- ETP-ISO/IEC TS 22237-5*, Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 5: Infraestructura de cableado de telecomunicaciones. 1a Edición.*

Peruvian Codes and Standards, continued

- ETP-ISO/IEC TS 22237-6, *Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 6: Sistemas de seguridad. 1a Edición.*
- ETP-ISO/IEC TS 22237-7, *Tecnología de la información. Instalaciones e infraestructuras de centros de datos. Parte 7: Información de administración y operación. 1a Edición.*
- NTP 264.100, *TELECOMUNICACIONES. Inspección y evaluación de conectores de fibra óptica. 1a Edición.*
- NTP-IEC 60793-1-40, *Fibras ópticas. Parte 1-40: Métodos de medición de la atenuación. 1a Edición.*
- NTP-ISO/IEC 11801-1, *Information technology. Generic cabling for customer facilities. Part 1: General requirements. 1st Edition.*
- NTP-ISO-IEC 19395, *Tecnología de la información. Sostenibilidad para la tecnología de la información. Monitoreo y control de recursos de centro de datos inteligente. 1a Edición.*
- NTP-ISO-IEC 21836, *Tecnología de la información. Centros de datos. Métrica de la eficacia de la energía de los servidores. 1a Edición.*
- NTP-ISO-IEC 30129, *Tecnología de la información. Redes de enlace de telecomunicaciones para edificios y otras estructuras. 1a Edición.*
- NTP-ISO-IEC 30134-1, *Tecnología de la información. Centros de datos. Indicadores clave de rendimiento. Parte 1: Resumen y requisitos generales. 1a Edición.*
- NTP-ISO-IEC 30134-2, *Tecnología de la información. Centros de datos. Indicadores clave de rendimiento. Parte 2: Efectividad del uso de energía (PUE). 1a Edición.*
- NTP-ISO-IEC 30134-3, *Tecnología de la información. Centros de datos. Indicadores clave de rendimiento. Parte 3: Factor de energía renovable (REF). 1a Edición.*
- NTP-ISO-IEC 30134-4, *Tecnología de la información. Centros de datos. Indicadores clave de rendimiento. Parte 4: Eficiencia energética de equipos de TI para servidores (ITEEsv). 1a Edición.*
- NTP-ISO-IEC 30134-5, *Tecnología de la información. Centros de datos. Indicadores clave de rendimiento. Parte 5: Utilización de equipos de TI para servidores (ITEUsv). 1a Edición.*

Turkish (TR) Codes and Standards

Turkish Standards Institution (TSE)

TSE produces standards relating to telecommunications. Some of the most relevant are:

- TS EN 12825, *Yükseltilmiş Taban Sistemleri* (Raised Floor Systems).
- TS HD 60364, *Alçak Gerilim Elektrik Tesisleri* (Power System Earthing).

Turkish Building Legislation

Turkish legislation relating to telecommunications includes:

- 5809'*nolu Elektronik Haberleşme Kanunu* (Electronic Communications Law).
- Gazette 12937: *Binaların Yangından Korunması Hakkında Yönetmelik* (Fire Protection for Buildings Legislation).
- Gazette 18565*: Elektrik* İç *Tesisleri Yönetmeliği* (Building Electric Code).
- Gazette 24500: *Elektrik Tesislerinde Topraklama Yönetmeliği* (Earthing for Electric Facilities).
- *Taşınır Kod Listesi* (Categorization and coding standard for all equipment).

United Kingdom (UK) Codes and Standards

NOTE: See also European Codes and Standards listed earlier in this handbook for additional applicable standards within the UK.

British Standards Institution (BSI)

BSI produces standards relating to telecommunications. Some of the most relevant are:

- BS 476-20, *Method for Determination of the Fire Resistance of Elements on Construction (General Principles)*.
- BS 6701, *Telecommunications Equipment and Telecommunications Cabling–Specification for Installation, Operation, and Maintenance*.
- BS EN 1366-3, *Fire Resistance Tests for Service Installation–Penetration Seals.*
- BS EN 60038, *CENELEC Standard Voltages.*
- BS EN 60073, *Basic and Safety Principles for Man-Machine Interface, Marking and Identification–Coding Principles for Indicators and Actuators*.

BS 6701 extends the requirements of the EN 50174 series of standards to the installation, operation, administration, and maintenance of telecommunications equipment and telecommunications cabling other than cabling within the scope of the EN 50174 series of standards. It also specifies requirements beyond the scope of the EN 50174 series of standards for telecommunications equipment and all types of telecommunications cabling.

The requirements contained within Clause 4 are primarily for the installers of telecommunications equipment and telecommunications cabling.

The requirements contained within Clause 5 are primarily for owners of premises housing telecommunications systems. These owners may delegate selected responsibilities to designers, specifiers, operators, and maintainers of installed telecommunications equipment and telecommunications cabling.

BS 7671, *Requirements for Electrical Installations–IET Wiring Regulations, 17th Edition*

In the United Kingdom, electrical installations are required to comply with statutory regulations such as *The Electricity Safety, Quality and Continuity Regulations 2002* (and amendments) and *The Electricity at Work Regulations 1989* (and amendments). The regulations represent the principal legal requirements. BS 7671 (and amendments) is the national standard to which all domestic and industrial wiring must conform.

Amendment number 2 primarily concerns a fundamental change to the colors of fixed wiring cables along with some changes because of the introduction of the *Electricity Supply Quality and Continuity Regulations* and some certificate changes. The regulations are to be applied generally to electrical installations. However, in certain circumstances, these regulations may be supplemented by the requirements or regulations of other UK or European standards.

United Kingdom (UK) Codes and Standards, continued

BS 8300-1, ***Design of an accessible and inclusive built environment Part 1: External environment–Code of practice***

BS 8300-2, ***Design of an accessible and inclusive built environment Part 2: Buildings–Code of practice***

Design of Buildings and Their Approaches to Meet the Needs of Disabled People–Code of Practice

These UK standards give recommendations for the design of new buildings and their approaches to meet the needs of disabled people. These standards explain how the built environment can be designed to anticipate and overcome restrictions that prevent disabled people from making full use of premises and their surroundings. An accessible environment is one in which a disabled person can enter and make use of independently or with help.

Some facilities may be designed in such a way as to incorporate access for disabled people. In other situations, additional features such as grab rails, touch legible signs, and hearing enhancement systems may be needed. The guidance in these standards cover a wide range of impairments and the use of the built environment by disabled people who may be residents, visitors, spectators, customers, employees, or participants in sports events, performances, and conferences.

These documents should be read in conjunction with building design and requirement documents and local authority guidelines.

BS 8492, ***Telecommunications Equipment and Telecommunications Cabling–Code Of Practice For Fire Performance and Protection***

This British standard gives recommendations for fire performance and fire protection of all types of telecommunications equipment and telecommunications cabling. It covers:

- Designing and implementing cabling infrastructures.
- Selecting products, including materials, and construction.
- Minimizing fire spread.
- Increasing safety levels for personnel and property.

BS 8492 details the relationship between its recommendations, the usage of premises, and fire protection measures. It is applicable to certain hazardous environments, but it does not exclude additional requirements that are applicable in particular circumstances (e.g., electrified railways, petrochemical sites, intrinsically safe areas, explosive ordnance storage facilities [bomb dumps]).

NOTE: Annex A of BS 8492 considers the fire hazard posed by the installation of telecommunications equipment and telecommunications cabling infrastructure within premises.

United Kingdom (UK) Codes and Standards, continued

Department for Business, Energy, and Industrial Strategy—Office for Product Safety and Standards

This is a UK government agency responsible for implementing EU safety regulations applicable to electrical equipment safety and electromagnetic compatibility. These include:

- *Electrical Equipment (Safety) Regulations: Guidance*.
- *Electromagnetic Compatibility Regulations: Guidance*.

Office of Public Sector Information (OPSI)

Operated as a part of the UK National Archives, OPSI serves as the central administrator of government legislation, regulations, and similar information. The OPSI publishes *Electricity at Work Regulations*.

United States (U.S.) Codes and Standards

Administrative Council for Terminal Attachment (ACTA)

The ACTA is an open organization established to:

- Adopt technical criteria and to act as the clearinghouse, publishing technical criteria for ICT terminal equipment connected to AP/SP networks as developed by ANSI-accredited standards development organization.
- Create and maintain a registration database of equipment approved as compliant with the technical criteria.

The ACTA has been designated by the FCC as the organization tasked with implementing Part 68 requirements concerning connection of customer-owned ICT equipment to the Public Switched Telephone Network, by utilizing TIA and ATIS standards, specifically TIA-168, TIA 968, TIA-1096, and ATIS T1.TR-05.

NOTE: Refer to the TIA and ATIS sections in this handbook for further details on these standards.

Alliance for Telecommunications Industry Solutions (ATIS)

ATIS develops standards in areas such as cloud services, device solutions, machine-to-machine communications, cyber security, health, network evolution and interfaces, quality of service, billing support, and operations, including the following:

- ANSI/ATIS 0600001, *Electrical Protection Standards and Reference Documents Associated with Telecommunication Networks.*
- ATIS 060003.01, *Network and Customer Installation Interfaces (ISDN)–Primary Rate Layer 1 Electrical Interfaces Specification.*
- ATIS 0600003, *Battery Enclosure and Rooms/Areas.*
- ATIS 0600010, *Temperature, Humidity, and Altitude Requirements for Information and Communications Technology (ICT) Equipment Utilized in Controlled Environmental Spaces.*
- ATIS 0600010.01, *Temperature, Humidity, Altitude, and Salt Fog Requirements for Information and Communications Technology (ICT) Equipment Utilized in Outside Plant Environments.*
- ATIS 0600012, *Electrical Protection Considerations for Broadband Systems.*
- ATIS 0600012.02, *Electrical Protection for Ethernet Systems.*
- ATIS 0600012.05, *Electrical Protection for Ethernet Systems.*
- ATIS 0600012.06, *Electrical Protection for Ethernet Radio Systems.*
- ATIS 0600013, *Electromagnetic Compatibility (EMC) and Electrical Protection.*
- ATIS 0600017, *Non-Halogenated DC Power Wire and Cable for Telecommunications Power Systems.*
- ATIS 0600028, *DC Power Wire and Cable for Telecommunications Power Systems–for XHHW and DLO/Halogenated RHW-RHH Cable Types.*
- ATIS 0600029, *Standard for Irreversible Compression Lugs, Inline Splices, and Taps.*

