



## Online Courses for Wildland Firefighters

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## S-212 ~ Fireline Communications

### S-212 ~ Introduction

This course is designed to give firefighters a working knowledge of how to use portable two-way radios while on the fire line. The information is consistent with the version of the S-212 course originally developed by the BC Ministry of Forests and can be considered an S-212 equivalent.

Communications on any emergency incident is critical to both a successful mitigation and for the safety of all involved. This course is designed to help emergency workers properly use a portable two-way radio and have everyone use standardized procedures and terminology.

### Outline:

- Section 1- Introduction to Radio Communication
- Section 2- Radio Frequency Waves
- Section 3- Transmission Techniques and Radio Procedures
- Section 4- Distress Calling
- Section 5- Radio Position / Location
- Section 6- Radio Equipment and Care
- Section 7- Fire Repeaters
- Section 8- Terminology / Phonetic Alphabet
- Section 9- Exam

## Section 1~ Introduction to Radio Communication

Not many years ago a two-way radio was the only way to communicate wireless. Today, with the onset of cell phone use, two-way radios play a lesser (but important) role in communications. As we all know, cell phone service can be unreliable at times and there are parts of the Province that still do not have cell coverage.

Two-way radios rely on a repeater and are therefore more reliable, especially in an emergency situation where the use of cell phones can overwhelm the support system. BCWS relies on two-way radios for communications on wildfires.

In Canada, the Department of Innovation, Science and Economic Development controls the use of radio wave Spectrum and requires a license for the use of a two-way radio. I.S.E.D. may, at any time, monitor the use of radio frequencies it has assigned. Regulations control the following aspects of radio transmission:

- Interference. One may not deliberately interfere with any transmission except for an emergency broadcast.
- Superfluous Transmission. Communications are restricted to official business and the transmission of unnecessary or superfluous communications is not permitted.
- Profane or Obscene Language. Profane and obscene language is strictly prohibited.
- False Distress Signals. Any person who knowingly transmits, or causes to be transmitted, a false distress signal or message is guilty of an offence.
- Confidentiality. Divulging, abuse or using information that is overheard over the radio is strictly prohibited.

Fines or imprisonment can be imposed for any violation of these regulations.

## Section 2~ Radio Frequency Waves

What is a radio frequency and modulation? This section will try to make some sense of just what comes out of the radio.

Radio wave. A radio wave is a natural phenomenon and is basically an electromagnetic carrier signal (wave) which travels in space without artificial assistance. This natural wave becomes a wave length capable of carrying information when it has been manipulated (modified) by humans.

A radio wave has to be modulated to carry information. This is done in three basic ways, Amplitude modulation (AM), Frequency modulation (FM) and Single sideband (SSB).

Amplitude modulation is how high and low a radio frequency can go. See fig. 1

Frequency modulation is how far apart a radio frequency can go. See fig. 2

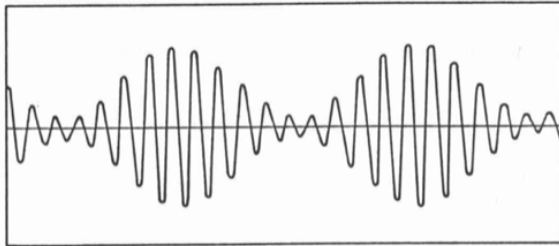
Single Sideband is a modified form created by removing part to the amplitude signal.

AM is used for High Frequency radio stations (HF) and aviation. FM is used for better radio station quality. SSB is used for long distance radio communication.

The word "frequency" means some action being repeated in intervals. A "cycle" describes one complete interval from peak to peak. See fig. 3 The number of completed cycles per second is called Hertz. The higher the Hertz rating (i.e.: 30 GHz) the more information can be carried. A lower the rating (i.e.: 30 KHz), the less information can be carried.

