General Communication Technician - Level 2 (GCT2) Competency Requirements

The General Communications Technician Level 2 certification is a journeyman level program modeled after wide-ranging industry communication systems encompassing more specific detailed items along with the U.S. Department of Homeland Security (DHS) guidelines covering all of the disciplines in the COMT program. The purpose of the GCT2 is to provide a certification program and testing that expands upon the coverage included in the GCT1 competencies. The GCT2 certification technician candidate must hold the GCT1 or the Associate CETa as the minimum pre-requisite certification. Prior RF experience is highly suggested.

The GCT2 competency comprises more complex areas in which a radio communications technician and/or engineer will encounter in the public safety communications or business / commercial radio fields. Please see the General Communication Technician Level 1 and Level 3 competencies for other specific descriptions of communications theories. This GCT2 certification will involve more knowledge of intricate skills and troubleshooting. The GCT program will require re-testing to renew every four years to keep current in the newest technology for all Levels.

The following **Level 2** Competency listing is a more thorough recognition and description of extensive individual subject topics in electronics areas in which industry General Communications Technicians (GCT2) would comprehend and experience daily.

1.0 Safety

- 1.1. List the basic building / workplace safety protocols per industry standards to include:
  - 1.1.1. falling object mitigation
  - 1.1.2. fire prevention and suppression
- 1.2. Describe general power safety guidelines, including:
  - 1.2.1. Battery systems
  - 1.2.2. Lock Out / Tag Out rule
    - 1.2.2.1. Other power system precautions
- 1.3. Describe general tools and equipment safety
- 1.4. List personal protection equipment (PPE) used in the communication fields
- 1.5. Describe Radio Frequency (RF) safety
- 1.6. Describe communications safety requirements used near machinery
- 1.7. Describe safety measures used with tower and elevated surfaces
- 1.8. Describe grounding and lightning protection safety measures
- 1.9. List fiber optic safety requirements
- 1.10. List laser use safety requirements

2.0 Electronic and Electrical Principles

- 2.1. Explain Ohm's law and formulas to include:
  - 2.1.1. Voltage
  - 2.1.2. Current
  - 2.1.3. Resistance
    - 2.1.3.1. Conductors and resistance
- 2.2. Describe Watt's Law formula including power calculations
- 2.3. Explain complex DC circuits to include:
  - 2.3.1. Series
  - 2.3.2. Parallel
  - 2.3.3. Series-Parallel
- 2.4. Describe Alternating Current (AC) Waveforms to include:
  - 2.4.1. Polarity reversal
    - 2.4.1.1. Frequency
    - 2.4.1.2. Period
  - 2.4.2. Define the relationship between frequency and period
  - 2.4.3. Describe relationship of each of the following to each other:
    - 2.4.3.1. Root Mean Square (RMS)
    - 2.4.3.2. Peak
    - 2.4.3.3. Average (Avg)

2.4.3.4. Peak-to-Peak
2.5. Describe decibels and their use including:
2.5.1. RF
2.5.1.1. Effective Radiated Power formula
2.5.2. Power
2.5.3. Audio
2.6. Explain how to use the metric system including:
2.6.1. prefixes and their acronyms
2.7. Describe harmonics applications in communications and affects
2.8. Calculate power conversions for loads

