SECTION V
MAINTENANCE

5.1   INTRODUCTION

This section contains test and alignment procedures for an operational GMH Series mobile radio. This section also contains disassembly and alignment procedures. An understanding of the theory of operation is recommended before maintenance is attempted.

5.1.1   Test Equipment Required

RF Signal Generator	HP8640 or equivalent
Distortion Analyzer	HP334A or equivalent
Power Meter	HP435B with 30 dB pad or equivalent
Service Monitor	Cushman 4000 Radio Communications Test Set or equivalent
Digital Multimeter	IBM PC or equivalent, with 256K memory and an RS-232 serial port LAA0705 or LAA 0725 programming cable GMH Editor Software
GMH Tool/Cable Kit	LAA 0621, P/N 050-03152-0000 This tool kit consists of the following parts:

Heatsink	076-01475-0000
Spanner Tool	076-01451-0000
GMH RF Test Cable	155-02773-0000
2 X 6 Test Cable	155-02705-0000
Flex Cables (2 included)	155-02705-0000
2 X 5 Test Cable (2 included)	155-02622-0000
Audio Cable	155-02269-0000

5.2   OVERHAUL

5.2.1   Visual Inspection

This section contains instructions to assist in determining, by inspection, the condition of GMH assemblies. Defects resulting from wear, physical damage, deterioration, or other causes can be found by these inspection procedures. To aid inspection, detailed procedures are arranged in alphabetical order.

5.2.1.1 Capacitors, Fixed

Inspect capacitors for case damage, body damage, and cracked, broken, or charred insulation. Check for loose, broken, or corroded terminal studs, lugs, or leads. Inspect for loose, broken, or improperly soldered connections. On chip caps be especially alert for hairline cracks in the body and broken terminations.

5.2.1.2 Capacitors, Variable

Inspect trimmers for chipped and cracked bodies, damaged dielectrics, and damaged contacts.

5.2.1.3 Chassis

Inspect the chassis for deformation, dents, punctures, badly worn surfaces, damaged connectors, damaged fastener devices, loose or missing hardware, component corrosion, and damage to the finish.

5.2.1.4 Connectors

Inspect connectors for broken parts and other irregularities. Inspect for cracked or broken insulation and for contacts that are broken, deformed, or out of alignment. Also, check for corroded or damaged plating on contacts and for loose, improperly soldered, broken, or corroded terminal connections.

5.2.1.5 Covers and Shields

Inspect covers and shields for punctures, deep dents, and badly worn surfaces. Also, check for damaged fastener devices, corrosion, and damage to finish.

5.2.1.6 Flex Circuits

Inspect flex circuits for punctures and badly worn surfaces. Check for broken traces, especially near the solder contact points.

5.2.1.7 Fuse

Inspect for blown fuse and check for loose solder joints.

5.2.1.8 Insulators

Inspect insulators for evidence of damage, such as broken or chipped edges, burned areas, and presence of foreign matter.

5.2.1.9 Jacks

Inspect all jacks for corrosion, rust, deformations, loose or broken parts, cracked insulation, bad contacts, or other irregularities.

5.2.1.10   Resistors, Fixed

Inspect the fixed resistors for cracked, broken, blistered, or charred bodies and loose, broken, or improperly soldered connections. On chip resistors, be especially alert for hairline cracks in the body and broken terminations.

5.2.1.11   RF Coils

Inspect all RF coils for broken leads, loose mountings, and loose, improperly soldered, or broken terminal connections. Check for crushed, scratched, cut, or charred windings. Inspect the windings, leads, terminals, and connections for corrosion or physical damage. Check for physical damage to forms and tuning slug adjustment screws.

5.2.1.12   Terminal Connections, Soldered

1. Inspect for cold-soldered or resin joints. These joints present a porous or dull, rough appearance. Check for strength of bond using the points of a tool.

2. Examine the terminals for excess solder, protrusions from the joint, pieces adhering to adjacent insulation, and particles lodged between joints, conductors, or other components.

3. Inspect for insufficient solder and unsoldered strands of wire protruding from conductor at the terminal. Check for insulation that is stripped back too far from the terminal.

