# Moncton Area Amateur Radio Club, Inc.
# Tri-County Amateur Radio Club Inc.

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# Club Member projects

This area is for members that are working on personal projects and would like to share information with other Amateurs.

## RADIO OPERATOR

**By: Gord Skiffington VE1AJF**

### WHAT IS A RADIO OPERATOR?

A Radio Operator describes a person who efficiently uses and maintains an efficient use of a radio station.

Although a radio operator or R/O may be called on to do a variety of tasks associated with a radio station, their base tasks are that of:

- A Communicator and
- A Technician

Radio stations may take various forms from a communicators point of view.....as simple as a channelized transceiver for local voice operation to a more complex, multi-mode, multi-band, station full of seperate equipment which requires considerable technical knowledge to effectively use frequencies, filters, tuning aids and communications interfaces such as computer terminals,

telephone or other radio links as well as considerable communicator ability to pick effective modes, frequencies and antenna patterning while operating computer terminals, telephone patches, teleprinters, morse keying devices or effectively using their voice as an effective communications tool with standardized procedures.....and maybe all of the above while keeping 2 way or multi-link or even broadcast schedules (as amateurs we're not generally allowed to broadcast).....and while logging communications and technical issues (where required).

A great many budding "Radio Operators" are surprised to find that because of the use of their station, their jobs (amateur or professional) may also require monitoring of unrelated equipment or processes, or providing services to mobile or other fixed stations, compiling and understanding processes for which the station is used and the logging and clerical duties associated with any of these. In an amateur (or non-paid) setting, these sort of added responsibilities become quickly apparent when we, as amateur radio operators, are called upon to provide all kinds of emergency or public service communications for people who have a need for an effective radio station and operator but to whom the latter is not often understood. Our ABILITY to be BOTH a COMMUNICATOR and a TECHNICIAN is the reason we've been called on over the decades.

From their technician's point of view, a Radio Operator's technical knowledge will be used to determine how well the various equipment is operating, and making adjustments where necessary (if solely looking after the station) and / or detailing and making repairs to the various station equipment to keep it on the air. In many commercial, industrial, military and even amateur stations, these are the responsibilities of the station radio operator but may also be the job of specialists or may require specialist help where required.

## The following introduces one part of being a technician - Troubleshooting

**THE MAKING OF A TROUBLESHOOTER**

MANY PROBLEMS A TECH FACES INVOLVE THE REPAIR OF "THINGS"

*People designed them, people built them, people used them and people caused them to break.....people.....can fix them.*

**HOW TO TROUBLESHOOT ALMOST ANYTHING:**

1. GAIN KNOWLEDGE OF THE PROBLEM - See required resources.
2. VERIFY POWER SUPPLY (if actively powered)
3. TROUBLESHOOT FROM OUTPUT back to INPUT.

This strategy works on the most complex powered, diverse and simple passive "things".....even a piece of coaxial cable has an input and an output (which becomes reversed depending on whether you're transmitting or receiving.....and could be both at the same time!).
Software, Television sets, 2 meter rigs, HF transceivers and even toilets have a designed purpose.....a desired output with input and control, utilizing power as an active device or acting against applied power as a passive device.

## WHAT DO I NEED?

TESTING or TROUBLESHOOTING - Requires the following resources:

1. Knowledge of electrical principles.....basic electricity and how components work and are used.
2. Knowledge of how measurements are made and the significance of measured results. Having confidence in your test equipment through repeated use and confirmation of results resultsin gaining competence in their use and confidence in the measurements bserved.

3. Knowledge of how the individual device or "black box" or unit is supposed to operate.
The parameters or specifications of a device/circuit or unit are highly useful to determining the results of your troubleshooting and repairs.

4. Gaining knowledge of the history of the problem by making notes of what the symptoms are,how they occurred or were noticed, and what unusual interactions may be taking place with the usual, and more importantly, the designed operation of the device/circuit or unit.

NOTE THAT THE PRIMARY RESOURCE IS KNOWLEDGE. - ALTHOUGH MANY TECHNICIANS HAVE A VAST PERSONAL KNOWLEDGE OF THE ABOVE, ALL GOOD TECHNICIANS RECOGNIZE THE USEFULNESS OF HAVING GOOD SERVICE AND OPERATING MANUALS, CIRCUIT AND PICTORIAL DIAGRAMS FOR THE UNIT OR PROBLEM BEING WORKED ON. GAIN AS MUCH INFORMATION AS YOU CAN CO-INCIDENT WITH THE ANTICIPATED LEVEL OF REPAIR BEFORE BEGINNING WORK.