3.0 Fundamentals of Radio Systems

3.1. Explain that radio systems have four different components including:
3.1.1. Transmitters
3.1.2. Receivers
3.1.3. Power Supplies
3.1.4. Audio and Control
3.2. Describe how transmitters are under processor control including:
3.2.1. sending information on a carrier on an assigned frequency
3.2.2. frequency control having stages which includes:
3.2.2.1. Oscillators for operating frequency, channel steps and accuracy
3.2.2.2. Amplifiers
3.2.2.3. Multipliers and mixer stages
3.2.2.4. Intermediate power amplifiers
3.2.2.5. Power Amplifiers
3.2.2.6. Power Control Boards
3.3. Explain how modulation is the process of adding intelligence to an RF carrier
3.4. Describe the most common modulation modes including:
3.4.1. Amplitude (AM) is a heterodyne process
3.4.2. Frequency (FM)
3.4.3. Phase (PM)
3.4.4. Digital
3.4.4.1. Digital Signal Processors (DSP)
3.4.5. Frequency-shift keying-non-return-to-zero (FSK-NRZ)
3.4.6. 4-level (C4FM)
3.4.6.1. NXDN
3.4.6.2. DMR
3.4.6.2.1. MOTOROLA TRBO
3.4.7. Time Division Multiple Access (TDMA)
3.4.8. Global signaling for mobile communications (GSM)
3.4.9. Project 25 (P25)
3.4.9.1. Phase 1
3.4.9.2. Phase 2
3.4.10. Code Division Multiple Access (CDMA)
3.4.11. Terrestrial Trunked Radio (TETRA)
3.4.11.1. TETRAPOL
3.4.12. Phase Shift Keying (PSK)
3.4.12.1. Quadrature PSK (QPSK)
3.4.12.2. Coherent (CPSK)
3.4.13. Quadrature Analog modulation (QAM)
3.5. Describe how receivers return frequency signals to their original format including:
3.5.1. receiver bandwidth must match the transmitter modulation scheme
3.5.2. superheterodyne receiver stages:
3.5.2.1. RF
3.5.2.2. Mixer
3.5.2.3. Local oscillator
3.5.2.4. IF
3.5.2.5. Limiter

3.5.2.6. Detector - Demodulator
3.5.2.7. Audio or Data
3.5.3. additional receiver stages:
3.5.3.1. Squelch
3.5.3.2. Automatic Gain Control
3.5.3.3. Automatic Volume Control
3.5.3.4. Automatic Frequency Control
3.5.3.5. Ultra High Stability Oscillator
3.5.3.6. Audio Amplifier
3.6. Explain how demodulation is the process of separating intelligence from an RF carrier
3.7. Describe the most common demodulation schemes including:
3.7.1. diode in AM called Envelope Detection
3.7.2. detector in FM was one of the following:
3.7.2.1. discriminator
3.7.2.2. ratio
3.7.2.3. quadrature
3.7.2.4. slope
3.7.3. digital demodulation via DSP
3.8. Describe how audio or RF filters allow frequencies to pass through radio systems including:
3.8.1. Low-pass (LPF)
3.8.2. High-pass (HPF)
3.8.3. Band-pass
3.8.4. Band-stop
3.9. Explain how RF power supplies work including:
3.9.1. analog
3.9.2. switching

4.0 Tools, Methods and Test Equipment

4.1. Describe the common tools used in RF communications including:
4.1.1. hand
4.1.2. power
4.1.3. miscellaneous
4.2. Describe the use and operation of the following meters:
4.2.1. standalone Voltmeters to include
4.2.1.1. Analog Multimeter
4.2.1.2. Digital Multimeter (DMM)
4.2.1.3. impedance loading
4.2.2. Wattmeters to include:
4.2.2.1. Inline
4.2.2.2. Analog
4.2.2.3. Digital
4.3. Describe the use and operation of Communication Service Monitors (CSM) to include:
4.3.1. instrumentation:
4.3.1.1. RF Monitor
4.3.1.2. Signal Generator
4.3.1.3. Spectrum Analyzer
4.3.1.4. Modulation Monitor
4.3.1.5. Tone Encoder
4.3.1.6. Tone Decoder
4.3.1.7. Antenna Analyzer
4.3.1.8. Power Meter
4.3.1.9. Voltmeter
4.3.1.10. Transmission Levels
4.3.1.11. Oscilloscope
4.3.1.12. Tracking Generator
4.3.1.13. Distortion Analyzer
4.3.1.14. SINAD Meter
4.3.1.15. RF Frequency Error Meter

- 4.3.1.15.1. Transmitter Frequency Error
- 4.3.1.15.2. Receiver Frequency Error
- 4.3.1.16. Cable Fault Analyzer
- 4.3.1.17. Audio Frequency Counter mode
- 4.3.1.18. Bit Error Rate Meter

4.3.2. accuracy:

- 4.3.2.1. Frequency
- 4.3.2.2. Modulation
  - 4.3.2.2.1. Deviation Meter Bessel Null
- 4.3.2.3. Output level
- 4.3.2.4. Automatic Testing
- 4.3.2.5. Port Power Maximums

4.4. Describe the use and operation of additional antenna test equipment including:

- 4.4.1. Frequency Domain Reflectometer (FDR)
- 4.4.2. Time Domain Reflectometer (TDR)
- 4.4.3. Standing Wave Ratio (SWR) meter