4.   Inspect for corrosion at the terminal.

5.2.2   Cleaning

A.   Using a clean, lint-free cloth lightly moistened with soap and water only, remove the foreign matter from the equipment case and unit front panel. Wipe dry using a clean, dry, lint-free cloth.

B.   Using a hand controlled dry air jet (not more than 15psi), blow the dust from inaccessible areas. Care should be taken to prevent damage by the air blast.

C.   Clean the receptacles and plugs with a hand controlled dry air jet (not more than 25psi), and a clean, lint-free cloth lightly moistened with soap and water only. Wipe dry with a clean, dry, lint-free cloth.

5.2.3   Repair

This section describes the procedure along with any special techniques for replacing damaged or defective components.

5.2.3.1 Connectors

When replacing a connector, refer to the appropriate PC board assembly drawing and follow the notes to insure correct mounting and mating of each connector.

5.2.3.2 Crystal

The use of any other than a BK Radio crystal is considered an unauthorized modification.

5.2.3.3 Diodes

Use long nose pliers as a heat sink under normal soldering conditions. Note the diode polarity before removal.

5.2.3.4 Integrated Circuits

Refer to Appendix A for removal and replacement instructions.

5.2.3.5 Wiring/Coaxial Cable

When repairing a wire that has broken from its terminal, remove all old solder and pieces of wire from the terminal, restrip the wire to the necessary length and resolder the wire to the terminal. Replace a damaged wire or coax with one of the same type, size, and length.

5.3   DISASSEMBLY & ASSEMBLY

The GMH radio has three major assemblies which contain the following circuit boards:
- Control Head Assembly (at the front of the radio)
    - Switch Board
    - Control Board
    - Option Board
- Core Assembly (in the extruded housing)
    - Systems Board
    - RX/TX Board

VCO Board
PA Flex Circuit
- PA Assembly (in the heatsink casting)
Filter Board
PA Board
Accessory Board

5.3.1   Unit Disassembly

1. Remove the four corner screws from the back of the heatsink casting.

2. Carefully pull the heatsink casting from the core assembly.

3. Disconnect the two flex cables and two coaxial cables from the PA board.

   NOTE: The black-end coax is the RX input to the receiver. The white-end coax is the exciter
                   input to the PA.

4. Place both thumbs on the back of the core assembly and push it out of the extruded housing.

5.3.2   The Control Head Assembly

1. Remove the PA Assembly.

2. Remove the 6 flat head screws around the Control Head housing.

3. Carefully pull the Control Head from the core assembly.

4. Disconnect the two flex cables from the Option board.

5. Remove the 2 flat-head screws from the audio amplifier and 2 pan-head screws that hold the unit
   together.

6. Remove the audio heat sink.

7. Remove the Option board.

5.3.2.1 Control Board

1. Pull off the two rotary knobs from the front of the radio and remove rubber resistance washer
   behind volume knobs.

2. Using the spanner tool, remove the nuts holding the rotary switches in place.

   NOTE: The spanner tool (076-01475-0000) has been modified for use with GMH radios. Older
                   spanner tools may not have sufficient depth.
   NOTE: These 2 nuts do not have the same thread pitch and are not interchangeable. During
                   reassembly, replace each nut in its original location.

3. Carefully remove the Control board by prying it up.

   NOTE: During reassembly, check that the microphone jack is seated properly in the housing
              before tightening the nuts on the rotary switches.

5.3.2.2 Display Board

1. Remove the Control board.
2. Remove the flat spring clip by prying the end with the tab toward the top of the housing.
3. Lift out the Display board.
   NOTE: During reassembly, check that the flex cable does not block the display by folding between the display and window.

5.3.2.3 Pushbutton Labels

1. Pull out a pushbutton from the front of the radio.
2. Remove the old label by pushing from the back.
3. Insert the new label.
4. Insert the pushbutton in its original location.

5.3.2.4 Reconnect Control Head

1. Attach flex cables before placing Control Head onto Core assembly.
2. Check that coax cables are not on the lid of the harmonic filter.

3. Attach Control Head to Core Assembly with 6 flat-head screws.

   NOTE: Use care to prevent breaking the 6 Control Head tabs when tightening the flat-head screws.

