MODULE 2
(V)2 STARTING PROCEDURES

OBJECTIVE

Given TO 31S1-2TSC60-12, perform the TSC-60(V)2 starting procedures IAW para 3-29 thru 3-66.

PREREQUISITES

Must complete QTP Module 1.

INFORMATION

The purpose of this module is to help you to learn the starting procedures for the TSC-60(V)2 van. The starting procedures are basically how to turn on the system, or each unit within the system. We could simply say turn on knob A, turn knob B, etc., and you would have the system turned on. But, you'd get more out of it if you understood how the power gets to that unit. Besides, if you turn a unit on and nothing happens, you need to know where the power comes from and how it gets to your unit.

Obviously, you can't just plug a TSC-60 into a wall outlet and go on your merry way. Just what kind of power is required to run a TSC-60? Every TO on every piece of equipment should have a table near the beginning that outlines the specifications of the equipment. The TSC-60 is no exception. Get TO 31S1-2TSC60-12, and let's take a look at the "specs" for the TSC-60.

Turn to Table 1-1. The first thing listed is primary power. Note that this power does not include the power for the ECU (Environmental Control Unit--the air conditioner). The ECU's requirements are shown separately. The remainder of the information in this table doesn't apply to this module, but take a look at it anyway while you're here. Here you'll find the "specs" for each unit within the system.

Now you know what kind of power is required to run the van, right? Let's see what to do with it. Turn to sheet 1 of Figure 4 in the Diagrams booklet and follow along as we take a trip through the TSC-60 electrical system.

The starting point has to be the connector (J1) on the rear of the van. J1 is shown in the lower-left corner of the schematic. The three phases of power are applied through MT1, 2, and 3 over to FL1. MT1 thru 3 are inductive pickups that sample the current on each phase of the electrical power. Each sample is fed through a filter and a fuse up to switch S3. Pin 12 is the wiper of this half of the switch. From pin 12 the voltage representing the current on each phase is fed to the AC Amperes meter. Let's analyze this measurement.

We can measure the current drain on each phase of the power coming into the van. Each one of the measurement lines is fused separately. Each fused line only goes to the metering system. So, if one of these fuses is blown, there is no effect on the remainder of the system. That was simple enough. Now, let's see how we can measure the voltage on each phase.

From MT1, 2, and 3 each phase is applied through FL1 to the Main circuit breaker and up through fuses F4, 5, and 6 to the other side of S3. The wiper of this half of S3 is

connected to the AC Volts meter. The lines from these three fuses also go over to the frequency sensor. We'll cover the frequency sensor a little later.

In addition to feeding the frequency sensor, phase C from F5 also goes to two meters, M3 and M4. These are the meters for measuring the 60Hz or 400Hz power frequency. Now, let's backtrack a little.

Just after MT1, 2, and 3 is a connection which applies each phase up and over to circuit breaker CB1. This circuit breaker controls the power to J3, which is the power connector for the ECU. Obviously, any current drawn by the ECU can also be measured on the AC Amperes meter since the current goes through MT1, 2, and 3.

You should notice that phase A is also fed through another circuit breaker, CB2, to utility outlet J2. This is the outlet on the back of the van next to the Main Power connector.

Look back at the big filter, FL1. Phase A not only goes up to the metering circuit, it also goes through fuse F7 to the 28-volt power supply. F7 is probably the most important fuse in the entire system. If F7 is blown, you have no 28VDC. That 28 volts is very important. Why?

Without this 28VDC you cannot turn on the blower in the Receiver/Exciter Rack, and without that blower, you cannot turn on the Receivers or Exciters. Follow the 28VDC coming from terminal 3 of TB1 through the Main Power circuit breaker (CB1) to pin D of P1. Notice, P1 is tied to the Receiver/Exciter Rack. We'll cover what it does in detail shortly. So, one little 1-amp fuse can disable the entire radio system.

So far, the only thing we have power applied to is the 28-volt power supply. Let's see if we can power up the equipment. The first thing we'd have to do is turn on the Main circuit breaker, so let's start there.

The MAIN circuit breaker directly feeds the RCVR/Exciter circuit breaker and the Power Ampl-1 and Power Ampl-2 circuit breakers. Their functions are pretty self-evident. Now look back at the Main circuit breaker and follow the lines up and to the right on the schematic. These lines all go to sheet 2 of Figure 4.

