6.0. Power Supply:

The power supply used in the amplifier is an International Series Linear, single output power supply. The part number is HB24-1.2-A which is an adjustable 24VDC with a 1.2A rating. The range of the adjustment is about ±10%. It is adaptable to various AC voltage inputs by changing the jumpering on the primary side of the transformer. The choices are: 110/120/220/230/240 VAC. In this application, its default setting is 120VAC.

7.0 BASIC MAINTENANCE

Please note that the following are basic maintenance guidelines and general information and not all may be applicable to your particular equipment.

7.1 GENERAL

When the transmitter was installed and commissioned it was in proper operating condition. During final tests, all circuits were checked for optimum adjustment to ensure both peak performance and conservative operation of components, and test results were recorded for future reference.

Given reasonable care and attention the transmitter will provide efficient and reliable service for many years.

Experience indicates that equipment which is regularly and carefully maintained is far less likely to be subject to sudden failure than that which is operated continuously without regard to basic maintenance requirements. It is therefore desirable that a detailed preventive maintenance program be established to ensure that the original efficiency and picture quality is maintained throughout the life of the equipment.

Preventive maintenance techniques do not necessarily involve extensive dismantling of the various assemblies; on the contrary, this practice is to be discouraged unless a valid reason exists for doing so. Preventive maintenance is more concerned with detailed physical inspection and the general observation of the equipment during and after operation, to detect the presence of any abnormality which if not corrected might later develop more serious proportions, resulting in operational failure.

In preparing any maintenance program, the frequency and scope of the inspections must be determined, and to a great degree will be influenced by site location and the station's market parameters consequently its hours of operation, equipment configuration, and technical personnel deployment. For example, is the station on the air for 24 hours a day, are there main/standby transmitters, and are they attended or unattended? In general, the following routines should form the basis of any maintenance program.

7.2 DAILY

At an attended site, the operator is afforded the opportunity to make daily or more frequent checks on the equipment and thereby increase his/her familiarity with its operation. The "transmitter log" entries made during these checks would include all meter readings, also any irregularity in performance, or in picture quality, for later analysis. An unattended site where equipment is operated by remote control, and monitored by telemetry and a high quality off-air receiver or demodulator located within the primary coverage area at the studio site, can also be continuously checked for performance by studio technical personnel, using VITS or VBI test signals encoded into the video signal vertical blanking interval.

7.3 WEEKLY

If the site is unattended, and VITS or VBI test equipment is not available, many broadcasters schedule their operational tests and transmitter inspections to be performed once a week during weekend hours, such as from midnight Sunday to six AM Monday, depending on their market conditions.

If there is an emergency alternator, it should be checked out completely, and run for at least an hour under full load. The checking of this unit should include the condition of its battery, its ease of starting (and its Winter starting enhancers such as block heater, battery warmer, fuel antifreeze), its engine oil level and condition (see "Monthly" below), its radiator coolant condition and level; and its fuel tank should be topped up. This simple check will serve as a reminder to order more fuel if necessary.

7.4 MONTHLY

In addition to the normal operational tests, thorough physical inspection of every piece of equipment should be made, with all power turned off. All surfaces should be dusted off or wiped down, terminal boards checked for loose connections, and all components examined for any evidence of overheating. Air filter media should be inspected and replaced if necessary. High pressure air, not over 20 psi, may be used with discretion to dislodge dust from inaccessible places.

Change the engine oil and oil filter in the emergency alternator, if it has been operated longer than its manufacturer's recommended time since this was last done. In the absence of recommendations, don't let it run more than about 100 hours between oil changes. When put into perspective, 100 hours is the time logged by a vehicle running 6000 miles at 60 mph. Oil is cheap, when compared with engine parts.

7.5 SEMI-ANNUALLY and ANNUALLY

Check all external RF connections for tightness. Test the antenna and transmission line with a transmission test set or network analyzer if one is available, to identify any potential problems with the antenna or line. Inspect and clean contacts on all switches and contactors; carefully redress contact surfaces if pitted.

