THE EXAM CORNER #5

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This is the last in the series of three lessons on propagation. The General Class license is so desirable because it gives us access to worldwide communications on HF bands, but over-the-horizon signals have to be "bounced" (technically refracted) back down to Earth one or more times by the atmosphere (most often, by the ionosphere).

Again, I will briefly discuss what you need to know about an aspect of that subject, then show you the only exam questions that could appear on that aspect, and follow with hints as to how you can remember the right answer. The correct answer is in bold.

● Remember from the last lesson that the layers of the ionosphere are in alphabetical order with D being closest to the Earth, then E, then F1 and F2. The higher you go, the farther radio waves can "bounce" in one hop. Recall also that propagation depends on solar intensity which of course is maximized when the Sun is directly overhead, which also heats the ionosphere and causes it to rise higher from the ground.

G3C01 Which ionospheric layer is closest to the surface of the Earth?

A. The D layer
B. The E layer
C. The F1 layer
D. The F2 layer

G3C03 Why is the F2 region mainly responsible for the longest distance radio wave propagation?

A. Because it is the densest ionospheric layer
B. Because it does not absorb radio waves as much as other ionospheric regions
C. Because it is the highest ionospheric region
D. All of these choices are correct

G3C02 Where on the Earth do ionospheric layers reach their maximum height?

A. Where the Sun is overhead
B. Where the Sun is on the opposite side of the Earth
C. Where the Sun is rising
D. Where the Sun has just set

● The D and F layers are most important for HF communications. During the day, the D layer absorbs the lower HF frequencies below 10 MHz (*i.e.* the 160, 80, 60 and 40-meter bands) while it lets higher HF frequencies, up to 10 meters, through to be sent back to Earth by the F layers.

G3C05 Why is long distance communication on the 40-meter, 60-meter, 80-meter and 160-meter bands more difficult during the day?

A. The F layer absorbs signals at these frequencies during daylight hours
B. The F layer is unstable during daylight hours
C. The D layer absorbs signals at these frequencies during daylight hours
D. The E layer is unstable during daylight hours

G3C12 Which ionospheric layer is the most absorbent of long skip signals during daylight hours on frequencies below 10 MHz?

A. The F2 layer
B. The F1 layer
C. The E layer
D. The D layer
Hint: notice that these two questions ask the exact same thing in slightly different ways.

● Now we need to refine our mental model of the ionosphere a little. Until now we have treated it essentially as a mirror, that smoothly "reflects" (actually refracts) radio waves back down to Earth. In reality the ionosphere, like the rest of the atmosphere, is uneven and turbulent. Under good conditions, the ionosphere does "bounce" a substantial fraction of the radio energy reaching it straight ahead and back down to Earth. However, the ionosphere always scatters some of the radio energy reaching it in all directions. Signals received due to atmospheric scatter are often distorted and have a "wavering" sound because the signal is received over multiple radio wave paths.

Due to this scattering effect, signals can be distributed over a limited area even if they are aimed straight up; this is called NVIS (Near Vertical Incidence Skywave). Also, the Maximum Usable Frequency (MUF) is based on normal skywave propagation and scatter can occur at frequencies above the MUF.

G3C06 What is a characteristic of HF scatter signals?
A. They have high intelligibility
B. They have a wavering sound
C. They have very large swings in signal strength
D. All of these choices are correct

G3C07 What makes HF scatter signals often sound distorted?
A. The ionospheric layer involved is unstable
B. Ground waves are absorbing much of the signal
C. The E-region is not present
D. Energy is scattered into the skip zone through several different radio wave paths
Hint: key word "scatter" appears in the question and correct answer.

G3C13 What is Near Vertical Incidence Sky-wave (NVIS) propagation?
A. Propagation near the MUF
B. Short distance MF or HF propagation using high elevation angles
C. Long path HF propagation at sunrise and sunset
D. Double hop propagation near the LUF
Hint: "near vertical" = "high elevation angle"

G3C11 Which of the following antenna types will be most effective for skip communications on 40-meters during the day?
A. A vertical antenna
B. A horizontal dipole placed between 1/8 and 1/4 wavelength above the ground
C. A left-hand circularly polarized antenna
D. A right-hand circularly polarized antenna
Hint: this question actually relates to NVIS although it does not say so – that kind of antenna generates a mostly vertical radiation pattern.

G3C10 Which of the following might be an indication that signals heard on the HF bands are being received via scatter propagation?
A. The communication is during a sunspot maximum
B. The communication is during a sudden ionospheric disturbance
C. The signal is heard on a frequency below the Maximum Usable Frequency
D. The signal is heard on a frequency above the Maximum Usable Frequency

● There is a “skip zone” between the end of the ground wave signal (where the signal can be heard directly from the transmitter) and the place where the skywave comes back down to Earth after the first hop – in this region, a signal could not normally be heard, but scatter tends to fill in the skip zone to a degree. However, scatter signals in the skip zone are weak since only a small part of the signal energy is scattered into the skip zone.

G3C09 What type of radio wave propagation allows a signal to be detected at a distance too far for ground wave propagation but too near for normal sky-wave propagation?

A. Faraday rotation
B. Scatter
C. Sporadic-E skip
D. Short-path skip

G3C08 Why are HF scatter signals in the skip zone usually weak?

A. Only a small part of the signal energy is scattered into the skip zone
B. Signals are scattered from the magnetosphere which is not a good reflector
C. Propagation is through ground waves which absorb most of the signal energy
D. Propagations is through ducts in F region which absorb most of the energy

● The angle to the ground that a signal takes off from a transmitter matters. If it is too low, it will be obstructed by hills, trees, and buildings before reaching the ionosphere. If it is too high (too vertical), it can scatter (NVIS as discussed above) but cannot be refracted back to the ground as a normal skywave. The highest takeoff angle that works to get normal skywave “reflection” under the current ionospheric conditions is called the “critical angle”.

G3C04 What does the term "critical angle" mean as used in radio wave propagation?

A. The long path azimuth of a distant station
B. The short path azimuth of a distant station
C. The lowest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions
D. The highest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions

That’s the end of installment #5, and the conclusion of our discussion of the three exam sections on propagation. One question on the exam is guaranteed to come from the list above (so there will be a total of three exam questions on propagation).

Comments are welcome -- contact me at aa8sw@att.net, or Robert at ak3q@ak3q.com.