On sheet 2 follow the lines down to CB5, 6, and 7. These are the small push-button type circuit breakers located along the bottom of the main power distribution box. It's rather obvious that these three circuit breakers apply power directly to the Teletype (TTY) Rack and the Console utility outlets and, through an isolation transformer, to the workbench utility outlets.

Beneath the utility outlets, the lines continue over to circuit breakers for the two Transmit Orthogonal Antenna Couplers and the circuit breaker for the lights. All of these circuit breakers are also the push-button type located on the bottom of the main power panel. Let's take a look at the circuit for the lights.

This may seem like an awful lot of tracing to go through just to turn on the lights, but there is more to it than just that. This shelter is equipped with blackout lights. If you're out in the middle of a war zone, late at night, the last thing you want to do is light up the area with your lights when someone opens up the door. There is a switch on the door that turns off the lights when the door is opened and turns them back on again when the door is

closed. It works like the dome light in your car, only in reverse.

Power is applied from the circuit breaker to the light (LTS) switch, which is located on the bottom of the main power panel next to the push-button circuit breakers. From here we go to the Blackout switch with one leg and the Blackout Door switch with the other. The Blackout switch is actually an override switch. That is, blackout is considered to be the normal operating mode. With this switch in the ON position, blackout operation is overridden, and the lights will remain on whether the door is open or closed. With the Blackout switch in the OFF position, power for the lights goes through the Blackout Door switch and is only applied to the lights when the door is closed. This switch is shown in the door open position on the schematic.

Notice that the lights at the top of the schematic are not only the shelter ceiling lamps, but also the lamps over the top of the Console. The Blackout switch does not control the pilot and indicator lamps on individual pieces of equipment. Now look back at the Blackout switch and the Blackout Door switch. Both of these switches have contacts that go to the Emergency Lighting Assembly.

The Emergency Lighting Assembly gets its power from the LTS circuit breaker. However, the emergency light will only come on when pins 8 and 6 are connected together. You can see that this only happens when the Blackout switch is on (override) or the door is closed.

Now look back at the left edge of sheet two and follow phase C, which is on bus C, over to the CSL (Console) circuit breaker, CB8. This is another of the push-button circuit breakers at the bottom of the power distribution panel.

From the CSL circuit breaker, AC is applied to terminal 1 of 1A11TB26. Where is TB26? For that matter, where is 1A11? Let's take a few minutes and find out where they are and at the same time learn how to trace wires within the system.

First, you need a TO. In Air Force TO numbering systems, the -3 TO is normally schematics, block diagrams, etc. In this case you need TO 31S1-2TSC60-13. Go get that TO now. Don't forget to put an AF Form 614 in its place when you take the TO from its file. If you don't know what a 614 is or how to use it, have your trainer assist you.

Got it? Did you remember to put a form 614 (pink card) in its place? If not go back and do so now. Remember, when the next person needs that TO, the 614 will tell him where to find it.

Now, let's get back to what we were talking about, shelter wiring. Turn to the table of contents. Notice that this TO is broken down into four main areas: (1) from-to wiring tables, (2) schematic diagrams, (3) cabling/signal flow diagrams, and (4) wiring schematic diagrams. Read the Introduction on page iii.

Now look back at the Table of Contents again and see that the cabling/signal flow diagrams start at Figure 15. Turn to that figure now.

The drawings in this figure show you how the wiring within the (V)2 shelter is routed. Each cable is identified with a number, such as W307, or W138. In the left corner of the first drawing is the power distribution panel. The power comes in to this panel from the power entry panel then follows a cable tray in the corner of the van next to the ceiling. Follow along that tray and you will see that the

power is applied to the Receiver/Exciter Rack on W307, and to PA #1 via W305.

Follow the tray on around the shelter and notice the cables going to the Emergency Light, PA #2, and the TTY Rack. The power duct ends just above the Console where cables W309, 326, 328, 340, and 341 are fed to the Console. Now switch to the third drawing and find where those same five cables come into the Console in the upper-left corner.

Follow this line down to the first intersection and turn right. Then continue on to the right until you get to 1A11TB26. Isn't that what we started out looking for? We found it. Don't lose this page, but look back at Figure 4 in the Diagrams booklet for a minute.

From TB26 the AC is applied to the Maintenance Display on W322, the Monitor/Switching Panel on W321, the Local Radio Control on W324, and the Remote Radio Control on W320. Now let's look back at Figure 15 in the TO and find those four cables.

