
CHAPTER 3

3 HF RADIO (TERRESTRIAL SYSTEMS)

'Terrestrial' means 'of the ground' or 'of the earth' In this context it means any system having no part in the air or in space, as all the radios are on the ground and do not communicate with satellites in space.

Do **not** confuse Terrestrial with the so called "Landline" systems. Landline systems mean the normal 'phone' lines (PSTN), TELEX and Mobile Phones. As stated earlier we are assuming that the landline systems are not working because of the disaster, or that they have never been provided in the area we are working.

Terrestrial in this context will mean 'by **HF radio**'. In contrast to the 'technologically sexy' image of space systems, 'Steam Radio' can seem rather obsolete, but not so. It takes its own place in the market as we shall now see.

For an explanation of how HF radio works, see the tutorial in the **Appendix**.

The main networks of interest to us are:-

- HF Marine Radio
- HF Gateway services
- HF Amateur Radio.
- Private HF radio networks

3.1 INTRODUCTION

Radio waves travel in straight lines (except at very low frequencies) and the earth is curved, so we should not be able to communicate with anything we can't see. In the TITANIC era, ships used very low frequencies (500KHz) to take advantage of a bending effect called refraction, but even then the range was only about 1000 miles. (this is called the Ground Wave mode). Above about 3MHZ this effect is less pronounced, and so amateur scientists were given this apparently useless frequency range, which no-one wanted, to play with. This was the origin of Amateur radio or HAM radio.

Imagine their huge joy when they found that, quite unexpectedly, these shorter wavelengths could travel across the Atlantic Ocean, and in fact world wide. The phenomena was called Short Wave radio, because the wavelengths were shorter than they used before, and it changed everything. Soon the phenomena was better understood to have been caused by reflection of the waves from a layer in the atmosphere called the Ionosphere. (Called the Sky Wave mode). For a tutorial, see the appendix, 'How HF radio works'.

Naturally the Marine Radio people were interested and soon utilised the Sky Wave mode for Marine Radio use, which is how it still is today, with ships of the world communicating by Short Wave radio, now called High Frequency radio (HF radio). Ships send telegrams by Morse code, Teleprinter Over Radio systems (TOR) or phone calls by Single Side Band (SSB) to especially set up radio stations back in their home country.

Historically these stations have usually been built near to coasts, so they are called Coast Stations, though now few of them are. The British coast station is known by the name "PORTISHEAD RADIO" (because it used to be in Portishead Nr. Bristol but is not now).³² There is a huge international network of these stations in most sea faring countries. The details of them can be found in the **Admiralty List of Signals** (HMSO) or the ITU List Of Coast Stations, which are like a phone directories for coast stations and contains their frequencies etc. It is best and cheapest to pass messages to the coast station nearest to where the message is going, preferably in the country to where the phone call is being placed .³³

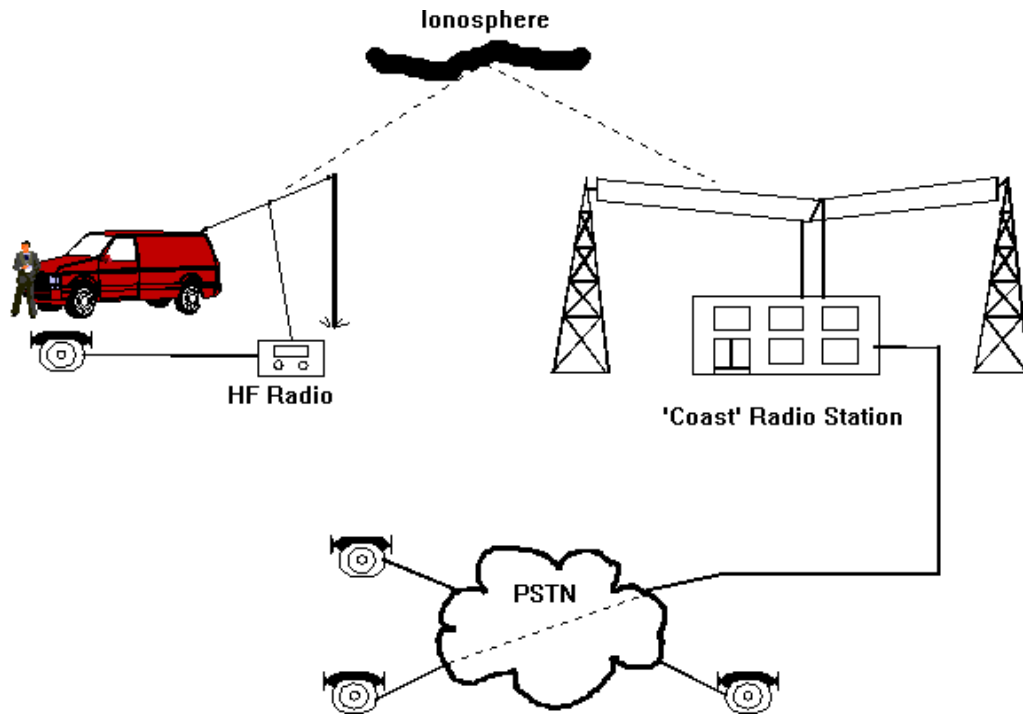


FIG 11 Coast Stations enable HF radios to 'plug in' to the PSTN, or TELEX network.

