# *Introduction*
# *To High Frequency Radio*


***Presented by:***
***Mr. Bryan Buck WO1***
***Virginia Defense Force***


# *Introduction*

- TASK: To aid personnel in using high-frequency (HF) radio systems to achieve successful communications.
- CONDITION: The individual is provided with classroom training, documentation, and equipment.
- STANDARD: Standard is met when personnel can successfully identify the basic components of an HF system, put the components into operation, and make a communications check.

# *Introduction*

- RISK ASSESMENT: Moderate

- SAFETY CONSIDERATIONS: Do not permit antennas to come into contact with high power lines or other sources of electricity. **IT CAN CAUSE INJURY OR DEATH**. DO NOT install antennas or operate equipment during thunderstorms or high winds.

# *Introduction*

- What is an HF radio system?
- What are the characteristics, frequencies, and capabilities of an HF system?
- When to utilize HF communications.
- How to assemble an HF system.

# *What Is HF Radio?*

- HF is an abbreviation for High Frequency.
- High Frequency is a term used to describe the 1.6MHz. To 30 MHz. Portion of the radio spectrum.
- This range of frequencies can provide both short-range and long-haul communications.
- In the VaDF HF will typically be used for beyond line of site communications with a range of apox. 250 miles.

# *Radio Frequency Band Designations*

- 30-300 Hz ....ELF (extremely low frequency)
  300-3000 Hz .....…(voice / hearing range)
  3-30 kHz .....VLF (very low frequency)
  30-300 kHz .....LF (low frequency)
  300-3000 kHz ....MF (medium frequency)
  3-30 MHz .....HF (high frequency)
  30-300 MHz .....VHF (very high frequency)
  300-3000 MHz ..UHF (ultra high frequency)
  3-30 GHz .....SHF (super high frequency)
  30-300 GHz EHF(extremely high frequency)

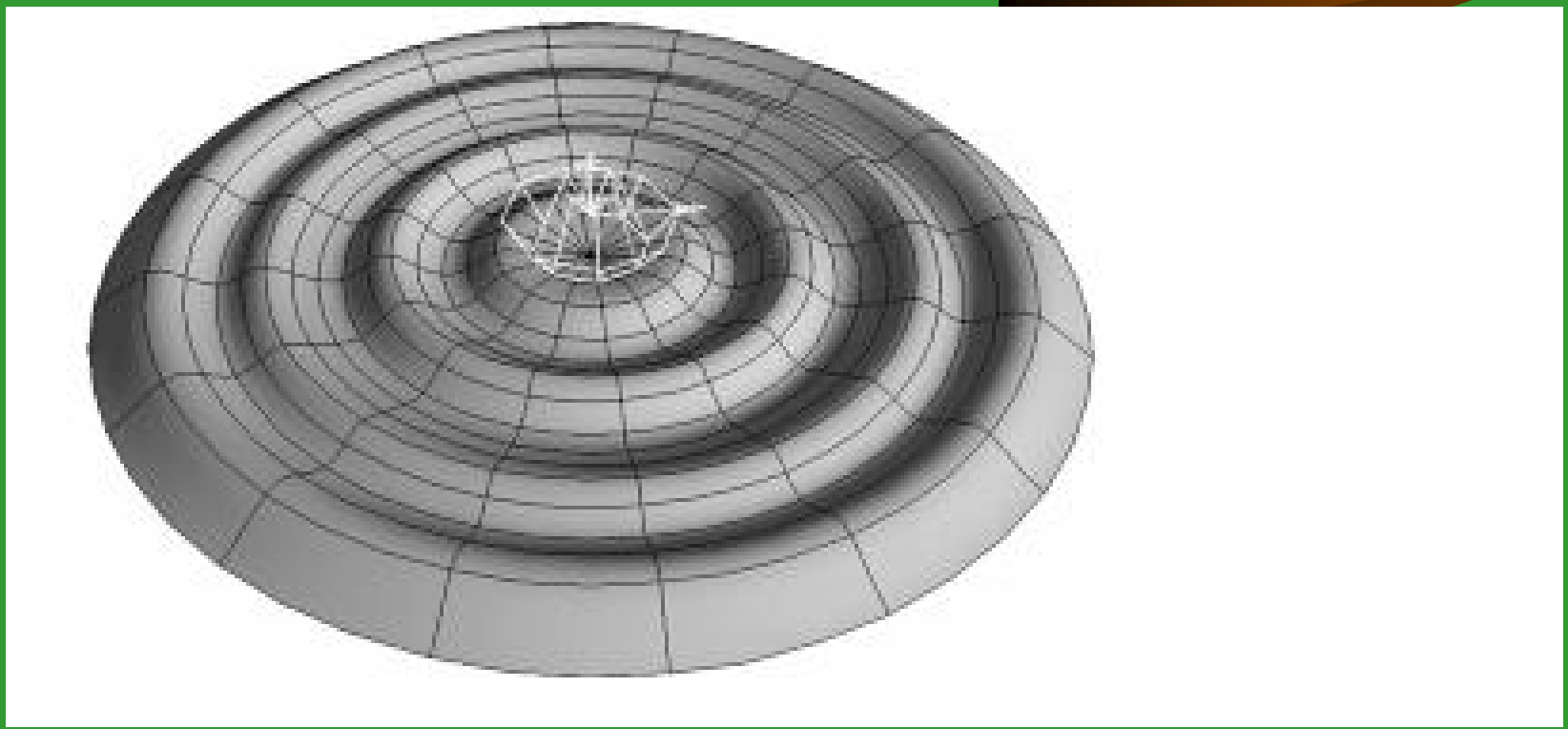
# *Characteristics*

- To communicate effectively with HF, it is necessary to understand some of its characteristics and how the earth’s atmosphere effects this frequency range.

# *Propagation*

- Propagation describes how radio signals radiate outward from a transmitting source.
- The transmitter's antenna emits radio waves much like a wave formed by dropping a stone in a pool of water.
- This is easy to imagine for radio waves that travel in a straight line in free space.
- The true path radio waves take, and how the earth's atmosphere effects radio waves is more complex.