United States (U.S.) Codes and Standards, continued

- ATIS 0600030, *Line-Powering of Telecommunications Equipment on Outside Plant (OSP) Copper Twisted Pair Loops.*
- ATIS 0600076*, Numbering and Dialing Plan within the United States.*
- ATIS 0600216, *Integrated Services Digital Network (ISDN) Management–Basic Rate Physical Layer.*
- ATIS 0600217, *Integrated Service Digital Network (ISDN) Management–Primary Rate Physical Layer.*
- ATIS 0600307, *Fire Resistance Criteria–Ignitability Requirements for Equipment Assemblies, Ancillary Non-Metallic Apparatus, and Fire Spread Requirements for Wire and Cable.*
- ATIS 0600311, *Telecommunications–DC Power Systems–Telecommunications Environment Protection.*
- ATIS 0600313, *Electrical Protection for Telecommunications Central Offices and Similar Type Facilities*.
- ATIS 0600315, *Voltage Levels for DC-Powered Equipment Used in the Telecommunications Environment.*
- ATIS 0600316, *Electrical Protection of Telecommunications Outside Plant.*
- ATIS 0600318, *Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings.*
- ATIS 0600329, *Network Equipment–Earthquake Resistance.*
- ATIS 0600330, *Valve-Regulated Lead-Acid Batteries Used in the Telecommunications Environment.*
- ATIS 0600332, *Electrical Protection of Network-Powered Broadband Facilities.*
- ATIS 0600333, *Grounding and Bonding of Telecommunications Equipment.*
- ATIS 0600334, *Electrical Protection of Communications Towers and Associated Structures.*
- ATIS 0600337, *Requirements for Maximum Voltage, Current, and Power Levels Used in Communications Circuits.*
- ATIS 0600338, *Electrical Coordination of Primary and Secondary Surge Protection for Use in Telecommunications Circuits.*
- ATIS 0600401, *Network to Customer Installation Interfaces–Analog Voice Grade Switched Access Lines Using Loop-Start and Ground-Start Signaling.*
- ATIS 0600404, *Network and Customer Installation Interfaces–DS3 and Metallic Interface Specification.*
- ATIS 0600405, *Network-to-Customer Installation Interfaces–Direct Inward Dialing Analog Voice Grade Switched Access Using Loop Reverse-Battery Signaling.*
- ATIS 0600409, *Network-to-Customer Installation Interfaces–Analog Voice Grade Special Access Lines Using E&M Signaling.*
- ATIS 0600413, *Network to Customer Installation–Asymmetric Digital Subscriber Line (ADSL) Metallic Interface.*
- ATIS 0600605, *Integrated Services Digital Network (ISDN) Basic Access Interface for S and T Reference Points (Layer 1 Specification)*.

United States (U.S.) Codes and Standards, continued

- ATIS 1000640, *Broadband ISDN Network Node Interfaces and Inter-Network Interfaces–Rates and Formats Specifications.*
- ATIS 1000646, *Broadband ISDN–Physical Later Specification for User-Network Interfaces Including DS1/ATM.*
- ATIS T1.TR-05, *Network and Customer Installation Interface Connector Wiring Configuration Catalog.*

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO represents highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system. AASHTO develops technical standards for all phases of highway system development. Standards are issued for design, construction of highways and bridges, materials, and many other technical areas.

A relevant ICT publication concerning OSP MH and HH and associated component (e.g., frames, covers) traffic loading requirements is AASHTO M 306-10, *Standard Specification for Drainage, Sewer, Utility and Related Castings.*

American Institute of Architects (AIA)

The AIA is a professional membership association for licensed architects, emerging professionals, and allied partners. Their publications that relate to project and construction management include:

- A101, *Standard Form of Agreement Between Owner and Contractor.*
- A201, *General Conditions of the Contract for Construction.*
- C401, *Architect-Consultant Agreement.*

American Ladder Institute (ALI)

ALI is the ANSI approved developer of ladder safety standards. Some standards applicable to ICT work include:

- A14.2, *Portable Metal Ladders*.
- A14.7, *Safety Requirements for Mobile Ladder Stands and Mobile Ladder Stand Platforms*.

American National Standards Institute (ANSI)

ANSI is a private, nonprofit organization that serves as the administrator and coordinator of the United States' private sector voluntary standardization system. ANSI's mission is to promote and facilitate voluntary consensus standards and conformity assessment systems.

Although ANSI did develop standards in the past, some of which are still in effect, currently it does not develop new or revised standards. ANSI now provides a forum for numerous ANSI-accredited standards developers. A standard that has been adopted as an American National Standard typically has "ANSI" within the standard's designation.

United States (U.S.) Codes and Standards, continued

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

ASHRAE publishes standards that cover general mechanical topics such as terms, definitions, ratings, measurements, thermal performance, and energy conservation. ASHRAE also publishes standards covering specific mechanical items such as air-conditioning equipment, condensers and compressors, airflow (outlets/inlets), refrigerants, heat pumps, solar collectors, refrigerators and freezers, positive displacement condensing units, liquid coolers, mechanical refrigeration installations on shipboard, automatic ice makers, proportion of oil in liquid refrigerants, fluid flow measurement of gases, floc point of refrigeration grade oils, and energy conservation.

Some standards and other documents applicable to ICT include:

- ASHRAE 90430, *Liquid Cooling Guidelines for Datacom Equipment Centers.*
- ASHRAE 90441, *High Density Data Centers Case Studies and Best Practices.*
- ASHRAE 90445, *Design Considerations for Datacom Equipment Centers.*
- ASHRAE 90447, *Best Practices for Datacom Facility Energy Efficiency*.
- ASHRAE 90451*, Datacom Equipment Power Trends and Cooling Applications.*
- ASHRAE 90454, *IT Equipment Power Trends.*
- ASHRAE 90462, *IT Equipment Design Impact on Data Center Solutions.*
- ASHRAE 90554, *Green Tips for Data Centers.*
- ASHRAE 90577, *Thermal Guidelines for Data Processing Environments.*
- ASHRAE Guideline 13, *Specifying Building Automation Systems.*
- ASHRAE Handbook, *HVAC Applications.*
- ASHRAE STD 135*, BACnet–A Data Communication Protocol for Building Automation and Control Networks Best Practices for Datacom Facility Energy Efficiency*.
- *Design Considerations for Datacom Equipment Centers*.
- *Thermal Guidelines for Data Processing Environments*.

American Society of Mechanical Engineers (ASME)

ASME is the leading international developer of codes and standards associated with the practice of mechanical engineering. The code applicable to ICT is:

- ASME 17.1, *Safety Code for Elevators and Escalators*.

American Society of Safety Professionals (ASSP)

ASSP is a global association for occupational safety and health professionals. A standard applicable to ICT work is:

- ASSP A1264.1, *Safety Requirements for Workplace Walking/ Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems*.

United States (U.S.) Codes and Standards, continued

Americans with Disabilities Act (ADA)

The ADA as it relates to telecommunications is covered in:

- Title IV: Telecommunications in the *Telecommunications Act*, which covers the functionality of devices for hearing and speech impaired individuals.
- Section 4.31: Telephones in the Americans with Disabilities Act (ADA) Accessibility Guidelines (ADAAG). "Accessibility Guidelines for Buildings and Facilities" covers accessibility to telephones and communications devices by the physically impaired.

Additionally, as stated in Section 255 of the *Telecommunications Act*, the industry is obligated to ensure accessibility and usability.

The overall governing laws and regulations are:

- Title 47, Chapter 5, United States Code, *Americans with Disabilities Act* (*ADA*) of 1990, Public Law 101-336.
- ADA *Amendment Act of 2008*.
- *2010 ADA Standards for Accessible Design*.

Under the authority of the ADA, an independent federal agency, the Architectural and Transportation Barriers Compliance Board (Access Board) is responsible for developing and maintaining design criteria for the built environment, transit vehicles, telecommunications equipment, and for electronic and information technology. The following Access Board publications are applicable to ICT:

- *Information and Communication Technology (ICT) Standards and Guidelines.*

Association for Professionals in Infection Control and Epidemiology (APIC)

APIC is the leading professional association for infection preventionists. Their publications include the *Infection Prevention Manual for Construction & Renovation.*

ASTM International

ASTM International publishes standardized testing methods in categories including metals, construction, paints, petroleum products, plastics, textiles, rubber and electric insulating materials, and general test methods. Some of the standards applicable to the telecommunications industry include:

- ASTM B258, *Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors.*
- ASTM D2239, *Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.*
- ASTM D2863, *Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).*
- ASTM D3035, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter*.

United States (U.S.) Codes and Standards, continued

- ASTM D4565, *Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.*
- ASTM D4566, *Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.*
- ASTM D4730*, Standard Specification for Flooding Compounds for Telecommunications Wire and Cable.*
- ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials.*
- ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials.*
- ASTM E814, *Standard Test Methods for Fire Tests of Through-Penetration Firestops.*
- ASTM E1399/E1399M, *Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.*
- ASTM E1966, *Standard Test Method for Fire-Resistive Joint Systems.*
- ASTM E2226, *Standard Practice for Application of Hose Stream.*
- ASTM E2307, *Standard Test Method for Determining the Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate Scale Multi-Story Test Apparatus.*
- ASTM F512, *Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation*.
- ASTM F1446, *Standard Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear*
- ASTM F2412, *Standard Test Methods for Foot Protection.*
- ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*.

Construction Specifications Institute (CSI)

CSI is a national association of volunteers, including specifiers, architects, engineers, contractors, facility managers, product representatives, manufacturers, owners, and others who are experts in building construction and the materials used therein. The CSI produces the following publications:

- *MasterFormat*™: *MasterFormat* is the master list of titles and numbers used to organize specifications and other project information for most commercial building design and construction projects in North America. It lists titles and section numbers for organizing data about construction requirements, products, and activities. By standardizing such information, *MasterFormat* facilitates communication among architects, specifiers, contractors, and suppliers, which helps them meet building owners' requirements, timelines, and budgets.
- *SectionFormat*™ and *PageFormat*™: *SectionFormat* provides a uniform standard for arranging specification text in a project manual's sections using a three-part format. It reduces the chance of omissions or duplications in a specification section. *PageFormat* offers a recommended arrangement of text on a specification page within a project manual by providing a framework for consistently formatting and designating articles, paragraphs, and subparagraphs. It also includes guidance for page numbers and margins.

United States (U.S.) Codes and Standards, continued

Electronic Components Industry Association (ECIA)

The ECIA produces standards for items such as passive and active electronic components, component arrays and assemblies, and commercial and industrial electronic equipment and supplies.

The ECIA produces EIA/ECA-310, *Cabinets, Rack, Panels and Associated Equipment.*

Facility Guidelines Institute (FGI)

The FGI is an independent, not-for-profit organization dedicated to developing guidance for the planning, design, and construction of hospitals, outpatient facilities, and residential health, care, and support facilities.

The FGI publishes the following documents:

- *Guidelines for Design and Construction of Hospitals.*
- *Guidelines for Design and Construction of Outpatient Facilities.*
- *Guidelines for Design and Construction of Residential Health, Care, and Support Facilities.*

United States (U.S.) Codes and Standards, continued

Federal Communications Commission (FCC)

At the federal level in the United States, the FCC publishes numerous reports and orders that deal with specific issues, some of which are listed in this handbook. Table 3 lists important FCC documents.