5. Test equipment necessary to troubleshoot the equipment under controlled conditions. A controlled environment means limiting the circuit or unit being tested t predictable operation within it's designed specs.A common frustrating experience is to learn too late that the "fault" is a result of misapplication or mis-operation.

## HOW TO PROCEED?

**HOW TO REPAIR ALMOST ANYTHING:**
1. TROUBLESHOOT THE PROBLEM ACCURATELY - PROCEED LOGICALLY - SEE TROUBLESHOOTING ABOVE!

There are a great many people who consider themselves technicians who are always looking for the "silver bullet" solution to a repair.....a quick fix.....Although this sort of "tech"occasionally gets stuff running again, they seldomknow much about the problem and will be at a loss when the same problem looks slightly different.

IMPORTANT - MAKE NOTES AS YOU PROCEED to avoid duplication and to keep the goal of the repair in view!

2. DIVIDE AND CONQUER
Seemingly complex problems into managable bites with predictable outcomes. Your ARE making notes - aren't you!

PLAN YOUR TESTING - A great many times I've sketched and jotted some notes as to how I want to proceed with a test or course of testing.This allows you to scrutinize it before you're buried in it, to see whether your plan makes sense. Also a great many times, when troubleshooting with other fellow amateurs, discuss the plan of attack to define who's doing what, and when! (This may involve co-ordination at 2 or more ends of a radio system....i.e. one tech up a tower, one below testing and co-ordinating and perhaps one or more at a distance making measurements.)
A repeater site is just one place this sort of thing can take place.

3. BE ABLE TO ANSWER THE QUESTION- WHAT CAUSED THE PROBLEM

4. USE QUALITY PARTS AND COMPONENTS
- As you feel comfortable with the consequences of the alternative! Obviously the consequences of failure could be more dire in medical equipment versus entertainment equipment.....or in assemblies which require a LOT or disassembly.....you get the picture :)

5. USE QUALITY TOOLS
- sufficient for the level of the repair.Intermittent soldering irons, unsharp wire cutters, sloppy pliers, worn or cheap/poorly fitting sockets, bits and wrenches merely serve to aggravate the ability to make quality repairs.

6 . MAKE A QUALITY MECHANICAL REPAIR
- Mount or remount components and wiring securely and without mechanical strain or stress. Many repairs include physical destruction due to impact, misuse or burning/melting. One common repair situation involves circuit malfunctions as a result of cobbled previous repair attempts!

7. MAKE A QUALITY ELECTRICAL REPAIR
- Ensure connections are clean and of low resistance. This includes soldered connections which are have been prepared clean, corrosion and contamination free, which are well flowed and shiny (not grainy or balled which indicate cold or poor flow and/or contamination(inability to

effectively flow between parts).

8. MAKE A QUALITY THERMAL REPAIR
- Where applicable, ensure that any heat sinks are attached with thermal conducting sheets or with just the necessary amount of thermal transfer or heat-sink compound. Ensure that parts which dissipate heat do not adversely affect neighboring components, circuits or circuit boards etc.

9. VERIFY THE REPAIR! NEVER GUESS.
- A radio man is always keen for knowledge so take the time to documentyour repair. It's quite surprising how reviewing past notes keep you sharp and may save a lot of time on specific or similar pieces of equipment.

***DON'T LOSE SIGHT OF THE FOREST FOR THE TREES!***

## EXAMPLES OF TEST EQUIPMENT

**POWER SUPPLIES** - Sources of 120 / 240 vac (as necessary) and both heavy current regulated (such as nominal 12vdc) and variable voltage, filtered and regulated bench top supplies are often necessary and useful for powering up circuits and equipment under test and for substituting power to circuits where the circuits have to be isolated or where the associated power supply is suspect.

- NOTE: Battery Chargers are usually a VERY POOR source of test power BY THEMSELVES but can indeed be useful to float-charge an automotive type battery while using that battery as your test supply. If the charging current and charging voltage are kept reasonable for the desired output, then objectionable ripple from the charger may not be an issue. Of course this type of setup, especially with a "smarter" type charger can indeed make a quick and effective no-break power source for your station as well.

