Personal Communication Service-Cellular (PCS-C) Technician
CATEGORIES LIST

The following is a listing of the major areas required for courses, training or study for PCS-C

1.0 PCS-C Concepts
2.0 RF Transmit, Propagate and Receive Principles
3.0 Backhaul Transmission System and Mobile Switching Center Principles
4.0 Technical Procedures
5.0 Technical Capabilities
6.0 Test Equipment
7.0 Knowledge of Components
8.0 Antennas
9.0 Frequency Bands
10.0 Customer Relations
11.0 Safety and Regulations
Personal Communication Service-Cellular (PCS-C) Technician

ITEMS LIST

The following is a listing of the major items required for courses, training or study for PCS-C

1.0 PCS-C CONCEPTS

1.1 network structures; SS7; IS-41 protocols
1.2 antennas; transmitters; receivers
1.3 acronyms for cellular systems identities: MIN, ESN, SID, PSID, RSID, TLDN; industry terms: VSWR, return loss (RL) dBm, Capture Effect, frequency reuse, frequency planning, and co-channel interference
1.4 analog; digital modulation
1.5 vocoder; speech encoder
1.6 pre-emphasis; de-emphasis; compression/expansion
1.7 purpose of a duplexer; TV combiner, isolator and RX block filters, multicouplers
1.8 base station systems and subscriber phones; RF components
1.9 frequency ranges in 1900 MHz PCS, 800 MHz Cellular
1.10 frequency duplex separation in PCS and Cellular operations
1.11 channels, and co-channel interference; RF interference and frequency planning
1.12 intersystem and intercell handoffs
1.13 MSC functions and basic systems components
1.14 cells, sectors, handoffs
1.15 GPS system, Stratum clocks
1.16 CDMA, and GSM Systems
1.17 Wireless data transmission

2.0 RF TRANSMIT, PROPAGATION AND RECEIVE PRINCIPLES

2.1 RF-signal
2.2 signal frequency; wavelength frequency
2.3 frequency selective fading; multipath signals
2.4 digital systems; GSM; CDMA, signal propagation
2.5 CDMA call capacity; multipath combination
2.6 packet burst transmission; battery life; on/off times; data bit rates with GSM and CDMA technology

3.0 BACKHAUL TRANSMISSION SYSTEM AND MOBILE SWITCHING CENTER PRINCIPLES

3.1 T1, DS-1 signaling standards
3.2 DS3 links
3.3 OC , STS and optical fiber transport standards
3.4 CSU, DSUs and Smart Jacks
3.5 DSX-1 patch panels
3.6 TMS- transmission measuring test set operation
3.7 Base station to MSC interconnects
3.8 Equipment Cross connects
3.9 DACS operation
3.10 MSC, MTX mobile switching center functions
3.11 Interconnecting Trunks
3.12 Intersystem handoffs
3.13 ROAMING principles
3.14 Service features
3.15 Networks

4.0 TECHNICAL AND TROUBLESHOOTING PROCEDURES
4.1 signal-to-noise ratio
4.2 frequency error and FM deviation on a service monitor
4.3 volts; watts; decibels
4.4 wavelength, frequency; watts and decibels
4.5 RF wattmeter; standing wave meter; VOM
4.6 frequency variation
4.7 equipment specifications
4.8 multiplexing; demultiplexing
4.9 A/D conversion, digital modulation and VOCODER operations
4.10 network operations center, base station alarms
4.11 T1 analyzer testing and troubleshooting
4.12 T1 span and DSX-1 cross-connect panel

5.0 TECHNICAL CAPABILITIES
5.1 Journeyman troubleshooting procedures
5.2 UHF radio equipment
5.3 transmission line testing
5.4 ‘dropped call’ reports
5.5 Analog Control Channels; Analog Voice Channels; Digital Voice Channels, Digital Control Channels; Slow Associated Control Channel; Fast Associated Control Channel
5.6 troubleshooting battery powered communications equipment
5.7 DC power supply; rectifiers; charging circuits; floating; equalize; backup supplies; UPS operation
5.8 transmitter final amplifiers
5.9 audio clipping; waveform frequency response
5.10 band pass; notch filters
5.11 DS1/DS3 theory; BER; base station interface equipment; MSC
5.12 digital data transmission; packet switching; data rates; DS1; fiber optic OC3; larger capacity systems
5.13 RF cellular/PSC and logical sub channels
5.14 analog and digital Mobile Assisted Handoff (MAHO)
5.15 GPRS, EDGE, 1xRTT EVDO, EV-DV, 3xRTT standards
5.16 Helix transmission lines; adaptors; connectors
5.17 TDOA and GPS assisted E911, geographic mapping, location based services