Table 3
Federal Communications Commission (FCC) documents

Document	Subject Matter
CC Docket 88-57	Defines the location of the demarcation point. The third report and order (99-405) established category 3 UTP as the minimum cable standard for simple premises cabling.
CC Docket 99-216	*The Privatization and Streamlining of Part 68 of the Commission's Rules*. Effective July 23, 2001, the ACTA assumed operational responsibility for Part 68. The ACTA was established to assume relevant responsibilities privatized by the FCC.
Fact Sheet ICB-FC-011	Connection of 1- and 2-line terminal equipment to the telephone network and installation of premises cabling. FCC Part 15 *Radiated Emission Limits* (revised 1998) addresses electromagnetic radiation.
47CFR68	*Connection of Terminal Equipment to the Telephone Network* (1998) provides regulations for connecting premises cabling and customer-provided equipment to the regulated networks NOTE: As stated above, the ACTA has assumed operational responsibility for Part 68 implementation. Refer to the ACTA section in this handbook for further details on this organization.
47CFR76	Multichannel Video and Cable Television Service
47CFR76.605	Technical Standards
Telecommunications Act, 1996	Established new rules for provisioning and competition in telecommunications services
FCC 18-111	*Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment* establishes new rules and procedures for ICT attachments to existing utility poles and structures, commonly known as "One Touch Make Ready"

United States (U.S.) Codes and Standards, continued

Fiber Optic Association (FOA)

The FOA is a nonprofit organization that provides education, certification, networking, and information relevant to optical fiber technology.

Publications of note include:

- *FOA Outside Plant Construction Guide.*
- *FOA Reference Guide to Fiber Optic Network Design.*
- *FOA Reference Guide to Fiber Optic Testing.*
- *FOA Reference Guide to Fiber Optics.*
- *FOA Reference Guide to Outside Plant Fiber Optics.*
- *FOA Reference Guide to Premises Cabling.*

IEEE®

National Electrical Safety Code® (NESC®)

Published by the IEEE, the *NESC* IEEE C2 is an important document for safeguarding persons against electrical hazards during the installation, operation, and maintenance of electric supply and communication lines. The document contains extensive updates and critical revisions that directly impact the power utility industry.

Adopted into law by the majority of states through their Public Service Commissions or similar bodies across the United States, the *NESC* is a performance code that is considered the authoritative source on sound electrical engineering practices.

The *NESC* covers basic provisions for the safeguarding of persons from the hazards arising from the installation, operation, or maintenance of OSP overhead and underground electrical supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communication lines and equipment.

The code is typically applicable to those systems and the equipment operated by utilities or similar systems and equipment of an industrial complex under the control of qualified persons. The *NESC* is also applicable to privately owned or operated complexes. This can include campus environments such as hospitals, college campuses, or industrial complexes.

The *NESC* parts, sections, and rules applicable to telecommunications distribution requirements are listed in Table 4.

United States (U.S.) Codes and Standards, continued

Table 4
National Electrical Safety Code® (*NESC*®) parts, sections, and rules applicable to ICT/communications distribution requirements

NESC® Reference	Title
Section 1	Introduction to the *NESC*®
Section 2	Definitions of special terms
Section 3	References
Section 9	Grounding Methods for Electric Supply and Communications Facilities
Part 2	Safety Rules for the Installation and Maintenance of Overhead Electric Supply and Communication Lines
Section 20	Purpose, Scope, and Application of Rules
Section 21	General Requirements
Rule 215	Grounding of Circuits, Supporting Structures, and Equipment
Rule 217	General
Section 22	Relations Between Various Classes of Lines and Equipment
Rule 222	Joint Use of Structures
Rule 223	Communications Protective Requirements
Rule 224	Communication Circuits Located Within the Supply Space and Supply Circuits Located Within the Communication Space
Section 23	Clearances
Rule 230	General
Rule 230F	Fiber-Optic Cable
Rule 231	Clearances of Supporting Structures from Other Objects
Rule 232	Vertical Clearance of Wires, Conductors, Cables, and Equipment Above Ground, Roadway, Rail, or Water Surfaces
Rule 233	Clearances Between Wires, Conductors, and Cables Carried on Different Supporting Structures
Rule 234	Clearance of Wires, Conductors, Cables, and Equipment from Buildings, Bridges, Rail Cars, Swimming Pools, and Other Installations
Rule 235	Clearance for Wires, Conductors, or Cables Carried on the Same Supporting Structure
Rule 236	Climbing Space
Rule 237	Working Space
Rule 238	Vertical Clearance Between Certain Communications and Supply Facilities Located on the Same Structure
Rule 239	Clearances of Vertical and Lateral Facilities From Other Facilities and Surfaces on the Same Supporting Structure
Rule 239F	Requirements for Vertical and Lateral Communication Conductors on Communication Line Structures or Within the Communication Space on Jointly Used Structures

United States (U.S.) Codes and Standards, continued

Table 4, continued
National Electrical Safety Code® (*NESC*®) parts, sections, and rules applicable to ICT/communications distribution requirements

NESC® Reference	Title
Rule 239G	Requirements for Vertical Supply Conductors and Cables Passing Through Communications Space on Jointly Used Structures
Rule 239H	Requirements for Vertical Communication Conductors Passing Through Supply Space on Jointly Used Structures
Section 24	Grades of Construction
Section 25	Loadings for Grades B and C
Section 26	Strength Requirements
Part 3	Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines
Section 31	General Requirements Applying to Underground Lines
Section 32	Underground Conduit Systems
Section 34	Cable in Underground Structures
Section 35	Direct-Buried Cable and Cable in Duct Not Part of a Conduit System
Section 38	Equipment
Section 39	Installation in Tunnels
Part 4	Work Rules for the Operation of Electric Supply and Communication Lines and Equipment
Section 40	Purpose and Scope
Section 41	Supply and Communications Systems-Rules for Employees
Section 42	General Rules for Employees
Section 43	Additional Rules for Communications Employees

United States (U.S.) Codes and Standards, continued

Illumination Engineering Society of North America (IES)

IES publishes standards related to lighting and illumination of spaces and areas. Their documents and standards include:

- ANSI/IES RP-1, *American National Standard Practice for Office Lighting*.
- IES LEM-3, *Upgrading Lighting Systems in Commercial and Institutional Spaces*.

Insulated Cable Engineers Association (ICEA)

ICEA is a wire and cable manufacturers' organization that provides telecommunications specifications for the telephone and electrical power industries.

ICEA publications are adopted in the public interest and assist users in selecting and obtaining proper products for their particular need.

ICEA standards of interest are:

- ANSI/ICEA P-61-694, *Coding Guide for Copper Outside Plant and Riser Telecommunications Cables.*
- ANSI/ICEA P-79-561*, Guide for Selecting Aerial Cable Messengers and Lashing Wires.*
- ANSI/ICEA S-83-596, *Fiber Optic Premises Distribution Cables*.
- ANSI/ICEA S-84-608, *Standard for Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor Technical Requirements.*
- ANSI/ICEA S-85-625, *Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements*.
- ANSI/ICEA S-86-634, *Standard for Buried Telecommunications Wire-Filled, Polyolefin Insulated, Copper Conductor Technical Requirements.*
- ANSI/ICEA S-87-640, *Standard for Optical Fiber Outside Plant Communications Cable.*
- ANSI/ICEA S-89-648, *Standard for Telecommunications Aerial Service Wire Technical Requirements.*
- ANSI/ICEA S-90-661, *Standard for Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems Technical Requirements.*
- ANSI/ICEA S-91-674, *Standard for Coaxial and Coaxial/Twisted-Pair Composite Buried Service Wires Technical Requirements.*
- ANS/ICEA S-92-675, *Standard for Coaxial & Coaxial/Twisted Pair Composite Aerial Service Wires Technical Requirements.*
- ANSI/ICEA S-98-688, *Standard for Broadband Twisted-Pair Cable, Aircore, Polyolefin Insulated Copper Conductors Technical Requirements*.
- ANSI/ICEA S-99-689, *Standard for Broadband Twisted-Pair, Cable Filled, Polyolefin Insulated Copper Conductors Technical Requirements*.

United States (U.S.) Codes and Standards, continued

- ANSI/ICEA S-100-685, *Standard for Thermoplastic Insulated and Jacketed Telecommunications Station Wire for Indoor/Outdoor Use.*
- ANSI/ICEA S-101-699, *Standard for Category 3 Individually Unshielded Twisted Pair Indoor Cable for use in General Purpose Non-LAN Telecommunication Wiring Systems Technical Requirements.*
- ANSI/ICEA S-103-701*, Riser Cables Technical Requirements.*
- ANSI/ICEA S-104-696, *Standard for Indoor-Outdoor Optical Fiber Cable.*
- ANSI/ICEA S-106-703, *Standard for Broadband Aerial Service Wire, Aircore, Polyolefin Insulated, Copper Conductor.*
- ANSI/ICEA S-107-704, *Standard for Broadband Buried Service Wire Filled, Polyolefin Insulated, Copper Conductors Technical Requirements.*
- ANSI/ICEA S-109-709, *Standard for Distribution Frame Wire Technical Requirements*.
- ANSI/ICEA S-110-717, *Standard for Optical Fiber Drop Cable*.
- ANSI/ICEA S-112-718, *Standard for Optical Fiber Cable for Placement in Sewer Environments.*
- ANSI/ICEA S-115-730, *Standard for Flame-Retardant Compact or Rugged Optical Drop Cables.*
- ANSI/ICEA S-116-732/NEMA WC66, *Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in LAN Communications Wiring Systems.*
- ANSI/ICEAS-119-741, *Standard for Fiber to the Antenna (FTTA) Optical Fiber Cable.*
- ANSI/ICEAS-120-742, *Standard for Hybrid Optical Fiber and Power Cable for use in Limited Power Circuits.*
- ANSI/ICEAS-122-744, *Standard for Optical Fiber Outside Plant Microduct Cables*.

International Association of Electrical Inspectors (IAEI)

IAEI is a core leader in the electrical industry and actively promotes safe products and safe installations. Active members and partners in the association include many diverse groups, including electrical inspectors, testing agencies, standards organizations, manufacturers, distributors, installers and contractors. Guidebooks of interest include:

- *Soares Book on Grounding and Bonding.*
- *Hazardous Locations.*
- *Photovoltaic Power Systems.*

United States (U.S.) Codes and Standards, continued

International Committee for Information Technology Standards (INCITS)

The INCITS is the primary U.S. organization focusing on standardization in the field of IT encompassing storage, processing, transfer, display, management, organization, and retrieval of information.

INCITS also serves as ANSI's Technical Advisory Group for ISO/IEC JTC 1. JTC 1 is responsible for international standardization in the IT field. Some specific standards include:

- INCITS 256, *Radio Frequency Identification (RFID).*
- INCITS 543, *Information Technology–Fibre Channel–Physical Interfaces*.
- INCITS 565, *Information Technology–Next Generation Access Control (NGAC).*

National Electrical Contractors Association (NECA)

NECA develops and produces national installation standards. Standards of interest are:

- ANSI/FOA/NECA 301, *Standard for Installing and Testing Fiber Optics.*
- NECA NEIS 1, *Standard for Good Workmanship in Electrical Construction.*
- NECA NEIS 100, *Symbols for Electrical Construction Drawings.*
- NECA NEIS 101, *Standard for Installing Steel Conduits (Rigid, IMC, EMT).*
- NECA NEIS 105, *Standard for Installing Metal Cable Tray Systems.*
- NECA NEIS 111, *Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).*
- NECA NEIS 303, *Standard for Installing Closed-Circuit Television (CCTV) Systems.*
- NECA NEIS 305, *Standard for Fire Alarm System Job Practices.*
- NECA NEIS 411, *Standard for Installing and Maintaining Uninterruptible Power Supplies (UPS).*
- NECA NEIS 605, *Recommended Practice for Installing Underground Nonmetallic Utility Duct.*

United States (U.S.) Codes and Standards, continued

National Electrical Manufacturers Association (NEMA)

NEMA is the association of electrical equipment manufacturers. Its member companies manufacture a diverse set of products, including power transmission and distribution equipment, lighting systems, factory automation and control systems, and medical diagnostic imaging systems.