5.3.3   The Core Assembly

5.3.3.1 VCO and RX/TX Boards

1. Remove the sheet metal shield from the RX(TX board by prying it up with a flat-blade screwdriver.
2. Remove the 4 screws from the VCO cover and lift off the VCO cover.
3. Carefully remove the VCO by lifting it from the center or prying it up evenly around the sides.
4. Remove the 7 screws from the RX/TX board, pull both coax leads (one at a time) through the ferrite bead, and carefully lift out the RX/TX board.

5.3.3.2 VCO and RX/TX Reassembly

1. Insert the RX/TX board into the   g, pulling the two coaxial cables through the hole in the housing. Pull the coaxes snug and make certain they clear the 12-pin connector between the RX/TX board and the System board. Thread each coax through the ferrite bead.

   NOTE: Check that connectors are properly aligned with the System board before seating them firmly.

2. Insert the VCO, using care to not bend the pins.
3. Attach the VCO cover and snug down the screws.
4. Fasten the RX/TX board to the housing with the seven screws.
5. Insert the flex cables.

5.3.3.3 System Board

1. Remove the 4 screws and lift off the Synthesizer cover.

2. Remove the 3 screws from the System board.
3. Disconnect the front flex cable.
4. Lift out the System Board by lifting the front of the board first, then pulling the back flex through the casting.

5.3.3.4 System Board Reassembly

1. Insert the System board in the housing, carefully threading the back flex through the casting.
2. Attach the Synthesizer cover with the 4 screws. Insure that the rubber tubing is in the cavity above the large rectangular capacitor C119.

   NOTE: When reassembling the Synthesizer and VCO, snug down the screws on the covers or malfunctions may occur.

3. Attach the System board with the 3 screws.
4. Insert the other flex cable.

5.3.4 The PA Assembly

1. Using a 7/16" deepwell socket, remove the hex nut from the antenna connector on the back of the heatsink housing.
2. Remove the 13 screws from the PA board.
3. Remove the PA board from the heatsink housing by pushing the power connector and antenna connector.
4. Remove the Accessory board by removing the one screw on the back.
   NOTE: During reassembly, press the heatsink housing evenly against the core assembly while inserting the 4 screws. Tighten screws at diagonal corners to seat the heatsink housing firmly. Install the remaining screws.

5.3.5 Unit Assembly

To assemble the unit, complete the disassembly procedure in reverse order.

5.5   ALIGNMENT PROCEDURES

The GMH radio uses all electronic tuning with no manual adjustments. Use the GMH Editor computer software when alignment or adjustment is required. You will need an IBM or compatible computer with a disk drive, an RS-232 serial port, and DOS 3.3 or later. You will also need the GMH Editor software diskette (LAA0737) and an RS-232 interface cable (LAA0725), available from BK Radio.

Refer to the GMH Editor Software Manual for details on using the program. When performing a complete alignment with the GMH Editor program, follow these steps in order:

1.   Radio Set-up

2.   Read Radio

3.   Tune Radio

4.   Synthesizer Calibration

5.   Crystal Color

6.   Transmit Power Adjust

7.   Freq Adjust

8.   Deviation Adjust

9.   Reference Mod

10. Tune Receiver

11. Discriminator Adjust

12. Squelch Adjust

5.5.1   RADIO SET-UP

Mount the radio in a suitable fixture supplied with 1 3.8VDC power from a negative ground external power supply. Connect the interface cable to the radio's microphone connector and the computer's serial port. Set the radio's manual controls as follows:

Channel Selector:	Channel 1
On/Off Volume:	On, Volume minimum
Scan:	Off
Priority:	Off

Start the GMH Editor computer program by typing EMEDIT and pressing Enter. After the title screen appears, press any key on the computer keyboard to proceed to the Edit Screen.

5.5.2   READ RADIO

From the Edit Screen, press F9 (Read Radio) to upload the settings currently in the radio into the GMH Editor program. The radio displays PROG during upload.

5.5.3   TUNE RADIO

From the Edit Screen, press F6 (Menu). Press the down arrow key to select "Tune Radio" then press Enter. The program reads the EEPROM map of the core microprocessor Ii (system board). This takes about 5 seconds, during which the radio displays PROG.

5.5.4   SYNTHESIZER CALIBRATION

Select "Synthesizer Calibrations" from the "Tune GMH" menu then press Enter. The radio will automatically perform any necessary adjustment. This takes about 15 seconds, during which the radio displays PROG.