6.0 TEST EQUIPMENT
6.1 test equipment; applications
6.2 installation tools for connectors and shelf rack equipment
6.3 RF circuits; transmission line; antenna sweep; service monitor
6.4 transceiver commissioning
6.5 transmitter frequency error, power output
6.6 modulation measurements — (deviation and constellation patterns)
6.7 receiver SINAD and BER testing;
6.8 receiver sensitivity, squelch threshold and handoff points; DRIVE testing
6.9 remote diagnostic software
6.10 monitoring system functions in field test mode

7.0 KNOWLEDGE OF COMPONENTS
7.1 electronic signal filters
7.2 coax cable types, connectors, adapters; comparative loss factors for each
7.3 solid state components, ICs and transistors used in control functions; display drivers, transmitter output, and RF receive circuits
7.4 components that affect system optimization and performance
7.5 types of handheld terminals, phones, PDAs that use text, multimedia and video, and associated services with each

8.0 ANTENNAS
8.1 common antenna types and names
8.2 vertical and horizontal polarization antenna patterns
8.3 antenna bandwidth and gain factors
8.4 return loss; VSWR; use of a tracking generator with a spectrum analyzer in a communications service monitor; use of a site analyzer to perform a sweep of an antenna system
8.5 types of towers and antenna supporting structures
8.6 micro, macro and pico cell sizes and coverage areas
8.7 omni and sectorized antenna installations

9.0 FREQUENCY BANDS
9.1 frequencies; channels; block assignments
9.2 service bands; spectrums
9.3 Interference Issues from other services
9.4 FCC rules
9.5 3G frequency bands

10.0 CUSTOMER RELATIONS
10.1 service facility
10.2 phone operation
10.3 E911 systems
10.4 Location based services
10.5 Voice mail, Text messaging and Service features

11.0 SAFETY AND REGULATIONS
11.1 base stations
11.2 tower safety
11.3 high-current battery
11.4 backup power supply systems; charging systems
11.5 UHF and microwave radiation
11.6 log keeping
Personal Communication Service-Cellular (PCS-C) Technician
COMPETENCY REQUIREMENTS

PCS-C technicians are expected to obtain knowledge of personal cellular basics and concepts which are then applicable to all the various types of personal communication systems. Once the PCS-C has acquired these skills, abilities and knowledge, he or she will be able to enter employment in any part of the PCS-C communications field. With minimal training in areas unique to specific products, the PCS-C should become a profitable and efficient part of the PCS Cellular electronics-communications workforce.

PCS-C technicians must be knowledgeable and have abilities in the following descriptive technical and human relationship Competencies:

1.0 PCS-C CONCEPTS

1.1 Describe PCS/Cellular network structures, using IP network backbones, SS7 common channel signaling links and IS-41 protocols.
1.2 Describe RF communications theory used in cellular base stations including antennas, transmitters and receivers.
1.3 Identify common terms and acronyms used in the PSC-C field such as, but not limited to: MIN, ESN, SID, PSID, RSID, TLDN identities, (GSM systems use IMSI, IMEI, PLMN, TMSI as similar acronyms); VSWR, Return Loss (RL), dBm, Capture Effect, frequency reuse, frequency planning, and co-channel interference.
1.4 Describe common analog and digital modulation methods such as FM, PM, GMSK, BPSK, QPSK, OQPSK, Pi/4DQPSK, as well as multiple user access methods of FDMA, TDMA, GSM and CDMA.
1.5 Describe vocoder, speech encoder and decoder operations.
1.6 Describe pre-emphasis/de-emphasis theory, and compression/expansion companding theory in Analog systems.
1.7 Explain the purpose of duplexer, TX combiner, isolator and RX block filters, multicouplers in a base station.
1.8 Describe the operation of RF output section of base station systems and subscriber phones. State what RF components are used.
1.9 State frequency ranges expected in 1900 MHz PCS and 800 MHz Cellular.
1.10 State the standard frequency duplex separation between transmit and receive frequencies in PCS and Cellular operations.
1.11 Identify co-channel and adjacent channel interference and their causes and other common forms of RF interference.
1.12 Describe how Intersystems Handoffs are coordinated between system operators and explain the type of intercell handoff that a particular system uses (hard, soft, softer).
1.13 Describe MSC functions and basic systems components.
1.14 Describe intercell Handoff operation between cells, sectors, and intersystem handoffs between cooperating roaming partners.
1.15 Explain GPS technology and Stratum time devices.
1.16 Define CDMA and GSM digital access methods.
1.17 Describe current wireless data transmission methods.
2.0 RF TRANSMIT, PROPAGATE AND RECEIVE PRINCIPLES
2.1 Describe RF-signal propagation principles.
2.2 Explain the relationship of signal frequency to wavelength.
2.3 Explain how frequency selective fading and multipath signals can be improved with diversity receiver operation.
2.4 State the different characteristics of digital systems, such as GSM and CDMA, and how signal propagation is affected by these processes.
2.5 Describe the benefits of CDMA in call capacity and effective combining of multipaths to enhance signal quality.
2.6 Compare packet burst transmission, the effects on voice signal quality, user handset battery life, transmitter on and off times, and overall data bit rates possible with each access technology (GSM and CDMA systems).