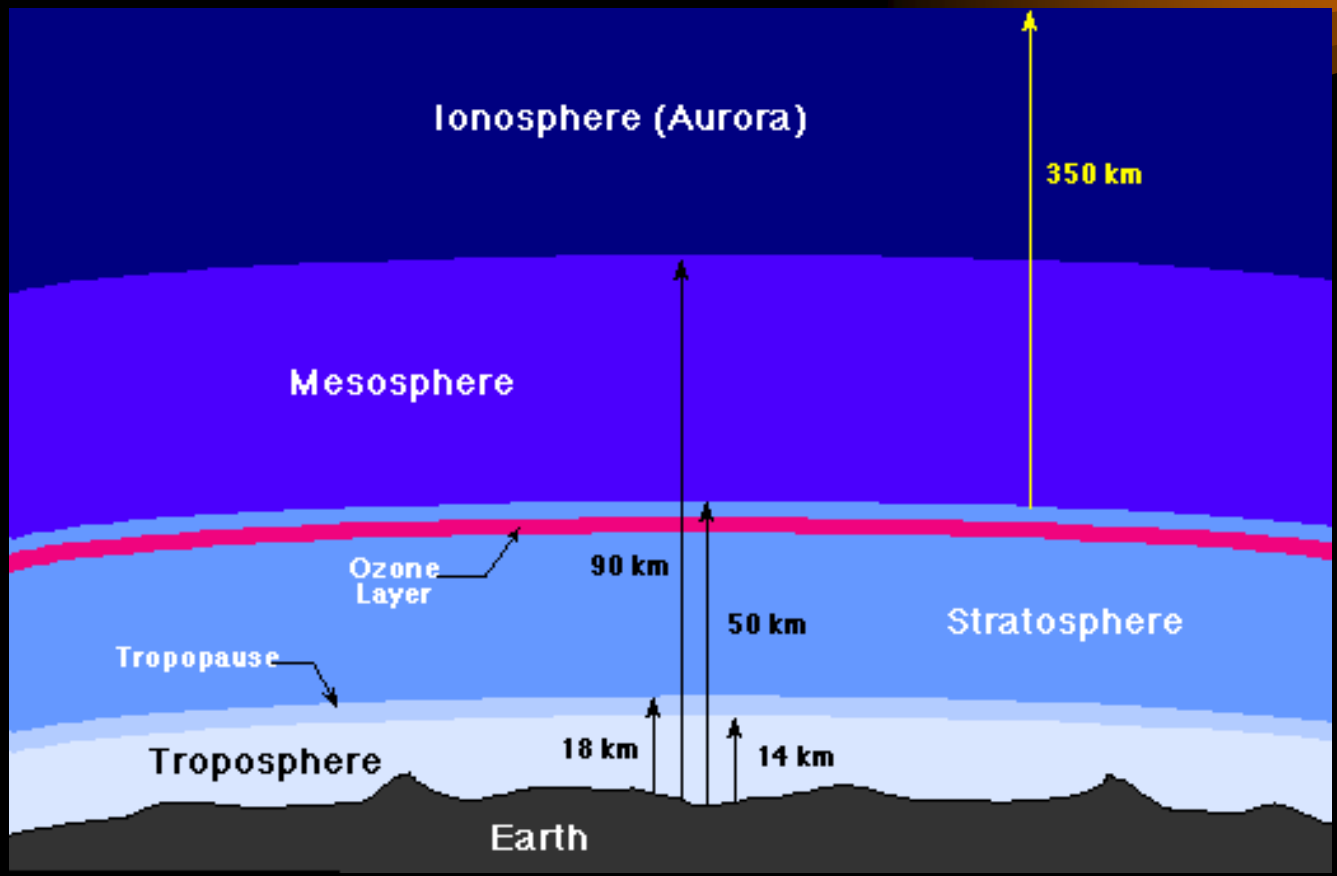
# *Propagation of Radio Wave*



# *Earths Atmosphere*

- The earth's atmosphere is divided into three separate regions, the troposphere, the stratosphere, and the ionosphere.
- The ionosphere which extends from 30 to 375 miles up, contains up to four cloud-like layers of electrically charged ions.
- It is this region and its ionized layers that enable radio waves to be propagated great distances.

