General Communication Technician - Level 2 (GCT2)  Competency Requirements

The General Communications Technician Level 2 certification is a journeyman level program modeled after wide-ranging private wireless industry communication systems encompassing more specific detailed items along with the U.S. Department of Homeland Security (DHS) guidelines covering many of the disciplines in the COMT program. The GCT2 competency comprises more complex areas which a radio communications technician and/or engineer will encounter in the public safety communications or business / commercial radio fields. This GCT2 certification will involve more knowledge of intricate skills and troubleshooting.

The purpose of the GCT2 is to provide a certification program and testing that expands upon the coverage included in the ETA® GCT1 competencies. The GCT2 certification technician candidate must hold the GCT1 or the Associate CETa as the minimum pre-requisite certification. Prior RF experience in industry and public safety best practices is highly suggested. The GCT program certifications are maintainable for all Levels.

The following Level 2 Competency listing is a more thorough acknowledgement and description of extensive individual subject topics in electronics areas in which industry General Communications Technicians (GCT2) would comprehend and experience daily. (Some competencies may be similar to items in GCT1, kept for emphasis and may apply in multiple categories).

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
   1.1.3. Occupational Safety and Health Administration (OSHA) rules

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 communication sites including:
   1.7.1. tower and elevated surfaces
   1.7.2. ladder safety (ANSI A14)

1.8. Describe grounding and lightning protection safety measures

1.9. List fiber optic safety requirements

1.10. List laser use safety requirements

1.11. Describe hazardous chemicals and materials handling situations

2.0 Electronic and Electrical Principles

2.1. Review Ohm’s law and formulas

2.2. Review Watt’s Law formula

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 AC calculations
   2.4.3.1. reactance
   2.4.3.1.1. inductive
   2.4.3.1.2. capacitive
   2.4.3.2. impedance

   2.4.4. Describe relationship of each of the following to each other:
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2.4.4.1. Root Mean Square (RMS)
2.4.4.2. Peak
2.4.4.3. Average (Avg)
2.4.4.4. Peak-to-Peak

2.5. Describe decibels (dB) and their use including:
   2.5.1. RF
      2.5.1.1. effective radiated power (ERP) formula
   2.5.2. Power
      2.5.2.1. compare relative power levels (dB)
      2.5.2.2. measure absolute power (dBm)
   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 and effects in communications

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 to 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. Next generation digital narrowband (NXDN™)
      3.4.6.2. Digital mobile radio (DMR)
      3.4.6.2.1. MOTOTRBO™
   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 amplitude modulation (QAM)
   3.4.14. 4-level pulse amplitude modulation (PAM-4)

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 (image frequency)
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 (AGC)
   3.5.3.3. automatic volume control (AVC)
   3.5.3.4. automatic frequency control (AFC)
   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 as 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 (preselector)
   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. Review the common tools used in RF communications
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
         4.3.1.2.1. repeater received signal strength (RSS)
      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
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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 (AFC) mode
4.3.1.18. bit error rate (BER) meter

4.3.2. accuracy:
  4.3.2.1. frequency
  4.3.2.2. modulation
    4.3.2.2.1. Deviation Meter Bessel Null measurement
  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 the “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
4.11. Explain “Equipment Testing” best practices to include:
   4.11.1. calibration
   4.11.2. stabilization
   4.11.3. warm-up procedure
   4.11.4. test lead loss compensation

4.12. Identify pass/fail limits for tolerances

5.0 Connectorization

5.1. Define the terms connector/connection
5.2. Describe common connector types to include:
   5.2.1. networking connectors
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. TIA-568A and TIA-568B sequences
   5.5.3. color coding to the TIA-598 standards:
      5.5.3.1. DC
      5.5.3.2. AC
      5.5.3.3. 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 especially ground/bonding practices
   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)
         6.1.2.1.4. surge protection
      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
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6.1.2.4.4. hydro
6.1.2.5. distribution systems
6.1.3. installation planning procedures including infrastructure

