ORDER

SO 6540.4A

MAINTENANCE OF RADIO COMMUNICATIONS LINK (RCL) SYSTEMS

January 14, 2003

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
AIRWAY FACILITIES – SOUTHERN REGION

Distribution: Selected A-X(AF)-3; FAF-0 (LTD); ANI-300 (3)

Initiated By: ASO-472

FOREWORD

1. **OBJECTIVE.** This order provides additional periodic maintenance tasks to those required by Order 6540.5A, Maintenance of Radio Communications Link (RCL) Systems in order to determine the true health of the RCL equipment, and to maintain the equipment at an acceptable performance level. This order provides simplified maintenance procedures in a logical order, and most procedures require test equipment more readily available in the field offices. More direction for equipment alignment following component replacement is provided.

William L. Lindsey
Manager, Airway Facilities Division

This page intentionally left blank.

TABLE OF CONTENTS

CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

1. **PURPOSE.** This directive provides guidance and direction for annual periodic maintenance procedures in addition to those required by Order 6540.5, "Maintenance of Radio Communications Link (RCL) Systems". This directive also provides simplified procedures and presents them in a logical order, thereby promoting better understanding of the equipment and easier troubleshooting. This order does not delete any of the requirements or direction provided by Order 6540.5. The information in this order augments information available in instruction books, and other handbooks, and complements Order 6000.15A, General Maintenance for Airway Facilities.

2. **DISTRIBUTION.** This directive is distributed to the branch level in the regional Airway Facilities Division, all Airway Facilities field offices and ANI-300.

3. **CANCELLATION.** Order SO 6540.4, Maintenance of Radio Communications Link (RCL) Systems, dated 2/17/00, is cancelled.

4. **FORMS.** The following form is required in addition to any forms required by Order 6000.15B: FAA Form 6000-8, Technical Performance Record, Continuation or Temporary Record/Report Form, NSN 0052-00-686-0001, unit of issue, PD.

5. **RELATED PUBLICATIONS.** This order shall be used in conjunction with Order 6000.15B, the applicable equipment instruction books, and the latest revision of Order 6540.5, Maintenance of Radio Communications Link Systems. The numbered paragraphs in parentheses referenced in this order refer to paragraphs in Order 6540.5.

6. **RECOMMENDATIONS FOR IMPROVEMENT.** Please provide recommendations for improvement to the Electronic Systems Support Section, ASO-472. Users are encouraged to submit recommendations for improvement.

This page intentionally left blank.

CHAPTER 2. TECHNICAL CHARACTERISTICS

200-1. GENERAL. Refer to Order 6540.5 for the radio communications link (RCL) technical characteristics.

CHAPTER 3. STANDARDS AND TOLERANCES

300-1. GENERAL.

a. This chapter prescribes the standards and tolerances for the radio communications link system, as defined and described in Order 6000.15B. All key performance parameters and/or key inspection elements are clearly identified by an arrow placed to the left of the applicable item.

b. The reference paragraphs below will show the appropriate paragraph in this order first, and where applicable, the appropriate paragraph in Order 6540.5 in parentheses.

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
300-2. RADIO COMMUNICATIONS LINK (RCL)				
a. Powers Supplies				
→ (1) Transmitter Power Unit (1474AL)	500-5a (105)			
(a) +5 V dc		+5 V dc	± 0.3 V dc	Same as Initial
(b) +15 V dc		+15 V dc	± 0.4 V dc	Same as Initial
(c) -15 V dc		-15 V dc	± 0.4 V dc	Same as Initial
(d) -24 V dc		-24 V dc	± 0.4 V dc	Same as Initial
→ (2) Receiver Power Unit (1474AM)	500-5b (120)			
(a) +5 V dc		+5 V dc	± 0.3 V dc	Same as Initial
(b) +15 V dc		+15 V dc	± 0.4 V dc	Same as Initial
(c) -15 V dc A		-15 V dc	± 0.4 V dc	Same as Initial
(c) -15 V dc B		-15 V dc	± 0.4 V dc	Same as Initial
(d) -24 V dc		-24 V dc	± 0.4 V dc	Same as Initial

	Parameter	Reference Paragraph	Standard	Tolerance/Limit Initial	Tolerance/Limit Operating
	b. Transmit Path (FR8)				
→	(1) Deviatable oscillator output frequency (GEN MON)	500-16 (65)	Order 6540.5A Tables 5-1 and 5-2	± 5 kHz	± 80 kHz
→	(2) Automatic level control (ALC) network radio frequency (rf) monitor level (RF MON)	500-18 (70)	Radio data card (RDC)	± 0.1 dB	± 0.5 dB
→	(3) Transmitter Linearity (MOD BIAS MON)	500-15 (118)	RDC	± 0.1 V dc	Same as initial
→	(4) Receiver Power Unit (MOD SEN)	500-17 (117)	Max. null of carrier waveform	Same as standard	Same as standard
	c. Receive Path (FR8)				
→	(1) Rf input power	500-7 (67)	RDC	± 6.0 dB	± 6.0 dB
→	(2) Down-converter rf frequency (GEN MON)	500-6 (66)	Tables 5-1 and 5-2	± 5 kHz	± 80 kHz
→	(3) If frequency (AUX IF OUT)	500-8 (77)	70 MHz	± 1 MHz	± 1 MHz
→	(4) Down converter if output power	500-9 (122)	RDC	± 3.0 dB	Same as initial
→	(5) AGC amplifier				
	(a) If frequency	500-10 (128)	70 MHz	± 1 MHz	Same as initial
	(b) Carrier resupply trip point	500-11 (130)	2 dB below noise level	Same as standard	Sane as standard
	(c) Receiver bandwidth (AGC V more negative than -10 Vdc)	500-11 (130)	LPW IN lights 72 to 79 MHz 61 to 68 MHz	Same as standard	Sane as standard

CHAPTER 4. PERIODIC MAINTENANCE

400-1. GENERAL

a. This chapter establishes the performance checks of the normal operating functions that are necessary to determine that the operation is within the established tolerance/limits, and the schedules for their accomplishment.

b. The reference paragraphs below will show the appropriate paragraph in this order first, and where applicable, the appropriate paragraph in Order 6540.5 in parentheses.

