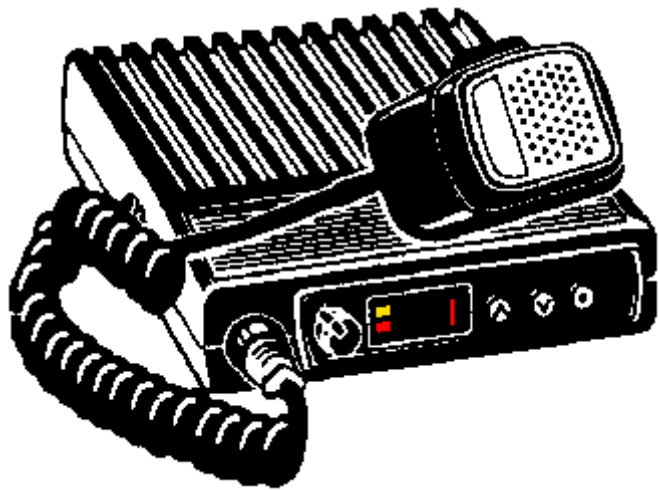




# Practical Guide

FOR

# TWO-WAY RADIOS



**Prairie and Northern Region**

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## Who is Industry Canada?

Industry Canada (formerly known as the Department of Communications, or DOC) is the federal government department that is responsible for planning and managing all frequencies in the radio spectrum and all aspects of radio systems, including equipment and towers.

For two-way radio systems, the department selects operating frequencies, issues radio station licences (for the radio apparatus) and works at maintaining an interference free environment for all radio systems.

## How do I contact Industry Canada?

See the Annex for Prairie and Northern Region contact information, or check our Internet Website at [http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/h\\_sf00000e.html](http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/h_sf00000e.html).

Alternatively, you can call 1-800-O-Canada (1-800-622-6232) or check <http://www.canada.gc.ca> for a referral to the nearest Industry Canada office.

## Do I need a radio licence?

In Canada, radio licences are required for all frequency assignments. Industry Canada selects frequencies and issues licences for two-way radios, either to you or your radio supplier.

Licences assist in the effective management of the

frequency spectrum, ensuring access to interference free spectrum for all of our clients. Without effective management, the spectrum would become chaotic. For this reason, we have legislation to enforce the licensing requirements.

Some radios are exempt from licensing but they generally have a very short range (children's toys or cordless telephones). If you are unsure whether you need a licence, call the nearest Industry Canada office (see Annex).

### **How do I apply for a radio licence?**

You have 2 options:

- Contact your local Industry Canada office (see Annex for contact information).
- go on-line to Spectrum Management's on-line services website at <http://spectrumdirect.ic.gc.ca/>

### **How do licence fees work?**

Fees for new licences are pro-rated from April 1 and expire March 31 and are payable once you receive the radio licence invoice. Invoices to renew existing licences are sent out in February and payment is expected before the licence expires.

Please contact an Industry Canada office for detailed licence costs (see section 'How do I contact Industry Canada' on page 1).

### **How long will it take to get a frequency?**

Normally, a frequency and authority to operate is issued within FOUR weeks of receiving your properly completed application. However, if you're within 120 Kms (75 miles) of the USA border, the frequency selected for your radio system must be co-ordinated with USA authorities. It may take up to SIX weeks to receive a response from USA agencies.

### **What if I need a two-way radio right away?**

Once you have submitted the necessary applications and licence fees, you can operate on a temporary frequency immediately. When a permanent frequency is assigned, you are required to change to that frequency as soon as possible (generally within eight weeks). For farm operations, we understand that changing your frequency during seeding or harvest may not be practical.

### **Can I have a private frequency?**

All frequencies are subject to sharing with existing licenced clients based on spectrum availability. If you wish to reduce the possibility of initially having to share a frequency, try purchasing radios in lesser used frequency bands such as low-VHF 30-50 MHZ. (UHF 406-470 MHZ is also available) If you use the VHF 150-174 MHZ band, there is a very good chance, either initially or in the future, that you will have to share a frequency.

When you apply for a frequency, you will be notified if your frequency will be shared with another user. This user will usually be within 16 Kms (10 miles) of your base station.

Tone-coded squelch can make this sharing arrangement easier. (See section 'What is Tone-Coded Squelch' on page 5).