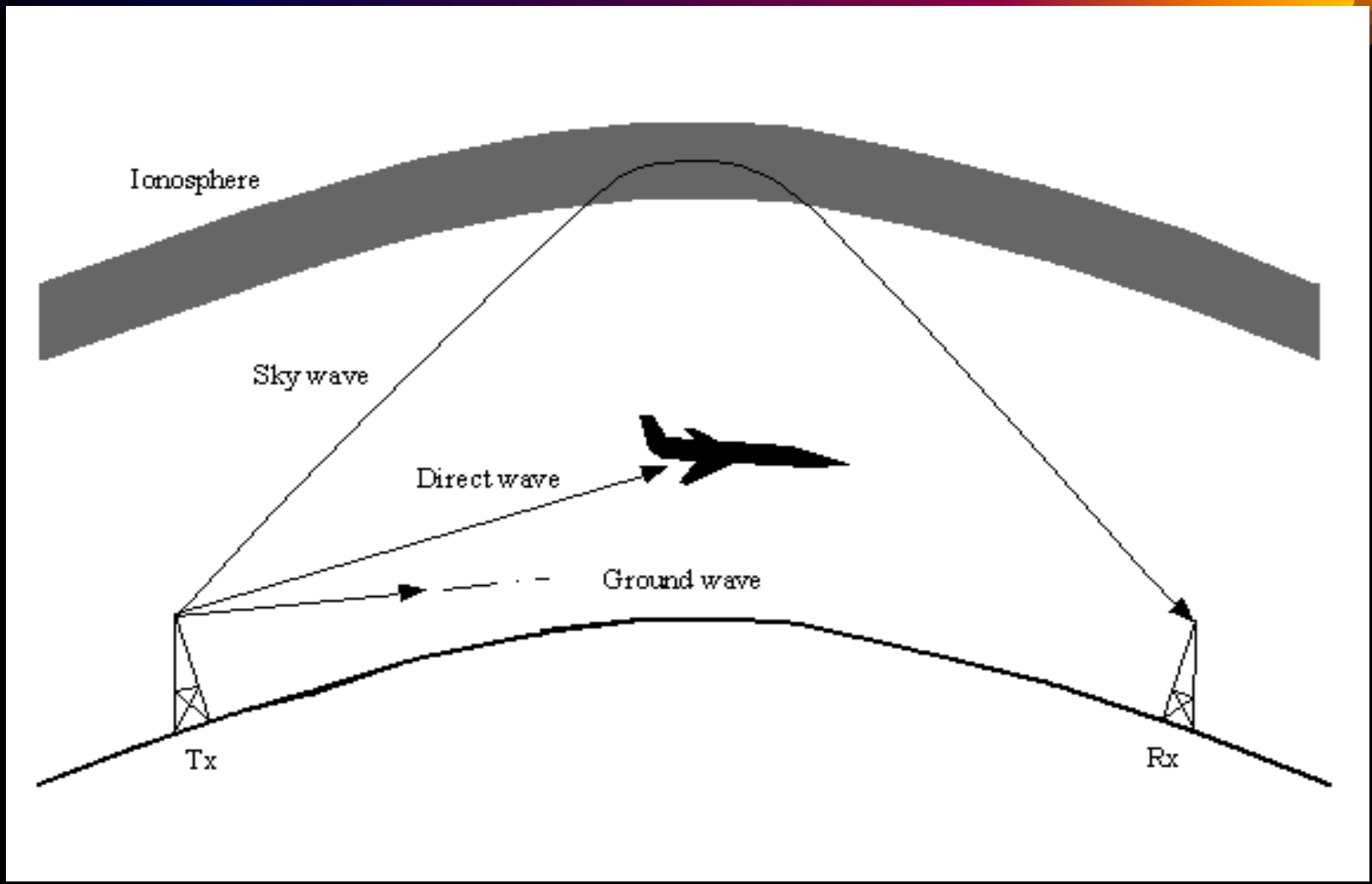
# *Earths Atmosphere*



# *Types of Propagation*

- There are two basic types of propagation:
- Ground Waves
- Sky Waves

# *Types of Propagation*



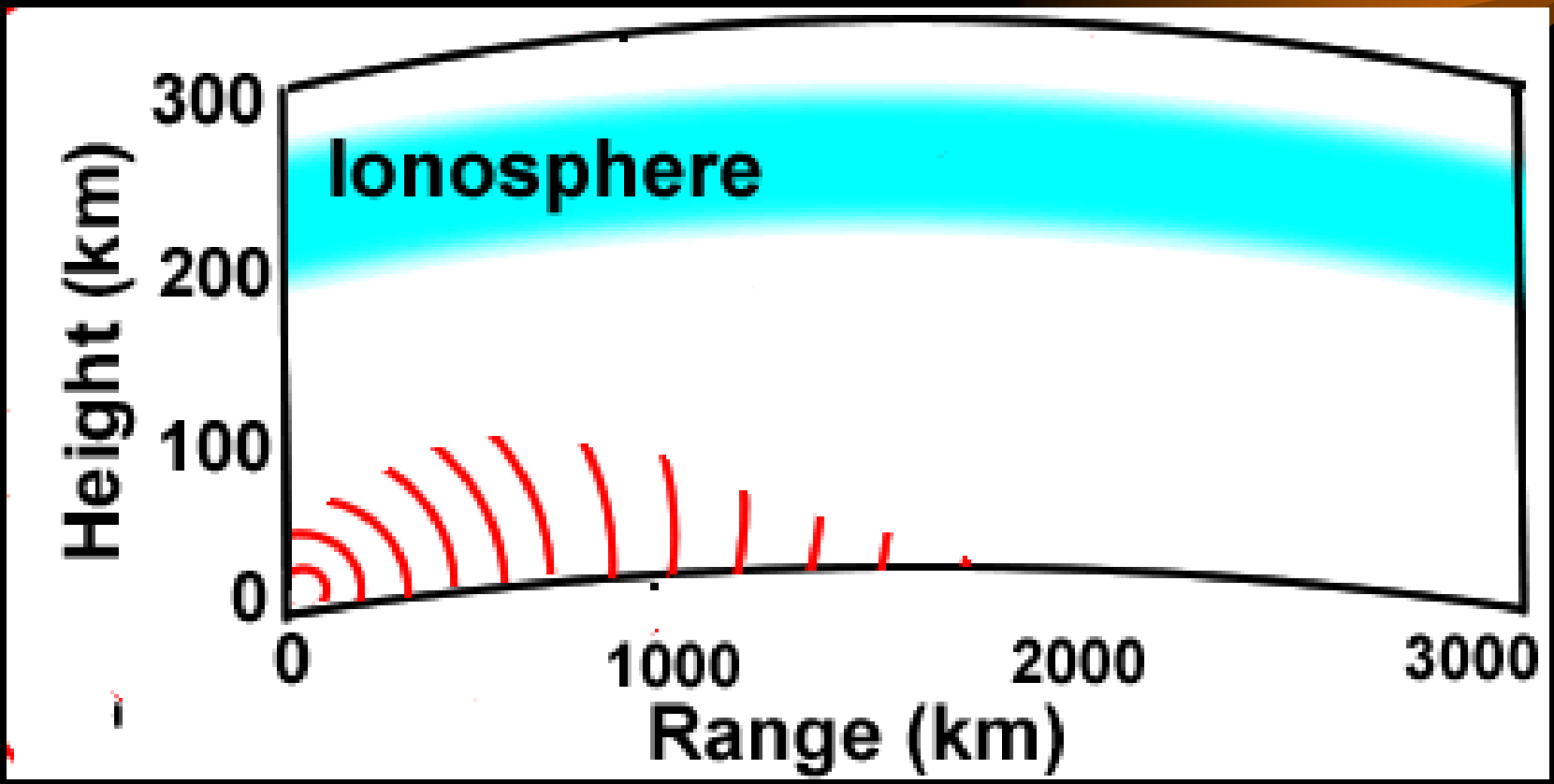
# *Ground Waves*

- Ground waves consist of three components:
- Surface Waves
- Direct or line-of-site waves.
- Ground reflected waves.

# *Surface Waves*

- Surface waves travel along the surface of the earth.
- Range is determined by frequency and the terrain it travels over.
- Range decreases with frequency, always try to use the lowest possible frequency.
- Bodies of water and flat land have the best range, forested areas and mountainous regions have the least.
- For a given HF station, the range can be 250 miles over open sea, to less than 20 miles over mountainous areas.