The Coast Station receives the message³⁴ and relays it via the International Telex network, or messages can be telephoned or FAXed to any number world-wide. When using the coast station's own ordinary phone lines, the coast station operator dials the shore phone number and connects the radio to the phone line over the PSTN, using a so called 'phone patch' circuit. This has been going on for years and they are very good at it.

Sadly, the ionosphere can vary a great deal in height, thickness, position and reflectiveness as it adapts, responding to solar flares and magnetic storms in space³⁵. This means that the right frequency to use to make the signal bounce down at Portishead keeps changing all day, and it has many other fickle tricks, some predictable some not.³⁶

Portishead knows this and counters by having transmitters available for use on all of the frequencies that are likely to work. But it is up to the skill and experience of the radio operator to choose and use the right frequency and right antenna.

In short, though it will probably work at some time in the day,³⁷ it is only about 70%-80% reliable at any one particular time, with a 1% chance of not working at all, during a particular day, (about as reliable as the BBC World Service). A great deal depends on the training of the Radio Operator. Being a good Radio Operator is a Craft Skill and this explains why Amateur radio is a hobby and making 'phone calls isn't. Having said that, anyone can be taught the basics in a few hours of teaching plus some practice of their own and there is much satisfaction from doing it well.

Sadly, the whole marvellous effect drops off about 30MHZ and radio starts to act more like light again, working in straight lines, but able to permeate through walls better than light does. These frequencies are called VHF (Very High Frequency) because they were very high compared to what Radio Officers were used to before.

The range of VHF is limited to a small region of between 5-50 km depending on the installation. UHF (Ultra High Frequency) bands have shorter range but are more reliable in a built up area as the waves tend to reflect off buildings and reach into dead spots better, so these tend to be used by 'walkie- talkies'. They are thus more for Local communications rather than global; VHF will be explained at more length in **PART 2** about local communications (range under 1000km) and not elaborated on further here.

3.1.2 HF RADIO EQUIPMENT

The equipment needed for all HF radio networks is substantially the same. This is good because the HF radio is a very flexible tool in the right hands. For instance, it can enable global intercontinental communications one moment, and be used for short distance local 'CB' style calls the next.

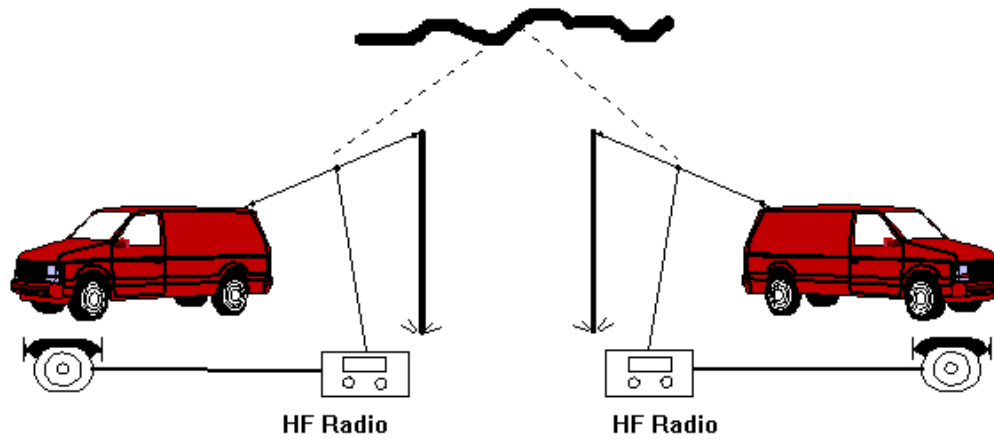


FIG 12 HF radios can contact each other directly over thousands of km. This method is **FREE** of call charges.

This ability is an advantage over INMARSAT terminals which charge for satellite usage. Thus when calling another terminal even 1km away from you as the crow flies, the charge is for two uses of the satellite.

The first thing needed is a Transmitter and Receiver. These days both devices are put into the same box, so they are called a Transceiver. The resulting device is usually about shoe-box sized, and weighs 5kg, plus power and antenna units.

What strikes fear into the hearts of most users is the constellations of knobs and lights on the front panel. This was done because in the old days, trained Radio Operators worked them, so manufacturers pandered to their tastes. Now however, the average user is a yachtsman or aid worker, so the manufacturers have replied by building much simpler controls.

Beware however that some of the most popular and heavily advertised radio sets for the non-consumer electronics market, such as yachtsmen, have a bad record in the harsh and rough conditions of disaster sites, made worse by tropical humidity. User experiences should be paramount in selecting equipment.