### **Can I have 2 frequencies in my base station?**

Generally **NOT**, because frequencies are scarce and sharing frequencies is common. It wouldn't make sense to make some people share a frequency and yet give others two frequencies (their own and a neighbour's). We suggest that if you need to communicate with your neighbour that you share the same frequency. Tone-coded squelch can make this sharing arrangement easier. (See the section 'What is Tone-Coded Squelch' on page 5).

There are limited special circumstances when we will authorize more than one frequency in a mobile. Please contact our offices for details.

### **How many people can I have on my frequency?**

There are no restrictions on numbers of users per frequency. However, when Industry Canada shares radio users, it is done with fairness and common sense in mind. Every attempt is made to ensure that direct business competitors are not on the same frequency. For

example, two farm service centres would not be placed on the same frequency. However, farmers may be placed on the same frequency as other farmers.

When frequencies are shared, base stations are licenced within 16 Kms (10 miles) of each other. Any further than this and one base station can unknowingly interfere with the second base station's distant mobiles because the first base station is not within hearing range.

Besides sharing a frequency in your local area (16 Kms or 10 miles), frequencies are reused approximately every 120 Kms (75 miles). You would not normally hear someone at this distance. However, see the section "What is skip" (page 10) for some exceptions.

### **What is Tone-Coded Squelch?**

This radio option screens incoming calls to your radio. If your radio recognizes the tone you use, then you will hear the conversation. Otherwise, you won't hear a sharing partner and most interference.

There are two types of tone-coded squelches: analog and digital. Analog tone provides basic protection but can allow some interference to be heard immediately after you have stopped transmitting. Digital tone provides superior protection as it also sends a "turn off signal" to receivers when you stop transmitting.

Some people ask, if I can't hear the person I share a frequency with, will I cut off their conversations?

Not if the radios are used correctly. All radios capable of tone-coded squelch either have a busy light, a monitor button or can tell if the microphone is off its cradle (hook). These are used to check that no one is using the channel. If the channel is busy, the busy light will come on or you will hear an ongoing conversation if you press the monitor button or when you take the microphone off its cradle (hook).

**REMEMBER:** If you share a frequency make sure the channel is free and clear before making your call.

**HINT:** You may want to have a multichannel programable radio and have your single frequency programmed in all the channels with a different tone-coded squelch in each one. By changing the channel, you really only change the tone-coded squelch. This way, a couple of people can talk to each other on one tone and a base station doesn't have to listen to them by being on a different tone. For example, if two people were combining until 4:00 A.M., they could use the radios without waking up anyone at a base station. If they choose, the people combining could change tones and call the base station or vice versa.

### Should I use a callsign?

It is recommended. Base stations are assigned unique callsigns. If someone is receiving radio interference and they hear a callsign, Industry Canada can immediately tell who it is and where they are located. This helps us to quickly determine the cause of the problem.

Most people can unknowingly cause interference to many users on frequencies other than their own. Using a callsign assists Industry Canada in resolving interference.

An example of using a base station callsign like XYZ123 :

Calling from a base station: "Truck One this is XYZ123"

Calling from a mobile: "XYZ123 this is Truck One"

### Can I get a frequency that I can use anywhere?

Industry Canada has allocated special frequencies that can be used over a wide area. However, base stations are not allowed on these wide area frequencies.

**NOTE:** If you apply for a frequency without a base station you may be given a wide area **mobile-only** frequency.

### Is there more than one type of FM two-way radio?

**Yes,** there are many different types of radio systems. However, for most small businesses purchasing their own radio system, there are three main types or frequency bands of radios:

Low VHF (30-50 MHZ)

Radios in this band can be up to 100 watts in power and base/mobile radio coverage is about 80 Kms. This band is excellent for use in hilly terrain. The drawback to this great coverage is a much

greater chance of interference and higher equipment costs. This is the least used and least shared frequency band.

#### VHF (138-174 MHz)

Radios are limited to 30 watts in power and base/mobile radio coverage is about 40 Kms. This is the most popular frequency band and has the lowest equipment costs. However, most of the sharing occurs in this frequency band.

#### UHF (406-470 MHz)

Radios are limited to 30 watts in power and base/mobile radio coverage is about 40 Kms. Equipment costs are slightly higher than VHF, however sharing doesn't occur as often as the VHF frequency band.

#### What is the best type of radio?

Every radio that bears a sticker indicating its model number and either a DOC type approval number or Industry Canada (IC) Technical Acceptability Certificate (TAC) number is certified by Industry Canada, meaning it meets our minimum technical standards. These are the only radios that Industry Canada can licence in Canada.