Section 1. PERFORMANCE CHECKS

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
400-2. ALL RCL FACILITIES-		
a. Annually		
(1) Check operation of power supplies	NA	500-4
(2) Measure voltages on transmitter power unit	300-2a(1)	500-5a
(3) Measure voltages on receiver. Power unit	300-2a(2)	500-5b
(4) Measure the rf frequency of the deviatable oscillator	300-2c(2) (45d(2))	500-6 (66)
(5) Measure the rf input power to each receiver	300-2c(1) (45d(1))	500-7 (67)
(6) Measure receiver if frequency	300-2c(3) (45d(3))	500-8 (77)
(7) Measure receiver down converter if output power	300-2c(4)	500-9 (122)
(8) Measure if AGC amplifier frequency and set output level	300-2c(5)(a)	500-10 (128)
(9) Set if AGC amplifier carrier resupply trip point	300-2c(5)(b)	500-11 (130)
(10) Check receiver bandwidth	300-2c(5)(c)	500-11 (130)

Performance Checks	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
(11) Check transmitter linearity	300-2b(3)	500-14 (118)
(12) Measure rf frequency of the deviation oscillator	300-2b(1) (45c(1))	500-16 (65)
(13) Set transmitter modulation sensitivity	300-2b(4)	500-17 (117)
(14) Measure rf output power	300-2b(2) (45c(2))	500-18 (70)

CHAPTER 5. MAINTENANCE PROCEDURES

500-1. GENERAL.

a. The following maintenance procedures may be performed in the sequence in which they are presented, to accomplish an overall equipment alignment.

b. The ALARM AND METER UNIT/POWER SUPPLY/NOISE checks are performed first because power supplies that fail these tests can cause noise problems at sites other than where they are located, as well as at the site being tested.

c. When performing an equipment alignment, first align the Receiver, then align the Transmitter to which the Receiver sends its IF. For example, (Refer to 6540.5 Fig. 2-5) if you align Radio Bay 1 Receiver, then you would align Radio Bay 3 Transmitter, because the IF from #1 Receiver feeds #3 Transmitter. Likewise, #3 Receiver feeds #1 Transmitter; #2 Receiver feeds #4 Transmitter, and #4 Receiver feeds #2 Transmitter.

d. When the Receiver is aligned first, the Receiver refresh can be used to assist in performing the alignment (Carrier null Paragraph 117) of its Transmitter. The IF outputs are checked, the LWP Trip Point checked and the output level of the refresh signal ensured. The frequency adjustments made in paragraph 500-6 and paragraph 500-16 should be as close to frequency specified in Order 6540.5, Table 5-1 as possible. There is evidence that frequency errors are accumulative, and therefore should be avoided.

e. Upon replacement of any of the equipment units, perform the alignment for that unit and the units which follow in the signal flow.

f. The Baseband Noise check is provided for troubleshooting purposes and may be performed at any point.

g. Some procedures refer to the use of a 75 to 50 ohm impedance matching transformer. The use of the transformer and the necessary cable adapters produces about the same signal loss as making the measurement with an impedance mismatch. Therefore, the use of the 75 to 50 ohm matching transform is omitted in these procedures.

500-2. REFERENCES. The following procedures contain paragraph references in parentheses, which refer to paragraphs in Order 6540.5A, Maintenance of Radio Communications Link (RCL) Systems

500-3. TEST EQUIPMENT REQUIRED:

MRC 6500 Microwave Repeater Checker
HP 8640B Signal Generator
HP 3336A Synthesizer/Level Generator
TEK 492 Spectrum Analyzer
TP-75 Matching Transformer
Anritsu Microwave System Analyzer
HP 3730B (with 3737B plug-in) Down Converter

Section 1. ALARM AND METER UNIT/POWER SUPPLY NOISE.

500-4. POWER SUPPLY NOISE.

a. With the channel being worked on out of service (OTS) in both directions and the ARTCC notified, turn the Transmitter Power Switch to Standby. If while in Standby, the TRMTR ON, ALARM AND METER display, or ALARM AND METER WARNING LIGHTS start flickering intermittently, replace the 1474AL TRMTR PWR unit as this is not normal. This problem is not apparent unless the Transmitter is in STANDBY, and if bad can generate noise on the transmitter.

b. Perform the above check on the RCVR PWR unit (1474AM), and look for intermittent RCVR ON lamp and any other intermittent alarm indications. If this occurs change the RCVR PWR unit (1474AM)

c. When the XMTR PWR SUPPLY is in standby, (this causes the site down from your site to go into refresh, and in effect isolates that section of the link) ask the ARTCC if there is any improvement in their received noise level, (on the appropriate channel). If so, then its possible either your site or a site somewhere above you may have a bad PWR SUPPLY or some other problem causing noise on the system. If the noise clears, then by turning on the XMTR PWR SUPPLY and disconnecting the receiver input to the XMTR being checked, (This puts your site into refresh), and the noise recurs then the noise problem is isolated to your site.

500-5. (PARAGRAPHS 105 and 120) VOLTAGES.

a. On the 1474AL TRMTR PWR UNIT, check that the voltages are as follows.

+5V/GRD	+4.7 TO +5.3 VDC
+15V/GRD	+14.6 TO +15.4 VDC
-15V/GRD	-14.6 TO -15.4 VDC
-24V/GRD	-20.0 TO -28.0 VDC

If the POWER SUPPLY voltages are not correct, remove and replace the 1474AL and recheck voltages.

b. On the 1474AM RCVR PWR UNIT, check that the voltages are as follows.