Older radios tended to have their tuning fixed by 'crystals' and it was the job of an expert to tune such a radio. Today most radios are tuned by synthesizers, microchips which take orders from a telephone style keypad. Anyone who can dial a telephone number can programme the radio and adjusting the circuits inside is automatic, so how can you go wrong?³⁸

3.1.2.1 Modulation Modes

These days, most radios have a switch marked CW,SSB,FSK, or something like that. This control selects the way the signal is put on to the radio carrier wave. The carrier wave gets its name because it is like a carrier pigeon. Just as the message is strapped to the leg of the pigeon and the pigeon flies to the destination, so also the carrier wave travels to the receiver at the other end with the message 'strapped' to its leg by a process called 'modulation'.

At the other end, just as the pigeon is not the message and so is disregarded when the message has been removed from the leg, so also the message is removed from the carrier wave by a circuit called a 'Demodulator'. Unlike pigeons however, radios need different modulators depending on the type of message. Here are some of them but there are many more.

CW stands for Continuous Wave, and is for when using Morse code. You need to be an expert telegraphist to do this so you probably won't need this much. However if you wish to listen to the Beacons that Portishead has running to indicate which band is open, you may select CW or you may also select SSB for this purpose.

SSB stands for Single Side Band. This is the one you will normally use most. How it works is not important, but you can tell when it is being used by the Donald Duck quacking voice it produces if your receiver is not tuned correctly to the transmitter frequency. There is a control marked 'Clarifier' or 'RIT' to adjust the pitch of the received voice and make it sound more natural. SSB is by far the most common mode for speech on the HF bands today, because you can fit more SSB channels on a band than any other speech system.

One thing to watch out for is a control marked USB-LSB. This should normally be in the USB position. The exception is when contacting an Amateur radio station on frequencies below 7.1 MHz, when LSB should be used. If you ever find that you just can't make Donald Duck make sense, try flicking this switch.

FSK stands for Frequency Shift Keying, and is used in conjunction with special circuits when sending TELEX or text messages by a system called Teleprinter Over Radio (TOR).³⁹ The field team would have a PC running special software to do this. The computer is then connected to a small box (or uses built-in circuits) which converts the text into a special signal suitable for sending over a HF radio link, even a very bad one.⁴⁰ The electronics in the TOR unit, called a Terminal Node Controller (TNC)⁴¹ make sure that the message is the same at both ends and is not corrupt.

=REPORT=REPORT=

The CICR (International Red Cross/ Red Crescent) after many years of experience , have found Teleprinter Over Radio (TOR) to be the most acceptable to them. It has the text message advantages as outlined earlier, and is very reliable and cheap. Over the same radio path on a given day, TOR is able to read messages from a far-flung office when speech by SSB is near impossible to read.

Teleprinter Over Radio (TOR) is finding many friends these days so without going into details, here is an explanation of some of the modes of TOR. Incidentally, SITOR or Simplex teleprinter over radio is the same, as is AMTOR or Amateur Microprocessor Teleprinter Over Radio.

Automatic Repeat request mode (ARQ) is also known as Mode A. In this mode, the sending radio sends three letters of the message plus some check information. Then it listens for the terminal at the other end to check if what was received was any good. If all is OK then an acknowledgement message is sent from the other end. Our end then sends the next three letters.

If there is something wrong with the received letters though, the other end sends a request to repeat the last burst, hence this mode's name. This is the best mode because even if the channel is very bad with lots of interference, only a perfectly good message will be received at the other end. This happens **even if there is no one at the other end to work the controls**, which is excellent if you think that there may not always be someone to 'baby sit' a hissing radio all day, as is very often the case. ARQ is the method used for the public Telex system by Portishead radio and others.

The only problem is that this can only be done on a one to one basis. If you wish to send out a message to everyone at once on a certain radio channel, another method called Forward Error Correction or FEC, also known as Mode B is used. This method repeats everything and equipment at the receiver decides what to print or prints an error character when in doubt. This is not as good as ARQ and should only be used when you are sending a messages to more than one station.

Paktor is an interesting combination of Packet data and TOR systems. It offers more, faster and better functions than plain old TOR, for example it can use both upper case and lower case letters so you can send computer generated files. Some commercial coast stations use Paktor or variations of it in their public TELEX or data systems.

There is a further consideration of data modes in **part 2**, so we will come back to this later and press on with HF radio for now.

3.1.3 ANTENNAS

The big operational problem with H.F. radio is, the antenna system. Antennas must be resonant at the frequency being used. This gives two problems. First, they tend to be much bigger than say CB antennas, secondly, as we have explained, we need to keep changing frequency through the day, so we need to keep changing antenna size!