Synthesizer calibration affects the way the voltage from the pretune DIA converter applied to the VCO STEER line changes with frequency. This adjustment may be necessary if VCO components are replaced. Synthesizer calibration should be performed before any other adjustments are made.

During the automatic calibration, the core microprocessor Ii (system board) will direct the synthesizer to acquire lock at various frequencies in both receive and transmit mode. For each test frequency the microprocessor will vary the voltage from the DIA converter network 1102 (system board) used to assist the synthesizer in obtaining frequency lock. The LOCK DETECT signal is monitored to determine when lock has occurred. The DIA voltages that result in proper operation will be recorded in the microprocessor non-volatile memory.

5.5.5   CRYSTAL COLOR

Select "Crystal Color" from the "Tune GMH" menu then press Enter. A list of crystal colors appears. Select the correct color from the list and press Enter. The message "Write Crystal Color to EEPROM (Y/)?" appears in the lower left corner of the computer screen. Press Y to store the new color value, or N to cancel.

The reference oscillator crystal must be compensated for temperature variations. One of four types, specified by a color dot on the crystal, is used in the GMH. If the reference oscillator crystal is replaced with one of a different color code, the programmed compensation value must be changed.

Different crystal temperature compensation curve parameters are stored in the radio core microprocessor Ii (system board) for each color dot. In normal operating mode, the microprocessor observes the temperature using RT1OO. This information, along with the stored curve parameters, is then used to develop a crystal temperature compensation value. This value is used to slightly modify the reference oscillator frequency using DIA network RN1 and varactors CR102 and CR103 (system board).

5.5.6   TRANSMITTER POWER

NOTE: Transmitter should not be keyed for extended periods while setting TX power. Prolonged transmitting will cause the thermal protection circuitry of the radio to decrease the TX power.

Connect a suitable 50~ power meter to the antenna output of the radio. Select "Transmitter power" from the "Tune GMH" menu and press Enter. Select "Start Transmit Power Test" and press Enter. "OK to Transmit?" appears in the lower left corner of the computer screen. Press Y to transmit. You can only adjust transmit power settings while transmitting.

Press the Tab or arrow keys on the computer to move the cursor to the 2-character hexadecimal value in the right column of the menu. Type in a different value, or press Page Up or Page Down to change the value. For each of the three frequencies, adjust the hexadecimal control value to obtain an output power of approximately 50 Watts.

To save the new settings in the radio, select "Store Transmit Power" and press Enter. "Write power values to radio?" appears in the lower left corner of the computer screen. Press Y to save the new values in the radio.

This setting is used to help maintain a constant transmitter output power of 50 Watts across the RF frequency band. If components on the PA board are replaced, this adjustment may be necessary.

Adjustment values at several RF frequencies are stored in non-volatile memory by microprocessor Ii (system board). The power is set by the voltage from DIA network RN2 (system board) which feeds the power control circuit.

NOTE: To adjust the GMH transmit power to a setting below 50 Watts, select "RF Power Code" from the "Edit Globals" menu.

5.5.7   FREQUENCY ADJUST

Connect a suitable attenuator and frequency counter to the antenna output of the radio. The attenuator must be capable of handling the full power output of the radio and protecting the input of the frequency counter. A 30dB attenuator capable of SOW is recommended.

In the "Tune GMH" menu, select "Freq Adjust" and press Enter. "Start Freq Adjust" appears in the middle of the computer screen. When you press Enter, the message "Ok to transmit?" appears in the lower left corner of the computer screen. When you press Y (for Yes) the radio begins transmitting and the Control value is outlined. The message "Transmitting!! Press <ESC> to stop" appears in the lower left corner of the computer screen.

With the cursor under the 2-character hexadecimal value in the right column of the menu, type in a different value, or press Page Up or Page Down to change the value. Adjust the control value up or down until the transmitter frequency is within +~00 Hz of the correct value. When the correct frequency is obtained, press the Esc key on the computer.

The GMH radio's exact transmit and receive frequencies are derived from the reference oscillator. The reference oscillator frequency may require adjustment due to crystal aging or if components in the reference oscillator circuit are replaced. The above "Crystal Color Dot' setting must be correct before performing this adjustment.
Changing the reference oscillator frequency setting causes the voltage applied to varactors CR102 and CR103 (system board) to be varied, in turn altering the oscillation frequency of reference crystal circuit slightly. the microprocessor Ii (system board) controls the voltage using /A network RN1 (system board). The final setting is stored in non-volatile memory.