+5V/GRD	+4.7 TO +5.3 VDC
+15V/GRD	+14.6 TO +15.4 VDC
-15VA/GRD	-14.6 TO -15.4 VDC
-15VB/GRD	-14.6 TO -15.4 VDC
-24V/GRD	-20.0 TO -28.0 VDC

If the POWER SUPPLY voltages are not correct, remove and replace the 1474AM and recheck voltages.

Section 2. RECEIVER

500-6. (PARAGRAPH 66) DOWN CONVERTER FREQUENCY CHECK. (NOTE. USE ORDER 6540.5, TABLE 5-1 FOR 4401A AND TABLE 5-2 FOR 4401C) Check Receiver Down Converter frequency at GEN MON using 50 ohm coax (refer to Tables 5-1 or 5-2 for Receiver Channel = Freq.). Adjust GEN FREQ ADJ to a reading within ± 5 kHz of frequency specified. After adjustment wait about 15 minutes for the reading to settle down. If necessary, readjust the frequency. If initial frequency measurement is greater than ± 250 kHz, replace the 149A Microwave Generator and refer to 6540.5A, Paragraph 66.

500-7. (PARAGRAPH 67) DOWN CONVERTER INPUT POWER CHECK. Remove semi-rigid coax from Receiver Wave-Guide Isolator/Transducer and RF IN port on 4401A Receiver Down-Converter. Connect Power Sensor Head to the Isolator/Transducer output port. (support head) The received RF power level should be within ± 3.0 dB of the value recorded on the Radio Data Card, RCVR CONV RF IN. (This level is dependent on weather conditions and amount of fading. You may have to wait for conditions to clear to get a valid result if conditions are bad.) More than 6dB low is a possible indication of misaligned antennas or path intrusion. Remove Power Head and reconnect semi-rigid coax.

500-8. (PARAGRAPH 77) RECEIVER IF FREQUENCY CHECK. Disconnect the cable from the AUX IF OUT jack on the installer interface panel at the top of the radio bay directly above the receiver. Connect the AUX IF OUT jack to the A IN jack on the MRC-6500. Measure and record the frequency reading. The reading should be 70MHz ± 1MHz. If paragraph 66 was performed properly the reading should be within tolerance. If the tolerance is not obtained, the transmitter and/or receiver frequencies are out of adjustment at sites which feed the receiver being checked. Disconnect the test equipment and restore the connection at the AUX IF OUT jack.

500-9. (PARAGRAPH 122) RECEIVER DOWN CONVERTER OUTPUT POWER CHECK. Remove coax from IF Output on Receiver Down Converter. Calibrate Power Meter for 70 MHz. Connect to IF output connector (support head). Measure and record the power reading. (Should be close to radio data value.) Disconnect Power Head and leave coax disconnected for next step.

500-10. (PARAGRAPH 128) IF AGC AMPLIFIER OUTPUT LEVEL ADJUSTMENT.

a. Coax was left disconnected during last step. Insure LPW lamp is lit on YJ105. AGC Amp Manual Auto SW in AUTO. Disconnect IF out cable from YJ105 IF AGC Amp. Connect Frequency Counter to IF out port on YJ105 IF AGC amp. Record the measured frequency. If the frequency is not 70 MHz ± 1.5KHz, subsequent tests requiring at 70 MHz source must use a signal generator. If the frequency is not 70 MHz ± 1 MHz replace the YJ105 IF AGC amp. (This port is 75 ohm but the 50 ohm coax from Counter won't affect the Counter reading.)

b. Calibrate power meter for 70 MHz. Connect to IF out port on YF105. Adjust RSPLY LEV to give 5.2 dB reading, and that the signal level is steady. (5.2 will give 5.0 at port). Reconnect Receiver RF input coax. Adjust YJ105 AUTO GAIN for 5.2 dB.

c. Select Manual gain on YJ105 and adjust Manual gain Adj. for 5.2dB. (This adjustment. will vary according to the in coming signal so a 5.2 dB approximation will be OK.)

d. Remove Power Head, and reconnect coax to the IF OUT connector. Manual/Auto SW back to AUTO.

500-11. (PARAGRAPH 130) IF AGC AMPLIFIER CARRIER RESUPPLY TRIP POINT.

a. Calibrate power meter for 70 MHz. Connect to the IF OUT jack on the installer interface panel directly above the receiver. Make sure that the YJ105 IF AGC AMPL MAN/AUTO Switch is in AUTO. Adjust LPW IN TRIP control fully CCW. Make sure the LPW IN indicator is not lighted, if it is replace the YJ105 card. Inject a -40 dBm (Do not exceed -20 dBm) RF signal on the receiver frequency into the RF IN jack on the 4401A or 4401C receiver downconverter/microwave generator. Connect the frequency counter to the microwave signal generator (MRC 6500) AUX RF OUT jack with the supplied semi-rigid coax.

b. While monitoring and adjusting the frequency to the receiver frequency, lower the injected signal level slowly until the NOISE led on the SL246 FM RECEIVER just lights steadily (usually -68 to -78 dBm). Reduce the injected signal 2 dB below this level.

c. Slowly turn the LPW IN TRIP control on the IF AGC AMPL clockwise until the LPW IN indicator just lights steadily.

d. Adjust RSPLY LEV on the IF AGC AMPL to give 5.0 dB reading at the IF OUT jack on the installer interface panel. (5.0 dB reading will give 5.2 dB at the port).

e. Use EXT MTR 20 V function on SL243 alarm and meter unit above the receiver to measure the AGC voltage at the AGC V test point on the IF AGC AMPL. Record this voltage in the RCVR AGC V: at LPW in position on the radio data card.

f. Disconnect the test equipment and restore equipment connections.

g. Use EXT MTR 20 V function on SL243 alarm and meter unit above the receiver to measure the AGC voltage at the AGC V test point on the IF AGC AMPL. Record this voltage in the RCVR AGC V: at Normal position on the radio data card.

h. Set up a HP 8640B (or any 70 MHz source) for a 70 MHz carrier with no modulation. Connect a test cable to the HP 8640B attenuator output and adjust for an output of -19.8 dBm (plus .2 dB added for loss through matching transformer) and connect the other end to Linear Delay Equalizer IF IN jack.

i. Slowly raise the frequency. Check that the LPW IN indicator lights between 72 and 79 MHz and that the agc voltage at the AGC V test point is greater (more negative) than -10 volts. Slowly return to 70 MHz. Check that the LPW IN indicator goes out. Slowly lower the frequency. Check that the LPW IN indicator lights between 61 and 68 MHz and that the agc voltage at the AGC V test point is greater (more negative) than -10 volts. Slowly return to 70 Mhz. Check that the LPW IN indicator goes out.

