

MODULE 3
(V)2 RADIO EQUIPMENT OPERATION

OBJECTIVE

Given TO 31S1-2TSC60-12, operate the TSC-60(V)2 radio equipment IAW para 3-97 thru 3-109.

PREREQUISITES

Complete Modules 1 and 2.

INFORMATION

This module covers operation of the radio equipment. Are you asking yourself "What is this? I'm no radio operator; I don't need to know how to operate the radio." True, you are not a radio operator in that the title of your AFSC doesn't say "radio operator." However, how do you as a maintenance person know if the radio will function properly for a radio operator if you don't know how to check it out yourself? And how can you check it out if you don't know how to operate it the same way as an operator would?

And don't forget the mission. What do you do if you're in a war zone and the operations van gets wiped out? Who's going to operate the radio then? The most available person, you!

So you see, you need to be able to operate the equipment in order to check it out, and you need to be able to take over the radio operations function if necessary. This module covers the equipment operation. Modules 20, 21,

and 22 of QTP 304X4-30R cover the radio operations function.

In its simplest form operating the equipment is just transmitting and/or receiving. In order to transmit a signal, you need to do the following:

- (1) Turn on the equipment
- (2) Set the frequency
- (3) Tune the Transmitter
- (4) Key the Transmitter
- (5) Send audio to the Transmitter

We'll discuss these in order. Turning on the equipment was covered in Module 2; so let's go on to setting the frequency.

Setting the desired frequency is no difficult task. Sometimes it's more difficult to determine which frequency you should be on than it is getting there. When setting the frequency, you first need to determine whether you will be transmitting "on the air" or into the dummy load.

If you will be on the air, any frequency used will have to be authorized by your unit Frequency Manager. If you have not obtained proper authorization to transmit on a frequency, **Don't do it.**

If you will be transmitting into the dummy load, it doesn't make any difference what frequency you use since it will be radiated into the atmosphere at a much lower level.

Once you've determined the frequency to use, you go to the Radio Control Group (OK-145) and dial it in. But which Radio Control Group do you use? There are three with each TSC-60.

The TSC-60 can be controlled locally within the shelter, or by controls located up to one-quarter mile away. The Radio Control Group in the center of the Console is the local control. It can control either Radio 1 or 2, depending on the position of the setting of Radio Control Select switch on the Monitor/Switching Panel. Take a look at Figure 1 in the Diagrams booklet.

There are three positions on the Radio Control Select switch: (1) 1/LCL, (2) REMOTE, and (3) 2/LCL. In the TSC-60 any radio that is not controlled locally is considered to be controlled remotely, regardless of where that remote control is located. Therefore, if Radio 1 is locally controlled, then Radio 2 is remote controlled, and vice versa. So, via this switch, the local Radio Control Group controls Radio 1, Radio 2, or nothing.

On the right side of the Console there is a slot for another Radio Control Group. Since there is only 1 local control, this has to be a remote control. Remember, we said the remote control could be located anywhere. Actually, the remote control lines for Radio 2 have a connector installed in them so they can be connected to this Radio Control Group. Therefore, only Radio 2 can be controlled here. Also, since it is connected to the remote lines, if Radio 2 is selected for local control by the Radio Control Select switch, this Radio Control Group controls nothing.

Let's recap. There are provisions for two Radio Control Groups in the Console. The control on the left (in the center of the Console) is the local control and can control either Radio 1 or 2, depending on the setting of the Radio Control Select switch on the Monitor/Switching Panel. The control on the right can be connected to the remote lines for Radio 2.

If you are doing PMIs, the local control is normally used to control the radio you are checking. One reason for this is that the Maintenance Display Panel is wired to monitor whichever radio is controlled by the local control. So, if you were doing a PMI on Radio 2, you could use the control on the right (Radio 2 in remote), but you'd be better off using the local control.

Now let's get back to setting the frequency. First you need to determine which radio you are going to operate, Radio 1 or Radio 2. Then set the Radio Control Select switch to locally control that radio. Now look at Figure 2.

