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Spectrum Management

Radiocommunication Information Circular

# **Study Guide for the General Operator's Certificate**

Radiocommunication Information Circulars are issued for the guidance of those engaged in radiocommunications in Canada. The information contained in these circulars is subject to change without notice. It is therefore suggested that interested persons consult the nearest district office of Industry Canada for additional details. While every reasonable effort has been made to ensure accuracy, no warranty is expressed or implied. As well, these circulars have no status in law. Additional copies of this or other circulars in the series are available from any office of the Department.

Comments and suggestions may be directed to the following address:

Industry Canada  
Radio Regulatory Branch  
300 Slater Street  
Ottawa, Ontario  
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Attention: DOSP

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## Introduction

The material presented in this publication, in addition to that found in Radio-communication Information Circular 23 (RIC-23), *Study Guide for the Restricted Operator's Certificate*, covers the scope of the General Operator's Certificate examination.

Canada is a member of the International Telecommunication Union (ITU), an organization established to regulate the spectrum, to provide basic standards for communication procedures and practices, frequency allocations and radio regulations on a worldwide basis. The ITU sets the minimum standards that candidates should meet for obtaining the various classes of radio operator's certificates.

Canada is also a member of the International Maritime Organization (IMO), which is responsible for marine equipment and operations, especially concerning safety at sea.

Industry Canada administers telecommunications in Canada, based upon both national and international acts, regulations and conventions. Marine operations in Canada are generally regulated by the Canadian Coast Guard of the Department of Transport.

The Coast Guard (*Ship Manning Regulations*) requires ships that are compulsorily fitted with radio equipment to carry persons who hold the appropriate certificate for the type of voyage and the equipment fitted.

Generally speaking, ships that are fitted with VHF radiotelephones must carry persons who hold a Restricted Operator's Certificate, and ships that are fitted with MF or MF/HF radiotelephones, or ship earth stations, must carry persons who hold either a General Operator's Certificate or a Radiocommunications Operator's General Certificate (Maritime). There are two exceptions to these requirements.

The first exception is for radio operators on "small fishing vessels". (A small fishing vessel is described as a vessel that is used in commercial fishing and that does not exceed 24 meters in length and does not exceed 150 tons, gross tonnage.) This exception permits such vessels fitted with MF or MF/HF transmitting equipment to carry radio operators who hold only a Restricted Operator's Certificate.

The second exception is for radio operators on vessels using the Athabasca-Mackenzie inland waterways. Even though HF radios may be carried by vessels on this waterway, the HF frequency used is outside of the marine bands. The only marine frequencies used in certain areas of the waterway are in the VHF band. Consequently, operators on these vessels are only required to hold a Restricted Operator's Certificate.

Other publications that will be of assistance to candidates taking the certificate examinations are the *Radio Aids to Marine Navigation* (RAMN) and, to a lesser extent, the *Manual for Use by the Maritime Mobile and Maritime Mobile Satellite Services*, the *Ship Station Radio Regulations* (SSR), and the *Ship Station Technical Regulations* (SST). These last two regulations have been established in accordance with the *Canada Shipping Act*.

The Global Maritime Distress and Safety System (GMDSS) is being implemented over a seven-year period, commencing February 1, 1992 and finishing on February 1, 1999. This worldwide system will enhance the assistance that can be given to ships in distress and

urgency situations. Certificate requirements and background on the area concept of the GMDSS can be found in Radiocommunication Information Circular 16 (RIC-16), *Professional Radio Operator's Certificates*. For additional information on this system, also refer to Radiocommunication Information Circular 23 (RIC-23), *Study Guide for the Restricted Operator's Certificate*, under the section entitled "The Global Maritime Distress and Safety System". Current information on the progress and availability of this system will be available in the latest edition of the *Radio Aids to Marine Navigation* and the annual edition of *Notices to Mariners*.