Applicable standards include:

- ANSI/NEMA C80.1, *Electrical Rigid Steel Conduit (ERSC).*
- ANSI/NEMA C80.3, *Steel Electrical Metallic Tubing-Steel (EMT-S).*
- ANSI/NEMA C84.1, *Electric Power Systems and Equipment–Voltage Ratings (60 Hz)*.
- NEMA 250, *Enclosures for Electrical Equipment (1000 V Maximum)*.
- NEMA CTTC P1, *Cable Ties and Fixing Devices for Electrical Installations–Type Classification Guide.*
- NEMA FB 1*, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.*
- NEMA FB 2.10, *Selection and Installation Guidelines for Fittings for Use With Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing).*
- NEMA FB 2.40, *Installation Guidelines for Expansion and Expansion/Deflection Fittings.*
- NEMA FG1, *Fiberglass Cable Tray Systems*.
- NEMA OS1, *Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.*
- NEMA OS2, *Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.*
- NEMA PE 1*, Uninterruptible Power Systems (UPS)–Specification and Performance Verification.*
- NEMA PRP 5, *Installation Guidelines for Surface Nonmetallic Raceway.*
- NEMA TC 2, *Electrical Polyvinyl Chloride (PVC) Conduit.*
- NEMA TC 3, *Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.*
- NEMA TC 6 & 8, *Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations.*
- NEMA TC 7, *Smooth-Wall Coilable Electrical Polyethylene Conduit.*
- NEMA TC 9*, Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.*
- NEMA TC 13*, Electrical Nonmetallic Tubing (ENT).*
- NEMA TC 14 series*, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.*
- NEMA TCB 2, *Guidelines for the Selection and Installation of Underground Nonmetallic Raceways*.
- NEMA VE 1, *Metal Cable Tray Systems.*
- NEMA VE 2, *Cable Tray Installation Guidelines.*
- NEMA WD6, *Wiring Devices–Dimensional Specifications.*

United States (U.S.) Codes and Standards, continued

National Fire Protection Association® (NFPA®)

The NFPA® develops and produces fire and safety standards and codes. The following codes and standards are associated with telecommunications:

- NFPA 10, *Standard for Portable Fire Extinguishers.*
- NFPA 70®, *National Electrical Code®* (*NEC*).
- NFPA 70E®, *Standard for Electrical Safety in the Workplace®*.
- NFPA 72®, *National Fire Alarm and Signaling Code®*.
- NFPA 75, *Standard for the Protection of Information Technology Equipment*.
- NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*.
- NFPA 99, *Standard for Health Care Facilities*.
- NFPA 101®, *Life Safety Code®*.
- NFPA 110, *Standard for Emergency and Standby Power Systems.*
- NFPA 130, *Standard for Fixed-Guideway Transit and Passenger Rail Systems*.
- NFPA 241, *Standard for Safeguarding Construction, Alteration and Demolition Operations*.
- NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.*
- NFPA 350, *Guide for Safe Confined Space Entry and Work.*
- NFPA 502, *Standard for Road Tunnels, Bridges and Other Limited-Access Highways*.
- NFPA 520, *Standard on Subterranean Spaces*.
- NFPA 730, *Guide for Premises Security.*
- NFPA 731, *Standard for the Installation of Electronic Premises Security Systems*.
- NFPA 780, *Standard for the Installation of Lightning Protection Systems*.
- NFPA 1221, *Standard for the Installation, Maintenance and Use of Emergency Communications Systems*.

United States (U.S.) Codes and Standards, continued

NFPA 70® *National Electrical Code®* (*NEC®*)

The NFPA sponsors, controls, and publishes the *NEC* within the U.S. jurisdictional area. The *NEC* is intended to protect people and property from electrical hazards. The *NEC* specifies minimum provisions necessary to safeguard persons and property from electrical hazards.

In the United States, most federal, state, and local municipalities have adopted the *NEC*, in whole or in part, as their legal electrical code. Some states or localities adopt the *NEC* and add more stringent requirements. Local jurisdiction determines the current edition recognized and does not always adopt the latest edition.

The *NEC*, which is revised every three years, is used by:

- Electrical and ICT contractors, electricians, and ICT installers to ensure code compliant installations.
- Architectural, engineering, and design organizations to design code compliant systems.
- Fire marshals and electrical inspectors in loss prevention and safety enforcement.
- Attorneys and insurance companies to determine liability.

In buildings that will contain the telecommunications systems, the *NEC* requirements do not address the electrical environment for reliable and error-free operation of the installed equipment. Additional considerations beyond those necessary for safety are described in performance standards.

The following list of chapters, articles, and sections is not intended to be all-inclusive. They are a representation of those that may impact telecommunications installations. Read the code carefully and verify interpretations with local code enforcement officials since jurisdiction of codes is their responsibility.

The *NEC* allows Chapter 8: Communications Systems to be separate and independent of the other chapters and articles of the code unless specifically referenced within Chapter 8. Although not all of the articles and sections listed in Table 5 are referenced by Chapter 8, the information in these articles and sections apply to telecommunications.

United States (U.S.) Codes and Standards, continued

Table 5
National Electrical Code® (*NEC*®) articles and sections that impact telecommunications installation

NEC® Reference	Title
Article 90	Introduction
Section 90.1	Purpose
Section 90.2	Scope
Section 90.3	Code Arrangement
Section 90.4	Enforcement
Section 90.5	Mandatory Rules, Permissive Rules, and Explanatory Material
Section 90.7	Examination of Equipment for Safety
Section 90.8	Wiring Planning
Article 100	Definitions
Article 110	Requirements for Electrical Installations
Section 110.12	Mechanical Execution of Work
Section 110.26	Spaces About Electrical Equipment
Section 110.32	Work Space About Equipment
Section 110.33	Entrance to Enclosures and Access to Working Space
Section 110.34	Work Space and Guarding
Article 200	Use and Identification of Grounded Conductors
Article 210	Branch Circuits
Section 210.25	Branch Circuits in Buildings with More Than One Occupancy
Article 225	Outside Branch Circuits and Feeders
Section 225.14	Open-Conductor Spacings
Article 250	Grounding and Bonding
Section 250.32	Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s)
Section 250.50	Grounding Electrode System
Section 250.52	Grounding Electrodes
Section 250.53	Grounding Electrode System Installation
Section 250.60	Use of Strike Termination Devices
Section 250.70	Methods of Grounding and Bonding Conductor Connection to Electrodes
Section 250.104	Bonding of Piping Systems and Exposed Structural Steel
Article 280	Surge Arresters, Over 1 kV
Article 285	Surge-Protective Devices (SPDs), 1 kV or Less

United States (U.S.) Codes and Standards, continued

Table 5, continued
National Electrical Code® (*NEC*®) articles and sections that impact telecommunications installation

NEC® Reference	Title
Article 300	Wiring Methods
Section 300.1	Scope
Section 300.3	Conductors
Section 300.4	Protection Against Physical Damage
Section 300.11	Securing and Supporting
Section 300.21	Spread of Fire or Products of Combustion
Section 300.22	Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air and Other Spaces for Environmental Air (Plenums)
Article 310	Conductors for General Wiring
Article 314	Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures
Article 324	Flat Conductor Cable: Type FCC
Article 342	Intermediate Metal Conduit: Type IMC
Article 344	Rigid Metal Conduit: Type RMC
Article 348	Flexible Metal Conduit: Type FMC
Article 350	Liquidtight Flexible Metal Conduit: Type LFMC
Article 352	Rigid Polyvinyl Chloride Conduit: Type PVC
Article 356	Liquidtight Flexible Non-metallic Conduit: Type LFNC
Article 358	Electrical Metallic Tubing: Type EMT
Article 360	Flexible Metallic Tubing: Type FMT
Article 362	Electrical Non-metallic Tubing: Type ENT
Article 366	Auxiliary Gutters
Article 372	Cellular Concrete Floor Raceways
Article 374	Cellular Metal Floor Raceways
Article 376	Metal Wireways
Article 378	Non-metallic Wireways
Article 386	Surface Metal Raceways
Article 388	Surface Non-metallic Raceways
Article 390	Underfloor Raceways
Article 392	Cable Trays

United States (U.S.) Codes and Standards, continued

Table 5, continued
National Electrical Code® (*NEC*®) articles and sections that impact telecommunications installation

NEC® Reference	Title
Article 400	Flexible Cords and Cables
Article 500	Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2
Article 605	Office Furnishings (Consisting of Lighting Accessories and Wired Partitions)
Article 640	Audio Signal Processing, Amplification, and Reproduction Equipment
Article 645	Information Technology Equipment
Article 646	Modular Data Centers
Article 647	Sensitive Electronic Equipment
Article 701	Legally Required Standby Systems
Article 706	Energy Storage Systems
Article 720	Circuits and Equipment Operating at Less Than 50 Volts
Article 722	Cables for Power-Limited Circuits
Article 724	Class 1 Remote-Control, Signaling, and Power-Limited Circuits
Article 725	Class 2 and Class 3 Remote-Control, Signaling, and Power-Limited Circuits
Article 726	Class 4 Power Systems
Article 760	Fire Alarm Systems
Article 770	Optical Fiber Cables and Raceways
Article 800	General Requirements for Communications Systems
Article 805	Communications Circuits
Article 810	Radio and Television Equipment
Article 820	Community Antenna Television and Radio Distribution Systems
Article 830	Network-Powered Broadband Communications Systems
Article 840	Premises-Powered Broadband Communications Systems

United States (U.S.) Codes and Standards, continued

National Institute of Standards and Technology (NIST)

The NIST is part of the U.S. Department of Commerce. NIST develops standards and measurements for elements such as IT system security, smart electric power grids, electronic health records and atomic clocks. Although a set of national standards, NIST is followed and implemented in different countries all around the world. Below are related standards:

- SP 800-12, *An Introduction to Information Security.*
- SP 800-39, *Managing Information Security Risk: Organization, Mission, and Information System View.*
- SP-800-53*, Security and Privacy Controls for Information Systems and Organizations.*
- SP 800-63-3, *Digital Identity Guidelines.*
- SP 800-82, *Guide to Industrial Control Systems (ICS) Security.*
- SP 800-98, *Guidelines for Securing Radio Frequency Identification (RFID) Systems.*
- SP 800-160, *Systems Security Engineering.*
- SP 800-162, *Supply Chain Risk Management.*
- SP 800-171*, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations.*

Project Management Institute (PMI)

PMI is a nonprofit organization that advances the project management profession through globally recognized standards and certifications, collaborative communities, an extensive research program, and professional development opportunities. PMI publishes:

- ANSI/PMI 99-001, *A Guide to the Project Management Body of Knowledge (PMBOK Guide).*

Rural Utilities Service (RUS)

RUS is an agency of the U.S. Department of Agriculture's Rural Development Program, which provides documents and specifications for telecommunications cooperative access and service providers within rural areas of the United States.