The Radio Control Group consists of three units: (1) Transmit Control Head, (2) Receive Control Head, and (3) the Audio Control Unit. Frequency control of the Transmitter and Receiver are completely independent of each other. So, you must dial-in the operating frequency for each one on their own control head. The thumbwheel switches at the top of the control heads are the frequency controls.

There are six thumbwheel switches for each frequency control. When setting the frequency, don't forget that the last thumbwheel on the right is 100Hz, not 1kHz.

Anytime you move any of the thumbwheels on either control head, the blue lamp just to the right of the thumbwheels comes on. This lamp is part of the Initiate push button. When this lamp comes on, the computer is telling you that you need to press the push button to enter the control head settings into the computer. So, once you've set the thumbwheels to the selected frequency, press the Initiate button, and the Receiver or Transmitter will set itself to that frequency. Let's see how Transmitter tuning is accomplished.

Tuning the TSC-60 Transmitter is a pretty simple task since it automatically tunes itself to the frequency you selected once two conditions are met:

1. A load must be connected to the Power Amplifier.
2. The transmit key line must be energized.

Connecting the antenna (load) sounds easy enough, but it can be a little confusing in the TSC-60 system. Figure 3 shows the RF patch panel, 1A3. Across the top of the panel are two rows of coax connectors. The second row is what we're interested in right now. These connectors are labeled Entry 1 thru Entry 6.

Remember the six antenna entry connectors on the rear of the van? Those six connectors feed directly to these six connectors. This gives you the versatility of being able to use any of the six possible antenna connections without having to go outside the shelter to change the connection.

On the bottom of the RF patch panel are four connectors, two on the left side and two on the right. The two on the left are for Receiver 1 and Power Amplifier 1; the two on the right are for Receiver 2 and Power Amplifier 2. These are the antenna connections for the Receivers and Transmitters. Obviously, to connect an antenna to Receiver 1, you make a patch from the RCVR 1 connector in the bottom-left corner to the Entry connector that has the antenna you want.

The RF patch cables that come with the TSC-60 will allow you to connect RCVR 1 to any of the six Entry connectors, but Entry 1 fits best. That means the bend in the cable is optimum when connected to Entry 1. So, when you connect your antennas on the outside of the van, connect

the antenna you will use on Receiver 1 to Entry 1.

Likewise, PA 1 can be connected to any of the six antenna connections, but Entry 2 fits best. So, when you connect your antennas, put the one that you intend to transmit with Radio 1 on Entry 2.

Connections for PA 2 and RCVR 2 follow the same guidelines. That leaves two empty connectors in the center, Entry 3 and Entry 4. These are for expansion. That is, if you have two antennas you may transmit on at different times, connect them side-by-side on Entries 2 and 3. Make sense? Now let's look at the rest of the RF patch panel.

At the top left of the panel is the PWR AMPL 1 Simplex Out connector. It is tied to one side of the antenna relay located in the top of the PA cabinet. This connector allows you to transmit and receive on the same antenna. You can only use it when you are in simplex operation. Simplex allows you to either transmit or receive but not both at the same time.

For simplex operation of Radio 1, you would connect the RCVR 1 In connector to the PWR AMPL 1 Simplex Out connector, and the PA 1 Out connector to the desired antenna. When the PA is keyed, the relay is energized, and the PA is connected to the antenna. When the PA is unkeyed, the relay is deenergized, and the Receiver is connected to the antenna. Simple enough? There is one more use for this connector.

The open contacts of a relay are not going to block 2.5kW of RF. In other words, when the PA is keyed, some of the transmit signal is present on the Simplex Out connector. Therefore, this is a handy place to measure that signal with a Frequency Counter or other test equipment. Keep that in mind. We'll discuss it again in another module.

Beside the Simplex Out connector are two BNC connectors labeled PWR AMPL 1 In and EXC 1 Out. This is where you would connect the output of the Exciter to the Power Amplifier. These connections are repeated on the right side of the panel for Radio 2.