Radiocommunication Information Circulars are available from your local district office of Industry Canada. Other publications, such as the *Radio Aids to Marine Navigation* and the annual edition of *Notices to Mariners*, are available from booksellers offering government documents and publications, or by mail from:

Canada Communication Group - Publishing  
Ottawa, Ontario  
K1A 0S9

Inquiries concerning the contents of this publication or suggestions for its improvement may be directed to:

Industry Canada  
Radio Regulatory Branch  
300 Slater Street  
Ottawa, Ontario  
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Attention: DOSP-A

## General Information

### Examiners

Only delegated examiners and Industry Canada inspectors are allowed to oversee and grade the examination papers. Contact your local district office for further information on delegated examiners and courses available in your area.

### Application

Application to attend an examination that is to be given by an Industry Canada inspector for a General Operator's Certificate can be made at the nearest district office. Examinations may be held at district offices or other locations selected by the Department.

Delegated examiners will make their own arrangements with the candidates.

### Candidate Requirements

Through written, practical or oral exercises, or combinations thereof, candidates are to show that they:

1. are capable of operating modern radiotelephone equipment,
2. have a general knowledge of radiotelephone operating procedures, of the regulations applicable to radiotelephone communications between stations and, in particular, of those regulations relating to the safety of life,
3. have a general knowledge of the Global Maritime Distress and Safety System (GMDSS),
4. have a general knowledge of the *Radiocommunication Act* and the regulations made thereunder,
5. have a general knowledge of the *Ship Station Radio Regulations* and the *Ship Station Technical Regulations*,
6. have a general knowledge of the propagation theory and its effect on radio communications,
7. have a knowledge of the equipment in general use in the Maritime Service, and
8. have a knowledge of equipment fundamentals and general electronic information, including fuses and electrical connections, as well as batteries and their maintenance and operation.

## Eligibility

- Nationality: There is no nationality restriction.
- Age: There is no age limit
- Physical: Candidates must attest to the fact that they do not have a disability that would impair their ability to safely operate a radio station.

## Documentation

Candidates must show proof of identity before writing the examination. A birth certificate, a citizenship certificate, a driver's permit or other identification documents may be used.

When applying for the General Operator's Certificate, two passport-sized photographs, showing the candidate's head and shoulders, are required.

## Radio Station Inspections and Certificates

Under the *Ship Station Radio Regulations*, established pursuant to the *Canada Shipping Act*, owners and masters of vessels that are required to be fitted with a radio installation must ensure that such installations are inspected by a radio inspector, and are issued an inspection certificate. Inspections of radio installations are also called radio surveys. These inspections must take place not more than one month before the ship proceeds to sea, and at least once a year thereafter. In the event that the radio installation undergoes a major modification or the ship returns to sea after having been out of service for more than 30 days, the radio installation must be re-inspected and a new certificate issued. A radio station inspection certificate is valid for no more than one year. A vessel that does not have a valid radio station inspection certificate on board may be detained by a Port Customs Officer until a valid certificate is obtained.

Applications for radio surveys or inspections should be made to the Industry Canada office nearest to the desired port of survey. *At least three days advance notice is required for most surveys. Additional time is required when inspectors have to travel to remote locations or to off-shore installations.* Application forms and further information may be obtained from any Industry Canada district office.

Should a radio inspection be required while a vessel is in a foreign port, the master, owner or agent is to apply for an inspection, by letter or telex, to the Director General, Telecommunications and Electronics Directorate, Department of Transport, Canadian Coast Guard, Ottawa, Ontario, K1A 0N7, telex 053-3128, fax (613) 998-9258.

Applications for the radio inspection of Canadian ships wintering in U.S. Great Lakes ports should be made by the owners, agents or masters on Federal Communications Commission (FCC) Form 809, and filed directly with the FCC engineering office nearest to the port where the inspection is to take place.

Should any difficulties be encountered in arranging for an inspection in a foreign port, assistance may be sought through the Canadian Consulate.

Radio inspectors of Industry Canada are authorized to inspect, at all reasonable times, vessels fitted with radio equipment. These inspections may take place as a result of investigations into radio communications interference, communications irregularities, violations, or as part of the Department's regular inspection program. Inspections may also take place upon the request of the owner, the master or the Coast Guard.