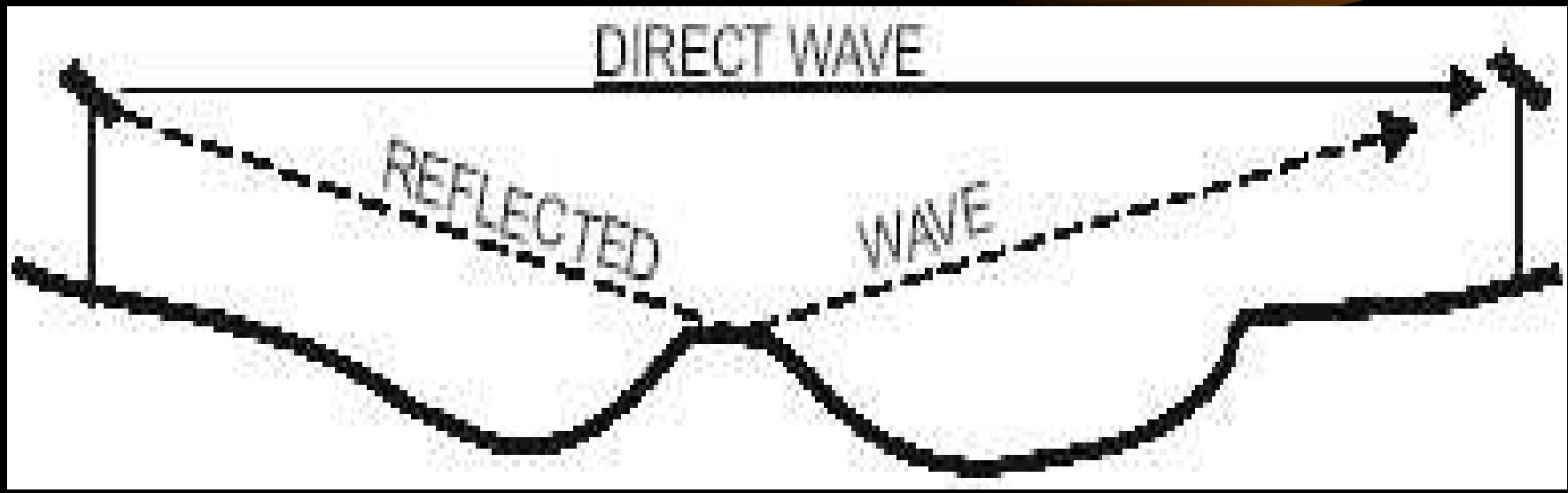
# *Surface Wave*



# *Direct Waves (LOS)*

- Direct or line-of-site waves, travel in a straight line from station to station.
- Signal becomes weaker as distance increases.

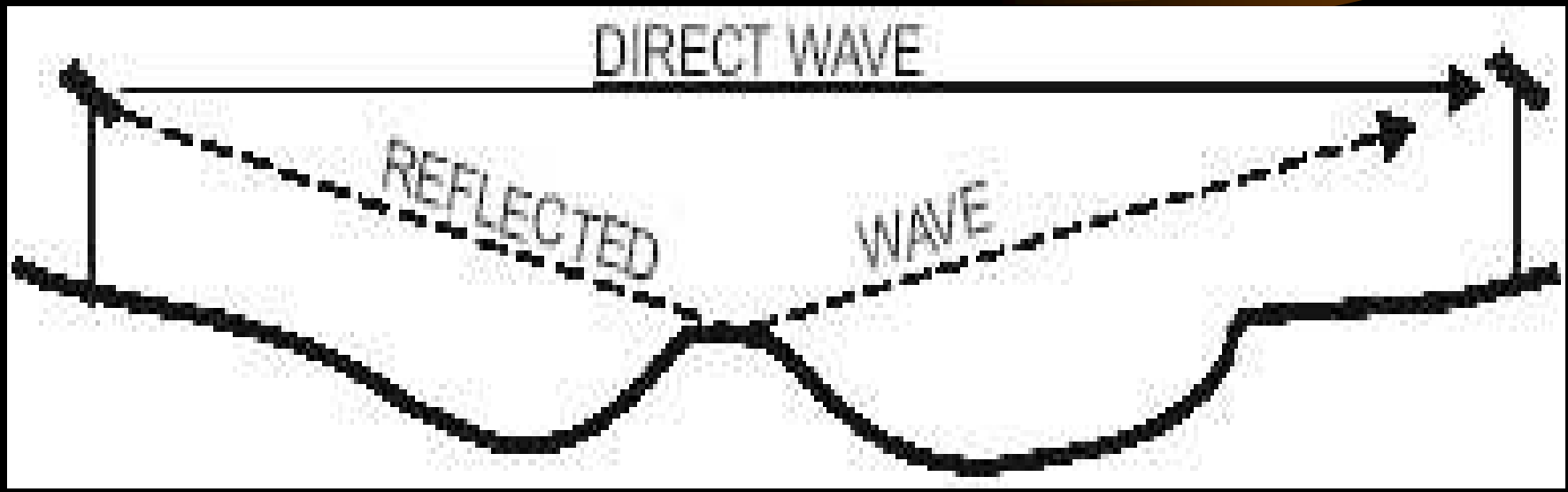
# *Direct Wave*



# *Ground Reflected Waves*

- Signals that are reflected from the surface of the earth between two stations.
- Cancellation or weakening of a signal can occur when a ground wave and a reflected wave arrive at the receiving station at the same time.
- Put simply, the direct wave arrives at the receiving station sooner than the signal that first went to the ground and was reflected back up.