3.1.3.1 ATUs

In reality though, this is not done, but a device called an Antenna Tuning Unit (ATU) is installed in the cable from the radio to the antenna. The operation of this is usually automatic these days,^{42, 43} but its disadvantage is that it can't make the antenna more efficient if it is off tune, so the antenna has to be resonant 'somewhere near' the frequency in use to be any good. Don't be tempted to let your ATU cure all of your antenna problems. ATUs won't make a bad antenna radiate better. The antenna is the most critical part of the set-up, pay attention to it if you value your communications links.

Some ATU's need special control signals from the radio.

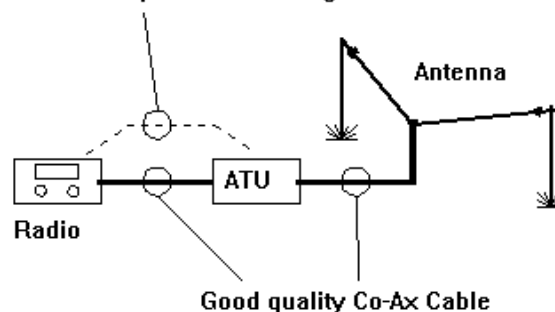


FIG 13 The position of an ATU.

Antenna manufacturers understand this, so they can make antennas that will be naturally resonant on several frequencies of your choice.

Here are some of the solutions you will hear about.

3.1.4 DIPOLES

These are simple looking but very effective pieces of wire, about 10-20m long, dangling from a handy tree or building. They can be wideband, Tuned or Multi-Band tuned by so called 'traps' (looking like bumps along the wire). The simplest types are just shortened or lengthened by reeling in or out from a bobbin once the frequency has been chosen. This is more fiddly, but makes a robust, compact and very cheap antenna.

Once reeled into the bobbins, the antenna is now about pocket book sized, which is very convenient for the team on the move.⁴⁴ This is the type used by the military Royal Signals, who swear by it, and have no plans to change to anything else. The DRCF also favour this method. The most practical general purpose configuration is the inverted vee, which needs support only at the centre and has no directional properties.

3.1.4.1 Widebanders

Widebanders are designed to be resonant on all HF bands. This makes tuning very simple, but has the disadvantage that some models can be rather long, about 30-50m , so you need to find space to string it up. A further problem is that they are so wideband that they tend to collect more noise for the receiver to handle, whereas narrow band antennas can help the receiver to be more sensitive by collecting less noise.

3.1.5 VERTICALS

These look a bit like knobbly aluminium flag poles, and are generally bolted to the roof or gables of a building, or can be placed on the ground. One good thing about them is that they take up little space (horizontally). Unfortunately they usually need guy ropes to hold them up and aid with the efficiency. They have to be assembled very carefully when packed away, and the operation of erecting the pole is critical if damage is to be avoided. So installing them is more difficult, but once installed they are quite effective and compact.

A favourite type of vertical antenna is the type mounted to the bumper or crash bar of a vehicle, called a mobile antenna. Models are available either manually tuneable by adjusting tappings or automatically tuneable by a servo motor in the base. These types must be extremely robust and so need fitting properly.



3.1.6 BEAMS

Beams look like huge, droopy TV antennas. They are the type most used by Embassies and Red Cross HQ's. Their advantage is that they put a powerful signal only in the direction they are pointing, so you need to know this direction from the start. Alternatively you can have a Rotator, an electric motor with controls near the radio, to turn the beam in the direction you want to transmit. These are good and popular antennas, but they are even more difficult to put up than the verticals, so they should only be used at fixed or semi-fixed locations unless your technicians are well drilled.

3.1.7 LOOPS

These look like large hula- hoops and have a diameter of about 1m. Their advantage is that they are very compact indeed, about the same size as a 'Dish'. They tend to be used by radio Amateurs who live in blocks of flats, where it is against local planning regulations to install a larger model of antenna. The loop is just placed near to a window. They are easily the most compact antennas when erected. and their efficiency, while not nearly as good as the beam, is still fair, so the arrangement is highly practical. They have the further advantage that they are very narrow band tuned, resulting in much better receiver selectivity even in the face of severe local interference.

The disadvantage is that they will not pack down any smaller, so carrying them around is a bigger problem for those on the move. As they are so narrow band they have to have a remote tuning system as part of the kit. There is little practical experience of the use of loops in the field as yet, but my information is that the military, attracted by the mobility it affords, are impressed.

3.1.8 Multi antenna systems

None of the antennas mentioned so far are perfect for all uses, some are better for short range, some for long range, so you may decide on more than one antenna. In any case you should have at least one 'home made' wire type antenna which you can repair yourself with few resources as the final back up. Therefore you may decide on a co-ax switching system to select the best antenna. The eventual choice depends on how much you want to spend and how much weight and bulk you want to carry around. Every expert has his favourite antenna and a thousand reasons for you to purchase only his type.

We are on the move and literally carrying every ounce of ironmongery with our own back, so I say, keep it simple.

Now that we have our transceiver set up, let us think how to use it to the best advantage. We will now consider the Networks open for HF radio users.