## Radio Logs and Watchkeeping

### General

All compulsorily fitted radio stations using maritime mobile frequencies are required to keep a radio log. The activities of the station, as well as the nature of messages and signals transmitted, received or intercepted by the station, are to be recorded in chronological order. The log must be located at the main operating position of the station during the time the ship is on a voyage. The log is to be kept by the operator maintaining the listening watch, in accordance with the *Ship Station Technical Regulations*. Foreign-going or home trade vessels of 50 tons, or over-registered tonnage, are also required to keep an official ship log, which contains some information on the radio installation and battery maintenance. [*Canada Shipping Act*, Chapter S9, Sections 261(1) and 263(e)]

A radio log must contain entries recording the following particulars:

- the name, port of registration and official registration or licence number of the vessel,
- the gross tonnage of the vessel,
- the frequency or frequencies guarded,
- the time, whether:
  - a) the local time of the area in which the vessel is operating, or
  - b) the Co-ordinated Universal Time (UTC) when the vessel is engaged in an international voyage, and
- the time and reasons for any radio communication interruption.

### Medium Frequency (MF) and Combined Medium Frequency/High Frequency (MF/HF) Radiotelephone Installations

In addition to logging the information outlined in the sections entitled "General" and "VHF Radiotelephone Installations" found in RIC-23, ship stations equipped with MF (300 - 3 000 kHz) or with combined MF/HF (300 - 30 000 kHz) radiotelephone equipment must make the following entries:

1. the time of, and the reason for, any interruption or failure to observe the silence periods prescribed by the *International Radio Regulations*,
2. details of any service incidents that relate to safety of life at sea, and
3. details of the Automated Mutual Assistance Vessel Rescue System (AMVER) messages sent by vessels conducting offshore voyages of more than 24 hours duration, beyond MF coverage (see the *Radio Aids to Marine Navigation* and section 64 of the *Ship Station Technical Regulations*, as well as the information on AMVER in this publication).

### Retention of Radio Logs

The radio log in its original form must be retained on board the vessel for one month from the date of the last entry. It must be kept in a place where it is available for inspection purposes for an additional period of not less than eleven months. When any portion of that radio log pertains to a marine casualty, it must be retained until all investigations and actions resulting from the incident are concluded.

At all reasonable times, radio logs must be made available for inspection by Industry Canada radio inspectors, either at the ship station or at the office(s) of the licensee.

**Note:** Should a hearing arise as a result of a marine incident, a ship's radio log may be used as evidence in a court of law. It is therefore considered good practice to keep an accurate and legible radio log so that it can be clearly understood.

### Watchkeeping on VHF

For compulsorily fitted vessels, the *VHF Radiotelephone Practices and Procedures Regulations* states that watchkeeping on the VHF band must start at least 15 minutes prior to the vessel leaving its dock or place of mooring. The regulations also state that this watch on Channel 16 (156.800 MHz) shall not be terminated until the vessel is securely anchored or moored.

### Call Signs

The majority of licensed radio stations are identified by a call sign, which appears on the licence. In the examples shown below for coast stations and ship stations, a "character" may be a letter or a number. The first two characters of the call sign, or, in certain cases, the first character, constitute the nationality designation.

### Coast Stations

Call signs for coast stations may be configured in the following ways:

1. two characters and one letter (VCF),

2. two characters and one letter, followed by no more than three numbers (VBX2, VCG34, XMF789), or
3. the geographical name of the place as it appears in the list of coast stations, followed by the word "radio" (i.e. Vancouver Coast Guard Radio).

### Ship Stations

Call signs for ship stations may be configured in the following ways:

1. two characters and two letters (VCJJ),
2. two characters, two letters and one number (VCBM3),
3. two characters followed by four numbers (VC2345),
4. the official name of the ship followed by, if necessary, the name of the owner (e.g. Seawolf-High Seas Fisheries), as long as the combination of names used cannot be confused with a distress, urgency or safety signal, or
5. two characters and one letter followed by four numbers (WXV9581).

In addition, administrations have been allocated blocks of Maritime Mobile Service identifiers. These blocks are formed by a series of nine numbers in such a way that the identity, or a part of it, can be used by telephone and telex subscribers.