3.0 BACKHAUL TRANSMISSION SYSTEM & MOBILE SWITCHING CENTER PRINCIPLES
3.1 Explain T1, DS-1 signaling standards.
3.2 Describe DS3 links.
3.3 Explain OC, STS and optical fiber transport standards.
3.4 Describe CSU, DSUs and Smart Jacks.
3.5 Describe DSX-1 patch panels.
3.6 Define TMS – transmission measuring test set operation.
3.7 Explain Base station to MSC interconnects.
3.8 Describe Equipment cross-connects.
3.9 Describe DACS operation.
3.10 Describe MSC, MTX mobile switching center functions.
3.11 Define Interconnecting trunks.
3.12 Explain Intersystem handoffs.
3.13 Describe ROAMING principles.
3.14 Describe Service features.
3.15 Define Networks.

4.0 TECHNICAL AND TROUBLESHOOTING PROCEDURES
4.1 Describe how to measure signal-to-noise ratio, quieting sensitivity.
4.2 Describe how to measure transmitter frequency error in percent and FM deviation on a communications service monitor.
4.3 Describe how to calculate signal levels using volts, watts and decibels.
4.4 Describe how to calculate wavelength from frequency and gain/loss in decibels.
4.5 Describe how to properly use RF wattmeter, standing wave meter, VOM and communications service monitor.
4.6 Describe how to determine maximum frequency variation in respect to listed tolerances.
4.7 Describe how to interpret and understand equipment specifications.
4.8 Describe multiplexing and demultiplexing.
4.9 Describe A/D conversion, digital modulation and Vocoder operations.
4.10 Describe how to properly communicate with network operations center to advise system status and understand how to monitor base station alarms.
4.11 Explain how to use a T1 analyzer to test, troubleshoot and provision a T1 span.
4.12 Analyze, test and properly terminate a T1 span with a DSX-1 cross-connect panel.
4.13 Describe how to properly terminate and test twisted pair RJ45x, fiber optic and coaxial hard line connectors.
5.0 TECHNICAL CAPABILITIES
5.1 List chronological troubleshooting procedures for transceivers, head-end RF, Computer or Telecom sections of a system.
5.2 Describe all special circuits used in UHF radio equipment.
5.3 Describe Transmission line testing
5.4 Explain dropped-call reports, how they are interpreted and utilized.
5.5 Define: Analog Control Channels; Analog Voice Channels; Digital Voice Channels, Digital Control Channels; Slow Associated Control Channel; Fast Associated Control Channel
5.6 Explain troubleshooting procedures for 48v, 24v and 12v battery powered communications equipment.
5.7 Describe DC power supply elements, rectifiers, charging circuits, floating and equalize, backup supplies and UPS operation.
5.8 Explain how to calculate power dissipation in transmitter final amplifiers.
5.9 Describe audio clipping, its causes, manifestation and potential corrections; the effects of poor low or high frequency response in waveforms.
5.10 Explain how band pass and notch filters work.
5.11 Discuss DS1/DS3 theory, terminology and troubleshooting. Explain the procedures for interpreting BER (bit error rates) and diagnosing base station interface equipment connecting to the MSC.
5.12 Describe digital data transmission, packet switching, and data rates associated with channels on a twisted pair DS1, and fiber optic OC3 and larger capacity systems.
5.13 Define types of physical RF cellular/PCS and logical sub channels:
5.13.1 Analog Control Channels (ACC)
5.13.2 Analog Voice Channels (AVC)
5.13.3 Digital Voice Channels (DVC)
5.13.4 Digital Control Channels (DCCH)
5.13.5 Slow Associated Control Channel (SACCH)
5.13.6 Fast Associated Control Channel (FACCH)
5.14 Describe how the analog and digital Mobile Assisted Handoff (MAHO) operations are performed.
5.15 Compare the current common wireless data transmission methods, GPRS, EDGE, 1xRTT EVDO, EV-DV, 3xRTT and other current licensed standards.
5.16 Identify types of coaxial Heilax transmission line sizes 7/8, 1 1/4, 1 5/8, 2 1/4, adaptors and connectors.
5.17 Describe TDOA and GPS assisted E911, geographic mapping and location based services.