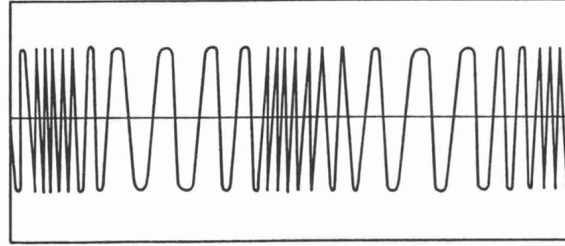
AM / Single Side Band frequencies are in the higher range and are therefore suited for two-way radio communications. See fig. 4

Fig. 1 Amplitude Modulation (AM)



*Amplitude modulation*

Fig. 2 Frequency Modulation (FM)



*Frequency modulation*

Fig. 3 Frequency Cycle

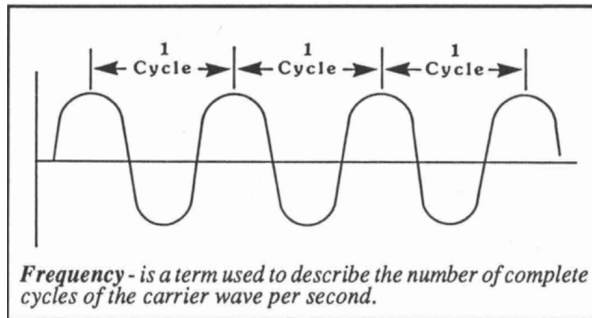


Fig. 4 Frequency Classification

Classification	Abbreviation	Frequency
Very Low Frequencies	VLF	10 - 30 kHz
Low Frequencies	LF	30 - 300 kHz
Medium Frequencies	MF	300 - 3000 kHz
High Frequencies	HF	3 - 30 MHz
Very High Frequencies	VHF	30 - 300 MHz
Ultra-High Frequencies	UHF	300 - 3000 MHz
Super-High Frequencies	SHF	3 - 30 GHz

Hz = 1 Hertz, kHz = 1,000 Hz, MHz = 1 million Hz, GHz = 1 billion Hz.

## Section 3~ Transmission Techniques and Procedures

Unlike speaking face to face with someone where you can pick up on visual cues to fully understand what is being said, radio communications is like talking in a darkened room.

When using a two-way radio, you must follow some basic rules:

- 1- Make sure the radio is turned on and on the channel you want.
- 2- Make sure no one else is broadcasting.
- 3- Hold the mic close to your mouth and speak in a clear and calm voice.
- 4- Call the person (or station) you want to talk to and state who you are.
- 5- Wait for a reply before saying anything else.
- 6- If you are being called, reply by repeating their call sign and then stating your own.
- 7- Do not speak too fast or use an uneven rhythm. If you have a lot to say, take a break and ask if they are copying you alright. Don't ramble on, just say what is needed.
- 8- Think about what you are going to say and try to avoid "er's" and "um's" or pauses where you have to think.
- 9- Be mindful of the time you spend on the radio, especially if others are using that same channel.
- 10- Avoid standing close to loud background noise such as pumps or heavy equipment.

Here is an example of a good two-way radio conversation. If you do not have a call sign, use your name or position.

I.C. ~ Pump operator, this is Incident Command. wait for a reply  
P.O. ~ Command this is pump operator

I.C. ~ Pump operator please up the pump pressure as high as it will go.  
P.O. ~ Roger, running the pump up to full pressure.

I.C.~ Thank you, I.C. clear  
P.O. ~ Pump operator clear.

If spelling something out, use the Phonetic alphabet. See appendix

If you are giving GPS coordinates, the decimal point should be spoken as "decimal"

Example: 23.55 sounds like two, three, decimal, five, five 23.05 sounds like two, three, decimal, zero, five.

### Common words or phrases:

Acknowledge- Let me know you have received and understood the message.

Affirmative- You agree with what was said.

Break- Indicates a break between separate parts of a message.

Break with (name)- Indicates you are done with one person and going to call another.

Clear- You are done with the conversation and signing off.

Confirm- Is my version correct.

Copy that- If you understood everything that was said.

Correction- If you said something wrong. Give the amended information.

Go ahead- Proceed with your transmission.

How do you read\*- Do you hear me ok?

I say again- use if you have to repeat yourself.

Negative- No or incorrect or permission not granted.

Over- Your transmission is over and you are waiting for a response.

Out- Your transmission is over and you are signing off.

Repeat- You did not understand what was said.

Roger- You have received and understood the message.

Stand by- You have to pause for a moment and want the other person to wait.

Standing by- Indicates you are waiting for the caller to return.

Say again- You did not understand and want the caller to repeat the message.

What is your location- You are asking for the other person's location.