Section 3. TRANSMITTER

500-14. GENERAL. IF THE DEVIATABLE OSCILLATOR LINEARITY HAS RECENTLY BEEN CHECKED ON-SITE OR AT THE FAALC, SKIP PARAGRAPH 500-15. IF THERE IS ANY DOUBT ABOUT THE ORIGIN OR RECENCY OF THE MOD BIAS VOLTAGE SETTING, PARAGRAPH 500-15 MUST BE DONE. (MOD BIAS voltages for various frequencies are recorded on the inside of the reference crystal access cover, but questionable practices of recent repair contractors have put the validity of these voltages in doubt.)

NOTE: To shift the deviatable oscillator NON INV/INV switch safely, the deviatable oscillator must be disconnected from its backplane connector. Placing the 1474AL transmitter power unit in STBY does not de-energize the deviatable oscillator, which receives its power directly from the battery bus supply connection at the top of the radio bay.

500-15. (PARAGRAPH 118). TRANSMITTER LINEARITY CHECK AND ADJUSTMENT

a. Set the Anritsu Microwave System Analyzer (MSA) transmitter as follows:
TRANSMITTER MODE: BB
SWEEP FREQUENCY: LINE
LOW BB FREQUENCY: OFF (out)
SWEEP OUTPUT Vp/75 ohms: 1.22 (Turn ADJUST knob to set sweep level)
BB FREQUENCY: 250 kHz
BB OUTPUT LEVEL dBm: -15.0
BB SWEEPER OUTPUT: BB + SWEEP OUTPUT (out)

b. Set the MSA receiver as follows:
RECEIVER MODE: IF
RANGE: MANUAL
FREQ SELECT: MARKER
MARKER FREQUENCY: Turn knob for a marker frequency reading of ± 4 MHz
X SELECT: IF
Y1 DISPLAY: LINEARITY
SCALE INTENSITY: OFF (out)

c. On the 4411A ALC network, place the ALC ON/OFF switch in the OFF position and remove the termination from the RF MON jack. On the installer interface panel at the top of the radio bay, disconnect the cable or termination plug at the BB IN jack and connect from the MSA transmitter BB SWEEPER OUTPUT jack to the BB IN jack.

d. (Skip this step at terminal locations). The cable between the IF IN jack above the transmitter under test and the IF OUT jack elsewhere on the installer interface panel should contain a 4 dB in-line pad. Disconnect the cable from the IF OUT jack (not over the transmitter under test) and, using a 75 ohm cable, connect the MSA transmitter CRYSTAL OUTPUT jack to the cable end removed from the IF OUT jack. Thus, the MSA output goes through the 4 dB pad and into the IF IN jack above the transmitter. If the test cable length is greater than 6 feet, cable loss due to attenuation must be taken into account (0.02 dB per foot for most 75 ohm test cables).

e. Using a 50 ohm test cable connect the RF MON jack on the ALC network to the RF INPUT on the HP 3730B down converter. If a 5W (+37 dBm) power amplifier is used, an in-line 6 dB attenuator must be used with the test cable. If the test cable length is greater than 6 feet, cable loss due to attenuation must be taken into account

(0.8 dB per foot for most 50 ohm test cables).

f. Set the down converter as follows:
RF RANGE: 5.7-8.5 GHz
IF RANGE: 70MHz
SIDEBAND: does not matter
AFC: OFF

g. Turn down converter TUNE knob to obtain the RF channel frequency in the digital display. Fine tune by adjusting the TUNE knob to center the if center frequency meter needle on 70MHz. Turn AFC switch to NORMAL.

h. Connect the OUTPUT jack on the IF SECTION of the down converter to the MSA receiver IF INPUT, using 75 ohm cable. If the test cable length is greater than 6 feet, cable loss due to attenuation must be taken into account (.02 dB per foot for most 75 ohm test cables).

i. On the MSA receiver press the COUNTER key under FREQ SELECT and adjust the down converter TUNE knob to obtain 70MHz in the display.

j. Set the MSA receiver as follows:
Y1 DISPLAY RANGE: 0.2% (using the up/down arrow keys)
BLANKING: OFF
X Phase: adjust to align center markers
BLANKING: ON
FREQ SELECT: MARKER
MARKER FREQUENCY: Turn knob for a marker frequency reading of ± 4 MHz
X-GAIN and X POSITION: adjust to place the ± 4 MHz markers at the edges of the screen graticule

k. The transmitter linearity trace on the MSA receiver display must be a smooth, continuous curve within a 1.0 % window (see Figure 5-42). If this requirement is met disconnect the test equipment and return the equipment to normal (See last paragraph this step).

l. Remove the 4400A/B/C transmitter deviatable oscillator network faceplate and adjust the LIN ADJ control to obtain the flattest possible transmitter linearity trace (within a 1.0% window).

m. Set the SL243 alarm and meter unit switch to the TRMTR PH LOCK V position. On the deviatable oscillator, adjust the FREQ ADJ control for a meter indication of -8.0 ± .3V. Set the switch to EXT MTR 200V and measure the voltage at the MOD BIAS MON test point on the deviatable oscillator. Record this voltage on the radio data card.

n. Disconnect all test equipment, reconnect the cable or termination plug to the BB IN jack, reconnect the cable to the IF OUT jack, replace the termination plug on the RF MON jack, return the ALC switch to the ON position, and replace the deviatable oscillator network faceplate.