6.0 TEST EQUIPMENT
6.1 Properly operate test equipment necessary for use in PCS-C applications.
6.2 List Installation tools for connectors and shelf rack equipment
6.3 Explain troubleshooting methods used to analyze and locate malfunctions in RF circuits, including transmission line TDR and FDR measurements on a typical communications service monitor.
6.4 Describe transceiver commissioning
6.5 Describe how to measure transmit power output in dBm and dBW.
6.6 Define modulation measurements –(deviation and constellation patterns)
6.7 Explain how to measure receiver sensitivity, squelch threshold and handoff points in dBm and in digital BER units.
6.8 Describe the method of analyzing system performance with drive testing and monitoring equipment.
6.9 Describe the method of analyzing system parameters with software on laptop computer.
6.10 Explain how to monitor system functions with a handheld phone in field test mode.
7.0 COMPONENTS
7.1 Explain all types of electronic signal filters.
7.2 List coax cable types, connectors, adapters and comparative loss factors for each.
7.3 Identify solid state components, ICs and transistors used in specific applications such as control functions, display drivers, transmitter output, and RF receive circuits.
7.4 Explain how the components affect system optimization and performance.
7.5 Recognize types of handheld terminals, phones, PDAs that use text, multimedia and video and list services associated with each.

8.0 ANTENNAS
8.1 Identify common antenna types and names.
8.2 Explain how vertical and horizontal polarization antenna patterns are used.
8.3 Describe the factors which affect the bandwidth and gain of an antenna.
8.4 Explain Return Loss, VSWR and list the procedures in using a tracking generator with a spectrum analyzer in a communications service monitor or in using a site analyzer to perform a sweep of an antenna system.
8.5 Describe common types of towers and antenna supporting structures.
8.6 Define micro, macro and pico cell sizes and coverage areas.
8.7 Recognize omni and sectorized antenna installations.

9.0 FREQUENCY BANDS
9.1 List the current frequencies, channels and block assignments used for Cellular and PCS systems.
9.2 List where interference could be generated in other service bands, UHF TV, pagers and other possible sources.
9.3 Locate adjacent service bands such as SMR, ESMR and show their locations with respect to 800 and 1900 MHz spectrums.
9.4 List the pertinent FCC rules and regulations governing Personal Communications Services and Cellular operations.
9.5 Identify frequency bands on the spectrum chart for 3G and newer services.

10.0 CUSTOMER RELATIONS
10.1 Describe the need to communicate and explain to the public what your job is and how it relates to their phone’s operation.
10.2 List competitive PCS or cellular systems and describe how and why the technician should treat them with respect.
10.3 Describe E911 systems
10.4 Describe location based services
10.5 Describe voice mail, text messaging and other service features

11.0 SAFETY AND REGULATIONS
11.1 Describe safety precautions involved in Cellular and PCS base stations.
11.2 List the dangers of working around high-current battery plant and charging systems.
11.3 List the potential health effects of long exposure to UHF and microwave radiation.
11.4 Define Backup power supply systems; charging systems
11.5 Describe UHF and microwave radiation
11.6 Define Log keeping

End of Personal Communication Service-Cellular Competencies (with 11 major Categories)

Find An ETA Test Site: http://www.eta-i.org/testing.html

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Study Guide Suggestions:


**GWED Curriculum Modules;** http://www.gwec.org/

Suggested Web sites:


Nokia:  [www.nokia.com](http://www.nokia.com);  

Ericsson:  [www.ericsson.com](http://www.ericsson.com)
Mobile Learning:  
Wireless Glossary:  

Training courses:  [https://training.lucent.com/Saba/Web/Main](https://training.lucent.com/Saba/Web/Main)

HP/Agilent educators corner:  [http://www.educatorscorner.com/index.cgi](http://www.educatorscorner.com/index.cgi)

Tessco:  [www.tessco.com](http://www.tessco.com)

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**PCS-C Committee Members:**

John Baldwin, CETsr, MN
James Arcaro, CETsr, OH
David Caldwell, CETsr, PA
Robert Ing, Ph.D., CESma, Ont. Canada
Cully Phillips, CET, PA
Kirby L. Wallace, IL
Tom Janca, CETsr, CO
Paul Menz, WI
Paul Muse, TX