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
         7.2.7.1.1. Effective Isotropic Radiated Power (EIRP)
         7.2.7.1.2. dBi, dBW, dBd
   7.2.8. match
   7.2.9. return loss versus VSWR (voltage standing wave ratio) (aka: SWR)
      7.2.9.1. maximum VSWR
         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
      7.2.12.8. handheld transceivers
   7.2.13. separation and its 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
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7.3.1.2.2. Ethernet
7.3.1.2.3. existing LAN/Cat5e/Cat6/6A

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
      7.4.4.3.2. riser rating
    7.4.4.4. shielding percentage
    7.4.4.5. bend radius
    7.4.4.6. design choices of cable type
    7.4.4.7. velocity factor

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 (DTF)
  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. standalone
    7.6.1.3. self-supporting
    7.6.1.4. portable:
      7.6.1.4.1. Cell on wheels (C.O.W.)
      7.6.1.4.2. S.O.W. (site on wheels)
      7.6.1.4.3. C.O.L.T. (cell on light truck)
      7.6.1.4.4. C.O.P. (cell on platform)
  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 its affects

7.7. Describe proficient engineering practices for grounding and lightning protection

8.0 Operating Principles of Radio and Electronic Communications Equipment

8.1. Explain basic international, federal, state, tribal and local (authorities having jurisdiction-AHJ) regulations rules and regulations pertaining to two-way communications including:
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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 (WTB) or similar department
  8.2.2.1. public safety
  8.2.2.2. Homeland Security (DHS)
8.2.3. FCC (other national) rules and regulations

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 band allocations 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 (BER)
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:
  \[20 \times \log_{10} \left( \frac{\text{Frequency} \times \text{Distance}}{2 \times \text{Height}} \right) + 36.6\]
  8.7.1.1. obstructions adjustment
  8.7.1.2. over water adjustment
8.7.2. Line-of-Sight (LoS) Range
  8.7.2.1. Formula: Distance(miles) = Square Root of \{2 \times \text{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 the consoles used in radio control schemes including:
  8.11.1. direct control
  8.11.2. DC control
  8.11.3. tone remote control
  8.11.4. internet protocol (IP) control:
    8.11.4.1. simple network management protocol (SNMP)

8.12. Describe radio paging systems including:
  8.12.1. types of pagers and systems
  8.12.2. page initiation and capcode
  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
  8.13.5. delivered audio quality (DAQ)

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 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

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
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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 FLs (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
      8.26.8.1. isolators
      8.26.8.2. circulators
   8.26.9. harmonic filters

8.27. Describe how transmitter combiners functions including:
   8.27.1. hybrid
   8.27.2. star

8.28. Describe the function of receiver multi-couplers

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

8.34. Describe tower top amplifiers (TTA)

8.35. Explain Keyloading

8.36. Define DTMF (dual-tone multi-frequency) signaling and where it is used

8.37. Define SCADA (supervisory control and data acquisition) and where it is used

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

9.1. Describe numbering systems
   9.1.1. decimal
   9.1.2. binary
   9.1.3. octal
   9.1.4. Hexadecimal
   9.1.5. binary coded decimal (BCD)

9.2. Describe the Open Systems Interconnect (OSI) model
   9.2.1. Define model layers
      9.2.1.1. Physical
      9.2.1.2. Data Link
      9.2.1.3. Network
General Communication Technician Level 2 Knowledge Competencies

9.2.1.4. Transport
9.2.1.5. Session
9.2.1.6. Presentation
9.2.1.7. Application

9.3. Describe the legacy RS232 interface standard including:
9.3.1. data terminal equipment (DTE)
9.3.2. data communications equipment (DCE)

9.4. Describe equipment port adapters interface standards including:
9.4.1. serial conversion to RS422 format
9.4.2. serial to USB (universal serial bus):
   9.4.2.1. prolific chip set
9.4.3. Ethernet
9.4.4. modem or short-haul modem

9.5. Describe data networks including:
9.5.1. hardwired Ethernet
9.5.2. wireless using IEEE 802 standards

9.6. Define IP addressing schemes including:
9.6.2. Version 6 (IPv6) ranges
9.6.3. dynamic host control protocol (DHCP)

9.7. Define Radio over IP (RoIP) including:
9.7.1. gateway conversions from Analog/Digital (A/D) to D/A
9.7.2. describe latency
9.7.3. multicasting
9.7.4. transmission control protocol (TCP)
9.7.5. user datagram protocol (UDP)