In the center of the panel is the Load Select switch. This switch connects the dummy load to either PA 1, PA 2, or nothing. The connections are done internally so you don't have to fool around with coax connections like you would with most radios.

Underneath the Load Select switch is the Remote Load Control. If you are using the (V)3 van, this switch controls the dummy load connection in that van, just like the Load Select switch does in the (V)2 van. If you don't have the (V)3 van connected, this switch does nothing.

The two meters on the RF patch panel are wattmeters tied to PA 1 and PA 2. These are average reading Voltmeters, not actual RF wattmeters. The switch underneath each meter selects whether the meter reads forward power or reflected power or turns the meter off. This is an important point to remember.

RF power in the TSC-60 can be measured on either the RF patch panel or the Maintenance Display Panel, but you can't measure it at both places at the same time. If you try, you will only read half of the power on each meter. So, when you are trying to measure transmit power at one point, make sure the other meter is turned off or you will get false readings.

The amplifiers in the TSC-60(V)2 and (V)3 require a DC return in order to operate. That means there must be a DC short, or near short, across the antenna terminals. Notice

we said a DC short. There can be a short to DC that would not be a short to RF. That's what we're looking for.

50 ohms is a pretty low DC resistance; however, that is the normal RF impedance of our antennas. So, 50 ohms at the antenna terminal would allow the PA to key. Some antennas won't measure 50 ohms or any resistance for that matter. A dipole antenna is an ideal example. The center conductor of the coax is connected to one half of a dipole and the shield to the other. If you measure across the coax with an Ohmmeter, you'd measure an open. For this reason you can't transmit on a dipole antenna with the TSC-60.

On the other hand, if your antenna uses a balun transformer, you would measure nearly a short across the primary winding with your Ohmmeter. That coil is not a short to the RF. This is a good point to remember when you get to the field and find your PA won't transfer energy to the antenna, but works fine with the dummy load. Chances are you either forgot to connect the antenna, or there is not a DC return to the PA from the antenna. We've already covered the antenna connections, so let's see how to check the DC return.

One way would be to measure the entry connector with an Ohmmeter. However a better method would be simply to check a lamp on the Maintenance Display Panel. Look at Figure 4.

The 24 lamps on the left side of the Maintenance Display Panel indicate the condition of various parts of the system. The switch in the lower-left corner of the panel selects which status the lamps display. With the switch in the PA position, the lamps will display the status of the PA. But there are two PAs in the van. Which one is displayed?

Remember, the Maintenance Display is tied to the computer in the local control position. So, the radio that is selected to be controlled locally by the switch on the Monitor Switching Panel is monitored by the Maintenance Display. If the switch on the Monitor/Switching Panel is placed to REMOTE, indicating both radios are remotely controlled, the Maintenance Display doesn't monitor anything unless it is patched. Patching will be discussed in another module. How do you know what the 24 lamps represent? Get TO 31W2-2TSC60-12, and we'll see.

Tables 3-3 thru 3-8 outline the meanings of the 24 lamps. Table 3-7 covers the PA, so let's look at it. The first column lists the lamp numbers. You don't need to worry about the second column right now. The third column tells you what that lamp is monitoring, and the fourth column tells you how to interpret the lamp indication. Take a look at lamp 17.

Lamp 17 is the Antenna Interlock Monitor. When on, the lamp indicates the antenna interlock is open, which means the PA did not get its DC return. Take a look at Tables 3-3 thru 3-8 while you're here, and see what is monitored by the Maintenance Display lamps.

Okay, you have the antenna connected, and you have the DC return. Now all you need to do is key the Transmitter, and it will tune itself.

In the TSC-60 there are a number of ways to key the Transmitter. Look back at Figure 2. The simplest way to key the Transmitter is with the Keyline Control switch located on the Transmit Control Head. This switch has three positions: (1) KEY, (2) VOX/PTT, and (3) OFF.

The KEY position keys the Transmitter and keeps it keyed as long as the switch is in that position. This position is normally used when the Transmitter and Receiver are operated in duplex, such as when you are sending teletype. The VOX/PTT (Voice Operated Transmit/Push-To-Talk) position is normally used when you are using a microphone. The OFF position turns the key line off and prevents you from keying the Transmitter.