500-16. <u>(PARAGRAPH 65) TRANSMITTER DEVIATABLE OSCILLATOR NETWORK ADJUSTMENT</u>.
(NOTE: USE TABLE 5-1 FOR 4400A (4400B at ARTCC) AND TABLE 5-2 FOR 4400C)

a. On the alarm and meter unit in the transmitter under test, set the switch to the EXT MTR 20V position. Connect the meter test leads to the XTAL MON test point. Adjust the XTAL ADJ Control for a max voltage reading

(most negative). The final value should be between -0.1 to -1.2 volts.

b. Connect Frequency Counter to REF XTAL jack on DEV OSC. Adjust the REF ADJ to ± 100 Hz of the Reference Crystal Frequency listed in Tables 5-1 or 5-2. (or radio data card).

c. On SL243 Alarm and Meter Unit, set the selector switch to EXT MTR 200 V. Using the Alarm and Meter Unit, connect the Volt Meter leads to the REF MON and ground test points. The reading should be between +0.75 and +2.0 volts. If this is not met, replace the Reference Crystal.

d. On SL243 Alarm and Meter Unit, set the selector switch to EXT MTR 200 V. Connect the Volt Meter to the MOD BIAS MON test point on the DEV OSC, and adjust the LIN ADJ control on the DEV OSC for the Mod Bias Voltage reading on the Radio Data Card. This voltage should be ± 0.1 VDC of the recorded value.

> **IMPORTANT:** This Mod Bias Voltage is recorded on the inside of the Reference Crystal Cover and must be changed on the Radio Data Card any time a Deviation Oscillator is replaced. If you are not sure if your Radio Data Card is correct, perform 500-15 (paragraph 118). Refer to notes between Order 6540.5, Paragraph 18 and 19 on Page 64.

e. Connect counter to GEN MON jack on the 23A (77A at ARTCC). Hold the test/operate switch in the test position and adjust the FREQ ADJ until the Deviatable Oscillator output frequency is within ± 500 kHz of the oscillator freq specified in Tables 5-1 or 5-2. (Use non-magnetic screw driver). After 10 to 15 second delay, the TRMTR PH Lock Led should light. If proper output frequency cannot be obtained or the Led won't light, replace the Deviatable Oscillator **NOTE**: These last two steps (LIN ADJ and FREQ ADJ will interact, so repeat steps until Mod Bias and Deviatable Oscillator output frequency are both in tolerance.)

f. Release the Test/Operate Switch. The TRMTR PH Lock led should extinguish. On the SL243 Alarm and Meter Unit set the selector to TRMTR PH LOCK V position. The meter should indicate -4.0 VDC to -14.0 VDC.

g. On the DEV OSC, adjust the FREQ ADJ for TRMTR PH LOCK V on the SL243 to read -8.0 ± .3 VDC. Adjust the REF ADJ control until the Deviatable Oscillator output frequency is within ± 5 kHz of the frequency specified in Tables 5-1 or 5-2

500-17. (PARAGRAPH 117) TRANSMITTER MODULATION SENSITIVITY ADJUSTMENT (CARRIER NULL)

a. On the Receiver feeding the IF to the transmitter to be tested, remove the semi-rigid coax from the Receiver Wave Guide Isolator/Transducer and RF in port on the 4401A/C. This allows the use of the 70 MHz refresh (if within ±1.5 kHz) to be used as a 70 MHz Generator and removes the modulation from the Transmitter being tested. The frequency and output level was set up during the Receiver alignment so it is known to be OK.

OR, the HP8640B may be used if it is set to 70 MHz at 5.2 dB and connected to the Installers panel shown on Page 182 and described in Paragraph Q. (.2 dB was added to compensate for the matching Transformer and for going to the installer's panel. If connecting to the IF coax at the YJ105, subtract .2 dB and use a reading of 5.0 dB).

b. Connect Spectrum Analyzer Input to ALC RF MON Port and set Spectrum Analyzer as follows:
READOUT: ON
TRIGGERING: FREE RUN
TIME/DIV: AUTO
VERT. DISPLAY: 10 dB/Div.
VIDEO FILTER: WIDE
DIGITAL STORAGE: VIEW A
FREQ TO CHANNEL
RESOLUTION BAND WIDTH: 100 kHz
FREQ SPAN/DEV: 500 kHz to 5 MHz (adjust for view)
REFERENCE LEVEL: 10 dB
MIN NOISE/MIN DISTORTION: MIN DISTORTION, BUTTON NOT LIT.
MIN RF ATTEN dB: 0 dB

c. Set HP 3336A Synthesizer/Level Generator for 250 kHz at -8.5 dB output.
Connect 75 ohm coax to 75 ohm output on HP3336A and connect to MOD INPUT port on Deviatable Oscillator.

d. Setup Spectrum Analyzer to display carrier frequency and sidebands. Adjust MOD SEN pot on Deviatable Oscillator full CCW so only carrier is present, then adjust MOD SEN pot on Deviatable Oscillator CW for max null of carrier. (As carrier is nulled side bands will appear.)

e. Remove test equipment and restore RCL Equipment to normal.

500-18. (PARAGRAPH 70) TRANSMITTER RF OUTPUT POWER ADJUSTMENT.

a. Calibrate Power Meter for 8 GHz. On the Alarm and Meter Unit, place the selector switch to TRMTR ALCV position. Connect PWR head to ALC RF MON port.

b. Turn ALC Switch on. On the ALC, adjust the DET ADJ pot for the power reading marked on the ALC or on the Radio Data Card ALC: REF MON.

c. Turn ALC switch off and adjust I.F LEV ADJ on 23A (77A at ARTCC) for a "0" V reading on the Alarm and Meter Display. Watch the power meter also, as this reading should come up to the reading marked on the ALC or Radio Data Card.

d. Turn the ALC on and repeat this procedure until the power meter reads the correct reading and the Alarm and Meter Unit reads "0" V with the ALC switch in either position.

