USING HF

Original idea from Dan Manningham

HF transceivers can provide an entire world of communications options, and challenges….

High frequency (HF) radio is perhaps the oldest form of airborne radio communications. It provided the first primitive air-to-ground radio contacts as early as World War 1, as well as the radio links for Richard Byrd, Rene Fonk, Amelia Earhart and many other early pioneers of the 1920s and 1930s. It allowed World War II bombers and transports and piston-engine airliners to communicate over long distances.
It was the standard means of en route communications in the continental United States until approximately 1960. Since that time, however, VHF has completely replaced HF for routine communications in most of countries...

Still, HF remains a viable technology and actually has grown in usefulness. In the past few decades, HF radio has benefited from digital tuning, single-sideband (SSB) efficiency and power, new antenna concepts, compact size, affordable price and installation simplicity.

In the near future, HF will allow reception and transmission of digitized information using ACARS (ARINC Communications Addressing and Reporting System). HF radio is an old technology vastly improved by modern techniques which provide an entire spectrum of services unavailable anywhere else. If you fly outside the 48 contiguous United States, or if you just want an additional communications link for company purposes, consider HF radio.

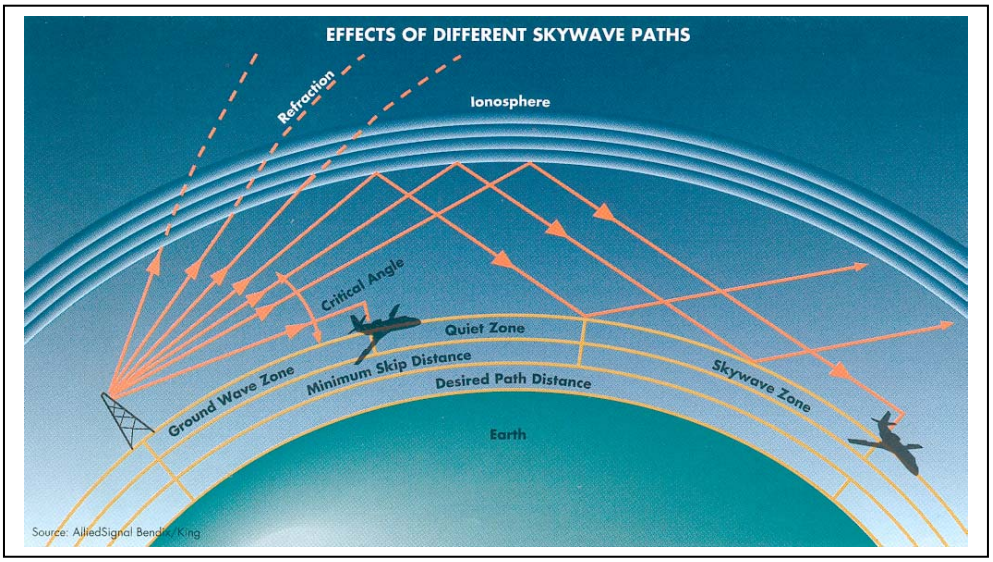
THE BASICS

First of all, HF radio is not really very high on the frequency spectrum-at least not by modern standards. HF is specifically defined as those radio frequencies from 2000 to 29999.9999 kHz, sometimes expressed as 2.0 to 29.9999 MHz. This band starts just above the medium-frequency (MF) band, which includes the commercial AM radio spectrum. It, in turn, is just above the low-frequency (LF) band used for "non-directional" navigational locators and beacons. That terminology was frozen in the early decades of this century before the advent of very-high frequency, ultra-high frequency and others.

HF's single greatest value is its ability to provide reliable long-range transmission and reception. HF routinely works over thousands of miles for two specific reasons : First, HF signals are reflected back to Earth by the ionosphere, an ionized layer 60 to 200 miles above the Earth.
Second, all modern HF transmitters use an SSB process that puts virtually all of the transmitter's power into the audio signal, providing about eight times the "talking" power of a basic AM transmitter.