\*Volume and clarity are used to indicate how well you are receiving on a scale of 1-5. 5 by 5 means loud and clear, 5 by 2 means loud but hard to understand, 3 by 3 means low volume and not very clear. And so on.

## Section 4~ Distress Calling

Broadcasting an emergency distress signal is now universally standardized. All radio operators should be familiar with the three levels of distress:

Mayday, Pan-Pan and Security.

**Mayday**- This indicates a life-threatening situation that requires immediate attention, such as an unconscious accident victim or immediate rescue is required.

- 1- Make sure the radio is turned on and on the channel you have been using.
- 2- When no one is speaking, call "Mayday, Mayday, Mayday" state your name, location and nature of the emergency. You can break into an ongoing conversation when no one is speaking. If someone is transmitting, another caller cannot be heard!
- 3- If you hear a Mayday call, do not respond to the caller if you are unable to help.
- 4- If you are the caller and get no response, move to a different location and try again.
- 5- If you can help, contact the caller with your call sign and ask what they need.

If you hear the call but cannot respond, and you hear that no one else has responded, call the caller and offer to relay the information. If you are not involved in the incident maintain radio silence until the emergency is over.

Mayday comes from the French word, m'aidez ("help me").

**Pan-Pan** - This indicates a non-life-threatening situation but has great urgency.

The call procedure is the same as above only use the words "Pan-Pan" three times.

Pan-Pan is derived from the French word "panne", which means failure or breakdown.

**Security** - This indicates a safety signal and can be used if the fire makes a sudden change, a section of a road is washed out, a power line is down and across the road.

The call procedure is the same as above, only use the words "Security" three times.

Security is derived from the Latin word, "securus", meaning freedom from anxiety.

## Section 5~ Radio Position / Location

Two-way radios can be fussy when it comes to transmitting and receiving (Tx & Rx) due to the nature of the signal emitted from the antenna and the power of the radio. Most hand-held radios are in the 3-5-watt power range whereas a truck mounted radio is 30-50 watts.

The antenna will send out a signal in all directions equally and will work best if held vertically.

The Very-High Frequencies (VHF) and Ultra-High Frequencies (UHF) used by the radios are considered a "line of sight" wave. This means it will not transmit to the other side of the mountain and can even be hampered by dense forest cover.

If you lose contact try a different location, preferable in an open area or at a higher elevation. Also make sure the battery is fully charged before leaving the base.

Because of the limited range of hand-held radios, BCWS and most Fire Departments employ a repeater station located on high ground to boost the signal. As there are a limited numbers of frequencies available for use, a tone can be used. A tone is a built-in sub frequency, allowing a single frequency to be used for several channels. Operator Selectable Tone (OST) can be used on the radios to change tones from T1 to T9.

## Section 6~ Radio Equipment and Care

**Antenna** A radio is only as good as it's antenna! No antenna, no reception. Today's radios come with antennas that are matched to the particular radio and frequencies used. Our job is to maintain them or exchange them when broken.

There are basically two types of antennas used these days:

VHF for a hand held, called a "Rubber Ducky". It is a coiled antenna imbedded in rubber so it is both flexible and water proof. Make sure it is screwed hand tight into the radio. If it is to be stored or transported in a small container it is best to remove the antenna. Watch for wear and tare especially at the base. Do not use the antenna as a handle.

VHF for base stations and trucks, called a "High Gain antenna. It is single wire antenna about 92 cm long. It so flexible in the upper portion but can be snapped off at the base in under stress. Make sure it is securely attached to the base.

**Battery** All hand-held radios have associated snap on batteries. The days of the dry cell AA or D batteries are long gone.

Make sure the battery is fully charged before you leave for the job site. 12 vDC charges are also available. The shelf life of the batteries is limited. Some are only good for 2-3 years, some longer. If it will not hold a charge very well when not in use, if it starts to leak or is getting hot in use it is probably time to replace it. There is also the recharge cycle. Once it has reached the limit (say 300 charges) it will be time to replace it.

Plan ahead, no one wants to be on a remote job site and have the only radio go dead on them!

**Water Immersion** If your radio drops into water, do not attempt to dry it out. Remove the battery. Put both parts into separate sealed plastic bag and get it to a radio repair shop as soon as possible. It must be completely disassembled and dried properly or a crust will form on the electrical parts and damage the radio.