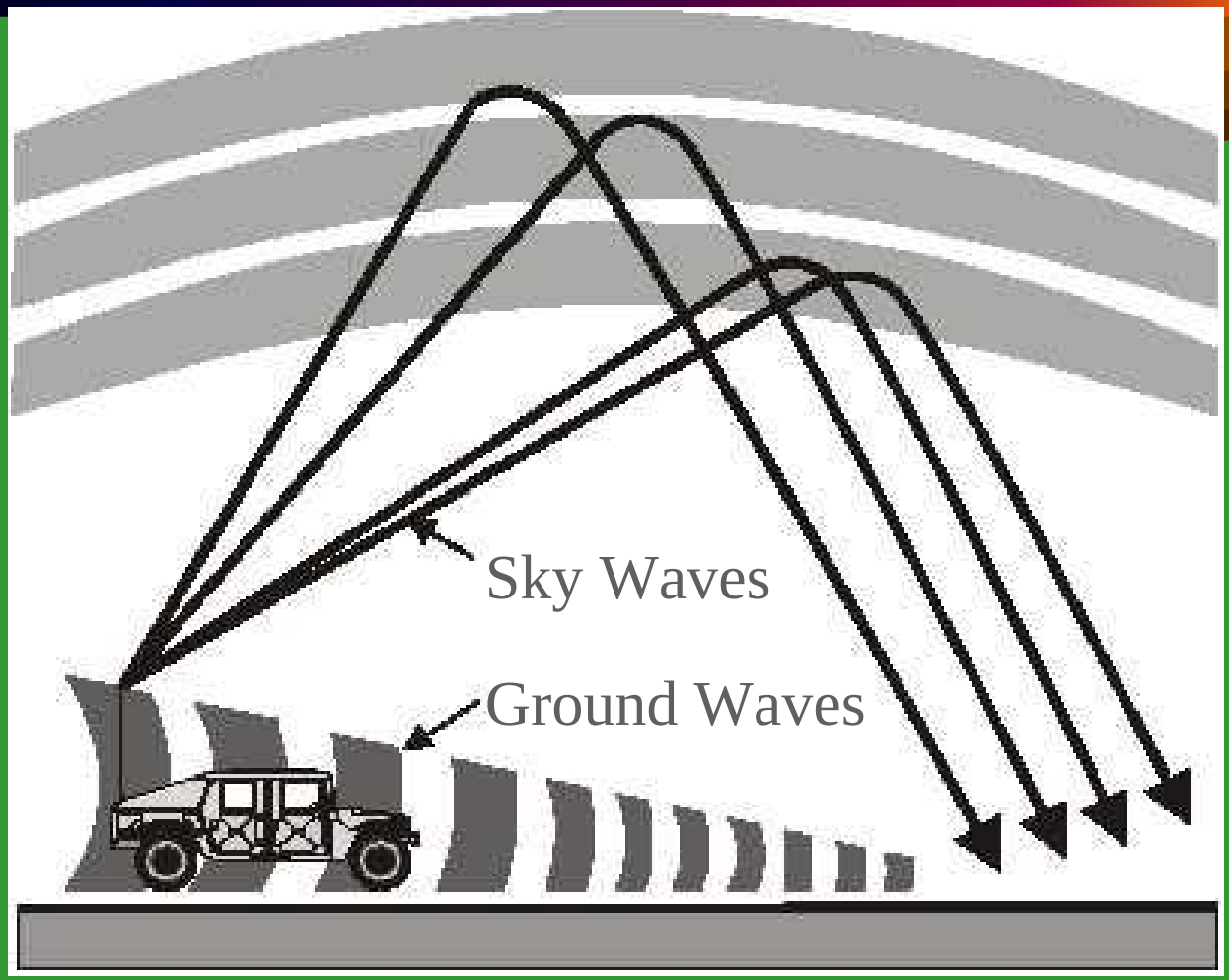
# *Ground Reflected Waves*



# *Sky Waves*

- Sky waves are radiated upward, making BLOS (beyond line of site) communications possible.
- At certain HF frequencies, radio waves are refracted (bent) back to earth hundreds or thousands of miles away.
- Frequency, time of day, and atmospheric conditions are all factors which can effect the distance covered by HF communications.
- Sky waves can be tricky to use since the ionosphere is constantly changing.

# Sky Waves



# *Frequencies*

- To establish effective HF communications, choosing the correct frequency is very important.
- Several factors need to be considered:
- What frequencies are available?
- Daytime or nighttime?
- Summer or winter?
- What is the predicted maximum usable frequency (MUF)?

# *Available Frequencies*

- The VaDF is authorized 10 HF frequencies by the VaARNG, listed in the SOI (signal operating instructions).

- Five of these frequencies are suitable for the type of HF communications that the VaDF will be most likely to establish.
- 4.440MHz.
- 5.877MHz.
- 7.375MHz.
- 8.047MHz.
- 8.157MHz.

# *Daytime or Nighttime*

- Due to the suns effect on the ionosphere, lower frequencies generally work better in the evening and at night, and higher frequencies work better mid-morning to sunset.
- General rule of thumb, use 4.440MHz. at night and 8.047MHz. during the day.
- The NCS (net control station) will make this decision.