Change the engine oil in the emergency alternator to summer or winter grade, depending on the season. Also inspect and if necessary replace, its fuel filter and air filters.

Inspection and maintenance (tighten all bolts, replace obstruction light bulbs) of the tower, antenna, and grounding system, should be conducted annually.

7.6 TRANSMITTER COOLING SYSTEM

Air filter material supplied with some transmitter cabinets has been impregnated with a polyester coating, which is designed to attract and hold very fine particles that may be in the air flow. This air filter material should be inspected every month or oftener, and replaced when dirty. Frequency of inspection and replacement, of course, will depend on your particular local environmental conditions.

All cooling fans in the transmitter are Rotron™ or equivalent, and all are fitted with sealed bearings requiring no lubrication during the lifetime of the motor.

7.7 STATIC 1, EQUIPMENT 0: Static vs. Sensitive devices...

Care must be taken at all times because this equipment contains static-sensitive CMOS and FET devices. Here is a brief tutorial on static, particularly pertinent to CMOS and other MOS device handling:

1. It is important to avoid surroundings or situations in which static can be generated. The building floor should have grounded conductive floor coverings, or a grounded conductive mat placed on the floor in front of the bench. Then, the bench itself should also have a grounded conductive mat on which the equipment is placed. Anybody working on the equipment should wear either a grounded wrist strap (preferably) or conductive overshoes. Vacuum cleaner tools should all be conductive and grounded to avoid static from air motion. (Vacuum cleaners made for computer servicing would be suitable). Soldering iron tips must be grounded. Use properly maintained soldering equipment that has a three wire, grounding plug, verifying low path resistance between ground and the tip with an ohmmeter every time this equipment is used.

2. The average person wearing rubber-soled shoes and walking across a woollen or synthetic carpet or untreated vinyl tiled floor is able to generate voltages in excess of 15 to 20 kV. Most MOS devices will suffer puncture of the oxide insulating their gates, at 20 to 40 V. Many CMOS devices are fabricated with built-in zeners which will clamp foreign voltages, but the amount of energy that must be dissipated may easily exceed the rating of this protection. It is therefore prudent to assume that little or no static protection exists in a CMOS device and therefore you must provide your own.

3. A typical unprotected gate of a CMOS logic IC has an input capacitance of about 5 pF and can self-immolate at 20 V, so the energy to destroy the IC is given by the expression $W = CV^2/2$ where W is in watt-seconds, C is in farads, and V is in volts. One watt-second is also known as a Joule. Substituting numeric quantities results in $W = 5 \times 10^{-12} \times 20 \times 20 \div 2 = 1 \times 10^{-9}$ Joule per gate. Stored energy in the approximately 100 pF capacitance of the human body charged to 15 kV, becomes $W = 100 \times 10^{-12} \times 15000 \times 15000 \div 2 = 11.25 \times 10^{-3}$ Joule. *Eleven and a quarter **million** times more energy than is needed to destroy one gate input!* Some of us may therefore be led to conclude that a body can annihilate more than eleven million CMOS gate oxides all at once.

4. This is serious stuff. To avoid destroying CMOS devices, the human body must be grounded first. That is the reason for all the "grounded surroundings" we suggest in paragraph 1. Don't forget, though, that a circuit board has conductive metallic paths connecting into the CMOS parts, which makes them all susceptible to mass devastation as easily as would be the destruction of any one CMOS chip all by itself. Always ground yourself first, then the board.

5. Avoidance of static exposure of boards and CMOS devices is easier. Ensure that boards are always kept in conductive bags or boxes when not in place in the equipment, and that spare CMOS ICs are in conductive chip carriers or plugged into conductive foam. Be careful about this point; many plastic foams can be coloured black, but may still be an insulator. Use your ohmmeter to be sure.

