Tactical HF communications operating range goes from zero (ground wave) to approximately 400 miles. This type of HF operation required operating in the Near Vertical Incident Skywave (NVIS) mode.

Optimum NVIS propagation is achieved by operating at or slightly below the local Critical Frequency (CF). The CF is defined as the highest frequency signal that will reflect directly back to its transmission location as shown in Figure 1. The signal will be reflected from the higher F-layer if the operating frequency is near the foF2 (frequency of the Ordinary wave reflected from the F2 layer) critical frequency. The CF is dependent on the intensity of the ultra-violet (UV) radiation from the sun and so varies with the time of day and day of the sunspot cycle. Increased UV radiation will increase the CF of the F-layer. The CF is measured by ionosondes located all over the world. An ionosonde measures the structure of the ionosphere directly overhead by transmitting a sequence of varying frequency pulses and then analyzing the strength and delay time of the echoes.

Figure 1: Critical Frequency Definition

Data from this world-wide series of ionosondes can be found at: http://ulcar.uml.edu/DIDBase/
Click on *Station List* and then select #13 EG931-Eglin AFB. This will bring up a series of screens that allow you to select the Year, Month, Day, and Time. All dates and times are in UTC (Zulu) time. Eglin AFB is 52 minutes in sun time ahead of central Texas (difference in Longitude) so what will happen to the ionosphere over Texas is occurring over Eglin about one hour earlier. For example, to determine the Critical Frequency for a 1400Z net (0800 CST) look at the 1300Z data for Eglin AFB. You can also look ahead in time to see what is going to happen to the CF during the net. This is valuable for an early evening net since typically the CF with drop rapidly after dark, requiring a frequency change during the net.

**Ionosonde Interpretation For Selection of Critical Frequency**

An idealized ionosonde plot is shown in Figure 2.

![Figure 2: Ionosonde Plot Definitions](image)

The Critical Frequency, foF2, is the frequency at which the Ordinary Wave reflection rises rapidly in height (Range). The Virtual height of the reflection is h’F2. An actual ionogram from Eglin AFB is shown in Figure 3.
Observe that the colors of the Ordinary and Extraordinary Wave plots are reversed from Figure 2. Typical multiple echoes, ionosphere/ground/ionosphere reflections can be seen above the first echo. If the controlling computer can scale the data, the ionospheric parameters will be listed in upper left table. A very useful second table, the MUF Chart, can be seen in the lower left part of Figure 3. The parameter “D” is the skip (exclusion) distance in Km. From Figure 3, Net operation on 60m would be excellent but 40m would have a skip zone of almost 800 miles. Many times the computer is unable to scale the data, but the plot is still available for your interpretation. Figure 4 shows an unscaled ionogram with a critical frequency of 3.9 MHz.
Critical Frequency

Computer failed to Compute critical frequency
But you can do it!

Figure 4: Ionogram Without Computer Scaling

Finally, the computer can make a scaling error resulting in reporting an incorrect CF as shown in Figure 5. This error is due to a U.S. Government requirement for U.S. ionosondes to not transmit on certain government frequencies. The computer then sometimes interprets this frequency “hole” as the rapid foF2 rise.
Figure 5: Ionosonde Computer Scaling Error

Net Frequency Selection
The optimum day time net frequency would be slightly below the CF but as high as possible to minimize D-layer absorption. Recall that D-layer absorption is inversely proportional to the frequency mathematically squared. So moving from 75m to 60m during the day time hours can produce a dramatic improvement in signal quality. Other factors such as solar x-ray flares and coronal mass ejections can have adverse effects on ionospheric propagation. Night time net frequency selection should also follow the CF only because antenna efficiency and atmospheric noise reduce communications ranges, i.e., 75m is better than 160m!

Please see: [http://www.txarmymars.org/lews_corner/NVIS Theory & Practice.pdf](http://www.txarmymars.org/lews_corner/NVIS Theory & Practice.pdf) for a more complete discussion of solar and other effects on NVIS propagation.