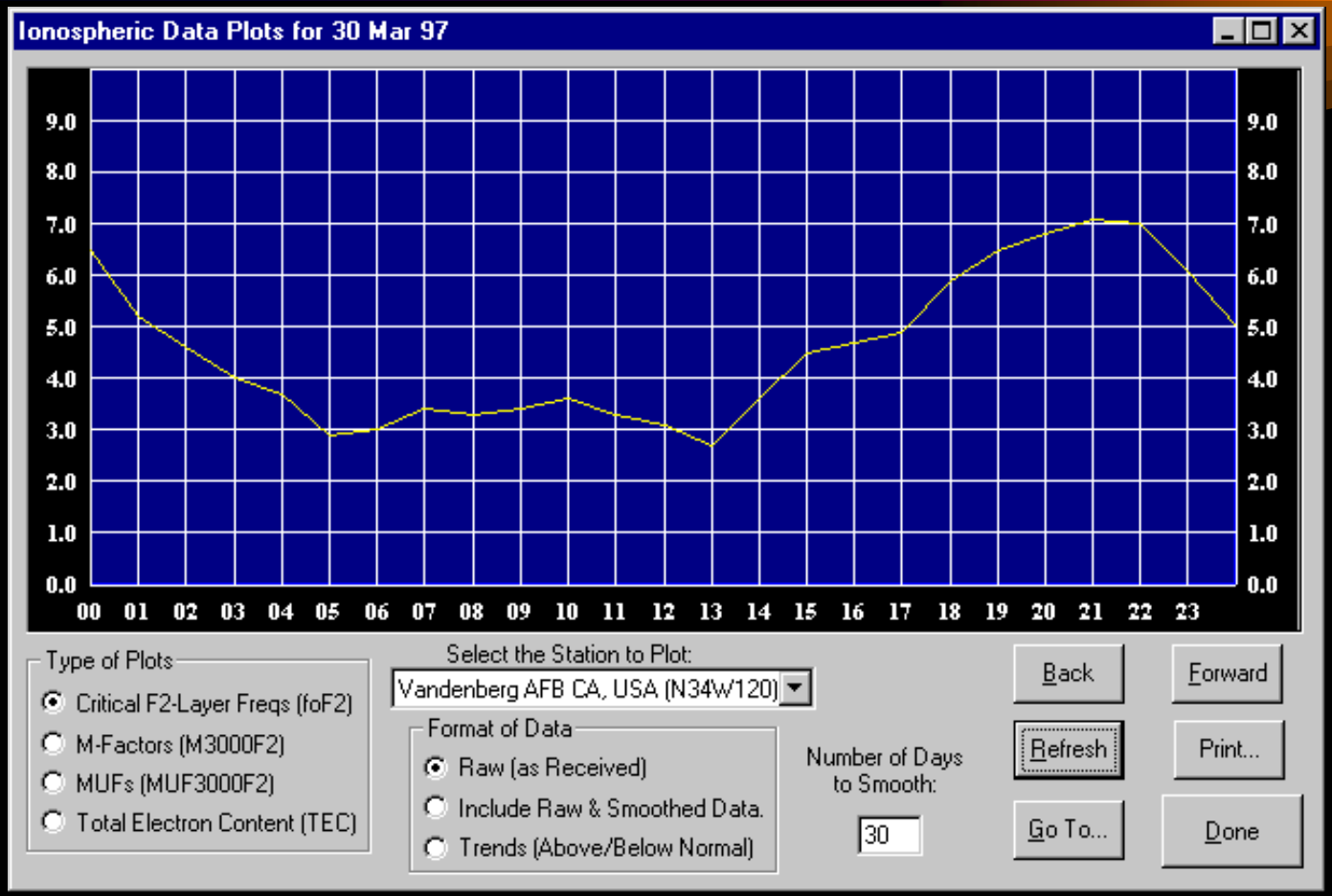
# *Summer or Winter*

- During the winter lower frequencies have less atmospheric noise (static).
- During the summer, some lower frequencies might be unusable due to increased levels of static caused by increased atmospheric noise as well as thunderstorms.

# *MUF (Maximum Usable Frequency)*

- MUF is the highest frequency that will allow communications between two stations.
- Due to the ionization frequencies reach a point where they will not “bend” back to earth and of the ionosphere, go straight into space.
- The MUF can change on an hourly basis.
- To ensure reliable communications the frequency chosen must be below the MUF.
- There are programs available that will assist in determining the MUF for the region you are located.

# *Sample of Ionosphere Data Plot*



# *When to Utilize HF*

- In the VaDF HF radio will be utilized any time we need to communicate beyond line of site, typically 20 miles or more.
- HF will be the method that the VaDF will communicate with other CPs (Command Posts) stationed around the state.
- The VaDF will use HF to communicate with other government agencies as well as the VaARNG when other communications have been disabled.

# *Modes of Operation*

- Radios use various modes of operation to convey information in a signal.
- There are three basic modes used in HF operation.
- SSB voice: USB (upper side band), LSB (lower side band).
- CW: (continuous wave) more commonly known as Morse code.
- Data: there are many different data modes in use today.

# *Modes of Operation*

- With data communications signals are received and processed by a computer to display text, pictures, files, E-mail, etc.
- One type of data mode that has been used by the VaDF is PSK31.
- PSK31 is similar to instant messaging.

# *Modes of Operation*

- In the VaDF, the primary mode of operation on HF will be USB (upper side band) voice on all frequencies.
- LSB operation under certain conditions will be used, only when authorized by the NCS (Net Control Station).

# *Putting the HF Station Together*

- There are four basic things needed to assemble an HF station:
- HF transceiver
- Power source
- Cabling
- Antenna

# *PRC1099 HF transceiver, one of the HF types of radios used by the VaDF*

# *PRC1099 HF Transceiver*

- The PRC1099 is a high frequency, manpack portable SSB (Single Side Band) transceiver, used for long range, two-way communications.
- The PRC1099 is capable of providing SSB voice, CW (Morse code), and data communications.
- The PRC1099s frequency range is 1.6 to 30MHz.
- The PRC1099 can operate from an internal battery or an external 12VDC power source.
- Depending on the antenna used, the PRC1099 can provide statewide or worldwide communications.

# *Power Sources*

- Most modern day HF transceivers can operate from 12VDC.
- This is very convenient when operating in an emergency operation where commercial power or fuel for a generator might be in short supply.
- When commercial power or generator is available, a 12VDC power supply can be used.
- The HF radios that the VaDF will use require an external power source.

# *Internal Battery PRC1099*

# *External Type Power Supply*

# *Datron TW7000 HF Transceiver*

- The Datron TW7000 HF transceiver is the type of radio installed in most of the VaARNG armories throughout the state.
- The Datron TW7000 is ALE (Automatic Link Establishment) capable.
- If regular communications go down in the state, the VaARNG will use these radios to tie the armories in the state together.

# *Datron TW7000 HF Transceiver*

# *Micom-2ES*

- The Micom 2-ES is the HF radio which will be installed in the mobile communication trailers.
- The 2ES is an advanced ruggedized HF transceiver, can provide Voice, data, Fax, and E-mail over HF with appropriate accessories.
- The 2-ES is ALE capable.

# *Micom-2ES*

# *Cabling, Coax, Connectors*

- Coax is the link between your transceiver and the antenna.  The coax carries the signal from the radio to the antenna.
- Coaxial cable consists of two concentric conductors with insulation in the space between the conductors. The inner conductor carries the signal (i.e. it is "hot") and the outer conductor is usually “ground” and acts as a shield.  RG8 and RG213 are two recommended types of 50 Ohm coax.
- Coax type is printed on the outside of the cable.
- In addition to coax,  other cables will be required to connect the transceiver to the power source and any additional accessories.
- A good heavy (10ga. or better) solid copper wire will be needed to connect your station to a good earth ground.