3.2 MARINE RADIO (MARITIME RADIO COMMUNICATIONS SERVICE)

The Marine Radio system means using our radio in the field to contact a coast station such as Portishead Radio.⁴⁵ The advantages of doing so are

many.

Marine coast radio stations are very fine establishments, very professional both in the excellent equipment they use and in the highly qualified and experienced staff they choose as Radio Officers.

For example, their receiving stations are situated far away from their transmitting stations, so there is no interference from their own transmitters, and this enables them to use very high gain receiving antennas and very sensitive receivers. The result is that even if you in the field are using very low power equipment and a makeshift antenna, they can boost your signal to make it sound stronger. Their transmitters are powerful and their antennas huge and very impressive. (you can see them when travelling from the M1 to the M6, the large masts and antennas on the left).⁴⁶

This means that with quite modest equipment in the field, your signal will still be readable in the UK and therefore a quite readable phone call is possible.⁴⁷

Their staff are very experienced and very helpful and friendly. They will gladly give advice if they think another channel is better. They are very easy going and will be patient if the operator can't use perfectly correct procedures.

They can offer several services,

- PHONE CALLS

To or from any phone in the world on the PSTN. These can be connected manually by Portishead radio, requiring only very basic mobile equipment or by a semi-automatic system called AUTOLINK, which costs about PS350.00 more but gives 20% savings on phone charges. Scramblers can be arranged if security is required.

- TELEX

For stations equipped with a special unit (TOR SYSTEM) a full duplex (chat back and forth in real time) automatic dial in and out public global Telex system. It is said to be very reliable by those who have used it and has the advantage that it can be left unattended.

- PHONETEX

This means they will accept a telex or telegram dictated by you over the radio with your ordinary microphone. **No special equipment is needed.** Portishead will then send it or FAX it for you.

The reverse is also true, they will hold messages for you, TELEX phoned in messages, FAXes etc. and then dictate them to you when you call in, however they do charge for this service.

This is excellent because the personnel in the field may only be able to set up equipment when not moving or otherwise busy. Also power requirements may be the primary influence on when they can call in. This may not be when the office is open or when the called person is available in which case Portishead is acting as a message bureau, saving messages until the team are able to call in.

- RADIO TELEX LETTER (RTL)

Messages from radiotelex stations can be sent to Portishead from where they will be forwarded by mail. Greetings Telex letters (GTL) to celebrate, for example births and weddings, are available in various designs of card.

- DIRECT BILLING

This means that phone calls to one number can be billed to another. This is ideal for personal calls or calls where the caller will not be billed by the Radio Operator at the sending station.

- INFORMATION SERVICES

Mostly of interest to TELEX users, a database of various information such as best frequencies to use, exchange rates etc.

- RADIO MEDICAL SERVICES,

FREE medical advice by doctors connected by line from Portishead.

3.2.2 HOW IT IS USED

The Radio Operator in the field has only to tune to one of Portishead's frequencies and call him up. The operator must use his skill and experience to choose which band will be the best one, see 'how HF radio works' in the appendix.

The best way, is to listen to the BBC World Service, then use the nearest Portishead frequency to the strongest BBC frequency. Also you could read the Morse code 'beacons' that Portishead has running to give away which band is open. Or you could listen for the traffic list which sounds the clearest.⁴⁸

The operator will then tune in his antenna and after consulting a simple table, type in the frequencies into the transceiver.

To call in, you just press the button on the Microphone and say.. "Portishead Radio..., this is 'Aidcamp Base' on 10.291...Over". Always indicate which frequency you are calling on as the Radio Officer will be listening to several speakers at once and maybe missed which one your voice came out of.

If he doesn't get through, well he can just try again on a different band. When he does get through, after quoting his callsign, Portishead will tell him if there are any messages for him.

When a landline PSTN caller wishes to call a mobile station, he simply phones Portishead radio and quotes the callsign of the mobile station concerned. If the mobile is expecting a message, he may wait on the main frequency if he wishes, in which case the call will be passed straight through. Otherwise a Booking is made and the call will be put through when the mobile unit calls in.

TELEX calls from a landline telex to a mobile are made by TELEXing Portishead radio and typing in the callsign of the mobile. If the mobile is ready, then the message will be put through immediately, even a two way conversation could be held. If the mobile can't be contacted (for example if it is switched off) the message will be kept in Portishead's computer and passed on to the mobile when he next calls in on a store and forward basis..

3.2.3 FOR MARINE RADIO

The main advantage is cheapness of service and convenience of equipment. Typical HF radio equipment is about PS 1,000-3,000. (very much cheaper than satellite).

The services provided by the coast stations are also cheaper, for example phone calls are about PS 2.75 per min. Telexes are about PS 3-5 per average message to send. Typical HF radio gear is about the size of two large shoe boxes and weighs about 3-5KG. There are also no standing or monthly charges to pay, its strictly pay-as-you-use, which is attractive to occasional users. There is no charge for opening an account, and this can be done in five minutes by exchange of FAX application form.