   Don't accept any devices whose pins are punched through aluminum foil into foam plastic. People who don't know better have used this method for shipment and storage of devices, but it cannot be depended upon, because many times the holes made in the foil by the device pins become enlarged simply from the motion of pressing the pins into the foam, and won't make contact any longer. When the device is withdrawn from the foam, the friction of the plastic against the pin can generate enough charge to cause puncture and consequent failure of the CMOS gate insulation.

6. Identical statements to those made in the above paragraphs apply to RF power MOSFETs, and although the gates of these devices might appear to be considerably more robust than those of the average CMOS logic device, this is due only to the much greater gate area and consequently greater input capacitance. The same order of magnitude of gate oxide breakdown voltage exists for RF power FETs as for small CMOS devices, therefore use the same order of care in handling.

7. Believe it or not, ordinary analog meters can also be affected by static. Years ago, meters were made with glass faceplates and had movements that were relatively insensitive, so were affected little by stray static charges accumulating on the glass. Today, almost all meters are made with clear plastic faceplates and many of these, such as the sensitive 50 µA ones we use, have extremely compliant moving parts, thus can be easily caused to read incorrectly from a static charge on their front surfaces. This charge can be readily generated by simply cleaning the meter face.

   It is important that meter accuracy be maintained within reasonable tolerances, because you as a broadcaster are responsible for ensuring that the transmitter complies with all regulations pertinent to its operation, and the easiest way of tracking its performance is from its meter readings.

It is recommended for better accuracy that meter faces be given an anti-static treatment, either by cleaning with an antistatic cleaning agent, or sprayed with an antistatic coating, or both.

Suitable antistatic chemicals should be available through your nearest electronics parts distributor, and typically carry such names as *"Zero Charge"* from Tech Spray™, *"Destaticizing Lens Cleaner"* from G-C™, and *"420 Antistatic Screen Cleaner"* from M.G. Chemicals™. Check them out. Similar brands should also be available in most reputable computer shops or office supply stores.

CAUTION: Antistatic cleaners or treatment chemicals must not contain organic solvents such as acetone, MEK, methyl isobutyl ketone, benzene, toluene, xylene, ethyl cellosolve acetate, or many of the chlorinated hydrocarbons including ethylene dichloride and 1,1,1 trichloroethane, as these solvents will etch or even dissolve most of the plastics used for meter faceplates.

Our meter supplier recommends and uses a harmless coating treatment which it keeps in stock under its catalog number FS 681. This coating is otherwise known to the trade as *ANSTAC 2-M.*

ANSTAC 2-M is made by *Chemical Development Corp.*
22 Portsmouth Rd.
Amesbury MA 01913 U.S.A.
Phone (508) 388-2221.

7.8 FIELD REPLACEMENT OF FETs and SURFACE MOUNT COMPONENTS:

TOXIC MATERIALS WARNING... Thermal management in certain RF devices in this equipment is accomplished through the use of Beryllium Oxide ceramic material. Beryllium Oxide is a hard white ceramic used as insulation for heatsinking of RF power semiconductors. *Beryllium Oxide is a POISON if taken into the body. In case of accidental breakage, DO NOT INHALE THE RESULTING BERYLLIUM DUST and AVOID GETTING BERYLLIUM DUST IN YOUR MOUTH. DO NOT LET BERYLLIUM DUST INTO YOUR BLOOD STREAM THROUGH CUTS OR OPEN WOUNDS !! Seek and get IMMEDIATE medical attention if the dust enters your body in any manner.* Avoid cuts by wearing gloves while picking up the broken pieces. Be careful - do not inhale dust while replacing or emptying vacuum cleaner filter bags, and wash your hands thoroughly afterward. Wash your hands thoroughly after replacing RF power devices. Dispose of defective RF power devices only through approved toxic waste facilities.