# *Cabling, Coax, Connectors*

Grounding Rod

PL259 Coax Connectors

BNC Connector



RG213


Typical Power Cable

# *Antennas*

- An antenna is a devices that picks up or sends out radio waves.
- The transmitter generates radio frequency  energy.  This energy is converted into radio waves with an antenna.
- An antenna works the other way also.  When a radio wave crosses an antenna, it generates a voltage in the antenna.
- This voltage travels through the coax to the radio.
- The same antenna will be used for transmitting and receiving.

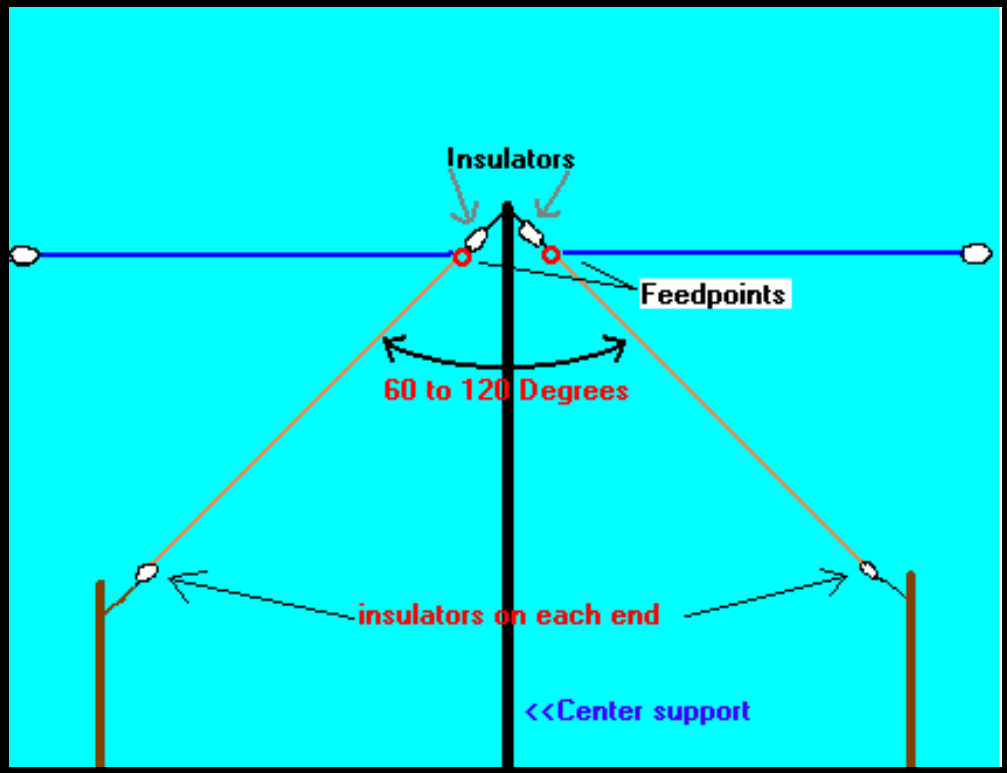
# *Antennas*

- There are many types of  HF antennas.  In order to establish reliable communications in the AO (Area of Operation), the correct type of antenna must be chosen.
- For HF communications that the VaDF will be tasked with, a standard half wavelength dipole configured to utilize NVIS (near vertical incidence skywave) techniques will be the best choice. (More on NVIS later).
- Vertical antennas because of their characteristics are not suitable for other than LOS (Line of Site) HF communications.

# *Antennas / Important Properties*

- Antennas are classified as either resonant or nonresonant.
- An antenna should be tuned to the frequency you are using, much like tuning the strings on a guitar are tuned to certain notes.
- If an antenna is fed with a frequency other than the one it was tuned for, much of the signal will be lost.
- A resonant antenna will effectively radiate a signal for frequencies close to the one it was tuned for.
- The fundamental antenna is the dipole.

# *Antennas / Dipole*




Typical dipole installations showing two ways to put up a dipole, horizontal and inverted.

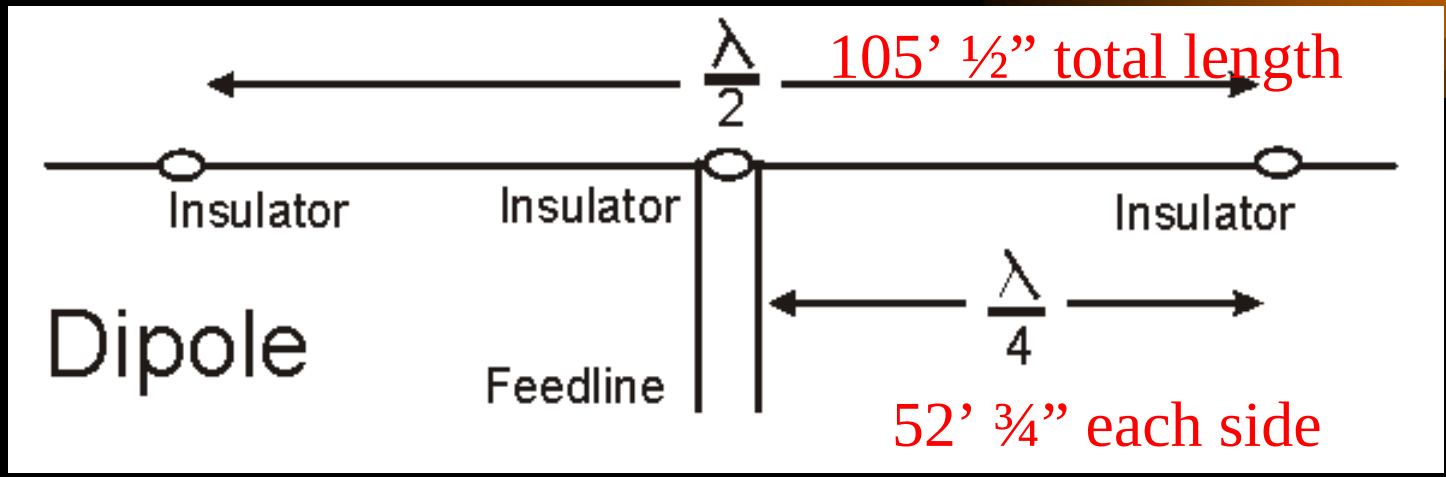
# *Antennas*

- Tuning the antenna for the frequency of operation can be done in two ways:
- Physically matching (or tuning) the length of the antenna to the frequency being used.
- Electrically matching the antenna to the frequency with an antenna tuner.
- The length of a half-wave dipole antenna can be calculated by dividing 468 by the frequency you want to operate on. This will give you the full length of the antenna in feet.