4.5. Describe the use and operation of audio transmission test sets to include:

- 4.5.1. Transmission Impairment Measurement Sets (TIMS)

4.6. Describe the use and operation of the following:

- 4.6.1. Lineman's handset (Butt-set)
- 4.6.2. Ground Resistance Tester
- 4.6.3. Local Area Network (LAN) Tester

4.7. Explain the use and operation of a Spectrum Analyzer including:

- 4.7.1. Frequency Range
- 4.7.2. Sensitivity
- 4.7.3. Selectivity
- 4.7.4. Span
- 4.7.5. Dynamic Range
- 4.7.6. Bandwidth Selection
- 4.7.7. Time Base Accuracy
- 4.7.8. Power Levels
- 4.7.9. Tracking Generator
- 4.7.10. Storage
- 4.7.11. Persistence
- 4.7.12. Markers
- 4.7.13. Sweep Speed

4.8. Explain a Noise Floor of a device or system

4.9. Explain the use and operation of an Oscilloscope including:

- 4.9.1. Vertical stage(s)
- 4.9.2. Bandwidth
- 4.9.3. Trace(s)
- 4.9.4. Horizontal
  - 4.9.4.1. Sweep Speed
- 4.9.5. Time base
- 4.9.6. Accuracy
- 4.9.7. Lissajous pattern
- 4.9.8. Triggering
  - 4.9.8.1. Auto
  - 4.9.8.2. Normal
  - 4.9.8.3. Single
    - 4.9.8.3.1. Re-arm switch
- 4.9.9. Delay
- 4.9.10. Storage

4.10. Describe Passive Intermodulation (PIM) testers to include:

- 4.10.1. PIM Theory
- 4.10.2. New construction versus legacy systems differentiation
- 4.10.3. External PIM

5.0 Connectorization

- 5.1. Define the terms connector/connection
- 5.2. Describe common connector types
- 5.3. Describe a connector's general characteristics
- 5.4. Describe a wire's physical material makeup
- 5.5. Describe the National Electrical Code (NEC®) specific articles to include:
  - 5.5.1. wire sizing standards also listing American Wire Gauge (AWG) properties
  - 5.5.2. color coding to the TIA-598 standards:
    - 5.5.2.1. DC
    - 5.5.2.2. AC
    - 5.5.2.3. Telecom
- 5.6. Explain why wire length should always include slack
- 5.7. Describe DC voltage and wiring to include:
  - 5.7.1. source voltage
  - 5.7.2. current
  - 5.7.3. polarity
- 5.8. Describe AC voltage and wiring to include:
  - 5.8.1. adhering to NEC® installation standards
  - 5.8.2. proper plug and receptacle use per National Electrical Manufacturers Association(NEMA®)
- 5.9. List Telecom Category cable designations
- 5.10. Describe RF cables and connection components to include:
  - 5.10.1. coaxial
  - 5.10.2. dielectric
  - 5.10.3. signal loss
  - 5.10.4. connector types
  - 5.10.5. impedance matching

6.0 Power Systems

- 6.1. Describe physical installation of infrastructure powered equipment including:
  - 6.1.1. power systems voltage and current requirements:
    - 6.1.1.1. AC power
    - 6.1.1.2. DC power
  - 6.1.2. power connections:
    - 6.1.2.1. fuse and breaker requirements:
      - 6.1.2.1.1. operating environment
      - 6.1.2.1.2. Load Centers
      - 6.1.2.1.3. disconnection requirements (Cut-off, Alarm, Transfer)
    - 6.1.2.2. battery power:
      - 6.1.2.2.1. sizing and handling
      - 6.1.2.2.2. 13.8 VDC devices
      - 6.1.2.2.3. 24/48 VDC battery operated devices
      - 6.1.2.2.4. Uninterrupted Power Supply (UPS)
      - 6.1.2.2.5. Low Voltage Disconnect
    - 6.1.2.3. generators
    - 6.1.2.4. renewable energy systems to include:
      - 6.1.2.4.1. Solar
      - 6.1.2.4.2. Fuel Cell
      - 6.1.2.4.3. Wind
      - 6.1.2.4.4. Hydro
    - 6.1.2.5. distribution systems
  - 6.1.3. installation planning procedures including infrastructure
- 6.2. Describe case study power load and design loading