**HINT:** Buying synthesized (dealer programable) radios may give you greater flexibility and better options than crystal radios.

For example, you should consider:

- the cost of new crystal radios versus programming a programmable radio.
- the cost of repairs for used radios versus a warranty for new radios.
- the costs of new antennas and the benefit of features such as tone coding which may not be available in older used radios.

Eventually, all radios will require service, therefore, the best radios are the ones that you can get serviced quickly and easily.

#### What if I buy used radios instead of new radios ?

Used radios can work fine. When you contact Industry Canada to start the licensing process, you should request the frequency that already exists in the radios. If the frequency is compatible at your location, it will significantly reduce your costs to not change frequencies.

Before buying used radios, do your homework on the cost and features of new radios. The cost of new two-way radios has decreased over the years. It is common for some people to spend almost as much for old radios and a frequency change as they would have for new radios.

#### What kind of coverage can I get with FM two-way radios?

Radio coverage is mainly line of sight. Most people report that they get about 30-40 Kms of **RELIABLE** coverage between their base stations and mobile radios.

This is when their base station antenna is about 20 metres high and the land is relatively flat around them.

Sporadic radio contacts can be made up to hundreds of kilometres away. However, this is not reliable and more commonly is a result of abnormal propagation or “skip.” (See the section ‘What is skip’ below)

**HINT:** The best way to improve radio coverage is to increase antenna heights. This means you would need to increase the base station’s tower height or relocate the base tower to a higher point of land. A base station radio can be operated remotely by an operator from many kilometres (miles) away.

### **What is skip?**

Skip (or abnormal propagation) results when radio signals travel much farther than they would normally due to unique atmospheric conditions. Skip on CB radios can let you hear people thousands of kilometres away. With skip on VHF radio (UHF is less susceptible ) you may hear people within a few hundred kilometres (couple of hundred miles).

Besides sharing a frequency in your local area (16 Kms or 10 miles) frequencies are reused approximately every 160 Kms (100 miles). Therefore, there will be a number of other users on the same frequency within the range where skip is most common.

Skip (or abnormal propagation) can be unpredictable and sporadic. However, it is more common around dusk and dawn, during spring and fall.

The only remedy for this annoyance is to either change frequency or use tone-coded squelch. The tone-coded squelch option is by far the best long term solution, as a new frequency may experience the same problem. (See the section ‘What is Tone-Coded Squelch’ on page 5).

### **Is there a limit to how high I can have an antenna?**

There is **NO SET LIMIT** to antenna or tower height. However, there may be restrictions imposed by Transport Canada (formerly the Department of Transport) for aircraft safety. Local land use authorities like rural municipalities or town administrations, and certain environmental requirements may also restrict the height. Our licence application process will include questions on these possible restrictions.

Transport Canada generally exempts antenna structures if they are less than 20 metres high and not located within 6 Kms of an airport or 2 Kms of a Transport Canada radar, radio navigation or communications antennas.

### **Can I have a repeater station?**

Not normally, as small businesses rarely have the justification to have their own repeater. Justification includes the demonstrated need for extended mobile to mobile coverage, the lack of local commercial repeaters and a high number of mobile radios.

A repeater station uses two frequencies. On one frequency, it receives radio conversations and at the same time,

retransmits those conversations on the second frequency. Repeaters extend mobile to mobile coverage. This way, a mobile 40kms North of a repeater can talk to another mobile 40kms South of the repeater.

However, a repeater cannot extend normal base to mobile communications. Repeaters are basically two base stations connected together. That's why repeaters can only get the same coverage as a similar configured base station.

### **Can I have more than one Base Station?**

You can have any number of base stations provided each one is licenced.

Instead of multiple base stations, we suggest using one base station radio and running "remote" units from it. This operates as an extension of a base station's speaker and microphone. A remote station like this doesn't require additional licensing.

However, if you wish to have more than one base station, Industry Canada recommends not putting them too close to each other. If they are, the bases may sound excessively loud to each other. As a result, operators may turn volumes down, causing weak calls from mobiles to be missed/not heard.

There is also a problem if the base stations are further than 16 Kms (10 miles) apart. One base station can unknowingly interfere with the second base station's distant mobiles because the first base station can't hear the distant mobiles.

### **Can I install my own two-way radios?**

**YES**, you can install your own radios. How well the radios are installed will dictate how well they will work. If you must install your own radios, it is highly recommended that you get advice from a Spectrum Management Officer or better yet, have them professionally install at least one radio so that you can see how it's done. These radios are unlike CB radios and operate very poorly if improperly installed.