5.5.8   DEVIATION ADJUST

Connect a suitable attenuator and service monitor to the antenna output of the radio. Connect the modulation output of the service monitor to the Mic High input of the radio. Adjust the service monitor modulation output to a level of 0.15 VRMS and a frequency of I KHz. Select "Deviation Adjust" from the "Tune GMH" menu and press Enter. Insure that "Start Deviation Adjustment" is highlighted and press Enter. "Ok to transmit?" appears in the lower left corner of the computer screen. When you press Y the radio begins transmitting and the present tuning values appear.

Press the Tab or arrow keys to move the cursor to the 2-character hexadecimal control value of the first transmit frequency. Type in a new value or press the Page Up or Page Down keys to set TX FM deviation to 4.5 kHz. Repeat for each of the four frequencies, then select "Store Deviation Adjustment" and press Enter. "Write Dev Comp values to radio?" appears in the lower left corner of the computer screen. Press Y to store the new values in the radio, or N to cancel changes.

This adjustment controls the maximum FM deviation of the transmitter. Since the deviation sensitivity changes with carrier frequency, the adjustment must be performed at several locations in the band. If components in the VCO or transmit audio amplifier or filter are changed this adjustment may be necessary to maintain an FM deviation below 5 kHz.

The level of the transmit audio is controlled using a digital potentiometer 19 (system board). The microprocessor Ii (system board) sets values for the attenuation as the adjustment is performed. The final setting is stored in non-volatile memory.

5.5.9   REFERENCE MODULATION

NOTE: For radios using Digital Code Guard only.
"Start Freq Adjust" appears in the middle of the computer screen. When you press Enter, the message "Ok to transmit?" appears in the lower left corner of the computer screen.

Connect a suitable attenuator and service monitor to the antenna output of the radio. Adjust the service monitor modulation output to a level of 0 VRMS. In the "Tune GMH" menu, select "Reference Mod" and press Enter "Start Ref Mod adjust" appears in the middle of the computer screen. When you press Enter, the message "Ok to transmit?" appears in the lower left corner of the computer screen. When you press Y the radio begins transmitting and displays "PROG." On the computer screen, the hexadecimal tuning value is outlined.

With the cursor under the 2-character hexadecimal value in the right column of the menu, type in a different value, or press Page Up or Page Down to change the value. Observe the Digital Code Guard signal on the service monitor display. Adjust the control value up or down to obtain the flattest waveform with as little overshoot as possible. When adjustment is complete, press the Esc key on the computer.

Reference modulation is used to allow transmission of low frequency Digital Code Guard signals. The reference modulation sensitivity must be adjusted to match the transmit audio deviation. This adjustment should be made after any necessary "Transmit Audio Deviation", "Reference Oscillator Crystal Parameters" or "Reference Oscillator Frequency" adjustments.

Unlike normal voice and audible tones, the low frequency signals present in Digital Code Guard cannot be applied as VCO modulation only. They must be presented to the reference oscillator using the DIA network RN1 and varactors CR102 and CR103 (system). The sub-audible information passes through the core microprocessor Ii (system board) where the variable attenuation is effected by software. The Digital Code Guard signals are generated by the control processor Ii (control board) and sampled by microprocessor Ii 5 stem board) on the LF AUDIO (pin 13) line using an AID converter. The final setting is stored in non-volatile memory.

5.5.10 TUNE RECEIVER

Connect an RF signal generator to the radio antenna input. Set the generator FM modulation to a frequency of 1 kHz and a deviation of 3 kHz. Connect a SINAD meter to the radio audio output. Select "Tune Receiver" from the "Tune GMH" menu and press Enter. Insure that "Start Rx Front End Alignment" is selected and press Enter. The radio displays "PROG". Press the Tab key to select an alignment frequency and perform the following procedure for each of the three listed frequencies.