NOTE: If the 23A (77A at ARTCC), POWER AMP, or ALC, HAVE BEEN CHANGED PROCEED AS FOLLOWS.

e. Turn ALC Switch to off. With PWR HEAD connected as in step a.

f. On the 23A (77A at ARTCC) adjust the LEV.ADJ for the power reading marked on the ALC, or on the radio data card. Then proceed with step a.

APPENDIX 1

BASEBAND NOISE CHECK PROCEDURE FOR REPEATER SITES

1. **OBJECT.** This check determines if the baseband signal being received at a repeater site is excessively noisy. This is not an established check for the RCL, but AOS-510 presently has an NCP in process to have it added to Order 6540.5.

2. **DISCUSSION.** See Appendix 2

3. **TEST EQUIPMENT REQUIRED.** Selective Level Meter, Hewlett Packard model 3586, or equivalent.

4. **CONDITIONS.** At repeater sites, since this jack is not used, this test can be performed without disrupting service. At terminals, if this jack is used, this check will cause a disruption of service on one channel.

5. **DETAILED PROCEDURE.**

   a. Configure the SLM as follows:

      (1) Termination: 75Ω

      (2) Measurement Mode: LO DIST

      (3) Bandwidth: 3100 Hz (no filter)

   b. Connect a 75 ohm cable from the SLM to the BB OUT2 jack on the SL246 FM Receiver.

      NOTE: This check shall be performed at 4 different channel frequencies throughout the baseband that are known to be idle.

   c. Tune the SLM to a baseband frequency known to be idle. Note the SLM reading.

   d. Upon completion of the 4 noise measurements, remove the test equipment and restore the facility to normal.

This page intentionally left blank.

APPENDIX 2

BASEBAND NOISE CHECK FOR REPEATER SITES

1. **DISCUSSION.** RCL technicians frequently receive complaints that the link is "noisy" and are asked to isolate the source. Paragraph 74 of Order 6540.5A specifies the procedure for checking RCL link end-to-end baseband noise once each year. This check is involved and requires the use of the Scientific Atlanta test set which most work centers do not have. In addition, if excessive noise levels are found, this test does not provide any means to isolate the source of the noise. This procedure allows the noise level of the baseband signal to be checked at a repeater site using the Hewlett Packard model 3586 selective level meter (SLM). The noise level is checked at the BB OUT2 jack of the SL246 FM Receiver. This check should be performed at 3 or 4 different frequencies throughout the baseband that are known to be idle.

a. The allowable noise level at the BB OUT2 jack depends on two factors, how many hops of RCL are contributing to the noise at that point, and what frequency in the baseband is being checked.

b. The expected baseband noise level at a repeater site increases as you go further down the link. Each hop will contribute a typical background noise level. Note that when noise is being monitored at the BB OUT2 jack on the SL246, you are only listening to noise from one direction on the link. If you are troubleshooting a problem with a Granger channel somewhere along the link, note that the Granger channel modem cards receive the combined baseband signal from both directions at their DIP site, so noise on the channel could be coming from either end of the link. On links that have spurs, hops on a spur should be counted if they contribute to the noise being received at a site. As an example, if only individual channels are bridged onto the link at the junction site, spur hops would only be counted if you were checking baseband noise at the frequency of a channel that was bridged onto the backbone. For all other channels, spur hops would not be counted.

c. The allowable noise level at the BB OUT2 jack will also depend on the frequency that you have the SLM tuned to in the baseband. At this point, the baseband signal has not yet been de-emphasized. De-emphasis is accomplished in the SL248 BB Switch module. Since the signal has not been de-emphasized, signals at frequencies below 2.568 MHz (the emphasis network cross-over frequency), will be at a lower level than they should actually be and signals at frequencies above 2.568 MHz will be at a higher level than they actually should be.

2. **CALCULATE NOISE LEVELS.**

The maximum allowable noise level that should be read at the BB OUT2 jack is determined by the following equation:

$$\text{Noise level (dBm)} = -88 + 10 \log N + F$$

Where:

N = number of hops that are contributing to background noise
F = pre-emphasis frequency correction factor, per table below

NOTE: As an example, assume that noise level is being monitored at a site. The receiver is receiving noise from 7 hops of RCL, and the frequency selected to monitor the noise is 1 MHz. The maximum allowable noise level is:

Noise level = -88 + 10 log 7 + (-3.7)
= -88 + 8.5 - 3.7
= -83.2 dBm

FREQUENCY CORRECTION FACTOR, F

Frequency (kHz)	Correction, F (dB)	Frequency (kHz)	Correction, F (dB)
250	-4.5	4,750	+4.6
500	-4.2	5,000	+4.8
750	-4.0	5,250	+4.8
1,000	-3.7	5,500	+4.6
1,250	-3.2	5,750	+4.5
1,500	-2.8	6,000	+4.2
1,750	-2.2	6,250	+4.0
2,000	-1.5	6,500	+3.8
2,250	-0.8	6,750	+3.6
2,568	0	7,000	+3.2
2,750	+0.6	7,250	+3.0
3,000	+1.2	7,500	+2.8
3,250	+1.9	7,750	+2.5
3,500	+2.4	8,000	+2.2
3,750	+3.0	8,250	+2.0
4,000	+3.5	8,500	+1.7
4,250	+4.0	8,750	+1.5
4,500	+4.4		