9.8. Describe cybersecurity to include:
9.8.1. keeping software and operating systems (O.S., O/S) updated with latest patches
9.8.2. using reputable antivirus programs
9.8.3. recognizing malware
9.8.4. using complex passwords
9.8.5. user names and passwords on multiple sites protocol
9.8.6. keeping personally identifiable information (PII) off social media sites
9.8.7. viewing email in a text format instead of html to avoid malicious links
9.8.8. using search engine protocol (results can lead to malicious sites)
9.8.9. running browsers in “sand box” or virtual machines to isolate files from attacks
9.8.10. using non-administrator accounts whenever possible
9.8.11. disabling Java Script™ in Adobe Acrobat™ readers

9.9. Describe fiber optic systems:
9.9.1. keeping software and operating systems (O.S., O/S) updated with latest patches
9.9.2. using reputable antivirus programs
9.9.3. recognizing malware
9.9.4. using complex passwords
9.9.5. user names and passwords on multiple sites protocol
9.9.6. keeping personally identifiable information (PII) off social media sites
9.9.7. viewing email in a text format instead of html to avoid malicious links
9.9.8. using search engine protocol (results can lead to malicious sites)
9.9.9. running browsers in “sand box” or virtual machines to isolate files from attacks
9.9.10. using non-administrator accounts whenever possible
9.9.11. 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

10.3. Explain the many fiber optic cable types and uses according to TIA® and NEC® standards
   10.3.1. Explain why you never mix and match modes or cores

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)
   10.7.5. visual fault locator (VFL)
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
   12.1.2. selection of geostationary versus LEO satellite orbits
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
      12.4.1.1. manually
      12.4.1.2. automatically
   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 (heating, ventilation, air conditioning)
      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 (radio freq. identification)
         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
General Communication Technician Level 2 Knowledge Competencies

Notes: Certain of the above items will appear redundant, having been addressed in more than one CATEGORY. Also, some of the Competencies above may well have been included in the GCT1 or Associate CET level training and certification skills standards and examinations. These are included more than once for the assurance that their application and importance in each category is addressed.

This competencies listing is compiled to serve two purposes:
1. To provide industry and educational institutions with the material they need to construct an outline for any course of instruction in wireless communications for employees or students.
2. To provide an outline for those studying to sit for the General Communications Technician – Level 2 examination (including the former USMSS, MSS or TRNI exams) as a guide to the knowledge and skills they will need. Wireless Communications (WCM) or FCC GROL exams have a more conventional radio communications approach.

Find an ETA approved test site:  
http://www.eta-i.org/test_sites.html

Additional Suggested Study Materials and Resources:

- **General Communications Technician, Level 2, 4th printing**: Ira Wiesenfeld, P.E., CETms, Rob Walker, CET, Jay Thompson, CETsr, A.J. Wiesenfeld, BSEE, CETsr; ISBN 978-0-9915913-3-6; Self Published; 2017; softcover. Contact ETA® International at 800-288-3824 or eta@eta-i.org
- **Standards and Guidelines for Communication Sites**: Motorola Solutions, Inc; Item# 68P81089E50-C; 2017; e-book. Contact Motorola Solutions, Inc Parts Dept. at 800-422-4210 or https://www.motorolasolutions.com/en_us/products/training.html
- **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

https://www.dhs.gov/rosa
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https://www.fcc.gov/
http://www.braddye.com/
https://www.iwceexpo.com/iwce19/Public/Enter.aspx
https://www.doverts.com
https://www.apcointl.org/
http://urgentcomm.com/
http://www.rcrwireless.com/
http://www.radiosource.com/

Refer to TIA TSB-88 information and many more related websites

ETA certification programs are accredited through the ICAC, complying with the ISO/IEC 17024 standard.
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Many outstanding subject matter experts have come off the committee, leaving a legacy that continues.