Actually, HF signals are propagated in two ways :

1) The so-called "ground wave" travels downward from the antenna and is rapidly attenuated by the ground. Ground-wave signals from a typical HF transmitter may travel 100 miles or less.
2) The "sky-wave" radiates at an upward angle from the antenna. If the frequency used is correct for the time of day, this sky wave will strike the ionosphere at an oblique angle that allows it to be HF radio is an reflected back to Earth. This reflection is what causes HF signals to travel thousands of miles. Sky-wave propagation is, however, greatly dependent on the time of day and the frequency selected. In general, higher frequencies work better during daylight and lower frequencies better at night, but you will notice that HF radio operators use any of several different frequencies during a 24-hour period as they search for the best one under prevailing conditions.



HF LIMITS

HF theory and reality are often quite different, because this frequency band is particularly susceptible to disturbances in the ionosphere. When those disturbances are serious, HF communications can be difficult at best.
Essentially, HF radio propagation is highly dependent on the multi-layered ionosphere for reflection. And, since the ionosphere is formed primarily by the action of the sun's ultraviolet radiation, its effectiveness as a reflector changes in relation to the amount of sunlight passing though it.
HF propagation is often called a black art even by the engineers who design the equipment, but the following general rules apply :

- Higher frequencies, those above 10.0 MHz, generally work better during the day.
- Lower frequencies, those below 10.0 MHz, generally work better when the sun is down.
- Any frequency may skip over the intended ground station when reflecting off the ionosphere. That so-called "quiet zone" under the skip contains no usable signal, so your options will be to try another station on the same frequency or to try the same station on another frequency. Such "skips" are not uncommon.
- Solar flares and magnetic storms can severely impact all frequencies at all hours. As they strike the ionosphere, the range of usable frequencies changes, and the quality of communications may be reduced, sometimes dramatically. At times, the entire band of frequencies may be marginally usable or even unusable, and especially so when you are flying in polar regions above 60 degrees north or below 60 degrees south.

Ironically, this very problem may scatter the radio energy in unpredictable ways that result in usable radio contacts at absurd distances and locations. When necessary, you can use those contacts to relay information. HF operators are generally understanding and helpful

in such conditions. In extreme conditions, they can call each other by landline. You can use any available HF contact to relay important information, such as required position reports, and ask for a confirmation.
Over HF, you can receive "geophysical alert" announcements that contain information pertinent to HF propagation, but more on that later.

HF SERVICES

HF communication is the standard for ATC en route services over approximately 75 percent of the Earth's surface. HF can be used for personal phone calls over long distances, for flight following and for the receipt of pertinent weather forecasts and communications.

HF RADIO WAVE CHARACTERISTICS

- Frequency band…….. 3 to 29.9999 MHz
- Maxi Range (miles)……... 12 000
- Propagation …….. F-layer reflection

In the near future, it will be possible to send and receive digitized messages over HF frequencies using ACARS.
ICAO, along with national aviation authorities, has assigned HF frequencies to various areas of the world for ATC purposes. Across the North Atlantic, for instance, Gander Radio (Newfoundland), New York Radio, Iceland Radio, Shanwick Radio (Ireland) and Santa Maria Radio (Azores) provide HF ATC functions. Communications with these and like facilities are limited to "flight safety" messages, those which involve ATC or weather communication.

When cleared through one of these areas, you will be assigned both a primary and a secondary frequency to assure radio contact even when one frequency fades or distorts. B/CA recommends initiating a radio check on both frequencies and always insisting on having two usable frequencies at all times. If your airplane is equipped with selective calling (SELCAL), get a positive check on both frequencies whenever possible, but you must have a check of at least one unless you plan to monitor the frequency.

In addition to its use for ATC, HF radio also offers several other services. In many areas of the world, you may have to communicate with the controlling ATC facility through a General Purpose (GP) radio facility. GP stations are staffed by professional radio operators who can relay messages by voice from aircraft or telegraph to ATC, your company or both. Conversely, GP stations can relay messages from ATC or the company to the pilot. Position reports given to GP radio facilities are automatically relayed to ATC.

Long Distance Operational Control Facilities (LDOC) can provide "flight regularity" messages. Flight-regularity messages are defined as those that require flightcrews or aircraft operators to take immediate action in order to minimize travel interruptions and maximize aircraft utilization. You would use an LDOC station to relay pertinent flight information to and from designated company personnel. Flight-regularity messages must pertain to the operation of the aircraft itself, or to the aircraft load, requiring radio handling to ensure safety and efficiency. Personal messages are not acceptable, but there are other facilities which can provide that service.