If for any reason it should become necessary to change a FET in the field, we strongly recommend following the handling precautions outlined on the next few pages:
Any FET can be damaged by static discharge. It is therefore mandatory that static-free handling

techniques as discussed in the foregoing "static 1, equipment 0" tutorial should be routine, and that soldering equipment must be suitable for insulated gate MOSFET work, and must be properly maintained.

a) Keep FETs in their anti-static containers until ready to install. The module and the technician should both be earthed/grounded. Observe the handling procedures discussed in Part 7 above, including the use of antistatic bench coverings, conductive overshoes, grounded wrist straps, etc.

b) The soldering iron tip MUST be at earth/ground potential at all times, that is, absolutely no AC voltage must be available on the tip. Test with an ohmmeter each time the iron is used; the test must indicate continuity from tip to ground. Special battery operated soldering irons are also available to avoid any chance of AC voltage being present on the tip, but these are not satisfactory for RF FET work as they do not heat to sufficiently high temperatures. Use an accurately controlled temperature regulated low voltage soldering iron, and set it for about 700° to 750°F.

7.9 FET Replacement Hints and Advice:

a) Remove the screws bolting the transistor to the heatsink. Some transistors are mounted on the heatsink using clamping bridges to improve the devices' thermal transfer. In the PA module remove the nuts holding the clamping bridge and FET to the heatsink, then salvage the clamping bridge, nuts, and spring lockwashers for later use.

b To minimize board damage, use a sharp "screwdriver" tip on the soldering iron, and carefully help it along with a solder pick tool, working it under one tab first, then once that tab is free and FET mounting screws have been removed, the FET can be rocked gently, allowing other tabs to be easily unsoldered in turn. The defective FET can now be lifted out. Remove excess solder with "no clean" fluxed copper braid wick.

c) Clean the FET heatsink area thoroughly with alcohol ***(CAUTION:- ALCOHOL VAPOUR IS TOXIC)***, and inspect to ***ensure that there are no defects nor debris present and that all old thermal compound has been completely removed***. The board solder areas should be lightly and uniformly pre-tinned.

d) Apply only enough heatsink thermal compound (supplied with the transmitter) to the new FET base and to the heatsink, that will result in a thin uniform coating on the FET base and heatsink. The metal should be faintly visible through the coating on both surfaces. Apply it sparingly; too much compound is every bit as bad for thermal transfer as an insufficient amount would be. To refresh your memory: thermal compound fills the tiny little tool marks left by the milling machine on the heatsink surface, but only enough that no microscopic air spaces remain between FET and heatsink. Heat transfer depends partly on the distance through which the heat must travel from the FET to the heatsink; too much compound effectively adds more distance, which could result in overheating.

e) Lightly pre-tin and gently bend the FET tabs upward slightly, so that the tabs and the circuit board do not prevent the FET from making proper thermal contact with the heatsink.

f) Torque the screws evenly to 4.5 inch-pounds. This amount is recommended by the FET manufacturer to allow for thermal expansion of the device. 4.5 inch-pounds also will avoid the possibility of stripping the threads in the heatsink, or breaking the screws

g) Solder each tab to the board in turn, using a solder-pick tool to hold each tab in contact with the board while soldering; apply enough heat to ensure that the pre-tin solder on the boards flows, and apply just enough new solder to give a "butt" free joint. Set the bias resistances at their highest values to get minimum start-up current (see step "I" below), and then set the stage bias currents as described in the applicable PA module, IPA2 (driver), or IPA1 section of this manual.

h) Use eutectic tin-lead 63/37 solder (preferred, but if 63/37 is not available, 60/40 is acceptable). Current manufacturing process at LARCAN uses AIM™ (American Iron & Metal Company Inc.) 63/37 solder containing a "no clean" flux which becomes inert during soldering, therefore does not require subsequent board cleaning. Other good brands are Kester and Ersin Multicore; equivalent 63/37 or 60/40 "no clean" tin-lead solders also should be available from other vendors. If "no-clean" is unavailable, "RMA" (Resin Mildly Activated) core solder can be used; carefully clean the flux residue from the board with an environmentally friendly board cleaning solvent, applied sparingly.