Remember, we started out to tune the Transmitter, and we said it needed two conditions to be loaded and keyed. We discussed how to connect the load and how to key the Transmitter. When the Transmitter keys, the Keyed lamp on the Transmit Control Head comes on and the Transmitter tunes itself. When it is finished, the OPR (Operate) light comes on. If for some reason it didn't complete its tuning within 20 seconds, the Fault lamp will come on. In this case you would look back at the Maintenance Display Panel and try to determine from the 24 data lamps what happened.

Tuning the Receiver is even simpler. You simply select the frequency, and then press the Initiate button on the Receive Control Head. When the Initiate button is pressed, the Receiver tunes itself and you're ready to go.

Now you've got the equipment turned on, and the Transmitter and Receiver tuned. What is next? How about getting some audio into the Transmitter or out of the Receiver!

Audio to the Transmitter can come from one of two sources: (1) the microphone connector on the Audio Control Unit or (2) from the audio patch panel.

Connecting the desk microphone to the connector on the Audio Control Unit allows you to transmit what you say into

the microphone if the controls are set properly. First let's look at the Transmit Control Head on Figure 2.

On the right side of the control head is the Mode switch. This switch has five positions:

ISB (Extreme left position-not marked) -- allows you to transmit any of the four independent sidebands.

SELF TEST -- Tests any of the four sidebands that is enabled.

AM -- Amplitude Modulation

CW/A1 -- CW on A1 sideband

CW/B1 -- CW on B1 sideband

To the left of this switch are the four sideband switches. In order to transmit on any sideband, that sideband must be enabled on the Transmit Control Head. This is done by simply setting the switch for the desired sideband(s) to ON. Once the Transmit Control Head controls are set, you need to set the controls on the Audio Control Unit.

On the left side of the unit are four knobs, each with positions RCV MON, OFF, and OPR. Just to the left of each of these knobs is a lamp labeled A2, A1, B1, and B2. A2, A1, B1, and B2 are the four sidebands that the TSC-60 is capable of operating. So, there is a knob and a lamp for each sideband. In order to transmit from the microphone connected to the Audio Control Unit, the knob for the sideband you want must be set to the OPR position. We'll cover the RCV MON position later; the OFF position is self-explanatory.

Setting the controls for receive is very similar to setting the controls for transmit. The Receive Control Head

has a Mode switch similar to the one on the Transmit Control Head except that the receive Mode switch only has four positions. The extreme clockwise position is for SELF TEST in the AM mode. For ISB operation, place the switch in the counterclockwise position.

The four sideband switches on the Receive Control Head are quite different from their transmit counterparts. On the Receiver you can select different modes of operation for each sideband, Voice, Data 1, or Data 2. Actually, the different modes just select different AGC characteristics within the Receiver. For voice reception simply set the desired sideband switch to VOICE. Now back to the Audio Control Unit.

You already know that setting a sideband switch to OPR allows you to transmit on that sideband if that sideband is enabled on the Transmit Control Head. If that sideband is turned on at the Receive Control Head, audio from the Receiver will be heard on the speaker. The lamp just to the left of the sideband switch on the Audio Control Unit will light, indicating that something is being received on that sideband. Setting the sideband switch to RCV MON will also allow the audio to come to the speaker but will not allow audio from the microphone to be fed to the Transmitter. This feature becomes handy if you want to listen to two sidebands, for example, but only want to transmit on one.

Now let's discuss the remainder of the controls on the Audio Control Unit. As we discuss each control, refer to Figure 2 to become familiar with the location of the control.

We briefly mentioned simplex and duplex operation earlier when we were talking about the RF Patch Panel. The Simplex/Duplex switch on the Audio Control Unit has nothing

to do with antenna switching. This switch serves as a mute switch for the Receiver. With the switch set to SIMPLEX, the audio from the Receiver is muted anytime the Transmitter is keyed. The purpose of this is to prevent your receive audio from feeding back into the microphone from the speaker when you are transmitting and receiving on the same frequency.