# *Antennas / Determining Length*

- Example:
- The operating frequency is 4.440MHz.
- 468 divided by 4.440 = 105 ½ feet (rounded off)
- Divide 105 ½ by 2 to give you the length of each side of the dipole, which would be 52 feet ¾ inches.
- An additional 12” should be added to each side for securing the antenna to feed point and insulators.

# *Antennas / Determining Length*

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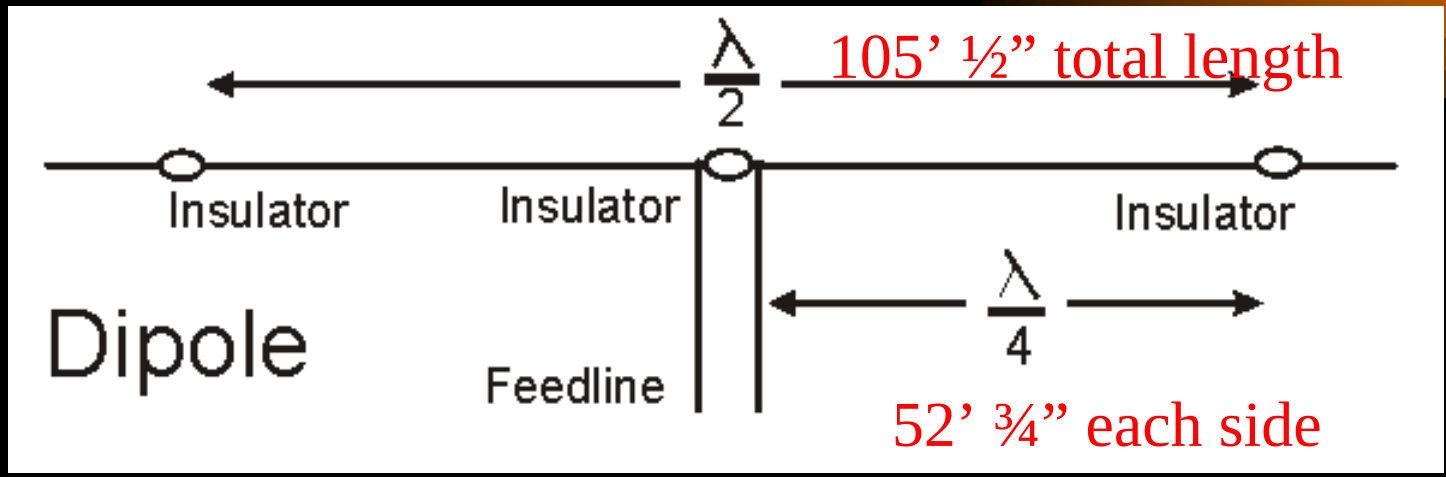


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# *Antennas / Electrically Matching*

- In instances where a dipole tuned to operate on one frequency must be used on multiple frequencies, an antenna tuner can be used to electrically match the antenna to the frequency.

# *Antennas / Electrically Matching*

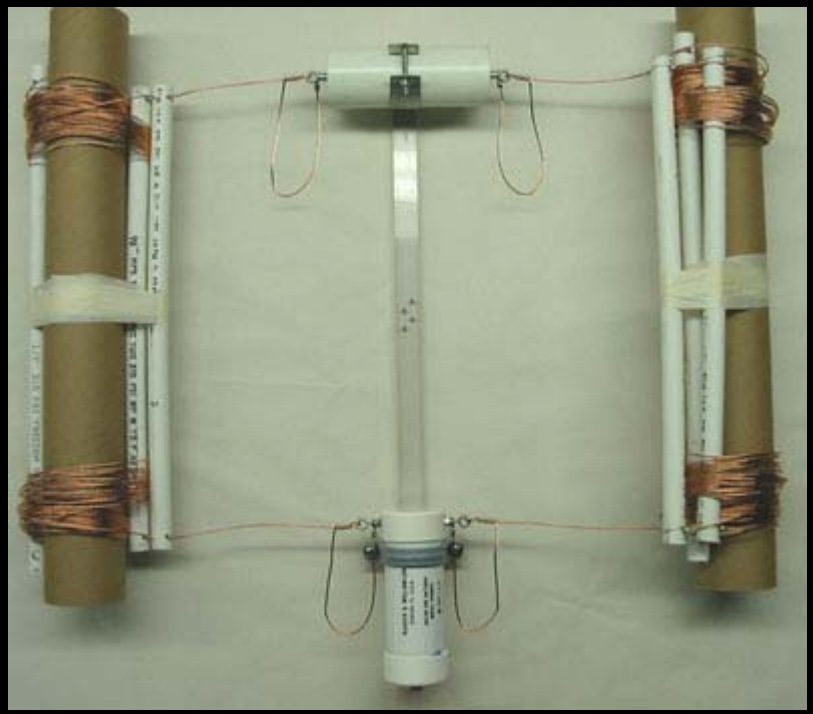

Automatic Type of Antenna Tuner


Manual Type of Antenna Tuner

# *Antennas*

- The Barker and Williamson broad band folded dipole is the type antenna the VaDF will be utilizing for use with the mobile command posts.
- Due to its design, an antenna tuner is not required.
- Works well for NVIS techniques and ALE applications where frequencies are changed at an extremely rapid rate.

# *Antennas*



Barker & Williamson Antenna
(Shown rolled up)

# *Antennas*


Barker & Williamson Antenna
(Typical application)

# *Configuring the B&W Antenna*

- Reference material in handout.

# *Putting It All Together*

- As stated earlier, there are four basic components needed to assemble an HF station.
- Transceiver
- Power Source
- Cabling
- Antenna

# *Precautions*

- As with any transceiver, never key the microphone until the antenna is in place and connected. Damage to the equipment can result.
- Make sure there are no personnel working on the antenna before the microphone is keyed. Serious RF burns to personnel can result.
- If not sure, do not key the microphone. Go and look.

# *Putting It All Together*

- Reference picture in handout.

- Questions???

- *TAKE A 15 MINUTE BREAK*