7.0 Antennas, Transmission Lines and Towers

- 7.1. Define the antenna performance of a radio system
- 7.2. Describe the antenna's:
  - 7.2.1. polarization orientation
    - 7.2.1.1. vertical
    - 7.2.1.2. horizontal
    - 7.2.1.3. circular
    - 7.2.1.4. cross
  - 7.2.2. length(s)
    - 7.2.2.1. wavelength
  - 7.2.3. Resonance
  - 7.2.4. Bandwidth
  - 7.2.5. Half-Power or 3dB Points
  - 7.2.6. Beamwidth
  - 7.2.7. Gain
    - 7.2.7.1. Isotropic Theory
  - 7.2.8. Match
  - 7.2.9. Return Loss versus SWR
    - 7.2.9.1. Maximum SWR
      - 7.2.9.1.1. Fixed
      - 7.2.9.1.2. Mobile
      - 7.2.9.1.3. Portable
  - 7.2.10. Downtilt
    - 7.2.10.1. Formula: Angle = ArcTAN (Height/Distance)
  - 7.2.11. devices
    - 7.2.11.1. drain holes
    - 7.2.11.2. Balun
  - 7.2.12. types
    - 7.2.12.1. Dipole(s), including variations on and complexities of:
      - 7.2.12.1.1. Ground Plane
      - 7.2.12.1.2. Collinear
      - 7.2.12.1.3. Panel
      - 7.2.12.1.4. Loaded Coil
      - 7.2.12.1.5. Log periodic
      - 7.2.12.1.6. Cardioid
    - 7.2.12.2. Omnidirectional
      - 7.2.12.2.1. Discone
    - 7.2.12.3. Directional
      - 7.2.12.3.1. Yagi-Uda (a complex parallel dipole)
    - 7.2.12.4. Dish
    - 7.2.12.5. Disguised / Hidden
    - 7.2.12.6. Low Profile
    - 7.2.12.7. Fractal
  - 7.2.13. separation and it's affects
- 7.3. Describe distributed antenna systems (DAS) to include:
  - 7.3.1. connectivity
    - 7.3.1.1. coaxial
      - 7.3.1.1.1. splitters
      - 7.3.1.1.2. taps
      - 7.3.1.1.3. leaky cable
    - 7.3.1.2. Internet Protocol (IP)
      - 7.3.1.2.1. fiber optic
      - 7.3.1.2.2. Ethernet
      - 7.3.1.2.3. existing LAN/Cat5e/Cat6
  - 7.3.2. Donor Antenna
    - 7.3.2.1. system gain design
  - 7.3.3. direct fiber connection to carriers

- 7.3.4. distribution system
  - 7.3.4.1. Channelized BDA– Class A
  - 7.3.4.2. Band Pass BDA – Class B
- 7.3.5. isolation between donor and distribution systems
- 7.3.6. performance of DAS

7.4. Describe transmission lines to include:
- 7.4.1. characteristic impedance
- 7.4.2. maximum power
- 7.4.3. causes of signal dB loss per 100 feet
  - 7.4.3.1. higher frequency
  - 7.4.3.2. longer length
  - 7.4.3.3. connector loss
- 7.4.4. physical dimensions
  - 7.4.4.1. weight
  - 7.4.4.2. diameter (gauge, shielding, and jacket)
  - 7.4.4.3. jacket rating
    - 7.4.4.3.1. plenum rating
  - 7.4.4.4. shielding percentage
  - 7.4.4.5. bend radius
  - 7.4.4.6. design choices of cable type

7.5. Describe other antenna system and transmission line measurements to include:
- 7.5.1. Wattmeter
- 7.5.2. Return Loss
- 7.5.3. Distance-To-Fault
- 7.5.4. PIM testing
- 7.5.5. PIM results
- 7.5.6. difference between FDR and PIM testing

7.6. Describe tower attributes and criteria to include:
- 7.6.1. types:
  - 7.6.1.1. pole
    - 7.6.1.1.1. guyed
    - 7.6.1.1.2. side mounted
  - 7.6.1.2. straight standalone
    - 7.6.1.2.1. guyed
  - 7.6.1.3. self-supporting
- 7.6.2. FAA and FCC regulations to include:
  - 7.6.2.1. height requirements
  - 7.6.2.2. visual requirements
    - 7.6.2.2.1. tower lamp
    - 7.6.2.2.2. tower painting
    - 7.6.2.2.3. aviation safety
  - 7.6.2.3. location and maintenance details
- 7.6.3. shadowing and it's affects