First, look back at TB26 and follow the line out of the right side and down the right-rear corner of the Console. The first line splits off and goes along the front of the Console at 1A14. This line has W321 going to 1A14, W322 going to 1A10, and W329 going over to 1A18. Go back to the right-rear corner of the Console and follow the line down to the bottom where it goes to power 1A8 on W320 and 1A18 with cable W324.

Now, you shouldn't have too much trouble finding any of the power lines within the shelter using this same procedure. Before you put the -13 TO back where it belongs, take a look at Figure 7. Look familiar? The schematic in your Diagrams booklet is a copy of this figure. Why put a

copy of a drawing in the QTP if it's available in the TO? Simple, the TO is needed in the shop for work, your QTP is not. With that in mind, go put the TO back where it belongs, but remember where it is located and what it contains.

Go back to sheet 1 of Figure 4 in your Diagrams booklet and find the Frequency Sensor in the upper right-hand corner. The three phases of power come in on terminals 1, 2, and 3 of TB2. All three phases are fed to contacts of relay K1, and phases A and B are applied through transformer T1 to the frequency sensing card. The frequency sensing card is shown in Figure 7 of your Diagrams booklet. Let's take a look at it.

The circuit between terminal E1 and the base of Q1 is a bandpass filter. The 50/60Hz is blocked; so there is not enough voltage to forward bias Q1. On the other hand, 400Hz is rectified, filtered, and provides voltage at the base of Q1 to forward bias it. Turning on Q1 also turns on Q2, which applies a ground on terminal E4. This ground is applied through the Frequency Select switch to energize relay K1.

Notice that the Frequency Select switch only ties the relay to the Frequency Sensor card in the AUTO position. In the 50/60 position, the relay is not connected. In the 400 position, the relay is constantly energized. Now look back at Figure 4.

When the relay is deenergized, the three phases are applied to DS2. When the relay is energized, the three phases are applied to DS1. DS1 and DS2 are phase indicators. In order for one of these indicators to light, all three phases must be present in the proper rotation. These two indicators are the only representation you have of

phase rotation. If the phase rotation is incorrect, the Receiver/Exciter blower and the ECU motor will not operate properly and damage to equipment could occur.

CAUTION

Always check for proper phase rotation before applying power to the equipment.

Big deal! Why did we go through all those gyrations just to apply voltage to the proper phase sensor? Obviously, there must be more to it than that. Look at pins 13 and 14 on the relay. In 50/60Hz operation pin 13 is open. In 400Hz operation the common side of the 28-volt power supply is applied to pin E of P1 on the Receiver/Exciter Rack. Figure 5 of the Diagrams booklet is the schematic of the power distribution frame for the Receiver/Exciter Rack. Let's look at it.

Our three-phase AC comes in on J1 in the upper-left corner. The three phases go through the Blower circuit breaker to the Blower assembly. The Frequency Sensor line goes from pin E of J1 directly to the Blower assembly on pin J. Let's check out the Blower assembly, and then we'll come back and finish up this panel. Turn to Figure 6.

The three phases are applied to the blower through the contacts of K1 and K2. K1 is the blower enable relay and K2 is the 60/400Hz transfer relay. Obviously, the transfer relay simply applies the AC voltage to different windings of the blower motor. The transfer relay is controlled by that frequency sensor line coming from the frequency sensor. When the frequency sensor relay is energized, a ground is applied to the Transfer relay to energize it. The blower

enable relay is controlled by the computer circuits that control the radios.

When any of the four radio units (two Receivers, and two Exciters) is turned on, a ground is applied to the BLO ENBL (blower enable) line. That ground is applied to CR2, CR3, CR4, or CR5 to turn on Q2, which in turn turns on Q1. When Q1 is turned on, it applies a ground to pin 7 of K3 and to a 6-second time-delay circuit.

The time delay circuit gets AC voltage on pins 2 and 3 as soon as power is applied to the Receiver/Exciter Rack. After 6 seconds, the time delay circuit connects pins 5 and 7. This allows the ground from Q1 to be felt on relay K1, turning on the blower. The ground from pin 5 of the time delay is also applied to the common connection of the Air Pressure switch (S1).