**OUTPUT TEST TOOLS** -
Dummy loads: DC - for checking power supplies including batteries - Resistors, incandescent or LED lamps, carbon piles etc. Audio - of the correct resistive values for checking audio amplifiers (silently!)
RF high power - for checking transmitters - Resistive and non reactive preferably. Small RF or data terminating resistors as may be needed to supply a predictable load to low level coaxial sources or data lines.
MECHANICA loads as may be required to load motors or other repaired actuators.
Audio Distortion meters - These may include a scope for signal observing and a dummy load and are used to quantify the purity of a sinewave when applied to a specified load.
Field Strength Meters - These are often simple, passive, RF voltmeter circuits with an antenna which can be used to check for the presence of an RF field. They can be used to check a transmitter enclosure for RF leaks or for a basic indication that an antenna is able to radiate. Because they're not very sensitive, they can also be useful when locating a hidden transmitter or RF source once you've gotten physically close to it. Usually a wideband device, sometimes they're available with a tuned front end to assist knowing that you've found a particular source.
A RECEIVER - A good station test setup uses either the station receiver or includes additional receivers to listen to signals under test.
When equipped with calibrated signal strength metering and paired with oscilloscopes and/or distortion analysers OR input to a computer via audio or other interfaces, can stand as a good near-field analyser for your own test bench or for assisting other radio operators with transmission problems they may be having.

SPECTRUM ANALYSER - Is a special type of oscilloscope in it's basic form which allows the tech to view signal levels versus frequency instead of just time as with the basic oscilloscope. This handy tool is used to look for signals within a slice of spectrum which the tech can see.
It's great for signal identification, checking modulation components where they create specific additions to the base signal or even bands of extra signals (i.e. sidebands of frequencies which appear displaced from the tuned frequency); checking for harmonics of signals and the levels of those harmonics.
Although the SPEC-AN (as techs call it) is often a less available piece of gear, it's surprising what can be found surplus or be made with receivers and / or just computer interfaces and software which can replicate this

versatility.Needless to say, most modern receivers and spectral analysis equipment have significant computerization built in.

ON-THE-AIR-TEST - Although more commonly used for verifying a repair, sometimes you need to operate your equipment while opened up and hooked up to the rest of your test equipment in order to simulate or verify some real-world complaint. Be careful here though, as you do not want to cause interference to other stations or injure yourself in the process. See the requirements for testing which REQUIRE KNOWLEDGE of what you're working on, and plan your test.

**VERIFY POWER SUPPLY - TROUBLESHOOT OUTPUT BACK TO INPUT.....**

**DIVIDE AND CONQUER TOOLS.....SMALL BITES PLEASE!**

INTERMEDIATE TOOLS -
These tools are for use partway through a circuit, either which is partially working or which is set up with input and output tools to measure the various voltage, resistance, reactance (or determined capacitance or inductance), current, power, signal levels and signal waveforms occurring in a circuit as we look for a problem in a logical order.

-Oscilloscope - This is in it's basic form, a visual voltmeter and is often one of the handiest test instruments a tech can have. Unlike a panel or multi-meter type instrument which has been calibrated to provide a voltage reading with assumptions about it's shape and frequency, the scope shows what that signal actually looks like in an amplitude (or level) versus time graph.

- VSWR bridges (aka SWR meter).....typically we use these at RF to assist with determining a TX to antenna mismatch. Note that these often also have a Field Strength Meter function, which when used with an included short whip antenna at a seperate connection point can be used as a relative indication of a transmitted signal or other RF in the vicinity of concern.

WATTMETERS - Typically these are RF units and may be both inline for testing between sources and loads or may be included with a dummy load in which case they're described as "Terminating Wattmeters". Similarly useful, though less seen on a typical amateur bench are wattmeters for both line and DC power and Audio wattmeters (often included with a terminating dummy load).

Multimeters.....VOM (Volt/Ohm/Milliameter).....and it's modern equivalent, the DMM (Digital Multi-Meter). Additionally, other, individual speciality (lab type ammeters, voltmeters etc) and salvaged or surplus "quality" panel meters are VERY handy to have on hand during a circuit test which can be used in a dedicated fashion to monitor a particular area of interest, freeing up the multimeter for progressive testing.