8.0 Operating Principles of Radio and Electronic Communications Equipment

8.1. Explain basic Federal Communications Commission (FCC) {or Canadian-'IC', United Kingdom-'Ofcom', etc} rules and regulations pertaining to two-way communications including:
- 8.1.1. licensing
- 8.1.2. spectrum usage
- 8.1.3. Type Acceptance Number (TAN) of a transmitter

8.2. Explain Federal Government Licensing including:
- 8.2.1. Broadcast Bureau or similar department
- 8.2.2. Wireless Telecommunications Bureau or similar department
  - 8.2.2.1. Public Safety
  - 8.2.2.2. Homeland Security
- 8.2.3. FCC Rules and Regulations (PARTS)
- 8.2.4. Frequency Coordinators
  - 8.2.4.1. National Telecommunications and Information Administration (NTIA)

- 8.2.4.1.1. federal government
- 8.2.4.1.2. military
- 8.2.4.2. public safety agency coordinators, such as APCO, EWA, et,al.
- 8.2.4.3. commercial and business coordinators

8.3. List frequency spectrum bands allocation to include:
- 8.3.1. VLF
- 8.3.2. LF
- 8.3.3. MF (300 kHz to 3.0 MHz; AM Broadcast, Maritime Ship to Shore, Maritime Long Range)
- 8.3.4. VHF (30 MHz to 300 MHz)
  - 8.3.4.1. Lowband
  - 8.3.4.2. Mid-band
  - 8.3.4.3. FM Broadcast
  - 8.3.4.4. Highband
  - 8.3.4.5. 220MHz (Ham, Commercial, Positive Train Control)
- 8.3.5. UHF
  - 8.3.5.1. 380-470 MHz (Military, Federal, Amateur Ham, Commercial)
  - 8.3.5.2. 470-512 MHZ (T-band)
  - 8.3.5.3. 700 MHz (Long Term Evolution{LTE}, Commercial and Public Safety)
  - 8.3.5.4. 800 MHz (Public Safety-Emergency Responders, Cellular, Specialized Mobile Radio{SMR or Trunking})
  - 8.3.5.5. 900 MHz
  - 8.3.5.6. 1.8-1.9 GHz (Broadband Personal Communications Service {PCS})
  - 8.3.5.7. 2.1 GHz (Universal Mobile Telecommunications System {UMTS}, 3G)
  - 8.3.5.8. 2.4 GHz (Industrial, Scientific and Medical)(802.11b,g, and n)
- 8.3.6. other higher frequencies

8.4. Describe additional transmitter technical specifications to include:
- 8.4.1. frequency stability
- 8.4.2. number of channels
- 8.4.3. power levels:
  - 8.4.3.1. power splitters
- 8.4.4. distortion:
  - 8.4.4.1. Bit Error Rate
- 8.4.5. radiation

8.5. Describe additional receiver technical specifications to include:
- 8.5.1. sensitivity
- 8.5.2. selectivity

8.6. Define propagation to include:
- 8.6.1. Line-of-Sight (LoS)
- 8.6.2. Groundwave
- 8.6.3. Skywave
  - 8.6.3.1. Near Vertical Incidence Skywave (NVIS)

8.7. Describe common RF formulas to include:
- 8.7.1. Free Space Path Loss (FSL) Formula for communication systems using LoS propagation: $20*LOG_{10}[Frequency(MHz)] + 20*LOG_{10}[Distance(miles)] + 36.6$
  - 8.7.1.1. obstructions adjustment
  - 8.7.1.2. over water adjustment
- 8.7.2. Line-of-Sight Range
  - 8.7.2.1. Formula: Distance(miles) = Square Root of {2 times Height(feet)}
  - 8.7.2.2. when Formula conditions hold untrue
- 8.7.3. Propagation Model software programs
- 8.7.4. Rayleigh Fading

8.8. Describe radio system communication types including:
- 8.8.1. simplex
- 8.8.2. half duplex
- 8.8.3. full duplex
- 8.8.4. Duty Cycle