When the blower has built up sufficient air pressure, S1 closes, applying the ground to relays K1 and K2 on the blower control circuit board to energize them. The ground from the computer to turn each piece of equipment on is applied through the contacts of K1 and K2 to the equipment.

If for any reason air pressure is lost, S1 opens and removes the ground from K1 and K2. This removes the ground from each piece of equipment, which turns it off. The ground is then applied to the air fault line to give a fault indication. Now go back to Figure 5.

That air fault signal (ground) comes into the power distribution frame on pin D in the lower-right corner. It is applied through TB3U to the Fault Alarm lamp to turn it on. This lamp is at the top of the Receiver/Exciter Rack. Now find TB3U again.

From terminal 3 of TB3U follow along to the left and up to pin 4 of each circuit breaker. Pin 3 of each circuit breaker is tied to ground through TB3V and TB2V. If any circuit breaker in the Receiver/Exciter Rack is off, it will apply a ground to the Fault Alarm lamp, turning it on.

Earlier we said that a failure in the 28VDC power supply would prevent the Receivers and Exciters from coming on. Without the 28 volts, none of the relays in the Blower assembly can operate. So the blower won't come on, and the enable signal can't be sent to the Receivers or Exciters to turn them on. Look at the bottom-left corner of Figure 5.

Notice that the 28VDC goes through a single fuse to the blower assembly via pin K of P5. Here again, a single fuse can prevent the entire radio system from operating.

Go back to Figure 4 and we'll finish up with this portion of the module. Find the Main circuit breaker in the bottom-right corner of sheet 1. Obviously, everything to the right of that circuit breaker only gets power when the circuit breaker is turned on. Let's see what is <u>not</u> controlled by the Main circuit breaker.

Follow the lines from the Main circuit breaker left to the junction just to the right of filter FL1. Everything on this junction has power applied all the time. This includes the following:

- AC Voltmeter and Ammeter
- 28VDC Power Supply
- Frequency sensing circuit
- Elapsed Time meter

To the left of FL1, power is applied to the ECU and the utility outlet through their respective circuit breakers.

The point is, not everything in the system has power removed when the Main circuit breaker is turned off. So, **BE CAREFUL**. Always treat everything as though it has power applied until you are absolutely certain that there is no power present.

Now that you understand how the power is applied to the various parts of the system, read TO 31S1-2TSC60-12, para 3-29 thru 3-66. These paragraphs will take you step-by-step through turning on the equipment and preparing for maintenance or operation. Refer to Figure 1 in your Diagrams booklet to locate each piece of equipment as the TO discusses it. Better yet, if a TSC-60 van is set up and available, sit in the van while reading the procedure and locate each control as it is mentioned. **Do not perform the procedure without your trainer.**

ADDITIONAL INSTRUCTIONS

Answer the 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. Describe the power requirements for the TSC-60(V)2.

2. What is the purpose of MT1, MT2, and MT3 in the power distribution panel?

3. Describe the effect when fuse F7 in the power distribution panel is blown.

4. What is the purpose of the blackout light system?

5. How is electrical power routed to the Console?

6. If you need a TO and discover it has been removed from the TO file, how would you know where to find that TO?

7. Is every TSC-60 system capable of operating on 50/60Hz, 400Hz, or both? Explain your answer.

8. What would be the result if air flow to the Receiver/Exciter blower were blocked?

PERFORMANCE PROCEDURES

Have your trainer show you the location of all the following items:

- The Utility Outlet on the outside of the van
- The 28 volt power supply
- The Frequency Select switch
- The power terminal board for the TTY Rack
- Power distribution panel circuit breakers
- LTS and Blackout Override switches
- Blackout microswitch on the door
- Receiver/Exciter power distribution panel
- 1A11TB26

CAUTION

The TSC-60 system is capable of operating on either 50/60Hz or 400Hz primary power. However, the ECU will only operate on one power frequency. Ensure the frequency of the primary power is compatible with the ECU before applying power to the system.

CAUTION

Do not switch the ECU control to the COOL position if the outside temperature has been below 50 degrees unless power has been applied to the ECU for at least 5 hours. Failure to comply could severely damage the ECU:

TO 35E9-102-11, para 4-14-2
TO 35E9-102-21, para 4-14d
TO 35E9-102-31, para 4-15d

Next, have your trainer demonstrate performance of this task. Then practice it until you feel confident. Your trainer will annotate your training records when he/she feels you are proficient.