A worldwide network of Public Correspondence stations providing personal or operational telephone service operates in the HF band. These stations link your airplane with regular land-line phone services. AT&T operates three of the U.S. Public Correspondence stations, and they are located in Point Reyes, California; Manahawkin, New Jersey and Fort Lauderdale, Florida. One other station, in Mobile, Alabama, is operated by Mobile Marine Radio. Two popular Public Correspondence stations in Europe are located in Stockholm

(Sweden) & Berne (Switzerland). In total, hundreds of these stations are scattered throughout the world, making it possible to place telephone calls from nearly any point on the globe.

Another service is provided by a pair of HF transmitters that have been established to broadcast time and other information. In the United States, these two stations are operated by the National Bureau of Standards in Fort Collins, Colorado (WWV) and Kekaha, Hawaii (WWVH). These stations broadcast continuously on 2.5, 5.0, 10.0 and 15.0 MHz. All of these frequencies carry the same program. Times are announced every minute by voice and are given as "Coordinated Universal Time" (UTC). For aviation purposes, UTC is identical to Greenwich Mean Time (GMT), sometimes referred to as "Zulu" time.
At 18 minutes past each hour, both stations make geophysical alert announcements that forecast the quality of HF-radio propagation based on a so-called "K" index.
The K-index scale ranges from one to nine, signifying that the higher the K index, the poorer the HF propagation will be. Another index reported on these hourly broadcasts is the "solar flux." Solar flux values run from approximately 65 to 400, with higher numbers favoring HF propagation.

At 16 minutes past each hour, WWV and WWVH broadcast Omega status reports for those navigating by reference to the worldwide network of Omega stations. At eight, nine and 10 minutes after each hour, weather information about major storms in the Atlantic and Pacific is broadcast. The National Institute of Standards and Technology (NIST) publishes a guide to these broadcasts, and you should ask for NIST Special Publication 432, *"Time and Frequency Services," from NIST Radio Station , 2000 E. County Rd. 58, Fort Collins, CO 80524 (USA).* You may also find some interesting data in your Jeppesen books…

One further service available over HF radio is the worldwide system of "VOLMET" broadcasts of meteorological information for aircraft in flight. (The word is a conjunction of the French words for flight and weather.) These are automated (recorded) voice broadcasts of current weather observations for up to 25 airports and 16 terminal areas. VOLMETs are broadcast on a fixed schedule, and Jeppesen publishes a meteorological section available as part of its subscription service that includes the sequence and schedule of those reports. VOLMETs are particularly useful for transoceanic flights on which pilots want to follow the weather trend for their destination and alternate airports.
One final capability exists for those who have airborne HF. Several frequencies in this band have been designated as international distress frequencies. These are continuously monitored worldwide and will provide priority communication for any aircraft in flight. The primary emergency frequency is 2182 kHz…

HF TECHNIQUES

All modern HF airborne transceivers use digital tuning techniques so that assigned frequencies can be easily and quickly tuned. Some HF radios have the capability to preset several frequencies that can be recalled with a two- or three-digit code, like autodialing a telephone.
It is the nature of HF radio to require different antenna characteristics for each frequency, so all HF transceivers include an "antenna coupler." The coupler electronically and automatically adjusts the antenna for each tuned frequency and identifies its action with a tone in the sender's headset. (The tone is initiated when the transmit button is first pushed.) Subsequent transmissions on the same frequency will not require additional tuning of the antenna. After tuning a new frequency on the HF, briefly click the transmit button and listen for the coupler tone. When the tone ceases in a few seconds, the antenna is tuned to that frequency, and the radio is ready for use.

HF transmissions are normally more distorted than VHF or UHF. There is often a warbling or static on the frequency (or both), and patience is a distinct virtue. If the frequency is unusable, try another, and another until you find one that is. You may have to try frequencies from different agencies or facilities, but persistence usually yields a usable station. And, any station can relay to others if you ask for that service. In extreme cases, it may be possible to contact another airplane on VHF and ask them to relay for you.

Finally, Modern HF radios are remarkably easy to operate, extremely powerful and reliable, and provide a spectrum of services…