8.9. Describe different types of radios including:
- 8.9.1. mobile

8.9.1.1. FCC Control Station
8.9.2. base station
8.9.2.1. repeater
8.9.3. portable
8.10. Describe why vehicular repeaters are required
8.11. Describe consoles use in dispatch operations including:
8.11.1. Direct control
8.11.2. DC control
8.11.3. Tone Remote control
8.11.4. Internet Protocol (IP) control
8.12. Describe radio paging systems including:
8.12.1. page initiation and capcode
8.12.2. types of pagers and systems
8.12.3. encoding schemes
8.13. Explain audio conditioning including:
8.13.1. automatic gain control
8.13.2. pre-emphasis
8.13.3. flat audio
8.13.4. de-emphasis
8.14. Define Interconnection to include public switched telephone network (PSTN) connection
8.15. Describe a Software Defined Radio (SDR)
8.16. Define Simulcast operations and systems
8.17. Describe coded squelch systems on a given radio channel to include:
8.17.1. Tone Squelch (a.k.a. continuous tone coded squelch system - CTCSS) to describe:
8.17.1.1. wideband allowed modulation
8.17.1.2. narrowband allowed modulation
8.17.2. Digital Coded Squelch (DCS) to describe:
8.17.2.1. allowed codes
8.18. Define Automatic Number Identification (ANI) (Fleet) Systems
8.19. Describe a Mobile Data System to include Dedicated Terminals and Keys, Laptops and Tablets
8.20. Describe the Receiver Voting Systems in very large communications systems including:
8.20.1. Noise or Signal-to-Noise(S/N)
8.20.2. Received Signal System Indicator (RSSI)
8.20.3. IP (lowest Bit Error Rate {BER} chosen)
8.21. Describe a trunking systems operation(s) for communications including:
8.21.1. Single Site
8.21.2. Multi-Site
8.21.3. P25 Standard exceptions
8.21.4. TETRA (Terrestrial Trunked Radio)
8.22. Define location systems signals to include:
8.22.1. Global Positioning Satellites (GPS)
8.22.2. NMEA interface standard (National Marine Electronics Association)
8.23. Define the need and use of gateway systems including:
8.23.1. dedicated gateway switches (Interface leads)
8.24. Describe the Amateur Radio Systems and Operators (Ham) importance
8.25. Explain radio frequency interference (RFI) inhibiting performance including:
8.25.1. natural interference
8.25.2. man-made interference containing electromagnetic compatibility (EMC) including:
8.25.2.1. co-channel
8.25.2.2. adjacent channel
8.25.2.3. desense (desensitization)
8.25.2.4. image (image frequency)
8.25.2.5. Spurious Emission
8.25.2.6. Spurious Response
8.25.2.7. harmonic interference
8.25.3. intermodulation
8.25.3.1. transmitter (an FCC violation)
8.25.3.2. receiver overload

8.25.3.3. external
8.25.3.4. passive (PIM)
8.25.4. power line noise and indicators
8.25.5. fluorescent lamps interference to include:
8.25.5.1. Compact FL's (CFLs)
8.25.5.2. Energy Saving FL ballasts
8.25.6. static electricity interference
8.26. Describe interference protective devices including:
8.26.1. Band Pass (BP) Cavities (Filters)
8.26.2. Band Reject (Notch)
8.26.3. Band Pass – Band Reject
8.26.4. Low Pass
8.26.5. High Pass
8.26.6. Crystal Filters
8.26.7. Duplexers
8.26.8. Intermodulation Control Panels
8.26.9. Harmonic Filters
8.27. Describe how transmitter combiners functions including:
8.27.1. Hybrid
8.27.2. Star
8.28. Describe receiver multi-couplers function
8.29. Define shielded enclosures benefits to negate interference
8.30. Describe bypass capacitors use to negate interference
8.31. Describe ferrite beads use to negate interference
8.32. Describe effective sensitivity for desensitization testing including:
8.32.1. an ISO-TEE test
8.33. Describe interference tracking devices and use to find signals including:
8.33.1. triangulation
8.33.2. Doppler systems