### Radio Silence Periods

In order to make it possible for distress and urgency calls to be heard readily, periods of silence have been made mandatory on 2 182 kHz in the Maritime Service. These periods of silence commence on the hour until three minutes past the hour, and repeat on the half-hour until thirty-three minutes past the hour. Unless in a distress or urgency situation, all stations fitted with the MF radiotelephone international distress and calling frequency of 2 182 kHz must maintain listening watch and radio silence during the silence periods. Stations should increase the level of their 2 182 kHz receiver volume controls during these periods in order to better hear weak distress signals (see the section entitled "Distress Frequency Watch Receiver" in this publication).

Radio silence periods are **not** required to be maintained on the VHF (Very High Frequency) International Distress and Calling Frequency of 156.8 MHz (Channel 16).

### Publications to be Carried on Board Compulsorily Fitted Ships

The documents and publications to be carried by a compulsorily fitted ship may be found in Schedule III of the *Ship Station Technical Regulations*.

## Radio and Accessory Apparatus Used in the Maritime Service

### General

The *Ship Station Radio Regulations* and the *Ship Station Technical Regulations* identify, respectively, the criteria for compulsorily fitted ships and their equipment carriage requirements.

### Portable Lifeboat Radio

Portable lifeboat radio apparatus is required to be carried on certain vessels. (See the *Life Saving Equipment Regulations*.)

Portable lifeboat radio apparatus must be capable of transmitting and receiving telegraphy on 500 kHz. It must also be capable of transmitting telegraphy on 8 364 kHz, or of transmitting and receiving on 2 182 kHz. D.C. power input to the anode, collector or drain of the final amplifier must be at least 10 watts.

All operating instructions and procedures, such as the set-up of the antenna, the use of function switches, etc., are explained on a comprehensive plasticized card secured to the inside of the lifeboat radio.

Prior to leaving port on any international voyage, and once a week while at sea, this apparatus and its power source must be checked by a qualified radio operator to ensure that they are in proper working order. A record of all tests must be noted in the ship's official radio log book.

### International Radiotelephone Distress Alarm

The International Radiotelephone Alarm Signal is a warbling sound consisting of two different tones of short duration, which is transmitted in order to clear the frequency before proceeding with the distress call and message. (Note that the signal may also be sent to precede a hurricane warning.) The distress alarm signal generator produces the signal, which is fed into the MF or MF/HF equipment either by wires or by a transducer. The signal is sent for at least thirty seconds, but less than one minute, on the frequency of 2 182 kHz.

If the alarm signal is followed by a single tone of approximately 10 seconds in duration, it indicates that the message to follow is a distress message being relayed by a coast station.

The distress alarm signal generator is not normally connected to the VHF radiotelephone equipment on board vessels, but Canadian Coast Guard radio stations may send the alarm signal on VHF when appropriate.

## **Distress Frequency Watch Receiver**

The distress frequency watch receiver is a single frequency receiver, located on the ship's bridge, tuned to the distress frequency of 2 182 kHz. The receiver has two settings, NORMAL and MUTED. In the NORMAL setting, the device functions as a conventional receiver tuned to 2 182 kHz. In the MUTED setting, the receiver remains quiet but is activated upon receiving the radiotelephone alarm signal.

## **Navtex**

Navtex is an international direct printing broadcast service. It is used to relay navigational and meteorological information to ships, as well as other safety information involving coastal waters up to 500 km offshore. The system operates worldwide on the frequency of 518 kHz.

## **Digital Selective Calling System (DSC)**

The Digital Selective Calling System (DSC) is a proposed system to be used in the Global Maritime Distress and Safety System (GMDSS) for transmitting distress alerts from ships, and associated acknowledgments from coast stations. It will also be used to relay distress alerts from ships or coast stations. The system will use discrete frequencies in the MF, HF and VHF bands.

Provision is also made by the International Telecommunication Union (ITU) for DSC to be used for purposes other than distress and safety. Frequencies for both of these services are noted in the ITU's *Radio Regulations* (RR62). Please refer to the *Radio Aids to Marine Navigation* for up-to-date information on these services in Canada.

## **Radio Facsimile**

Radio facsimile (FAX) is an imaging system being used by Canadian coast stations to transmit high-quality pictures, such as weather maps and ice charts. Images are received using a radio receiver attached to a special chart recorder. Transmitting stations, frequencies, information to be broadcast and the times of such broadcasts are listed in both the Atlantic/Great Lakes and Pacific editions of the *Radio Aids to Marine Navigation*.