BASEBAND NOISE CALCULATIONS FOR REPEATER SITES

	HOPS								
FREQ	1	2	3	4	5	6	7	8	9
250	-92.50	-89.49	-87.73	-86.48	-85.51	-84.72	-84.05	-83.47	-82.96
500	-92.20	-89.19	-87.43	-86.18	-85.21	-84.42	-83.75	-83.17	-82.66
750	-92.00	-88.99	-87.23	-85.98	-85.01	-84.22	-83.55	-82.97	-82.46
1000	-91.70	-88.69	-86.93	-85.68	-84.71	-83.92	-83.25	-82.67	-82.16
1250	-91.20	-88.19	-86.43	-85.18	-84.21	-83.42	-82.75	-82.17	-81.66
1500	-90.80	-87.79	-86.03	-84.78	-83.81	-83.02	-82.35	-81.77	-81.26
1750	-90.20	-87.19	-85.43	-84.18	-83.21	-82.42	-81.75	-81.17	-80.66
2000	-89.50	-86.49	-84.73	-83.48	-82.51	-81.72	-81.05	-80.47	-79.96
2250	-88.80	-85.79	-84.03	-82.78	-81.81	-81.02	-80.35	-79.77	-79.26
2568	-88.00	-84.99	-83.23	-81.98	-81.01	-80.22	-79.55	-78.97	-78.46
2750	-87.40	-84.39	-82.63	-81.38	-80.41	-79.62	-78.95	-78.37	-77.86
3000	-86.80	-83.79	-82.03	-80.78	-79.81	-79.02	-78.35	-77.77	-77.26
3250	-86.10	-83.09	-81.33	-80.08	-79.11	-78.32	-77.65	-77.07	-76.56
3500	-85.60	-82.59	-80.83	-79.58	-78.61	-77.82	-77.15	-76.57	-76.06
3750	-85.00	-81.99	-80.23	-78.98	-78.01	-77.22	-76.55	-75.97	-75.46
4000	-84.50	-81.49	-79.73	-78.48	-77.51	-76.72	-76.05	-75.47	-74.96
4250	-84.00	-80.99	-79.23	-77.98	-77.01	-76.22	-75.55	-74.97	-74.46
4500	-83.60	-80.59	-78.83	-77.58	-76.61	-75.82	-75.15	-74.57	-74.06
4750	-83.40	-80.39	-78.63	-77.38	-76.41	-75.62	-74.95	-74.37	-73.86
5000	-83.20	-80.19	-78.43	-77.18	-76.21	-75.42	-74.75	-74.17	-73.66
5250	-83.20	-80.19	-78.43	-77.18	-76.21	-75.42	-74.75	-74.17	-73.66
5500	-83.40	-80.39	-78.63	-77.38	-76.41	-75.62	-74.95	-74.37	-73.86
5750	-83.50	-80.49	-78.73	-77.48	-76.51	-75.72	-75.05	-74.47	-73.96
6000	-83.80	-80.79	-79.03	-77.78	-76.81	-76.02	-75.35	-74.77	-74.26
6250	-84.00	-80.99	-79.23	-77.98	-77.01	-76.22	-75.55	-74.97	-74.46
6500	-84.20	-81.19	-79.43	-78.18	-77.21	-76.42	-75.75	-75.17	-74.66
6750	-84.40	-81.39	-79.63	-78.38	-77.41	-76.62	-75.95	-75.37	-74.86
7000	-84.80	-81.79	-80.03	-78.78	-77.81	-77.02	-76.35	-75.77	-75.26
7250	-85.00	-81.99	-80.23	-78.98	-78.01	-77.22	-76.55	-75.97	-75.46
7500	-85.20	-82.19	-80.43	-79.18	-78.21	-77.42	-76.75	-76.17	-75.66
7750	-85.50	-82.49	-80.73	-79.48	-78.51	-77.72	-77.05	-76.47	-75.96
8000	-85.80	-82.79	-81.03	-79.78	-78.81	-78.02	-77.35	-76.77	-76.26
8250	-86.00	-82.99	-81.23	-79.98	-79.01	-78.22	-77.55	-76.97	-76.46
8500	-86.30	-83.29	-81.53	-80.28	-79.31	-78.52	-77.85	-77.27	-76.76
8750	-86.50	-83.49	-81.73	-80.48	-79.51	-78.72	-78.05	-77.47	-76.96