It is recommended that the battery be removed from the radio for long term storage after it is charged up. Keep batteries in a cool place to extend shelf life.

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## Section 7~ Fire Repeaters

Due to the fact that hand held radios have a limited range, radio repeaters are set up throughout the Province to boost the working range. There are two types of repeaters, fixed and portable. The fixed ones are located in commonly used areas and on mountain tops in order to give the greatest service. BCWS has portable repeaters that can be set up to service local radio traffic. These are used on large fires.

Portable radios will have the capacity to use these repeaters for long distance communications on repeater or duplex channels, as well as simplex channels that only go line of sight from radio to radio. For BCWS radio channels, the metal colours (gold, silver, bronze, etc.) are simplex and the pallet colours (Black, Orange, Blue, etc.) are the duplex channels.

Become familiar with whatever brand radio you are using. There are many functions available (such as scan, priority channels, lone worker and emergency) that are very helpful.

Practice using proper radio transmission procedures before the next emergency!

Look after your radio as it is literally your life line when you are out in the bush.

## Section 8~ Terminology / Phonetic Alphabet



Following is a list of terms used in radio communications and a list of the Phonetic letters. Radio operators should be familiar with all these terms.

**[Link to the "Radio Handbook" issued by the Radio Communication Services.](#)**

Fig. 5 Phonetic Alphabet














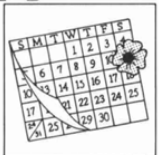


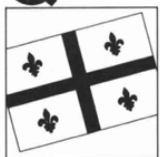




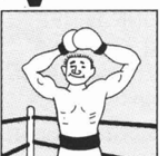




<h1>The Phonetic Alphabet</h1>					<b>A</b> lfa 
<b>B</b> ravo	<b>C</b> harlie	<b>D</b> elta	<b>E</b> cho	<b>F</b> oxtrot	
					
<b>G</b> olf	<b>H</b> otel	<b>I</b> ndia	<b>J</b> uliett	<b>K</b> ilo	
					
<b>L</b> ima	<b>M</b> ike	<b>N</b> ovember	<b>O</b> scar	<b>P</b> apa	
					
<b>Q</b> uebec	<b>R</b> omeo	<b>S</b> ierra	<b>T</b> ango	<b>U</b> niform	
					
<b>V</b> ictor	<b>W</b> hiskey	<b>X</b> -ray	<b>Y</b> ankee	<b>Z</b> ulu	
					

Fig. 6 Phonetic Numbers

<b>Number</b>	<b>Code Word</b>	<b>Phonetic Pronunciation</b>
0	Zero	ZEE-RO
1	One	WUN
2	Two	TOO
3	Three	TREE
4	Four	FOW-ER
5	Five	FIFE
6	Six	SIX
7	Seven	SEV-EN
8	Eight	AIT
9	Nine	NIN-ER
100	Hundred	HUN-DRED
1000	Thousand	TOU-SAND

Please note, several of these terms are old and no longer appropriate for today's use.

Fig. 7 Terminology

# Appendix 1

## FIRE COMMUNICATIONS GLOSSARY OF RADIO COMMUNICATION TERMS

**Antenna** - That part of a radio transmitting system that radiates an electromagnetic field into the surrounding space.

**Bandwidth** - The amount of space or range of frequencies in the electromagnetic spectrum occupied by a signal.

**Base Station** - Fixed radios (neither portable or mobile). Base Stations are usually installed in regional and district offices, but there is occasion when a base station is established in the field.

**Call Sign** - Identifies the transmitting or receiving radio station. A call sign is assigned to every fixed or transportable radio station by the Department of Communication and must be used at the beginning and end of every conversation. (Call signs for all Forest Service mobiles and hand carried portables are assigned by the Superintendent, Electronics, Ministry of Forests.) When in the field, Crew Bosses use their surname as a call sign to identify their radio.

**Carrier Wave** - The wave on which information is superimposed by modulation.

**Certification** - With a few exceptions, the Department of Communications requires that every person operating a radio transmitter hold a certificate of proficiency. Certificates may be obtained by passing a written exam given by the DOC. The Ministry of Forests grants "operator eligibility" to personnel who have received radio training (i.e., Fire Communications - Course S-212).