3.2.4 AGAINST MARINE RADIO

As an HF radio service, it can only work when the Ionosphere will allow. To use the service you will have to open an account with an international accounting company or directly with your coast station (though in an emergency or disaster this can be waived).

Not only are HF radios themselves fairly user unfriendly, but the user has to listen around the bands for the best frequency to use, and so some operator training is required for the best results.

Unlike a normal telephone connection, the charging for the call is from when the called person answers to when the CALLED person hangs up. Don't let the landline side waffle on at huge expense, set yourself a time limit for the call and say at the start of the call 'I have 5 minutes'.⁴⁹ Actually you have as much time as you like but this will trigger the landline user's mind into a more concentrated mode and prevent him from 'waffling' or becoming overawed at such a novelty.

When you are happy that the call is over, tell the landline caller very firmly, 'PLEASE HANG UP NOW'. You meanwhile keep listening on the channel so Portishead can tell you the charge for the call, which you should record in your log book.

Lastly, the transceivers used on Marine service must be capable of split frequency (DUPLEX OR SEMI-DUPLEX) operation.

3.2.5 FOR AUTOLINK

Also by Portishead radio, and other coast stations such as Cape Town Radio (with other versions from other stations such as the AT&T High seas service) Autolink is a semi-automatic direct dial system for HF radio. By means of special equipment which is linked up to the radio, a user can dial up the phone number required himself by the buttons on a mobile-phone style handset. This has the advantage that it is a little quicker but the biggest advantage is that the call charges are about 20% lower because there is no need for a Radio Officer to dial the number for you.

3.2.6 AGAINST AUTOLINK

The first problem is that the automatic system does not operate the radio itself, so the user still needs to use all his skills to select the right band, right frequencies, right mode and tune the antenna before Autolink will work. Experience has shown that it is easily disturbed by noise and static on the band so is not recommended for very long range use on frequencies above 6 MHZ.

3.3 GATEWAY SERVICES

It's Portishead radio again but by another name. It is also known as the '**Aeronautical Service**', but do not be confused by this heading on the frequency tables, it is exactly the same as Gateway. The service is intended for use by Aircraft on Oceanic passage. The Pilots pass position reports and ETAs to the ground at Portishead by SSB. The pilots can be connected by 'Phone patch' to their operations room to discuss operational problems. **Some of the HF frequencies are exclusive to this use and intruders would not be welcome.**(These are marked with an

asterisk on the tables).

Some however are set aside for private phone patches and chit-chat and these can be used by anyone else.

*NOTE

Actually, BT is now taking the view that a Gateway customer is anyone other than a traditional Marine Radio Customer. In fact, a Gateway caller is just as welcome to call on a Marine frequency. Gateway customers can also use TELEX or PAKTEL data modes if they have the special equipment.

3.3.1 FOR GATEWAY

The main difference is that Gateway customers may use the aeronautical channels which are SIMPLEX SSB (speech only). This means that the system can be used by older more basic radio equipment which may not be capable of DUPLEX operation. In addition the Aeronautical frequency bands are in different places to the Marine ones. So if you cannot get through on a Marine frequency, perhaps an Aeronautical channel will be better.

3.3.2 AGAINST GATEWAY

Gateway is a 'Simplex' system. This means that only one person at a time can talk, the other must listen. At the mobile station in the field, this is done by pressing a button called the 'press to talk' button on the microphone. Therefore the landline side user needs to understand the rules and keep disciplined, never interrupting the mobile user.⁵⁰ To avoid confusion, it is best to say 'Over' when you have finished what you have to say. You are charged for the call until the called party hangs up, so say 'Hang up now' when finished.

3.4 Amateur Radio Service

Amateur radio, also known as Ham radio in the USA, does not refer to special radios at such but to a special set of rules which apply to certain frequencies as defined by the International Telecommunications Union. (ITU). The rules allow these frequencies to be used for research, education and personal use by private persons, (as opposed to commercial institutions).

The word Amateur in the title implies the use of radiocommunications for non-commercial uses, not to the fact that many Radio Amateurs are not professional radiocommunications people, though just as many are. In fact many of the worlds most revered scientist and engineers are radio Amateurs. Many more would not be where they are today if the Amateur service had not provided them with a platform to learn their craft as unknown youths.

Many are drawn to Amateur radio for sport, recreation or the unique form of social contact it can bring. However many very important radiocommunications systems in use today, were developed by private individuals (some of whom were also professionals acting in a private capacity) using the Amateur bands. To make this possible, the rules about what can and can't be done on these bands are as loose as can be consistent with preserving the rights of other users. For example there is no type approval requirement in order that new experimental types of transmitter and receiver can be built and developed even though legislation has not caught up with it yet.

Obviously this could be a recipe for disaster if there were not some kind of requirement that the holders of licences on the Amateur bands are required to pass exams in basic electronics and radio law. The purpose of the exams is not to preclude anything less than whizz kids, but to be sure that the prospective holder of such powerful tools understands the potential for interference to others that bad operating can so easily cause.