BASEBAND NOISE CALCULATIONS FOR REPEATER SITES

	HOPS								
FREQ	10	11	12	13	14	15	16	17	18
250	-82.50	-82.09	-81.71	-81.36	-81.04	-80.74	-80.46	-80.20	-79.95
500	-82.20	-81.79	-81.41	-81.06	-80.74	-80.44	-80.16	-79.90	-79.65
750	-82.00	-81.59	-81.21	-80.86	-80.54	-80.24	-79.96	-79.70	-79.45
1000	-81.70	-81.29	-80.91	-80.56	-80.24	-79.94	-79.66	-79.40	-79.15
1250	-81.20	-80.79	-80.41	-80.06	-79.74	-79.44	-79.16	-78.90	-78.65
1500	-80.80	-80.39	-80.01	-79.66	-79.34	-79.04	-78.76	-78.50	-78.25
1750	-80.20	-79.79	-79.41	-79.06	-78.74	-78.44	-78.16	-77.90	-77.65
2000	-79.50	-79.09	-78.71	-78.36	-78.04	-77.74	-77.46	-77.20	-76.95
2250	-78.80	-78.39	-78.01	-77.66	-77.34	-77.04	-76.76	-76.50	-76.25
2568	-78.00	-77.59	-77.21	-76.86	-76.54	-76.24	-75.96	-75.70	-75.45
2750	-77.40	-76.99	-76.61	-76.26	-75.94	-75.64	-75.36	-75.10	-74.85
3000	-76.80	-76.39	-76.01	-75.66	-75.34	-75.04	-74.76	-74.50	-74.25
3250	-76.10	-75.69	-75.31	-74.96	-74.64	-74.34	-74.06	-73.80	-73.55
3500	-75.60	-75.19	-74.81	-74.46	-74.14	-73.84	-73.56	-73.30	-73.05
3750	-75.00	-74.59	-74.21	-73.86	-73.54	-73.24	-72.96	-72.70	-72.45
4000	-74.50	-74.09	-73.71	-73.36	-73.04	-72.74	-72.46	-72.20	-71.95
4250	-74.00	-73.59	-73.21	-72.86	-72.54	-72.24	-71.96	-71.70	-71.45
4500	-73.60	-73.19	-72.81	-72.46	-72.14	-71.84	-71.56	-71.30	-71.05
4750	-73.40	-72.99	-72.61	-72.26	-71.94	-71.64	-71.36	-71.10	-70.85
5000	-73.20	-72.79	-72.41	-72.06	-71.74	-71.44	-71.16	-70.90	-70.65
5250	-73.20	-72.79	-72.41	-72.06	-71.74	-71.44	-71.16	-70.90	-70.65
5500	-73.40	-72.99	-72.61	-72.26	-71.94	-71.64	-71.36	-71.10	-70.85
5750	-73.50	-73.09	-72.71	-72.36	-72.04	-71.74	-71.46	-71.20	-70.95
6000	-73.80	-73.39	-73.01	-72.66	-72.34	-72.04	-71.76	-71.50	-71.25
6250	-74.00	-73.59	-73.21	-72.86	-72.54	-72.24	-71.96	-71.70	-71.45
6500	-74.20	-73.79	-73.41	-73.06	-72.74	-72.44	-72.16	-71.90	-71.65
6750	-74.40	-73.99	-73.61	-73.26	-72.94	-72.64	-72.36	-72.10	-71.85
7000	-74.80	-74.39	-74.01	-73.66	-73.34	-73.04	-72.76	-72.50	-72.25
7250	-75.00	-74.59	-74.21	-73.86	-73.54	-73.24	-72.96	-72.70	-72.45
7500	-75.20	-74.79	-74.41	-74.06	-73.74	-73.44	-73.16	-72.90	-72.65
7750	-75.50	-75.09	-74.71	-74.36	-74.04	-73.74	-73.46	-73.20	-72.95
8000	-75.80	-75.39	-75.01	-74.66	-74.34	-74.04	-73.76	-73.50	-73.25
8250	-76.00	-75.59	-75.21	-74.86	-74.54	-74.24	-73.96	-73.70	-73.45
8500	-76.30	-75.89	-75.51	-75.16	-74.84	-74.54	-74.26	-74.00	-73.75
8750	-76.50	-76.09	-75.71	-75.36	-75.04	-74.74	-74.46	-74.20	-73.95

BASEBAND NOISE CALCULATIONS FOR REPEATER SITES

	HOPS						
FREQ	19	20	21	22	23	24	25
250	-79.71	-79.49	-79.28	-79.08	-78.88	-78.70	-78.52
500	-79.41	-79.19	-78.98	-78.78	-78.58	-78.40	-78.22
750	-79.21	-78.99	-78.78	-78.58	-78.38	-78.20	-78.02
1000	-78.91	-78.69	-78.48	-78.28	-78.08	-77.90	-77.72
1250	-78.41	-78.19	-77.98	-77.78	-77.58	-77.40	-77.22
1500	-78.01	-77.79	-77.58	-77.38	-77.18	-77.00	-76.82
1750	-77.41	-77.19	-76.98	-76.78	-76.58	-76.40	-76.22
2000	-76.71	-76.49	-76.28	-76.08	-75.88	-75.70	-75.52
2250	-76.01	-75.79	-75.58	-75.38	-75.18	-75.00	-74.82
2568	-75.21	-74.99	-74.78	-74.58	-74.38	-74.20	-74.02
2750	-74.61	-74.39	-74.18	-73.98	-73.78	-73.60	-73.42
3000	-74.01	-73.79	-73.58	-73.38	-73.18	-73.00	-72.82
3250	-73.31	-73.09	-72.88	-72.68	-72.48	-72.30	-72.12
3500	-72.81	-72.59	-72.38	-72.18	-71.98	-71.80	-71.62
3750	-72.21	-71.99	-71.78	-71.58	-71.38	-71.20	-71.02
4000	-71.71	-71.49	-71.28	-71.08	-70.88	-70.70	-70.52
4250	-71.21	-70.99	-70.78	-70.58	-70.38	-70.20	-70.02
4500	-70.81	-70.59	-70.38	-70.18	-69.98	-69.80	-69.62
4750	-70.61	-70.39	-70.18	-69.98	-69.78	-69.60	-69.42
5000	-70.41	-70.19	-69.98	-69.78	-69.58	-69.40	-69.22
5250	-70.41	-70.19	-69.98	-69.78	-69.58	-69.40	-69.22
5500	-70.61	-70.39	-70.18	-69.98	-69.78	-69.60	-69.42
5750	-70.71	-70.49	-70.28	-70.08	-69.88	-69.70	-69.52
6000	-71.01	-70.79	-70.58	-70.38	-70.18	-70.00	-69.82
6250	-71.21	-70.99	-70.78	-70.58	-70.38	-70.20	-70.02
6500	-71.41	-71.19	-70.98	-70.78	-70.58	-70.40	-70.22
6750	-71.61	-71.39	-71.18	-70.98	-70.78	-70.60	-70.42
7000	-72.01	-71.79	-71.58	-71.38	-71.18	-71.00	-70.82
7250	-72.21	-71.99	-71.78	-71.58	-71.38	-71.20	-71.02
7500	-72.41	-72.19	-71.98	-71.78	-71.58	-71.40	-71.22
7750	-72.71	-72.49	-72.28	-72.08	-71.88	-71.70	-71.52
8000	-73.01	-72.79	-72.58	-72.38	-72.18	-72.00	-71.82
8250	-73.21	-72.99	-72.78	-72.58	-72.38	-72.20	-72.02
8500	-73.51	-73.29	-73.08	-72.88	-72.68	-72.50	-72.32
8750	-73.71	-73.49	-73.28	-73.08	-72.88	-72.70	-72.52

This page intentionally left blank.