9.0 Networks - Serial Data, Internet Protocol (IP) to Wireless

9.1. Describe the legacy RS232 interface standard including:
9.1.1. data terminal equipment (DTE)
9.1.2. data communications equipment (DCE)
9.2. Describe equipment port adapters interface standards including:
9.2.1. serial conversion to RS422 format
9.2.2. serial to USB (universal serial bus):
9.2.2.1. prolific chip set
9.2.3. Ethernet
9.2.4. modem or short-haul modem
9.3. Describe data networks including:
9.3.1. hardwired Ethernet
9.3.2. wireless using IEEE 802 standards
9.4. Define Internet Protocol (IP) addressing schemes including:
9.4.1. Version 4 (IPv4) ranges
9.4.2. Version 6 (IPv6) ranges
9.4.3. dynamic host control protocol (DHCP)
9.5. Define Radio over IP (RoIP) including:
9.5.1. gateway conversions from Analog/Digital (A/D) to D/A
9.5.2. describe latency
9.5.3. multicasting
9.5.3.1. repeater received signal strength (RSS)
9.5.4. transmission control protocol (TCP)
9.5.5. user datagram protocol (UDP)
9.6. Describe cybersecurity to include:
9.6.1. keeping software and operating systems (O.S.) updated with latest patches
9.6.2. using reputable antivirus programs
9.6.3. recognizing malware

9.6.4. using complex passwords
9.6.5. user names and passwords on multiple sites protocol
9.6.6. keeping personally identifiable information (PII) off social media sites
9.6.7. viewing email in a text format instead of html to avoid malicious links
9.6.8. using search engine protocol (results can lead to malicious sites)
9.6.9. running browsers in “sand box” or virtual machines to isolate files from attacks
9.6.10. using non-administrator accounts whenever possible
9.6.11. disabling Java Script™ in Adobe Acrobat™ readers

10.0 Fiber Optic Systems

10.1. Describe basic fiber optic characteristics including:
10.1.1. bandwidth
10.1.2. attenuation
10.1.3. optical fiber parts
10.1.4. light source
10.1.5. signal speed
10.1.6. advantages over copper
10.1.7. minimum bend radius
10.2. Describe fiber optic modes and bands including:
10.2.1. Single-mode with a core at 9µm and at 1310nm or 1550nm
10.2.2. Multimode cores at 50µm or 62.5µm and usually 850nm
10.2.3. never mix and match modes or cores
10.3. Explain the many fiber optic cable types and uses according to TIA® and NEC® standards
10.4. Describe common fiber optic connectors including:
10.4.1. SC
10.4.2. ST
10.4.3. LC
10.5. Describe Fiber to the Antenna (FTTA) including:
10.5.1. baseband unit (BBU)
10.5.2. remote radio unit or head (RRU or RRH)
10.5.3. configurations
10.5.3.1. home run
10.5.3.2. hybrid cabling
10.5.3.3. separate fiber and power distribution
10.6. Describe fiber termination equipment including:
10.6.1. cleaning kit
10.6.2. splicing
10.6.3. tools
10.6.4. hardware
10.7. Describe fiber optic test equipment including:
10.7.1. Optical Power Meter
10.7.2. Video Probe Microscope
10.7.3. Optical Time Domain Reflectometer (OTDR)
10.7.4. Optical Loss Test Set (OLTS)
10.8. Describe fiber optic training and certification required to work on fiber plants

11.0 Telephony

11.1. Explain telephony basics including:
11.1.1. voice frequency:
11.1.1.1. signaling
11.1.1.2. digital: DSL, ISDN, T1
11.1.1.3. optical: SONET, FTTx
11.1.2. facsimile (FAX)
11.1.3. data transfer
11.1.4. Public Switched Telephone Networks (PSTN)
11.1.5. Private Networks dedicated direct connections
11.2. Describe telephony connectivity to include:
11.2.1. telecom block configurations

11.3. Describe telephony circuits type to include:
- 11.3.1. Plain Old Telephone System (POTS)
- 11.3.2. Two-Wire POTS
- 11.3.3. Two-Wire / Four-Wire radio circuits
- 11.3.4. E & M Signaling
- 11.3.5. apparatus used
- 11.3.6. demarcation from facility to premise
- 11.3.7. wiring types including:
  - 11.3.7.1. single pair
  - 11.3.7.2. two pair
  - 11.3.7.3. twisted pair
- 11.3.8. connections including:
  - 11.3.8.1. standard modular jack – 6P2C or 6P4C
  - 11.3.8.2. standard modular connector – RJ11, RJ14 or RJ45