Having passed the exam, the person is issued with a certificate, which is valid for life. He can at any time use this certificate to obtain an Amateur Radio Licence. Persons holding a licence to operate on the Amateur radio bands are called Radio Amateurs. In many countries, there are more than one different class of Amateur licence. In Britain for example, there is a novice licence, Class B and Class A. Novice licences are intended for the very young or very new operators, and are intended to be a temporary step to a class B licence.

Class B licence holders pass two exams, one in radiocommunications technology and one on radio law and regulations. However they are also only allowed to operate of frequencies above 50MHZ, so they cannot use HF radio frequencies.

Class A operators have rights to use the HF radio spectrum, with its very useful sky wave mode, enabling global communications. Class A is the top class, so this is the type of licence you would preferably look for in an operator intended to help with disaster communications.

In addition to purely technical reasons, most governments expect their Amateurs to provide emergency communications in the case of an emergency or disaster. Yugoslavia, Caribbean hurricanes and many more cases show Amateur radio will work when nothing else will. This is because HF radio does not use the ground based bearer network, and has power requirements modest enough to be met with batteries and generators. Therefore it is probable that your local Amateur is in contact with the local police or civil defence establishment, and is able to traffic messages around the area for you quite effectively.

Amateur radio is an unbeatable way of learning about radiocommunications, first hand and hands on, so I strongly recommend that anyone wanting to learn about it should obtain a Amateur licence. Not only will you learn much, but also you will meet many people who can be of help you, and be able to set up do-it-yourself communications if you get stuck.

3.4.1 Resolution 640

Resolution 640 of the ITU WARC Geneva convention 1979 is explained in greater depth in chapter 5. It is very important to us because it enables third party trafficking, meaning that Amateurs can traffic our messages on their radios. Though in normal situations Amateurs are forbidden to pass messages on behalf of a third party, or to talk to a non-amateur station, this can be waived in the case of a disaster if the host government has regulations permitting this and permanently allows and encourages it. This is a theme that needs expanding on much more, so I will return to it in chapter 5.

3.4.2 For Amateur Radio

It's free to use and relatively cheap to buy the equipment. It does not depend on any ground infrastructure and so it may be the only thing working in the area. If you invoke ITU Resolution 640 it can provide the least administrative and legal hurdles. It provides a common pool of frequencies both in the HF bands and the VHF and UHF bands, overcoming the severe problems when working with other organisations. However resolution 640 does not allow the use of equipment without a licence from the country in which it is operating. Most experts agree that Amateurs are the most skilful operators of their equipment.

Many governments encourage their local Amateurs to set up and practice emergency networks. In the USA, for instance, the Government allows the Radio Amateur Civil Emergency Service (RACES) and the Amateur Radio Emergency Service (ARES) to practice as much as twice per month. The more practice time a government allows, the better will be the morale, skill and preparedness of the local net.

3.4.3 Against Amateur Radio

Amateur radio networks are rather nebulous things and so you are very much at the mercy of the locals, (unless you provide your own equipment and operators). Amateurs are volunteers and so you have no rights to demand anything from them, you must keep their good will. It is best to have an Amateur along with you who can speak their 'language' and make them feel happy to work with you.

One serious problem is that of confidentiality. The Radio Operators working with you are unlikely to embarrass you, but many others will be listening in with great interest. It will be like doing your housework in the town square, with passing strangers looking on.

Ideally you would like to solve this problem by using data systems such as packet radio, in which case you would want to scramble the data before sending. The problem is that it is strictly forbidden for an Amateur station to send messages in anything other than 'plain language'. By contrast, your organisation rule book may insist that you preserve the confidentiality of those you are serving, making passing such information in such a public forum out of the question. This issue means that the use of Amateur radio may be limited to logistical matters, but in any case this will depend on what the policy of your organisation is, how urgent your need is, and if there is any other choice.

A further problem is that amateur networks are designed to relay written messages from net to net until they arrive at their destination. It takes quite some minutes for even a simple message to be spoken over the air, written down, checked, and spoken again to the next net controller etc. until the message arrives at the addressee. If this requires, for example, four repetitions of the message, then it can take 20-30 minutes to ask a question and get a reply. Again, packet operation improves this situation.

3.5 'Private' HF radio networks

This means that you own both the mobile station and the 'coast station'. In fact your mobiles communicate only with their own base station. The attraction with this idea is that there are no call costs at all, only the capital costs of the equipment needed.

Unfortunately there are many snags, the biggest of which is getting a licence for the equipment you wish to install and a frequency allocation. Such networks are a very good idea for networks within a given country or region where the frequencies given by the government may be quite adequate for communicating over 1000km or less; for global intercontinental communications you would need to have channels in many bands to ensure reliability.