#### **Some installation tips for base stations:**

Provide some strain relief on the coax cable to the base antenna. Usually this is done by having a small vertical loop of coax (15-30 cm diameter with flexible coax) just below the antenna. This way if the coax tries to pull away from the antenna, you can see that the loop has shrunk.

Make sure the bottom of the base station antenna is at least 1 metre (3 feet) from any metal surface especially TV antennas. Close proximity will distort the antenna pattern and will cause erratic coverage.

**Never** try to put connectors on coax cable. Buy coax cable with the connectors already on. Installing connectors properly is far more difficult than it looks. Incorrectly installed connectors will cause future problems.

Don't use a mobile antenna for a base station antenna unless you only want very short radio coverage.



### Some installation tips for mobile stations:

If you need maximum coverage, buy the best HIGH gain antennas you can afford and permanently mount them in the middle of the highest flat metal surface on the vehicle.

Do not install antennas on fibreglass cabs unless you use a special NO GROUND PLANE antenna or if you have added some sort of metal plate to act as a ground plane.

Usually 1/4 wave whip antennas are actually only half of an antenna. When mounted on a large flat metal surface, the surface electrically becomes the other half of the antenna. That's why performance of a 1/4 wave mobile antenna mounted on a non-conducting fibreglass cab is extremely poor.

Magnetic mounts for mobile antennas are common but their performance is not as good as a permanently mounted antenna. Also, if you put something under the magnet so as to not scratch the paint, it makes the performance worse. If you must use magnetic mounts and want maximum coverage then use a high gain, no ground plane antenna.

### Do I need more power to get more coverage?

**NO**, this is a common **MYTH**. More power doesn't mean you will get more coverage. Power has the least effect on coverage.

**HINT:** There's no benefit to spending more money for 45

watt radios since we only allow a maximum of 30 watts in mobiles. Also, the difference in power will **NOT** noticeably increase your coverage. You would get better coverage if you increased the base station antenna height, invest in good quality mobile and base antennas and have the radios professionally installed.

### My radios don't work as well as they did on a temporary frequency?

This can happen if the antennas have not been retuned for the new permanent frequency. In order to get the best performance from two-way radios, their antennas have to be tuned to their permanent operating frequency.

This means the whips on the vehicles have to be recut or replaced and the base station antenna needs to be retuned. Consult your manufacturer's retuning instructions and/or your Spectrum Management Officer.

### Do I need to tell Industry Canada if I'm adding radios?

**YES**, but only if you are increasing the total number of radios you will be using. (ie: increasing your fleet of radios) If you are replacing a radio that is already licenced with a similar radio you do not have to contact Industry Canada.

### Can I have the Weather channel in my two-way radios?

**Yes**, as long as the radio is only capable of receiving the weather channels. Transmitting on weather radio channels

is illegal.

The Environment Canada weather radio channels are 162.550 MHz, 162.400 MHz and 162.475 MHz.

### **Can I use my radios when travelling on vacation?**

**NO**, the only area in which you are permitted to use your radios is the area of operation stated on your licence.

Transmitting outside your licenced area could disrupt safety services, industrial control systems and other licenced radio users.

### **How can I tell which licence is for which radio?**

We don't ask for serial numbers and don't record them on the licenses. All you really need to know is that each radio you use is covered by a licence. However, this doesn't mean each mobile radio has its own separate licence. In order to reduce costs, we combine more than one similar mobile licence on a single sheet of paper and call it a Fleet licence. The licence with a callsign and geographical coordinates is the base station.

### **Do handheld radios require their own licence?**

**YES**, the licensing requirements for handheld radios are the same as mobile units you have in your vehicles.

### **What kind of coverage can I get with handheld radios?**

Handheld to handheld radio coverage might only be one or two kilometres.

This can be increased with the use of better antennas, like a magnetic mount mobile antenna on a vehicle. Other than that, radios are line of sight communications so try finding higher ground to transmit from.

### **Can I use marine radio on the farm?**

**NO**, marine radios are made for vessels operating on the coasts or large inland waters. They use frequencies in the VHF band with 25 KHz spacing, which differs from the normal spacing for land-mobile operation. Therefore, this makes marine radios incompatible with radios used on the prairies.

Also, marine radios do not meet the stricter specifications of land and mobile stations. Therefore, they are more likely to cause or receive interference from other users.