## **Radio Direction-Finding (RDF)**

A radio direction-finder (RDF) is a radio apparatus comprised of a special receiver coupled to a loop antenna. It is used to indicate the direction of a transmitting station. A series of special stations called radiobeacons are operated in Canada along both coasts and on the Great Lakes by the Department of Transport. Marine beacons operate in the band 285 to 325 kHz. With two or more such radiobeacons providing lines of position, it is possible to plot your position accurately on a chart.

The RDF receiver is also used to find ships in distress and to home in on specific locations. For several years, manufacturers have offered for sale direction-finding equipment, with extended coverage receivers tunable from 200 to 2 500 kHz. This allows users to locate ships in distress operating on 2 182 kHz. For further information on radiobeacons, refer to the *Radio Aids to Marine Navigation*.

## Loran

The Loran System (Long Range Navigation System - Type C) is a group or chain of four or five transmitters configured so as to provide the best possible coverage for users in the area. The system operates on approximately 100 kHz. A Loran receiver indicates the vessel's position in latitude and longitude, or provides two or three lines of position (LOP), which can be referenced to a Loran chart. Loran receivers, with computer derived chart displays showing the ship's actual position, are also available. Several such chains are in use on both coasts of Canada and the U.S.A., as well as on the Great Lakes. In these areas, this system is replacing radio direction-finding. For additional information on this navigational aid, refer to the current copy of the *Radio Aids to Marine Navigation*.

## Omega

Omega is a navigational system operating in the Very Low Frequency (VLF) band (approximately 10 kHz). When it is completely installed, this worldwide system will use 21 different stations. These stations are programmed to transmit at specific moments. The Omega receiver has a built-in computer which is controlled by a very accurate clock. The computer is programmed to have the receiver listen for the transmitting stations at these specific moments. The receiver compares the strength of each of the stations, takes the best three signals and provides the receiver output with the required position information.

## Satellite Navigation System

The Navstar/Global Positioning System (GPS) is a worldwide, continuous coverage, satellite navigation system developed by the U.S. Military. The satellites transmit their signals at times precisely controlled by atomic clocks. Signals from three (and preferably 4) of the 24 satellites in the constellation are routed to a computer, the output of which provides a position. This position is accurate to within 100 meters and the accuracy may be increased to within 15 meters when using the appropriate coding.

## Hand-held Transceivers

Operations such as docking, checking holds or tanks, etc., on board larger vessels, are now carried out using small portable hand-held transceivers. These units generally operate in the 450 to 470 MHz band, although VHF frequencies in the 150 to 174 MHz band are utilized in some instances. Licence applications for these units must be made to Industry Canada in order to obtain the operating frequency. Since these frequencies are often shared with other users, care must be taken not to create interference. Ships that are fitted under the Global Maritime Distress and Safety System (GMDSS) are required to have VHF transceivers equipped with 156.8 MHz for life saving (survival) craft. This is reflected in the *Life Saving Equipment Regulations*.

## Ship Earth Stations

The Standard "A" INMARSAT (International Maritime Satellite Organization) station provides a full data, telex and telephone system for a ship. The package includes a tracking antenna with gimbal and azimuth provision.

The Standard "C" INMARSAT station provides slow-speed data and telex only. The antenna is a small dipole giving an omnidirectional pattern. This system is considerably less expensive than the "A" system.

Two new INMARSAT systems are to be introduced in 1992 or 1993. These systems, to be called INMARSAT-B and INMARSAT-M, will be digitally based, providing enhanced services to users.

All of these systems provide service from latitude 70° N to latitude 70° S.

## Other Equipment

There are other types of equipment being used in the marine environment, which have not been discussed. If questions arise about other apparatus, you may read through the *Radio Aids to Marine Navigation*, contact a marine electronic equipment dealer or inquire at your local library.

## Canadian Coast Guard Radio Stations

The Canadian Coast Guard has established an extensive telecommunications network in order to promote safety in Canadian waters. This network includes Coast Guard radio stations on the Atlantic, Pacific and Arctic coasts, and along the St. Lawrence River and the Great Lakes.