11.4. Explain reporting trouble due to multiple carrier service providers

12.0 Satellite Communications Concepts

12.1. Explain how satellites are used in communication systems including:
- 12.1.1. Iridium system creating the Low Earth Orbiting (LEO) multiple satellites

12.2. Describe the equipment types used to interface systems to include:
- 12.2.1. handheld
- 12.2.2. portable
  - 12.2.2.1. SMART – federal “satellite mutual aid radio talk” groups
- 12.2.3. dish
- 12.2.4. mobile (vehicle)

12.3. Describe set-up routines to interface with communications systems including:
- 12.3.1. Azimuth
- 12.3.2. elevation
- 12.3.3. block upconverter (BUC) uplink
- 12.3.4. low noise block (LNB) downlink

12.4. Describe satellite communication troubleshooting procedures including:
- 12.4.1. alignment
- 12.4.2. latency settings

13.0 Physical Plant and Site procedures

13.1. Define authorization of physical access including:
- 13.1.1. sites
- 13.1.2. buildings
- 13.1.3. restricted rooms or areas

13.2. Describe on-site arrival procedures including:
- 13.2.1. site entrance
  - 13.2.1.1. evidence of site tampering resolution
- 13.2.2. other personnel on location

13.3. Describe site tasks including:
- 13.3.1. first visit
- 13.3.2. safety protocol
- 13.3.3. inspection
- 13.3.4. daily work activity
- 13.3.5. site egress

13.4. Describe site owner/lessee responsibility including:
- 13.4.1. contact information
- 13.4.2. federal governmental registration (FCC and FAA)
- 13.4.3. local governmental regulations and procedures

13.5. Describe site environmental responsibilities including:
- 13.5.1. HVAC systems
- 13.5.2. work lighting
- 13.5.3. vermin deterrence
- 13.5.4. weed deterrence

13.6. Describe access to systems including:
- 13.6.1. locks
  - 13.6.1.1. padlocks
  - 13.6.1.2. RFID
  - 13.6.1.3. card
  - 13.6.1.4. biometric
  - 13.6.1.5. keypad
  - 13.6.1.6. remote
  - 13.6.1.7. smartphone
- 13.6.2. video surveillance

13.7. Describe plant operational power systems including:
- 13.7.1. AC Power
  - 13.7.1.1. sourcing load
  - 13.7.1.2. rectifying to DC conversion
- 13.7.2. DC Power
- 13.7.3. Battery backup systems and regulations including:
  - 13.7.3.1. primary
  - 13.7.3.2. secondary
  - 13.7.3.3. recharging

End of General Communications Technician – Level 2 Competencies

Additional Suggested Study Materials and Resources:

General Communications Technician, Level 2; Ira Wiesenfeld, P.E., CETsr, Rob Walker, LAS, PIM, Jay Thompson, CETsr, A.J. Wiesenfeld, BSEE, LAS; ISBN 978-0-9915913-3-6; Self Published; 2015; softcover. Contact ETA® International at 800-288-3824 or eta@eta-i.org

Modern Electronic Communication, 9E; Jeff Beasley, Gary Miller, ISBN 978-0-13225113-6; Prentice Hall; 2007; hardcover.

Wiring for Wireless Sites; Ira Wiesenfeld, P.E., CETsr, ISBN 978-1-40181037-5; Prompt; 2002; softcover. Contact ETA® International at 800-288-3824 or eta@eta-i.org

ARRL Handbook, 2015 (Annual); Numerous Authors; ISBN 978-1-62595-019-2; The American Radio Relay League, Inc.; 2015

Practical Antenna Handbook, 5E; Carr, Hippisley; ISBN 978- 0071639583; McGraw-Hill; 2011

New HAM Radio License? Now What?; James Sanders, AG6IF; Kindle Edition; Amazon; 2014

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

http://www.dhs.gov/communications-technician-training http://www.eta-i.org/communications.html#GCT

http://www.iwa-radio.com/ http://www.braddye.com/ http://www.iwceexpo.com/iwce16/public/enter.aspx

https://www.fcc.gov/ http://wireless.fcc.gov/commoperators/index.htm?job=examinations

http://www.usmss.org/ (now TRNI=http://www.national-technology.com/) https://www.apcointl.org/

http://urgentcomm.com/ http://www.rcrwireless.com/ http://www.radioresourcemag.com/

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