### **What is Family Radio Service (FRS)?**

Family Radio Service (FRS) is a short-range two-way radio service which uses portable handheld radios to provide operation on one or more of 14 UHF radio channels. FRS radios incorporate tone coded squelch and are designed to provide an inexpensive short range means of communication.

FRS radios are licence exempt, meaning you don't need to

apply for a licence and there are no licensing fees.

However, the maximum power allowed for FRS radios is 0.5 (½) watt and base stations are prohibited. FRS may be an option for you if you only require short range mobile-only communications (range of a few hundred meters or yards).

## **-GLOSSARY-**

Base Station	This is any radio operated from a fixed location (like a building). This can even be a mobile radio with a direct current (DC) power supply.
Mobile Station	This is any radio that can be operated while in motion. This can be a radio in a truck, car, combine or even a handheld (walkie-talkie) radio.
Licence	Is the legal authorization issued by Industry Canada to allow someone to use a frequency in the radio spectrum. However, the licence does not constitute a monopoly as frequencies may need to be shared with other users.
Spectrum Management Officer	Is a person appointed by the Minister to enforce Regulations and Acts related to radio communications. This is the person who will select frequencies for radio stations, inspect radio systems, identify interference and if necessary take legal action against unlicensed radio operators. Also, Spectrum Management staff are a good source of radio system information. We welcome all inquires.
Repeater	A repeater station uses two frequencies, twice as many as a normal system. On one frequency, it receives radio conversations and at the same time it

## -GLOSSARY-

retransmits those conversations on its second frequency. This allows repeaters to extend mobile to mobile coverage.

Two-way Radio This is a generic term to describe radio communication equipment used mainly for private business purposes. Other phrases we have heard people use to describe two-way radio are:

FM two-way Radios

Two-Ways

FM Radios

FM's

Assigned Frequency Radios

VHF Radios

VHF's

VHS Radio

(Naturally, this should be "VHF Radios")

UHF's

UHF Radios

Private Radio

(Unfortunately, the word "Private" is misleading as all frequencies are subject to sharing)

Low VHF Low Very High Frequency (30-50MHz)

UHF Ultra High Frequency (406-470 MHz)

VHF Very High Frequency (138-174 MHz)

## -ANNEX-

### Contact Information:

#### Industry Canada, Prairie & Northern Region

##### Central and Northern Alberta District Office

Room 725, Canada Place  
9700 Jasper Ave.

Edmonton, AB T5J 4C3

Phone: (780) 495-2472 or  
1-800-461-2646

Fax: (780) 495-6501

e-mail:

[spectrum.edmonton@ic.gc.ca](mailto:spectrum.edmonton@ic.gc.ca)

##### Southern Alberta District Office

400-639 Fifth Avenue S.W.  
Calgary, AB T2P 0M9

Phone: (403) 292-4422 or  
1-800-267-9401

Fax: (403) 292-4295

e-mail:

[spectrum.calgary@ic.gc.ca](mailto:spectrum.calgary@ic.gc.ca)

##### Manitoba District Office

4<sup>th</sup> floor, 400 St. Mary Ave.  
Winnipeg, MB R3C 4K5

Phone: (204) 983-5851 or  
1-800-665-3421

Fax: (204) 984-6045

e-mail: [spectrum.wpg@ic.gc.ca](mailto:spectrum.wpg@ic.gc.ca)

##### Saskatchewan District Office - Regina

#600, 1945 Hamilton St.  
Regina, SK S4P 2C7

Phone: (306) 780-5010

Fax: (306) 780-6506

e-mail: [spectrum.reg@ic.gc.ca](mailto:spectrum.reg@ic.gc.ca)

##### Saskatchewan District Office - Saskatoon

7<sup>th</sup> floor, 123-2nd Ave. South  
Saskatoon, SK S7K 7E6

Phone: (306) 975-4896 or  
1-877-783-7757

Fax: (306) 975-4231

e-mail: [spectrum.sas@ic.gc.ca](mailto:spectrum.sas@ic.gc.ca)

##### Northwest Territories District Office

401, 4920 - 52 St.

Yellowknife, NWT X1A 3T1

Phone: (867) 920-6603

Fax: (867) 920-6601

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Both Dave Favreau and Richard Jackson are Electronic Engineering Technologists and are long time Spectrum Management Officers with the former Department of Communications (DOC) and the present Industry Canada (IC) in Saskatchewan.

This guide is a collection of experiences and knowledge they have gathered from their years of working with thousands of radio users.