Most commercially available alcohols are reasonable flux solvents that are harmless to circuit boards, and are CFC free and environment-friendly. Proprietary circuit board cleaning solvents are available that also meet these objectives; check with your local electronics parts dealer.

Inexpensive cotton swabs (available in drug stores or supermarkets) can be used for wiping the solvent over the area to be cleaned, then a stiff bristle brush (an old toothbrush) can be used to scrub if necessary. Use the swabs for mopping up the residue. Clean the board thoroughly, then inspect and clean it again; don't merely rearrange the residue. *Be careful - do not allow solvent to run under power transistors where it can dilute the heatsink compound.*

> ***CAUTION: VAPOURS FROM ALCOHOLS AND OTHER SOLVENTS ARE TOXIC AND FLAMMABLE... DO NOT INHALE! IF YOU ARE A SMOKER, DO NOT SMOKE WHILE USING FLAMMABLE SOLVENTS! USE ALL SOLVENTS ONLY IN A PROPERLY VENTILATED LOCATION!***

i) Finally, if you have not already done so, set the bias potentiometers for the stage to maximum resistance so that when power is applied, the FET will start at its lowest current. Then set the bias as described in the RF PA, Visual/Vision Driver, and IPA RF amplifier sections of this manual. We mentioned this procedure during step "j" above as well, because some circumstances may make it simpler to set the bias in a High Band PA before replacing L9. When L9 is in place, each half of the stage will need to be adjusted concurrently with a bias short on the opposite side (to turn off the side not being set), otherwise the DC path through L9 makes the procedure impossible. This is explained in the applicable PA, Visual Driver, or IPA section of the manual

7.1.1 Surface-mount Components Hints and Advice:

Failures of small surface mounted resistors on boards where they were companion to other components having leads, were traced to mechanical overstress of their end caps as a result of the soldering procedure to the component. Our manufacturing procedure has since been altered to fix this problem, and despite our embarrassment, we think it is important that you should know about it. For your information:

1. It is critical that surface mount components are soldered onto a clean flat surface. Use a suction device followed by fluxed braid wick material to ensure that all old solder is removed from pads of the board.

2. If this is not possible due to the presence of other components, try to clean at least one of the pads so it is flat (don't solder this end yet), then solder the other (solder-laden) pad FIRST, pressing the component down into the puddle of solder. (Plain wooden toothpicks will serve well as tools to apply pressure to components while soldering them). The remaining flat pad then can be soldered.

   To ensure minimum stress on any SM component, always be certain that the component is laying flat in contact with the board before soldering except as above when it is necessary to melt the solder on a pad first, and *never force it unless both ends of the component are free to move.*

3. If all the pads are loaded with solder, it will be necessary to heat all terminals of the component simultaneously. Check with your local electronic parts dealer for special soldering iron tips and/or other attachments (in addition to toothpicks) that will aid in surface-mount work.

4. Always keep the tip of your iron clean and freshly tinned (wetted), for maximum heat transfer.

7.1.2 REPLACEMENT PARTS

All component parts in the transmitter are available from:

LARCAN Inc., 228 Ambassador Drive, Mississauga, Ontario, Canada L5T 2J2; Phone (905)-564-9222, or FAX (905)-564-9244, during and after normal working hours.

To expedite delivery of your order, especially if you call after hours and get our answering service, please leave a number where we can return your call, and please identify the parts requested as specifically and completely as possible.

Our Renewal Parts Department may be able to more quickly identify your requirement if the assembly name and number where the part is used, and any applicable revision number for that assembly, are stated in addition to the part's symbol number, description, and its drawing and part number as listed.