Set the RF signal generator carrier frequency to the alignment frequency. Adjust the generator output level to obtain a SINAD of approximately 12 dB. Press the Tab or arrow keys to move the cursor to the hexadecimal tuning value in the "Common" column. Type in a new value or press Page Up or Page Down to change the value and obtain the maximum SINAD reading. (During the procedure, anytime the SINAD exceeds 18 dB, the generator output level should be decreased to return to 12 dB SINAD.)

Press the Tab or arrow keys to move the cursor to the hexadecimal tuning value in the "VARS" column. Type in a new value or press Page Up or Page Down to change the value and obtain the maximum SINAD reading. Once the SINAD has been maximized using the "VARS" value, repeat the procedure for VAR4, VAR3, VAR2, then VAR1. Press the Tab or arrow keys to select "Store Front End Alignment" and press Enter. The message "Write radio core EEPROM?" appears in the lower left corner of the computer screen. Press Y to store the new settings in the radio, or N to cancel changes.

The final settings of VAR1, VAR2, VAR3, VAR4, and VARS should be greater than 04. If this is not the case, decrease the "Common" value and repeat the adjustment of the VAR settings. When finished, press the Esc key to return to the main screen.

Bandpass filters in the receiver front end are varied for different receive frequencies to optimize radio performance. The tuning is customized using the receiver front end tuning adjustment. If components in the preselectors, RF amplifier, or mixer are replaced this adjustment may be necessary to maintain specified RF sensitivity.

Four varactors are used in the receiver front end bandpass filter. The control voltages for these varactors change to accommodate different receiver frequencies. The proper values are determined by microprocessor Ii (system board) using data stored in non-volatile memory. All four varactors share a common tuning voltage generated by DIA network I3 and RNA (RX/TX board). Each varactor also receives an individual tuning voltage from one of the D/A converters of 12 (RX[TX board) that corrects for minor differences in the varactors and other components of each filter. During the tuning process, all the individual varactors are set to a fixed value while the common voltage from 13 and RN1 is adjusted for best receiver sensitivity. The individual voltages from 12 are then adjusted to optimize the tuning of each varactor.

5.5.11 DISCRIMINATOR ADJUST

Connect an RF signal generator to the radio antenna input. Set the generator FM modulation to a frequency of 1 kHz and a deviation of 3 kHz. Connect an AC voltmeter to the Discriminator Audio output from the Accessory Connector.

In the "Tune GMH" menu select "Discriminator Adjust" and press Enter. The radio unmutes and displays "PROG". "Start Discr Adjust" appears in the middle of the computer screen. When you press Enter to begin, the frequency and hexadecimal tuning value are outlined. Set the RF signal generator carrier frequency to the alignment frequency. With the cursor under the 2-character hexadecimal value in the right column of the menu, type in a different value, or press Page Up or Page Down to adjust the control value to obtain a voltage reading of 0.707 V RMS on the voltmeter. When finished, select "Store Discr value" and press Enter.

This setting controls the amplitude of the receiver audio signal from the FM discriminator. If components in the discriminator are replaced, this adjustment may be necessary.

The level of the discriminator audio is controlled using a digital potentiometer 19 (system board). The microprocessor Ii (system board) sets values for the attenuation as the adjustment is performed. The final setting is stored in non-volatile memory.

5.5.12 SQUELCH ADJUST

Connect an RF signal generator to the radio antenna input. Set the generator FM modulation to a frequency of 1 kHz and a deviation of 3 kHz. Connect a SINAD meter to the radio audio output.

In the "Tune GMH" menu select "Squelch Adjust" and press Enter. The radio unmutes and displays "PROG". "Start squelch adjust appears in the middle of the computer screen. When you press Enter, the radio is automatically tuned to the indicated frequency (which can be changed before the test starts). Adjust the RF level to obtain 12dB Sinad. With "Store squelch values" highlighted, press Enter to save the changes in the radio.

The GMH is designed to turn the audio on at approximately a 12 dB SINAD level and off at about a 6 dB level. If components in the IF filter or squelch filter are replaced, adjustment of the squelch levels may be necessary. The "Discriminator Audio Level", "Receiver Front End Tuning", and "Second Local Oscillator Frequency" adjustments must be correct before performing the Squelch adjustment.

The channel noise is filtered by the squelch filter and applied to the SQUELCH AID converter input of the microprocessor Ii (system board). The noise signal is processed digitally according to values stored in non-volatile memory.