Some key documents include:

- Bulletin 1751F-643, *Underground Plant Design*.
- Bulletin 1751F-644, *Underground Plant Construction.*
- Bulletin 1753F-150, *Specifications and Drawings for Construction of Direct Buried Plant*.
- Bulletin 1753F-151, *Specifications and Drawings for Construction of Underground Plant*.
- Bulletin 1753F-152*, Specifications and Drawings for Construction of Aerial Plant.*
- Bulletin 1753F-153, *Specification and Drawings for Service Installation at Customer Access Locations*.
- Bulletin 1753F-201, *Acceptance Tests and Measurements of Telecommunications Plant*.
- Bulletin 1753F-204, *Specification for Aerial Service Wires (PE-7).*
- Bulletin 1753F-205, *Specification for Filled Telephone Cables (PE-39)*.

United States (U.S.) Codes and Standards, continued

- Bulletin 1753F-206, *Specification for Filled Buried Wire (PE-86).*
- Bulletin 1753F-207, *Specifications for Terminating Cables (PE-87).*
- Bulletin 1753F-208, *Specification for Filled Telephone Cables with Expanded Insulation (PE-89).*
- Bulletin 1753F-302, *Specifications for Outside Plant Housings and Serving Area Interface System (PE-91).*
- Bulletin 1753F-401, *Standards for Splicing Copper and Fiber Optic Cable (PC-2).*
- Bulletin 1753F-601a, *Minimum Performance Specification for Fiber Optic Cables (For Backbone, Feeder, and Distribution Plant) (PE-90a).*
- Bulletin 1753F-601b, *Minimum Performance Specification for Fiber Optic Cables (Subscriber Drop Cables)*.
- Bulletin 1753F-801, *Service Installations at Customer Access Locations (PC-5A).*

Society of Cable Telecommunications Engineers (SCTE)

The SCTE produces documents and standards relating to broadband telecommunications cable systems. Some important standards are:

- ANSI/SCTE 03, *Test Method for Coaxial Cable Structural Return Loss*.
- ANSI/SCTE 04, *Test Method for "F" Connector Return Loss*.
- ANSI/SCTE 05, *Test Method for "F" Connector Return Loss In-Line Pair*.
- ANSI/SCTE 07, *Digital Transmission Standard for Cable Television.*
- ANSI/SCTE 15, *Specification for Trunk, Feeder, and Distribution Coaxial Cable*.
- ANSI/SCTE 32, *Ampacity of Coaxial Telecommunications Cable.*
- ANSI/SCTE 44, *Test Method for DC Loop Resistance.*
- ANSI/SCTE 47, *Test Method for Coaxial Cable Attenuation*.
- ANSI/SCTE 49, *Test Method for Velocity of Propagation*.
- ANSI/SCTE 66, *Test Method for Coaxial Cable Impedance*.
- ANSI/SCTE 71, *Specification for Braided, 75–Coaxial, Multi-Purpose Cable*.
- ANSI/SCTE 74, *Specification for Braided 75–Flexible RF Coaxial Drop Cable*.
- ANSI/SCTE 77, *Specification for Underground Enclosure Integrity.*
- ANSI/SCTE 87, *Graphic Symbols for Cable Systems.*
- ANSI/SCTE 96, *Cable Telecommunications Testing Guidelines.*
- ANSI/SCTE 122, *SCTE Recommended Optical Fiber Cable Types for Outside Plant Drop Applications.*
- ANSI/SCTE 134, *Fusion Splicing Equipment and Applications for the Cable/Broadband Industry.*
- ANSI/SCTE 144, *Test Procedure for Measuring Transmission and Reflection*.
- ANSI/SCTE 171, *Passive Network Device (NID) Enclosure Specification.*
- ANSI/SCTE 174, *Radio Frequency over Glass Fiber-to-the-Home Specification*.

United States (U.S.) Codes and Standards, continued

- ANSI/SCTE 186, *Product Physical, Environmental, Electrical, Sustainability, and Quality Requirements for Cable Telecommunications.*
- ANSI/SCTE 210, *Performance Metrics for Energy Efficiency & Functional Density of Cable Data Generation, Storage, Routing, and Transport Equipment*.
- ANSI/SCTE 213, *Edge and Core Facilities Energy Metrics*.
- ANSI/SCTE 230, *Recommended Practice for Proper Handling of Audio-Video Synchronization in Cable Systems*.
- ANSI/SCTE 234, *ISO 50001:2011 Energy Management Systems, Energy Metrics, With Guidance for Use*.
- SCTE 86, *SCTE Recommended Optical Fiber Cable Types for Outside Plant Trunk and Distribution Applications.*
- SCTE 184, *SCTE Energy Management Operational Practices for Cable Facilities*.
- SCTE 205, *Outside Plant Power Recommended Preventive Maintenance Procedure*.
- SCTE 229, *Operational Practice for Cable Facility Design Process*.
- SCTE 238, *Operational Practice for Measuring and Baselining Power Consumption in Outside Plant Equipment and Power Supplies*.
- SCTE 241, *Key Performance Metrics: Energy Efficiency & Functional Density of Wi-Fi Infrastructure Equipment*.
- SCTE 246, *Best Practices in Photovoltaic System Operations and Maintenance for Cable System Operator.*
- SCTE/ISBE 180, *Recommended Practices for Coaxial Cable Construction & Test.*
- SCTE/ISBE 181, *Recommended Practices for Optical Fiber Construction and Testing.*

Telecommunications Industry Association (TIA)

TIA is accredited by ANSI to develop voluntary industry standards for a wide variety of telecommunications products. The TIA Standards Program has five divisions:

- Fiber Optics.
- User Premises Equipment.
- Network.
- Wireless Communications.
- Satellite Communications.

TIA produces several documents and standards for numerous ICT elements. The most notable TIA documents and standards are:

- ANSI/TIA-168, *Telecommunications Telephone Terminal Equipment Labeling Requirements.*
- ANSI/TIA-232, *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*.
- ANSI/TIA-322*, Loading, Analysis, and Design Criteria Related to the Installation, Alteration and Maintenance of Communication Structures.*

United States (U.S.) Codes and Standards, continued

- ANSI/TIA-422, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits.*
- ANSI/TIA-423, *Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits.*
- ANSI/TIA-440*, Fiber Optic Terminology.*
- ANSI/TIA-455*, Generic Requirements for Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.*
- ANSI/TIA-455 series xxx, *Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.*
- ANSI/TIA-485, *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.*
- ANSI/TIA-492 series xxxx, *Specifications for Optical Waveguide Fibers*.
- ANSI/TIA-526 series xx, *Standard Test Procedures for Fiber Optic Systems.*
- ANSI/TIA-559, *Single-Mode Fiber Optic System Transmission Design.*
- ANSI/TIA-568.0, *Generic Telecommunications Cabling for Customer Premises*.
- ANSI/TIA-568.1, *Commercial Building Telecommunications Cabling Standard*.
- ANSI/TIA-568.2, *Balanced Twisted-Pair Telecommunications Cabling and Components Standard.*
- ANSI/TIA-568.3, *Optical Fiber Cabling Components Standard*.
- ANSI/TIA-568.4, *Broadband Coaxial Cabling and Components Standard*.
- ANSI/TIA-569, *Telecommunications Pathways and Spaces*.
- ANSI/TIA-570, *Residential Telecommunications Infrastructure Standard*.
- ANSI/TIA-587, *Fiber Optic Graphic Symbols.*
- ANSI/TIA-590, *Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant.*
- ANSI/TIA-598, *Optical Fiber Cable Color Coding*.
- ANSI/TIA-604 series xx, *Fiber Optic Connector Intermateability Standards (FOCIS).*

United States (U.S.) Codes and Standards, continued

This standard includes the following connector types:

– TIA-604-2: Type ST.

– TIA-604-3: Type SC and SC-APC.

– TIA-604-4: Type FC and FC-APC.

– TIA-604-5: Type MPO.

– TIA/EIA-604-6: Fiber Jack Connector.

– TIA-604-7: Type SG.

– TIA-604-10: Type LC.

– TIA/EIA-604-12: Type MT-RJ.

– TIA-604-13: Type SFOC 1.25.

– TIA-604-15: Type MF.

– TIA-604-16: Type LSH.

– TIA-604-17: Type MU.

– TIA-604-18: Type MPO-16.

– TIA-604-19: Type CS.

- ANSI/TIA-606, *Administration Standard for Commercial Telecommunications Infrastructure*.
- ANSI/TIA-607, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*.
- ANSI/TIA-758, *Customer-Owned Outside Plant Telecommunications Infrastructure Standard.*
- ANSI/TIA-862, *Structured Cabling Infrastructure Standard for Intelligent Building Systems.*
- ANSI/TIA-942, *Telecommunications Infrastructure Standard for Data Centers*.
- ANSI/TIA-968, *Telecommunications Telephone Terminal Equipment Technical Requirements for Connection of Terminal Equipment to the Telephone Network.*
- ANSI/TIA-1003, *Telecommunications IP Telephony Equipment Requirements for a Wireless LAN Based IP Telephony Endpoint.*
- ANSI/TIA-1005, *Telecommunications Infrastructure Standard for Industrial Premises*.
- ANSI/TIA-1039, *QoS Signaling for IP QoS Support and Sender Authentication.*
- ANSI/TIA-1057, *Telecommunications IP Telephony Infrastructure Link Layer Discovery Protocol for Media Endpoint Devices.*
- ANSI/TIA-1096, *Telecommunications Telephone Terminal Equipment Connector Requirements for Connection of Terminal Equipment to the Telephone Network.*
- ANSI/TIA-1152, *Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.*
- ANSI/TIA-1179, *Healthcare Facility Telecommunications Infrastructure Standard*.
- ANSI/TIA-4966, *Telecommunications Infrastructure Standard for Educational Facilities*.

United States (U.S.) Codes and Standards, continued

- ANSI/TIA-4994, *Standard for Sustainable Information Communications Technology.*
- ANSI/TIA-5017, *Telecommunications Physical Network Security*.
- ANSI/TIA-5048, *Automated Infrastructure Management (AIM) Systems–Requirements, Data Exchange and Applications.*
- TIA TSB-19, *Optical Fiber Digital Transmission Systems Considerations for Users and Suppliers.*
- TIA TSB-116, *Telecommunications IP Telephony equipment Voice Quality Recommendations for IP Telephony.*
- TIA TSB-142, *Optical Return Loss Meters–Measurement and Application Issues.*
- TIA TSB-143, *Fiber Optic Power Meters–Measurement and Application Issues.*
- TIA TSB-149*, Generic Workmanship Guidelines for Fiber Optic Connector Interoperability.*
- TIA TSB-153, *Static Discharge Between LAN and Data Terminal Equipment.*
- TIA TSB-155, *Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T.*
- TIA TSB-162, *Telecommunications Cabling Guidelines for Wireless Access Points*.
- TIA TSB-172, *High Data Rate Multimode Fiber Transmission Techniques.*
- TIATSB-184, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling.*
- TIA TSB-185, *Environmental Classification (MICE) Tutorial*.
- TIA TSB-190, *Guidelines on Shared Pathways and Shared Sheaths*.
- TIA TSB-4940, *Smart Device Communications; Security Aspects.*
- TIA TSB-5018, *Structured Cabling Infrastructure Guidelines to Support Distributed Antenna Systems.*
- TIA TSB-5019, *High Performance Structured Cabling Use Cases for Data Centers and Other Premises.*
- TIA TSB-5021, *Guidelines for the Use of Installed Category 5e and Category 6 Cabling to Support 2.5GBASE-T and 5GBASE-T*.