Although LARCAN can supply any part when required, in many instances it may be more conveniently obtained from a local source. Part numbers of replaceable components used in LARCAN equipment are almost always the catalog numbers of the various parts manufacturers, with the rare exception of proprietary items such as tightly specified RF power FETs, crystals, or analog 50 µA meters. If your local dealer or distributor should encounter problems and you require further information, please feel free to call upon anyone in our customer service department at the telephone number given above. We have assumed that reliable dealers of electronic components are located in or near your station market area, and that they maintain adequate stocks of "commodity" items such as resistors and capacitors. We have further assumed that you prefer to obtain most non-proprietary replacement parts from your local dealer, therefore we have listed very few such commodity items here, but we believe the following information might be useful to you during your spares requirements planning:

Capacitors: Generally, most ceramic or film capacitors are reliable, and "5% spares" (1 spare for each 20 identical parts, and 1 each if less than 20) will be found to be a satisfactory inventory level. This includes ceramic, polystyrene, polyester, polycarbonate, polypropylene, and (usually) solid electrolyte tantalums.

Reliability notwithstanding, it is worth the trouble to know exactly what is inside your replacement capacitors. Use a bridge if available, to measure their capacitance (especially for electrolytics), stray inductance, and ESR (equivalent series resistance). Measure leakage current at rated voltage.

Aluminum electrolytics require further consideration. When you consider aluminum electrolytics, usually you will need to consider their operating temperature as well:

The transmitter cooling system was designed to provide worst-case internal temperatures no higher than 60°C, in all modules of the transmitter. This cooling is based on 45°C maximum ambient air temperature and normal air flow through the intakes of the transmitter cabinet.

Most capacitor vendors state that 60°C or lower operating temperatures can be expected to give service lifetimes for their aluminum electrolytic capacitors of ten years or longer, but as their operating temperature increases to the specified maximum of 85°C, the specified service lifetime decreases to a mere 1000 hours.

You may therefore wish to increase your spares level for aluminum electrolytic capacitors if site ambient temperatures are consistently higher than 40°C, because if cooling air flow becomes restricted due to filter saturation, it is entirely possible for on-board temperatures to reach or exceed 85°C. This is why your maintenance program MUST include the regular inspection and replacement of filter media.

Resistors: Experience has shown that a spares stock to the 5% spares level (1 spare for each 20 of the same thing, and 1 of each when less than 20) for each value and size of resistor, is usually sufficient. Incidentally, when a molded carbon composition resistor (as specified on LARCAN drawings 3R152, 3R77, 3R78, or 3R79) such as those made by Ohmite™ or Allen-Bradley™, is used in an RF circuit, it is not necessarily good practice to make substitution without knowing exactly what the replacement resistor is; in the past, certain makes of FILM resistors have been touted as replacements for molded composition, but unless the resistors are specifically made to be non-inductive, they may be unsuitable because some film resistors are laser-trimmed on a lathe to final value. The resulting helix has significant inductance which can make the resistor unsatisfactory for use in VHF circuits.

It is worth the trouble to know exactly what is inside your replacement components. Use an RF bridge if available, to measure any stray inductance and/or capacitance associated with your replacement resistors.

Spare Parts: The list on the following pages began as computer output listings "STS10B, STS50B, etc." from our database used to compile the parts list data for each Section of the manual, and the computer has classified recommended spare parts and suggested their quantities, by part number. Because the manual is written to apply to the entire low powered basic series of transmitters, we have made a composite suggested spares list by simply combining the computer's Low Band and High Band recommendations.

We suggest that the parts lists in each Section booklet comprising the manual should be thoroughly and rigorously scrutinized, with the intention of taking your specific local conditions, and your usual dealers or suppliers inventories and order turnaround times into account, before commitment to a sizable inventory of replacement parts.

7.1.3 SPARE PARTS RECOMMENDATIONS:

Although it is our sincere hope that they will never be found necessary, it is recommended that a minimum spares stock of the following items be kept on hand.

Assembly No.	Description
40D2180G1&G2	1W VHF AMPLIFIER

Where used	Part No.	Description	Quantity
40D2180G1&2	MDL-1	FUSE 1A, 250VAC, SLOW BLOW	2 EA
10A1453G8	MHW6185	IC AMP	1 EA

8.0 PARTS LIST (see the following pages):