-Substitution devices / boxes - These can vary from surplus lab-type resistance, capacitance and other passive substitution boxes to those limited by your imagination.....A nice 10 turn potentiometer with attached leads can make a nice precision resistance substitution. Similarly having a fine selection of used or NOS (New Old Stock) components on hand in your "junque" box is a tremendous resource both for substituting known-good parts and ultimately for final repairs.

- A RECEIVER: Just as a good receiver may be used to listen to parts of a signal path for the radio (or even other!) transmitter or receiver unit under test.

- INPUT TOOLS - Antenna analyzers -generate a signal and determine the resistive and reactive component of the load at determined frequencies.

- Signal generators - are substitute signal sources which are used to predictably generate a required signal shape, suitably modulated.

(if required) at a desired frequency AND at a predictable level (or amplitude). Generators can be stand-alone units designed to produce RF, AF, low level analogue, digital (often referred to as "function generators"), all of the above or be computerized enhanced to produce unique combinations of the above over time.

- Input tools can also take the form of simple circuits you build to replicate what is needed to complete troubleshooting on the main item of interest. If you need a level test tone into a microphone, there's no reason you can't hold a telephone up to the mic and press a digit. If you need a 3.5 volt DC signal that turns on and off intermittently, then measure and connect 3 worn out flashlight batteries through a switch.

- A RECEIVER - A very old tech trick is to tap into a working radio to, taking signals from it, to provide substitute signals to a radio (or other project!) on a bench! It begins to be obvious to the developing radio tech how useful a good receiver can be!

- YOUR Antenna - Don't overlook the obvious sources of signals!

***"Test Equipment"....needed or desired....is limited only by your KNOWLEDGE and IMAGINATION.....and good ideas are not always new ideas.....Don't be afraid to TRY NEW or OLD ones.***

**CONCLUSION.....Thoughts over a cup of coffee**
**Amateur and professional test benches a like are an ongoing and evolutionary process.**
**A well-evolved test bench can appear daunting and intimidating to a new amateur.....Remember the DIVIDE-AND-CONQUER strategy!**

***LEARN FIRST - TEST NEXT.....DO START***

**We've ALL started with the most basic sort of testing.....and any good tech will attest to returning to those roots over and over.**

**Just when you think you can troubleshoot anything because you've just found a deep problem in a computerized rig, you'll be humbled.....**

**..... by a dead flashlight that you can't see what's wrong instantly!**

**- KNOWLEDGE and INGENUITY are common equilizers**

**A true Amateur Radio Operator is known for their:**

***KNOWLEDGE of and INTEREST in the radio craft***
***QUALITY OPERATING TECHNIQUE at all times***

***INGENUITY in solving communicating and technical issues***
***SCROUNGING....making use of what others don't even see.***
***ASSISTANCE....to the new Ham developing these qualities***

**QUESTIONS TO ASK (yourself maybe!) - HISTORY OF A PROBLEM**

**1. WHAT "SEEMS" TO BE THE PROBLEM - list these**

**2. WAS THE UNIT WORKING NORMALLY BEFORE THIS PROBLEM?**

**This confirms that there has been an abnormal change.**

**3. DID THE PROBLEM OCCUR SUDDENLY OR WAS IT A GRADUAL CHANGE OR DEGRADATION.**

**4. ARE THERE ANY OTHER ABNORMAL INTERACTIONS WITH THE NORMAL OPERATION OF THE UNIT - list these, they will help with defining the limit of the problem and will confirm the repair.**

**5. ARE THERE ANY OTHER ISSUES. A seemingly unrelated issue such as an indicator light out has often been key in defining larger problems - list these.**

**One Tech's short list of observations :)**

**- A DEAD UNIT IS NOT ALWAYS THE WORST JOB.**
**- A "Problem unit".....condemned as scrap.....is "nothing ventured, nothing gained"....and can be your best learning experience!**

**PERCEIVED PERFORMANCE ISSUES REQUIRE VERIFICATION THAT THE UNIT IS OUT-OF-SPEC and HAVE OFTEN BEEN the source of TRYING TO "REPAIR" an UNREALISTIC EXPECTATION.**

**A REQUIREMENT to CHANGE SPECS (modify, change or improve) is not a repair.....though it often requires the same process as troubleshooting.....in order to redesign.**