**Cycle** - A single voltage, current, or power level change of a repetitive alternating nature/wave. The number of cycles completed in a given time is the frequency.

**Dipole Antenna** - A radio antenna, approximately 75 metres (225) long, which the Forest Service commonly uses with SSB radios such as the SBX-11.

**Directional Antenna** - An antenna designed to radiate more energy in one or more specified directions, than in others. (See: **Yagi**). The opposite of a directional antenna is an omnidirectional antenna.

**Distortion** - A change to the original signal wave form from transmission to receiving.

**Electromagnetic Waves** - Radiation of energy in the form of electric and magnetic fields. Electromagnetic waves travel in a vacuum and cover a very wide frequency range, of which radio waves are a part.

**Emergency** - An unforeseen combination of life-threatening circumstances that calls for immediate action. (See: **MAYDAY**).

**Fidelity** - The term applied to the ability of a reproducing system to recreate, at its output, a true reproduction of the input signal.

**Fire Repeater** - (See: **Repeater**).

**Frequency** - The rate at which repetitive cycles of voltage, current, power, or fields will change. The unit of frequency is the Hertz.

**Ground Plane Antenna** - A type of omnidirectional antenna which the Forest Service often uses with its base stations. (See: **Omnidirectional**).

**Ground Wave** - A wave in which its useful characteristics are observed at ground level. High Frequency signals travel along the earth's surface in the form of a ground wave similar to ripples and waves that spread outward when a stone is thrown into a pool of still water. The opposite of the Ground Wave is the Skywave.

**HF (High Frequency) Band** - The band of radio frequencies ranging from 3 to 30 MHz. Propagation on this band relies on the return of signals from the ionosphere. (See: **Skip Communications**).

**Hand-held Radio** - A type of portable radio. A desired feature of hand-held radios is their compactness, which makes them relatively nuisance-free and easy to use in the field.

**Hertz** - The unit of frequency defined as cycles per second and normally used in the abbreviated form Hz. The name (Hertz) was adopted to commemorate the work of Heinrich Hertz who, in 1887, first transmitted and identified radio waves.

**Interference** - This is the term given to describe the confusion of radio signals caused by stray radio waves or by radio waves of different frequencies affecting each other. In receivers: A general term for any disturbance produced to received signals by outside signals on the same channel during a transmission.

**Ionosphere** - The region of the earth's atmosphere extending from a height of about 160 km (100 miles) to about 1700 km (1,050 miles) where propagation of radio waves is influenced.

**Jamming** - A deliberate interference signal on a common channel, designed to render the channel useless. The Department of Communications monitors radio transmissions to ensure violations, such as jamming, do not occur. (See: **Monitor**).

**Licensing** - All radio stations must have a license which is issued by the Department of Communications, Canada. The original license for Forest Service radio stations is held on file by the Manager, Electronics, Ministry of Forests, in Victoria.

**MAYDAY** - The priority distress signal indicating serious life-threatening or imminent danger. Mayday is used when immediate assistance is requested. When transmitted, the word MAYDAY is always repeated three times.

**Microphone** - A device for converting sound waves into electricity in order that information can be transmitted to a receiving station.

**Mobiles** - Describes radios which are normally installed in vehicles. Mobile radios are often designed to run off the vehicle's 12-volt battery.

**Modulation** - A process whereby a carrier wave is varied or manipulated. Modulation can be affected by varying amplitude, frequency, phase, or various pulse signals. (The Forest Service Course, Fire Communications, reviewed only Amplitude Modulation - AM, Frequency Modulation - FM, and Single Sideband Modulation - SSB).

**Monitor** (verb) - In reference to the Department of Communications, continuous observation of transmissions to ensure violations do not occur.

**Network** - A combination or number of inter-connected stations or a repeater system which broadcast, or transmit, the same information. The Forest Service has established an extensive Repeater Network System in British Columbia. (See: **Repeater**).

**Noise** - Any unwanted disturbance in a communication channel. Noise results from a number of sources. No communication channel is completely free from noise (atmospheric noise, equipment noise, or man-made noise) which can be easily picked up by the antenna).