The main function of the Coast Guard radio station system is to continuously monitor international distress and calling frequencies to detect distress situations, and to ensure that assistance is dispatched in a timely manner.

The Coast Guard provides a Public Correspondence Service (telephone and telegraph). It is also responsible for continuously monitoring the Marine Radio Navigation Systems, and for broadcasting weather forecasts, ice information and *Notices to Shipping* (Notship). For information on these services and their availability, refer to Parts II through IV of the *Radio Aids to Marine Navigation*.

*Notices to Shipping* are transmitted on the coast station's broadcast frequencies:

1. upon receipt, and
2. at all scheduled broadcast periods during the following 48 hours unless cancelled.

After a period of 48 hours, *Notices to Shipping* still in effect are broadcast in an abbreviated format until cancelled, except for information of a safety nature and Notship broadcasts on Continuous Marine Broadcast Service (CMB).

The Continuous Marine Broadcast Service of the Canadian Coast Guard provides immediate access to the latest meteorological forecasts, ice information and hazards to navigation. This service is transmitted on discrete VHF frequencies as listed in the *Radio Aids to Marine Navigation*.

The Public Correspondence Service (duplex calls and radiotelegrams) consists of Coast Guard radio station facilities used to provide short- and long-range, ship-to-shore radio-telegraph and radiotelephone communications, as indicated in the station listings in the *Radio Aids to Marine Navigation*.

Coast Guard radio stations will broadcast traffic lists at scheduled times and on published frequencies ONLY when they have traffic on hand.

### **Automated Mutual-Assistance Vessel Rescue System (AMVER)**

The Automated Mutual-Assistance Vessel Rescue System (AMVER), operated by the U.S. Coast Guard, is a maritime mutual-assistance program that provides important aid to the development and co-ordination of search and rescue (SAR) efforts throughout the world. Merchant vessels of all nations making offshore passages of more than 24 hours are encouraged to send their sailing plans and periodic position reports to the AMVER Centre in New York. There is no charge for these radio messages when they are sent through Canadian Coast Guard radio stations. Information from these messages is entered into a computer that generates and maintains dead reckoning positions for participating vessels throughout their voyages. The predicted locations and SAR capabilities of all vessels known to be within a given area are furnished, upon request, to recognized SAR agencies of any nation for use during an emergency. A vessel's predicted location is disclosed only for reasons related to maritime safety. The benefits of such a system to shipping include a better chance of receiving rapid aid in emergencies, a reduction in the number of calls for assistance to vessels that are not in a position to assist, and a decrease in the time lost by these vessels responding to calls for assistance. An AMVER participant is under no greater obligation to render assistance during an emergency than a non-participating vessel.

For further information on the AMVER system, including detailed operating procedures, consult the current edition of *Radio Aids to Marine Navigation* or the annual edition of *Notices to Mariners*.

## Vessel Traffic Services

Vessel Traffic Services (VTS) is a communications and surveillance system operated by the Canadian Coast Guard in selected Canadian waters for the purpose of ensuring the safe and efficient movement of marine traffic, and the protection of the marine environment. There are essentially two categories of VTS in Canada.

1. The VHF Vessel Traffic Services exchanges pertinent traffic movement information and waterway status with ships operating in coastal and port approach areas, because of traffic density or environmental conditions.
2. The Eastern Canada Traffic Zone (ECAREG) and the Arctic Canada Traffic Zone (NORDREG) services, operating through the MF and HF facilities of a Coast Guard radio station, monitor the movement and on-board status of ships entering Canadian waters from the high seas, and maintain surveillance of shipping in coastal areas of lesser traffic density than the above category.

For additional information on VTS areas of operation, categories of service, clearance and reporting procedures, refer to *Notice to Mariners - TP390E*, available from the Canada Communication Group - Publishing, Ottawa, Ontario, K1A 0S9.

## Propagation

### Radio Frequency Bands

The radio spectrum is divided into specific radio frequency bands for radio communications. The main frequency bands that concern the marine radiotelephone operator are as follows:

Medium Frequency	MF	300 - 3 000 kHz
High Frequency	HF	3 - 30 MHz
Very High Frequency	VHF	30 - 300 MHz

Some of the factors that influence the transmission efficiency and the reception quality of radio waves are outlined in the following paragraphs.