Telcordia Technologies

Originally known as BELLCORE, Telcordia was formed to promote and define interoperability requirements among the service providers within the United States. To facilitate this functionality, Telcordia publishes GR (Generic Requirements), TR (Technical Reference) and SR (Special Report) documents. Some applicable documents include:

- GR-13-CORE, *Generic Requirements for Pedestal Terminal Closures.*
- GR-20-CORE, *Generic Requirements for Optical Fiber and Optical Fiber Cable*.
- GR-26-CORE, *Generic Requirements for Controlled Environmental Vaults (CEVS).*
- GR-43-CORE, *Generic Requirements for Telephone Huts.*
- GR-63-CORE, *NEBS Requirements: Physical Protection.*
- GR-110-CORE, *Thermoplastic Insulated Steam-Resistant Metallic Cable*.

United States (U.S.) Codes and Standards, continued

- GR-111-CORE, *Generic Requirements for Thermoplastic Insulated Riser Cable.*
- GR-115-CORE, *Generic Requirements for PIC Screened Cable (Filled, ASP Bonded, STALPETH, and Bonded PASP).*
- GR-126-CORE*, Generic Requirements for Network Outdoor Customer Premises, and Universal Cross-Connecting Wire.*
- GR-137-CORE, *Generic Requirements for Twisted-Pair Metallic Cable Products Used in Telecommunications Facilities.*
- GR-196-CORE*, Generic Requirements for Optical Time Domain Reflectometer (OTDR) Type Equipment.*
- GR-198-CORE, *Generic Requirements for Hand-Held Stabilized Light Sources, Optical Power Meters, Reflectance Meters, and Optical Loss Test Sets.*
- GR-326-CORE, *Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies.*
- GR-347-CORE, *Generic Requirements for Telecommunications Power Cable.*
- GR-356-CORE, *Generic Requirements for Optical Cable Innerduct, Associated Conduit and Accessories.*
- GR-409-CORE, *Generic Requirements for Indoor Fiber Optic Cable.*
- GR-421-CORE, *Generic Requirements for Metallic Telecommunications Cables*.
- GR-487-CORE, *Generic Requirements for Electronic Equipment Cabinets.*
- GR-492-CORE, *Generic Requirements for Metallic Telecommunications Wire*.
- GR-513-CORE, *Power Requirements in Telecommunications Plant.*
- GR-765-CORE*, Generic Requirements for Single Fiber Single Mode Optical Splices and Splicing Systems*.
- GR-771-CORE*, Generic Requirements for Fiber Optic Splice Closures.*
- GR-902-CORE, *Generic Requirements for Handholes and Other Below-Ground Splice Vaults.*
- GR-937-CORE, *Generic Requirements for Outdoor and Indoor Building Entrance Terminals(BETs)*.
- GR-950-CORE, *Generic Requirements for Optical Network Unit (ONU) Closures and ONU Systems.*
- GR-974-CORE*, Generic Requirements for Telecommunications Line Protector Units (TLPUs).*
- GR-1089-CORE, *Electromagnetic Compatibility and Electrical Safety–Generic Criteria for Network Telecommunications Equipment.*
- GR-1209-CORE*, Generic Requirements for Passive Optical Components.*
- GR-1399-CORE, *Generic Requirements for Coaxial Distribution Cable.*
- GR-1500-CORE, *Generic Requirements for Powering Telecommunications Load Equipment (TLE) in Telecommunications Systems.*
- GR-2834-CORE, *Generic Requirements for Basic Electrical, Mechanical & Environmental Criteria for Outside Plant Equipment.*

United States (U.S.) Codes and Standards, continued

- GR-2847-CORE, *Generic Requirements for Cable Penetration Seal Assembly for CEVS and Manholes.*
- GR-2908-CORE, *Generic Requirements for Surge Protectors on Coaxial Lines at Customer's Premises.*
- GR-2910-CORE, *Generic Requirements for Bonding and Grounding Hardware on Coaxial Drop Cable.*
- GR-2923-CORE, *Generic Requirements for Fiber Optic Connector Cleaning Products.*
- GR-2930-CORE, *NEBS: Raised Floor Generic Requirements for Network and Data Centers.*
- GR-2949-CORE*, Generic Requirements on Buried Hybrid Coaxial/Twisted Pair Cable.*
- GR-3031-CORE*, Generic Requirements for Indoor Electronic Equipment Cabinets.*
- GR-3033-CORE, *Generic Requirements for Indoor and Outdoor Battery Backup Cabinet.*
- GR-3151-CORE, *Generic Requirements for Copper Splice Closures.*
- GR-3160-CORE*, Generic Requirements for Telecommunications Data Center Equipment and Spaces.*
- GR-3161-CORE, *Generic Requirements for Multiple Dwelling Unit (MDU) Fiber Distribution Terminals.*
- GR-3163-CORE, *Generic Requirements for Metallic Telecommunications Service and Distribution Drop Wires.*
- GR-3164-CORE*, Generic Requirements for Metallic Telecommunications Premises Wires.*
- GR-3173-CORE, *Generic Requirements for Hybrid Optical and Electrical Cables for Use in Wireless Outdoor Fiber To The Antenna (FTTA) Applications.*
- GR-3174-CORE, *Generic Requirements for Hardware Attachments for Utility Poles.*
- GR-3175-CORE, *Generic Requirements for Intrabuilding Coaxial Cable.*
- GR-3178-CORE, *Generic Requirements for Wireless Transceiver Facilities.*
- SR-1421-CORE, *Manual of Construction Practices (Blue Book).*
- SR-2275-CORE, *Notes on the Network.*
- TR-NWT-001075, *Generic Requirements for Outside Plant Bonding and Grounding Systems Hardware.*
- TR-NWT-001121, *Generic Requirements for Self-Supporting Optical Fiber Cable.*
- TR-TSY-000757, *Generic Requirements for Uninterruptible Power Systems (UPS).*
- TR-TSY-000789, *Generic Requirements for Lashed Cable Supports.*

Enforcement of United States (U.S.) Building Codes, Standards, and Regulations

Overview

Generally, codes or federal regulations are enforced by the same local agency responsible for issuing building permits. In almost all communities, the local government produces ordinances establishing building codes and required standards for that jurisdiction.

Local Applications of National Standards

In almost all areas of the United States, local and state governments adopt all or major portions of the relevant building, fire, and electrical codes. In most cases, local code-making bodies make editorial and technical modifications to the major code they adopt.

Some states establish statutory regulations that are the minimum conditions under which any local government may permit construction to occur.

In almost all cases, a significant portion of the U.S. national codes are either adopted or used as a pattern by local government agencies. Significant in this standardization within the United States is the *NEC*, produced as NFPA 70. In many areas, it is the responsibility of the local AHJ to enforce the codes and establish local codes as necessary.

In some areas, compliance with more than one set of codes or regulations is required such as obtaining city and county construction permits.

ICT project management, design, and installation personnel are responsible for contacting the local AHJ to determine what code(s) their work must be performed under if it is not clearly stated in the applicable project documentation.

Government and Military Construction

Construction for branches of the U.S. military and federal agencies must comply with standards established by those service branches and government agencies. The following are some of those standards and practices:

- Federal Emergency Management Agency (FEMA):
  - BIPS 06/FEMA 426, *Reference Manual to Mitigate Terrorist Attacks Against Buildings*.
  - FEMA 413, *Installing Seismic Restraints for Electrical Equipment*.
- National Institute of Science and Technology (NIST) Federal Information Processing Standards, FIPS-201-2, *Personal Identity Verification (PIV) of Federal Employees and Contractors*.
- Nuclear Regulatory Commission, *NRC-070–U.S. Seismic Zone Map based on 1997 Uniform Building Code (UBC) map*.
- U.S. Department of Defense (DOD). UFC-3-550-01. *Unified Facilities Criteria (UFC): Exterior Electrical Power Distribution*.
- U.S. Department of Homeland Security (DHS)–Office of Information and Technology (OIT). *Customs and Border Protection (CBP) National Cabling Standards*.
- U.S. DHS–Immigration and Customs Enforcement (ICE), Office of Chief Information Officer (OCIO) (Network Implementation Branch (NIB) Engineering Division). *Structured Cable Plant Standards*.
- U.S. DHS–Transportation Security Administration (TSA). *Checkpoint Design Guide (CDG)*.
- U.S. DOD. Unified Facilities Criteria, UFC 3-580-01, *Telecommunications Interior Infrastructure Planning and Design*.
- U.S. General Services Administration (GSA), Public Buildings Service, *The Site Security Design Guide*.

Government and military construction normally is not subject to local government jurisdiction. However, most government and military branch standards:

- Follow the guidelines of national codes.
- Adopt the national codes in their own standards and specifications.

Federal Safety and Health Standards

The federal government, specifically OSHA, through the Occupational Safety and Health Act, enforces the safety aspects of codes and standards as they apply to employee working conditions.

The requirements of OSHA are listed within the *United States Code of Federal Regulations* (*CFR*), specifically Title 29, Chapter XVII. Chapter XVII contains parts 1900-1999, with Part 1910 being applicable to work site conditions and employee safety.

Commonly encountered requirements for ICT installation within Chapter XVII include:

- Part 1910: Occupational Safety and Health Standards.
  - Section 1910.23: Ladders.
  - Section 1910.29: Fall protection systems and falling object protection–criteria and practices.
  - Section 1910.132: General requirements, personal protective equipment.
  - Section 1910.136: Personal protective equipment, foot protection.
  - Section 1910.140: Personal fall protection systems.
  - Section 1910.146: Permit-required confined spaces.
  - Section 1910.268: Telecommunications.
  - Section 1910.1001: Asbestos.
- Part 1926: Safety and Health Regulations for Construction.

References to parts or sections of the *CFR* are expressed in an alphanumerical sequence. Examples include 29CFR1910.23, 29CFR1910.132, and 29CFR1926.

Wireless Transmission Standards

Overview

Wireless communication has existed for more than 100 years. For that long, it has had an international quality, exemplified by Guglielmo Marconi's demonstration of a transatlantic radiotelegraphy link in 1901. A number of international and regional standards and regulations in the wireless arena have been adopted since then.