**Omnidirectional** - Referring to antennas: The ability to send and receive radio waves equally well in all directions. The opposite of an omnidirectional antenna is a directional antenna. (See: **Ground Plane Antenna**).

**Oscillation** - The action of vibrating, modulating, or manipulating electrical energy in a radio antenna to produce a carrier wave.

**PANPAN** - The urgency signal indicating a very urgent message concerning jeopardy to safety is to be transmitted.

**Portables** - Radio units which can be used on-the-move and obtain their power supply from either dry cell or rechargeable batteries. There are basically two types of portables: The compact hand-held radio unit (e.g., ICOM-12), and the more cumbersome, but still portable, box radios (e.g., Motorola Handie-Talkie).

**Propagation** - The transmission of electromagnetic waves through solids, liquids, or gases.

**Radio Communication** - Communication by means of radio waves without any constraints (such as guides or wires), other than those imposed by the conditions prevailing, over the propagation path through space (e.g., the ionosphere).

**Radio Frequency** - An electromagnetic wave. It is produced by oscillating or modulating the electric current in the radio antenna.

**Radio Station** - An installation comprising of antenna system(s), radio receiver(s), and/or radio transmitter(s).

**Radio System** - A group of radio transmitters and receivers arranged in such a way as to allow communication over an extended distance. (See: **Network**).

**Radio Telephone** - A radio that is connected to the public telephone network which allows any radio on the same frequency(ies) to communicate over the telephone system.

**Radio Transmitter** - Apparatus for the generation of radio frequency carrier energy/waves and means for its modulation.

**Repeater** - An amplifier which can pick up a weak signal coming along a line and send out, or retransmit, a new identical signal at full strength. Repeaters are basically receiver -- transmitter combinations.

**Scan/Scanning** - A feature found on almost all multi-channel radios. Scanning permits the operator to monitor communications on all stations, or a combination of channels, by programming the radio to carry out scan functions.

**SECURITY (SAY-CURE-ITAY)** - The safety signal used to transmit a message concerning safety to navigation, road alerts, or weather warnings.

**Sideband** - a range of frequencies generated by modulation of a carrier wave.

**Signal** - The electrical characteristics of voltage or current changes that, when transmitted over a suitable path, convey information.

**Single-Sideband (SSB) Transmission** - A system of transmission in which only the upper or lower sideband, produced as a result of amplitude modulation (AM), is transmitted. SSB is a by-product of, superior to, and has replaced AM for Forest Service land communications.

**Skip Communications** - The phenomenon which occurs with SSB and AM transmissions. The Skywave reflects, or ricochets, off the ionosphere down to earth and back up to the ionosphere to repeat its reflective phenomenon once again. (See: **Skywave**).

**Squelch** - In receivers, a process sometimes used for the suppression of noise during a tuning operation. The squelch control is used for eliminating noise and is only operated when there is no signal on the channel. The degree of the sensitivity to incoming signals is adjustable. Operators are reminded never to turn the squelch beyond the point where the noise "just cuts out". Taking the squelch beyond this point could render the receiver inoperative.

**Wave** - The movement of energy from one point to another. In radio, the movement of electromagnetic energy.

**Whip Antenna** - A short, flexible, vertical rod, often used with mobile radios and usually attached to the roof of the vehicle. For best results, mobile antennas should be erected in the centre of vehicle roof.

**Yagi** - A type of high gain antenna which the forest service often uses with its base stations. The Yagi is a directional antenna. (See: **Directional**).

## Section 9~ Exam

- 1- On the fire line, two-way radios are more reliable than cell phones.  
 True  False
- 2- All radio frequencies in Canada are controlled by the Department of Innovation and Science.  
 True  False
- 3- There is only one type of wave length available for radios.  
 True  False
- 4- When transmitting on a radio, it is acceptable to ramble on.  
 True  False
- 5- It is acceptable to use your surname or position as a call sign.  
 True  False
- 6- The word "affirmative" means you are signing off.  
 True  False
- 7- "Mayday" should be repeated three times  
 True  False
- 8- Radio transmission is not affected by terrain or dense forest cover  
 True  False
- 9- If your radio is immersed in water, remove the battery and put it in a plastic bag and take it to a qualified repair person asap.  
 True  False
- 10- Your radio is your life line, keep it in good working order.  
 True  False

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Continue...