### Ionosphere

The region above the earth between 50 and 300 kilometers is known as the ionosphere. It consists of several ionized layers at various heights surrounding the earth. The density of these layers varies from day to night.

Radio frequency energy leaving the transmitting antenna travels to the receiving antenna by a number of directions and methods. For the sake of simplicity, we will mention only ground waves and sky waves, which have the greatest influence on the MF and HF radio frequency bands and the space wave, which has the greatest impact on VHF.

Throughout the daylight hours, the radio energy from MF transmissions, upon reaching the ionosphere, is normally absorbed and not reflected back to earth. The received signal travels along the surface of the earth and is known as the ground wave. During the daytime, MF transmissions (on frequencies such as 2 182 kHz) are usually reliable and consistent over ranges approaching 300 km, depending upon transmitter power, antenna type or other equipment-related qualities.

During the hours of darkness, however, the reliability of MF communications may be adversely affected by sky-wave interference. As darkness approaches, the ionospheric layers change and MF signals may reach your receiver by both ground- and sky-wave paths. Radio-frequency energy from many distant stations may be reflected off the ionosphere and back to earth, resulting in severe interference at the receiver. For example, during the hours of darkness you may hear distant stations which are located more than 1 600 km from your position, but stations within 80 km of your location may be unreadable.

Unlike MF, High Frequency (HF) depends upon the sky wave for long distance coverage, both day and night. The radio frequency energy from the transmitter reaches the ionosphere via the sky wave and is reflected back to earth over distances that exceed 1 600 km. On the HF bands, ground-wave energy is insignificant, making these bands unsuitable for communications with local stations. However, both MF and HF communications are also affected by other factors.

VHF transmissions are by direct or space waves. For optimum communications results, the transmitting and receiving antennas should see one another or be within line of sight. VHF communications are not greatly affected by atmospheric or ionospheric disturbances over normal communications distances, but physical obstructions can adversely affect the coverage area.

### **Sunspots and Ionospheric Anomalies**

During periods of high sunspot activity, solar flares are sometimes created. These flares produce radiation and particles that are propagated outwards. When they come in contact with earth's atmosphere, they can cause ionospheric disturbances, which in turn may seriously impair high frequency communications. When this happens, the result is auroral activity (northern lights) and partial or even total absorption (blackout) of the radio energy using the MF and HF bands. This is especially true north of latitude 50° N on the east coast and latitude 55° N on the west coast. Such occurrences can adversely affect communications from a few hours to several days.

### **Arctic Ground-Wave Propagation**

Ground-wave propagation in the Arctic tends to be deficient because of the poor conductivity of rock, frozen ground and ice. Radio frequencies in the 2 MHz band are particularly affected by loss of range since their propagation depends upon good conductivity. Consequently, most communications by radiotelephone is on HF or VHF.

## Seasons and Weather

Every operator should be aware that the time of year can also influence radio communications.

In the summer, electrical storms interfere with the reception of MF and HF signals. Lightning crashes can be heard on your MF or HF receivers, originating from electrical storms that may be hundreds of kilometers away. Usually, only severe local storms will affect VHF reception.

During periods of precipitation, whether it is rain, drizzle, snow or especially blowing snow, a phenomenon called "precipitation static" often occurs. This phenomenon, which may begin and end suddenly, results in very high noise levels at the receiver. It can last for periods of a few seconds to an hour or more. Under these conditions, MF and HF communications may be wiped out entirely. VHF communications can be affected, but to a much lesser degree.

## Frequency and Coverage

Communications distances in the MF, HF and VHF ranges are all affected to some degree by the following:

1. antenna height, especially for VHF communications where adequate antenna height is very important,
2. physical obstructions in the surrounding terrain, such as buildings, hills and mountains severely limit the range of VHF communications and, to a lesser degree, MF communications, and
3. the type of antenna being used, whether it is directional or non-directional, and whether the angle of radiation from the antenna is low or high.

The following shows the available bands and the distances you can expect to cover when using them for communications:

VHF Band - up to 80 kilometres

MF Band - up to 400 kilometres

HF Band - 300 to more than 1 600 kilometres