Setting the switch to the DUPLEX position defeats this muting function and keeps the Receiver on all the time. If you are operating on different antennas and different frequencies for transmit and receive, you can talk and listen at the same time as long as the switch is set to DUPLEX.

The VOX/CW/PTT switch controls the transmit keyline. In the VOX (Voice-Operated Transmission) position, remember, any audio applied to the microphone will key the Transmitter and be sent out if all the controls are set properly. Let's see what needs to be set.

First, the Keyline Control switch on the Transmit Control Head must be set to the VOX/PTT position. Then, of course, the audio and sideband switches on the Transmit Control Head and the Audio Control Unit must be set, as we just discussed.

In the CW/PTT position, the PTT (Push-To-Talk) switch, on the side of the microphone, keys the Transmitter during voice operation. If you are sending CW, closing the CW key will key the Transmitter.

The Power switch on the Audio Control Unit only controls the power to the OK-145. This switch has no affect on the radios. In fact, if you turn this switch off, the radios remain in a state of limbo. That is, they stay in

the last condition the computer put them in.

The SPKR/HDST switch allows you to use the desk microphone and the speaker in the SPKR position, or the headset/microphone in the HDST position.

The Order Wire switch controls the intercom between the Radio Control Groups. When you are going to operate the radios from remote control units, you take one OK-145 per radio to wherever the remote operation will be located and connect it to the TSC-60 via cables. You always have the local control unit in the van for maintenance purposes. The order wire is like a telephone link between you and the remote operators. The switches must be in the LISTEN position on all units for the system to function properly. To talk to the remote units, you press and hold the switch down to the TALK position and talk into the microphone. However, if you have the Transmitter set for microphone operation, everything you say on the order wire also goes out on the air. So, you must set the sideband switches on the Audio Control Unit to something other than OPR when using the order wire.

Also, you have to remember to return the Order Wire switch to the LISTEN position. This switch is spring-loaded for the TALK position only. Simply releasing the switch only returns it to the OFF position, and you cannot hear the audio on the order wire. For this reason, the control head order wire is not used very often. Usually there is some kind of telephone circuit between you and the remote operating locations.

That covers basic operation of the radios for voice transmitting and receiving. The TSC-60 can also be used for telephone, teletype, and data operation, but those modes require patching and the use of equipment that will be

covered in other modules. Now read TO 31S1-2TSC60-12, para 3-97 thru 3-109. Refer to Figures 1 thru 4 of the Diagrams booklet as you are reading to familiarize yourself with the locations of all controls and indicators.

ADDITIONAL INSTRUCTIONS

Answer the following review questions and check your answers with the confirmation key. For each wrong answer, review the material in the module. Next, ask your trainer for the KEP questions. After your trainer checks your answers and reviews the questions you missed, go on to the performance procedures.

REVIEW QUESTIONS

1. List five things that need to be accomplished in order to transmit with the TSC-60.
2. Which requirement must be fulfilled prior to transmitting on the air?
3. What is the function of the Radio Control Group in the 1A15 (left) position on the Console?
4. To which radio is the Maintenance Display connected?
5. After a frequency is selected using the thumbwheel frequency switches, what must you do in order for the Receiver to tune to that frequency?

6. What must be done in order for Receiver 1 to operate on the same antenna as Transmitter 1?
7. What is the simplest way to verify that the antenna is providing a DC return to the Transmitter?
8. What is required for VOX operation on the Transmitter?
9. If you need to transmit on the A1 sideband and receive on the A1 and B1 sidebands, how would you set the sideband controls on the Audio Control Unit?
10. On the RF signal entry panel, which connectors are normally used for the antennas that will be connected to Transmitter 1 and Receiver 1?

PERFORMANCE PROCEDURES

Have your trainer demonstrate the operation of the equipment to you. Operate the equipment under your trainer's supervision until you feel confident. Your trainer will annotate your training records when he/she feels you are proficient.