Organizations

The following are some of the most prominent organizations charged with writing and setting the standards used in the various wireless technologies:

- Association of Radio Industries and Businesses (ARIB).
- European Telecommunications Standards Institute (ETSI).
- Federal Aviation Administration (FAA).
- Federal Communications Commission (FCC).
- Innovation, Science and Economic Development Canada.
- Institute of Electrical and Electronic Engineers (IEEE).
- International Civil Aviation Organization (ICAO).
- International Electrotechnical Commission (IEC).
- International Organization for Standardization (ISO).
- International Telecommunications Union (ITU)
- Occupational Safety and Health Administration (OSHA).
- Sub-Secretariat of Telecommunications.
- Telecommunications Industry Association (TIA).
- Telecommunications Technology Association (TTA).

Organizations, continued

Association of Radio Industries and Businesses (ARIB)

ARIB is based in Japan and conducts investigations, research and development, and consultation and establishes standards for the utilization of radio waves from the view of developing radio industries.

ARIB promotes the realization and popularization of new radio systems in the field of telecommunications and broadcasting.

Some of the ARIB standards applicable to wireless infrastructure include:

- ARIB-STD-T57, *Electromagnetic Compatibility (EMC) for Radio Equipment.*
- ARIB-STD-T61, *Narrow Band Digital Telecommunication System (SCPC/FDMA).*
- ARIB-STD-T79, *Digital Mobile Telecommunication System for Local Government.*
- ARIB-STD-T80, *Digital Mobile Communication System for Local Government TYPE 2.*
- ARIB-STD-T109, *700 MHz Band Intelligent Transport Systems.*
- RCR-STD-38, *Radiofrequency-Exposure Protection.*

European Telecommunications Standards Institute (ETSI)

ETSI plays a major role in developing a wide range of standards and other technical documentation as Europe's contribution to worldwide standardization in telecommunications, broadcasting, and IT.

ETSI is actively involved in developing standards in key technical areas, including:

- 3G global system for mobile communications.
- High-performance radio LAN type 1 (HiperLAN/1).
- HiperLAN/2.
- Digital enhanced cordless telecommunications.
- Mobility for emergency and safety applications.
- Radio spectrum.
- Short-range devices.

Some of the ETSI standards applicable to wireless infrastructure include:

- ETSI TR 101 031, *Broadband Radio Access Networks (BRAN); HIgh PErformance Radio Local Area Network (HIPERLAN) Type 2.*
- ETSI TR 103 293, *Broadband Radio Access Networks (BRAN); Broadband Wireless Access and Backhauling for Remote Rural Communities.*
- ETSI TR 103 631, *Wireless Access Systems including Radio Local Area Networks (WAS/RLANs) in the band 6 725 MHz to 7 125 MHz.*
- ETSI TR 178, *Digital Enhanced Cordless Telecommunications (DECT); A high level guide to the DECT standardization.*

Organizations, continued

Federal Aviation Administration (FAA)

Within the U.S, projects involving tower or structure installations supporting antennas for wireless communications must be submitted to the FAA for review and issuance of a "determination of no hazard to air navigation" in return.

The FAA cannot enforce telecommunications tower regulations as this authority lies solely with the FCC. However, to help ensure aviation safety, the FCC requires that the FAA be notified of any proposed construction or modification to a tower above ≈61 m (200 ft).

Federal Communications Commission (FCC)

FCC rules cover a diverse range of subjects from FCC organization to requirements for different radio services and maximum permissible heights for antennas located near airports (see Table 6).

The FCC regulates the towers and other antenna supporting structures through the Antenna Structure Registration program.

All applicable wireless equipment must have an FCC authorization. The requirements for equipment authorization are found in Title 47 of the *Code of Federal Regulations*.

Table 6
Federal Communications Commission (FCC) regulations

Specification/ Standard Number	Title
47CFR2	Code of Federal Regulations Title 47, Telecommunications–Part 2: *Frequency Allocations and Radio Treaty Matters, General Rules and Regulations*.
47CFR17	Code of Federal Regulations Title 47, Telecommunications–Part 17: *Construction, Marking and Lighting of Antenna Structures*.
47CFR20	Code of Federal Regulations Title 47, Telecommunications–Part 20: *Commercial Mobile Services*.
47CFR22	Code of Federal Regulations Title 47, Telecommunications–Part 22: *Public Mobile Services*.
47CFR24	Code of Federal Regulations Title 47, Telecommunications–Part 24: *Personal Communications Services*.
47CFR27	Code of Federal Regulations Title 47, Telecommunications–Part 27: *Miscellaneous Wireless Communications Services*.
47CFR90	Code of Federal Regulations Title 47, Telecommunications–Part 90: *Private Land Mobile Radio Services*.
47CFR95	Code of Federal Regulations Title 47, Telecommunications–Part 95: *Personal Radio Services*.
47CFR96	Code of Federal Regulations Title 47, Telecommunications–Part 96: *Citizens Broadband Radio Service*.

Organizations, continued

Innovation, Science and Economic Development Canada

This is the government department responsible for regulating telecommunications equipment in Canada. Section 5 of the Radiocommunication Act and Section 69.3 of the Telecommunications Act give the Minister of Industry the authority to develop technical standards and to ensure that telecommunications equipment meets these standards. The term telecommunications equipment is used as a generic term covering telecommunications apparatus (terminal equipment that connects directly to the public switched telephone network), radio equipment (equipment intended for, or capable of being used for, radio communication), broadcasting equipment (radio and TV equipment intended for broadcasting services), and interference-causing equipment (equipment, other than radio receivers, that causes or is capable of causing interference to radio communications).

Institute of Electrical and Electronic Engineers® (IEEE®)

The work of the IEEE 802 LMSC is of particular interest to wireless practitioners. Additional information related to IEEE standards can be found earlier in this handbook.

International Civil Aviation Organization (ICAO)

ICAO, an agency of the United Nations, develops the principles and techniques of international air navigation and fosters international air transport planning and development to ensure a safe and orderly growth.

The ICAO Council adopts standards and recommended practices concerning air navigation, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation.

In addition, it defines the protocols for air accident investigation for the transport safety authorities of the Chicago Convention signatories. The ICAO rules that impact the wireless design include the heights and markings of structures around airports required for a smooth flight operation and accident prevention.

International Telecommunications Union-Radiocommunications Sector (ITU-R)

ITU's Radiocommunications Sector (ITU-R) assembles experts from around the world to develop international standards known as ITU-R Recommendations which act as defining elements in the global infrastructure of wireless communications. Some of their standards include:

- *ITU-R Handbook on Land Mobile (including Wireless Access)–Volume 3: Dispatch and Advanced Messaging Systems*.
- *ITU-R Handbook on Land Mobile (including Wireless Access)–Volume 4: Intelligent Transport Systems*.
- *ITU-R Handbook on Land Mobile (including Wireless Access)–Volume 5: Deployment of Broadband Wireless Access Systems.*
- ITU-R M.2084*, Radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure two-way communications for Intelligent Transport System applications.*

Organizations, continued

Occupational Safety and Health Administration (OSHA)

OSHA is an agency of the U.S. Department of Labor. OSHA promotes regulations for the protection of workers who build, service, or operate wireless infrastructure towers.

Sub-Secretariat of Telecommunications

In Chile, the Sub-secretariat of Telecommunications regulates the radioelectric spectrum, including frequencies associated with IEEE 802.11 standards, with certain restrictions.

Telecommunications Industry Association (TIA)

- ANSI/TIA-102 series, *Telecommunications, Land Mobile Communications (APCO/Project 25).*
- ANSI/TIA-222, *Structural Standard for Antenna Supporting Structures and Antennas.*
- ANSI/TIA-603, *Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.*
- TIA TSB-88.x series*, Wireless Communications Systems Performance in Noise and Interference-Limited Situations.*

NOTE: Additional information on TIA can be found earlier in this handbook.

Telecommunications Technology Association (TTA)

TTA is an IT standards organization in Korea that develops new standards and provides services for the establishment of IT standards as well as testing and certification for IT products.

The scope of TTA activities includes telecommunications, IT, radio communications, and broadcasting.

Approval of Electrical Products and Equipment

United States (U.S.)

Product Certification

Most states or localities accept certification of electrical products by an NRTL as evidence that products and materials are safe for use in that jurisdiction. Examples of NRTLs in the U.S. include:

- Underwriters Laboratories® (UL®).
- Factory Mutual.
- Intertek.

NOTE: ICT personnel are responsible for ensuring that the AHJ will accept a particular NRTL's certification for materials used during the design and installation phases of a project. Some agencies may perform their own tests to determine acceptability for installation in their jurisdiction.

Product Ratings

The categories used within the United States to rate products are:

- Listed
- Classified
- Recognized
- Verified

Listed

A product is listed after it successfully completes a series of mechanical, electrical, and thermal characteristics tests that simulate all reasonable, foreseeable hazards.

The listed classification is exclusive to the product for the specific applications for which it was tested and is not valid for other applications.

Classified

A product is classified after it is evaluated and passes tests for one or more of the following:

- Specific hazards only.
- Performance under specified conditions.
- Regulatory codes.
- Other standards, including international standards.

The classified rating is generally restricted to industrial or commercial products.

Recognized

A product is recognized after it is tested for use as a component in a listed package and passes. These component products are tested for electrical, mechanical, and thermal characteristics. The recognized classification is a more general-purpose approval than listed because it allows a product to be certified for a category of equipment uses.

United States (U.S.), continued

An example is insulated wire, which is recognized as appliance wiring material, a category of uses that includes:

- Data communications.
- Telecommunications.
- Instrumentation.

Verified

Some NRTLs also produce a performance verification of communications cabling with the classification of verified. As an example, cabling manufacturers and their cabling types are listed in the UL publication, *Performance Levels Certification Program*, for meeting the base performance criteria for each product.

A performance verification mark allows manufacturers to demonstrate that telecommunications cabling products are certified for both safety and performance, and they comply with industry performance standards.

Examples of Nationally Recognized Testing Laboratory (NRTL) Standards

Some of the UL standards that are applicable to telecommunications systems and materials include:

- UL13, *Power-Limited Circuit Cables.*
- UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*.
- UL263, *Fire Tests of Building Construction and Materials*.
- UL444, *Communications Cables*.
- UL467, *Grounding and Bonding Equipment.*
- UL 497, *Protectors for Paired-Conductor Communications Circuits*.
- UL497A, *Secondary Protectors for Communications Circuits.*
- UL497B, *Protectors for Data Communications and Fire Alarm Circuits.*
- UL 651, *Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.*
- UL 651A, *Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.*
- UL723, *Test for Surface Burning Characteristics of Building Materials*.
- UL 1449, *Surge Protective Devices.*
- UL1479, *Fire Tests of Through-Penetration Firestops*.
- UL1666, *Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.
- UL 1685, *Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test of Electrical and Optical-Fiber Cables*.

Canada

Product Certification

All provinces or territories accept certification of electrical products by a recognized (the Standards Council of Canada) testing laboratory to the applicable CEC Part 2 standard or Underwriters Laboratories of Canada (ULC) standard as evidence that products and materials are safe for use in that jurisdiction.

Some agencies may perform their own tests to determine acceptability for installation in their jurisdiction per CSA SPE-1000, the standard for Model Code for the Field Evaluation of Electrical Equipment.