You would need to have permission from the countries at both ends of the link for the use of the same frequencies and at the same time. This is a problem because channels are often allocated on a time share basis. Demand for HF channels is huge and the competition very fierce. You would be very lucky indeed to get a private allocation that would be half way near any good. Then you would need to set up your own base station at the office. Not only would this be very expensive, and not nearly as good as a professional coast station but also you would have to find skilled radio operators to monitor the system round the clock.^{51, 52}

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The Red Cross and the UN have private HF radio networks. They use them in the FACTOR mode for passing low priority e-mail messages from office to office. The use of satellite equipment means that very urgent messages are no longer transmitted by HF radio. Therefore there is no need to build very powerful transmitters and high gain antennas in order to cater for 24HR operation (as was formerly done at great cost). Instead, much more modest equipment of a few hundred watts and simple antenna systems are now used. Since low priority electronic mail is transmitted this way, we can afford to wait for propagation to open a channel, even if this takes all day. The system stores outgoing messages until a band opens, then automatically sends them over the first available open band. The clear advantage is cost. There is no call charge to pay other than the first cost of the equipment and the maintenance of the very simple system.

Despite the seeming attractions of private global⁵³ network, few experts advise it because the coast station fees will amount to less than the cost of running your own network. but if you think that the volume of traffic is fairly high, get a good consultant to study the feasibility of so doing. Frankly I wouldn't unless you are really serious.

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- ³²The British long-range HF radio station is known as 'Portishead Radio' and is located at Highbridge in Somerset. The original transmitting site at Portishead near Bristol was closed in 1979 but the name has been kept.
- ³³Information relating to Portishead radio is similar to services offered by other coast station of other nationalities. Check with your national marine and aeronautical service for details.
- ³⁴The messages are either automatically or manually typed into a computer VDU. The computer then tracks the message to ensure that it is not lost and is passed on as soon as possible.
- ³⁵Many of these phenomena are still a mystery but the greatest effects seem related to sun spots. Therefore you may see some propagation documents mention the sun spot number.
- ³⁶You can receive predictions of propagation from Portishead Radio either as charts or by automatic telex data bank.
- ³⁷The actual figure depends on the path between the coast station and the field team. More accurate estimates can be obtained from coast stations or other expert consultants. In any case the path is much more reliable for working through a coast station than for working from mobile to mobile or mobile to base. This is because coast stations have highly superior antennas and receivers and they have more frequency bands at their disposal.
- ³⁸Actually some countries forbid the use of synthesised radios unless the programming can only be done by an expert technician in a workshop, leaving the user with only a channel selection knob.
- ³⁹Also known as TOR, it is the same as Amateur Microprocessor Teledata over Radio (AMTOR).
- ⁴⁰Experts reckon SITOR to be the most reliable HF radio system yet devised.
- ⁴¹Or just a modem
- ⁴²There are manually operated ATUs available from several sources. They are very much smaller, lighter and cheaper than the automatic versions. but you have to remember to tune them when you change frequency. Tuning can be tricky and so an operator has to be shown how to do this.
- ⁴³Some models of automatic ATU need special control cables from the transceiver. Often they will work only with a particular model of transceiver so beware!
- ⁴⁴However one model has the driving loop made of a soft band instead of a solid tube. This make it easier to pack but the makers don't recommend regular flexing of the loop.
- ⁴⁵For your best Coast Station consult your national PTT. A full list can be found in the book 'Admiralty List Of Signals' published by HMSO (the British government press).
- ⁴⁶The antenna systems in use at Portishead Radio consist of omnidirectional transmitting aerials (for Morse code and Telex operation and rotatable log periodic (RLP) directional antennas for voice communication. The output power is in the region of 10KW per transmitter. The transmitter site is located at Rugby, Warwickshire. The receiving aerials are located at Somerton near Yeovil in Somerset, and are highly directional rhombics spaced every 15 degrees. The direction of the aerials is controlled by the Radio Officer at the Portishead control room in Highbridge.
- ⁴⁷The performance can be better than that of a much closer base station with less advanced equipment.
- ⁴⁸A Traffic list is a list of mobiles that the coast station has calls from PSTN pending. It is broadcast on several frequencies at the same time, Usually the main frequency in each band. This is usually done every hour on the hour so listening to all of them will quickly show which band is the strongest signal. This is one advantage of having Receivers with memory settings as you may miss the list if you take too long to tune to the next band manually.
- ⁴⁹You can get Portishead to remind you when a certain time is up. This helps you to control your spending. Inmarsat do not offer this service at all.
- ⁵⁰A good trick is for the landline user to cover the Mic. on the telephone when listening. This prevents noises in the room from cutting off the incoming voice.
- ⁵¹The CICR has a whole department based at Geneva staffed with many technicians devoted to this task. They have sufficiently high levels of traffic to justify the costs of such an arrangement. Also they have the luxury of having several frequencies assigned to them but not on an absolutely private basis.

⁵²UNDHA uses the transmitters of the Swiss PTT on a permanent lease basis.

⁵³When running local networks within the region, private base stations make much more sense and in any case may be the only alternative.