Some examples of product performance standards from the CSA are:

- CAN/CSA-C22.2 No. 12.6.2, *Nonmetallic cable tray systems.*
- CAN/CSA-C22.2 No. 182.4-M90, *Plugs, Receptacles and Connectors for Communication Systems.*
- CAN/CSA-C22.2 No. 226, *Protectors in TelecommunicationNetworks*.
- CAN/CSA-C22.2 No. 227.1, *Electrical nonmetallic tubing.*
- CAN/CSA-C22.2 No. 262, *Optical Fiber Cable and Communication Cable Raceway Systems.*
- CAN/CSA-C22.2 No. 60950-22, *Information technology equipment–Safety–Part 22: Equipment to be installed outdoors (Binational standard with UL 60950-22).*
- CAN/CSA-C22.2 No. 62275, *Cable management systems–Cable ties for electrical installations (Tri-national standard with NMX-J-623-ANCE and UL 62275).*
- CSA C22.2 No. 0.3, *Test Methods for Electrical Wires and Cables.*
- CSA C22.2 No. 18.1, *Metallic outlet boxes*.
- CSA C22.2 No. 18.2, *Nonmetallic outlet boxes.*
- CSA C22.2 No. 18.3, *Conduit, tubing, and cable fittings.*
- CSA C22.2 No. 18.4, *Hardware for the support of conduit, tubing, and cable.*
- CSA C22.2 No. 35, *Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable.*
- CSA C22.2 No. 40, *Junction and pull boxes.*
- CSA C22.2 No. 41, *Grounding and bonding equipment (Tri-national standard, with NMX-J-590- ANCE and UL 467).*
- CSA C22.2 No. 45.1, *Electrical rigid metal conduit–Steel.*
- CSA C22.2 No. 56, *Flexible metal conduit and liquid-tight flexible metal conduit*.
- CSA C22.2 No. 83, *Electrical metallic tubing.*
- CSA C22.2 No. 83.1, *Electrical metallic tubing–Steel.*
- CSA C22.2 No. 85, *Rigid PVC boxes and fittings.*
- CSA C22.2 No. 126, *Metal cable tray systems.*
- CSA C22.2 No. 126.1, *Metal cable tray systems (Binational standard with NEMA VE 1-2017).*

Canada, continued

- CSA C22.2 No. 211.1, *Rigid types EB1 and DB2/ES2 PVC conduit.*
- CSA C22.2 No. 211.2, *Rigid PVC (unplasticized) conduit.*
- CSA C22.2 No. 214, *Communications Cables (Bi-national standard, with UL 444)*.
- CSA C22.2 No. 232, *Optical Fiber Cables.CSA C22.2 No. 233, Cords and Cord Sets for Communication Systems.*
- CSA C22.2 No. 267, *Armoured segmented power and communication assembly (ASPCA).*
- CSA C22.3 No. 1:20 *Overhead systems.*
- CSA C22.3 No. 7:20 *Underground systems.*
- CSA C83, *Communication and Power Line Hardware*.

Underwriters Laboratories of Canada (UL Canada) is an independent product safety testing, certification and inspection organization accredited by the Standards Council of Canada.

Some examples of ULC Canadian safety standards are:

- CAN/ULC-60839-11-1, *Alarm and Electronic Security Systems–Part 11-1: Electronic Access Control Systems–System and Components Requirements*.
- CAN/ULC-62263, *Live Working–Guidelines for the Installation and Maintenance of Optical Fibre Cables on Overhead Power Lines*.
- CAN/ULC-S102, *Standard Method of Test for Fire and Smoke Characteristics of Electrical Wiring, Cables and Non-Metallic Raceways*.
- CAN/ULC-S115, *Standard Method of Fire Tests of Firestop Systems*.
- CAN/ULC-S143, *Standard Method of Tests for Non-Metallic Electrical and Optical Fibre Cable Raceway Systems*.
- CAN/ULC-S576, *Standard for Mass Notification System Equipment and Accessories*.
- CAN/ULC-S2577, *Standard for Suspended Ceiling Grid Low Voltage Systems and Equipment*.

UL marks that are displayed on Canadian products (see Figure 3) include:

Figure 3
Underwriters Laboratories (UL) of Canada marks

European Union (EU)

Waste Electrical and Electronic Equipment (WEEE) Directive

Directive 2002/96/EC, WEEE addresses the prevention of electrical and electronic equipment waste as well as the reuse, recycling, and other forms of recovery of these wastes to minimize the overall amount disposed. WEEE covers ten categories, including IT and telecommunications equipment, electrical and electronic tools, and lighting equipment.

Products used in the EU that fall within these categories must be WEEE compliant. Additionally, there may be jurisdictional requirements concerning the proper disposal and recycling of items covered under WEEE.

Restriction of Hazardous Substances (RoHS) Directive

In the EU, 2002/95/EC, *Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment*, was adopted in February 2003. Now known as RoHS1, this directive established restrictions on the use of the following six substances:

- Lead (Pb).
- Mercury (Hg).
- Cadmium (Cd).
- Hexavalent chromium (Cr6+).
- Polybrominated biphenyls (PBB).
- Polybrominated diphenyl ether (PBDE).

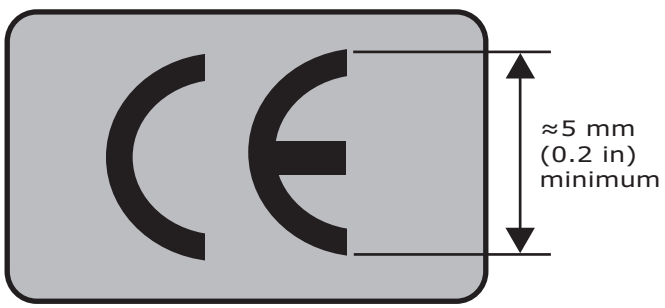
As many of these substances are used within electronics and ICT products, materials installed within the jurisdiction of the EU must be RoHS compliant.

RoHS1 was revised by the EU in 2011 with additional requirements and clarifications, with the 2011 version being commonly referred to as RoHS2. Within RoHS2, the CE mark (see next section) was defined as being the only official mark denoting RoHS compliance.

Conformité Européenne (CE) Mark

Products placed on the single market in the European Economic Area are required to meet the applicable EU consumer safety, health, or environmental requirements. Electronic products and equipment that conform to the EU's EMC Directive (and all applicable directives) are labeled with the CE mark as shown in Figure 4.

Figure 4
Conformité européenne mark



European Union (EU), continued

The CE mark may be placed on the:

- Equipment.
- Equipment packaging.
- Instructions for use guidelines.
- Guarantee certificate.

For ICT equipment (e.g., computers, computer peripherals), the requirements of the EN 55022 standard are similar to the FCC EMI requirements.

GS Mark–Geprüfte Sicherheit (Safety Tested)

The GS mark (Figure 5) is recognized throughout Germany and EU countries as a symbol of safety. Any product bearing the GS mark indicates that it was tested and complies with the minimum requirements of the German Product Safety Act (i.e., ProdSG). The GS mark, which stands for "Geprüfte Sicherheit" in German and means Safety Tested, is a licensed mark of the German government and may only be issued by an accredited product safety testing and certification agency.

Figure 5
GS mark

South American Countries

In most of the Latin American countries, there is a government structure that approves the electrical equipment that enters the country.

For Chile, it is the Superintendencia de Electridad y Combustibles generating a logo that identifies certified products.

Regulations and Standards for Emissions and Immunity

Overview

This section provides information about various standards and regulations related to EMI and ESD as they apply to ICT equipment. The information is from both the United States and the European Economic Area (EEA). The ICT distribution designer should be familiar with regulations applicable in the region where a project is located.

Commercial Products Marketed in the United States (U.S.)

The FCC regulates, in the public interest, interstate and international communications by radio, TV, wire, satellite, and cable in all 50 states, the District of Columbia, and U.S. territories.

The FCC is concerned about any device that emits EMI. Therefore, it has written the *Code of Federal Regulations*, Title 47, Part 15, Subpart B, which establishes emission limits for unintentional RF devices.

The regulated products include "any unintentional radiator (device or system) that generates and uses timing pulses at a rate in excess of 9 kilohertz (kHz) and uses digital techniques." This includes almost every product that employs a microprocessor including workstations, computers, POS terminals, printers, modems, and many electronic games.

It is illegal to sell or advertise for sale any products regulated under Subpart B until their radiated and conducted emissions have been measured and proven compliant.

The FCC rules set limits on two kinds of emissions:

- Conductive emissions that travel through the conductors in the electrical power cord.
- Radiated emissions that emanate from the computing device into space.

Radiation Limits for Class A and Class B

Radiation limits for class A and class B computing devices are specified by the FCC, as follows:

- Class A devices are intended for use in a commercial or business environment.
- Class B devices are intended for use in a residential environment.

Emission Limits for Class A and Class B

The emission limits for class B devices are levels low enough to avoid interference to radio and television reception when there is more than one wall and 3 m (≈10 ft) separating the computing device and the receiver. The 3 m (≈10 ft) and one wall limit represent the separation between two households.

Class B digital devices must meet stricter standards for both conductive and radiated emissions than the industrial and commercial equipment designated as class A.

Class A equipment is allowed to produce a nearly 10 times higher interference than class B equipment. The high allowable limit for possible interference assumes that most residential areas are substantially farther than 10 m (≈33 ft) away from industrial or commercial buildings. The greater separation means that, even with greater RF emission levels, class A devices should not bother the residential neighbors' equipment.

Commercial Products Marketed Outside the United States (U.S.)

EMC requirements vary from country to country; however, most countries have requirements on emissions similar to the FCC requirements.

Countries in the EEA and many other countries have adopted emissions standards based on a document by the IEC, CISPR 22, *Information Technology Equipment–Radio Disturbance Characteristics–Limits and Methods of Measurement*.

NOTE: CISPR is the IEC committee that develops standards to facilitate trade between countries.

The IEC CISPR 22 standard categorizes products as class A or class B and specifies a test procedure and emission limits that resemble (but are not exactly the same as) the Part 15, Subpart B requirements.

EN 61000-6–Generic Immunity Standard

To claim conformity with the EU's EMC Directive (and all applicable directives), the product must be labeled with the CE mark.

The CE mark may be placed on the:

- Equipment.
- Equipment packaging.
- Instructions for use guidelines.
- Guarantee certificate.

The requirements of the EN 55022 standard, which applies to information technology equipment (e.g., computers and computer peripherals), are similar to the FCC EMI requirements.

EN 55022 and its companion document, IEC CISPR 22, describe test procedures and limits similar to, but not identical to, the FCC Part 15 requirements and the test procedures set forth in ANSI/IEEE C63.4, *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz*.

Electrostatic Discharge (ESD)

IEC 61000-4-2, *Electromagnetic Compatibility (EMC)–Part 4: Testing and Measurement Techniques–Section 2: Electrostatic Discharge Immunity Test* (originally IEC 801-2), applies to equipment subjected to ESD.

The three types of ESD used in testing are:

- Discharge through a spark in air.
- Radiated effects of ESD.
- Contact discharge.

In contact discharge, the tip of the ESD simulator is held in contact with a metal surface of the equipment. The discharge takes place in a high-voltage vacuum relay inside the simulator. Contact discharge, while not realistic, affords a measure of repeatability to the test, a necessity in a test with legal implications.