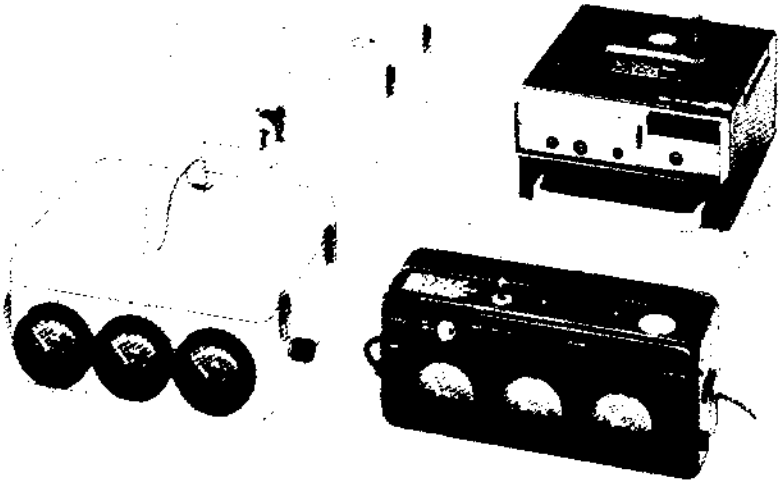
OPERATOR'S INSTRUCTION MANUAL 1970

AERIAL SURVEY METER

OCD ITEM NO. CD V-781, MODEL NO. 1

MANUFACTURED BY
NUCLEAR-CHICAGO CORPORATION DES PLAINES, ILLINOIS



OFFICE OF CIVIL DEFENSE

NOTE

This manual contains necessary instructions for installation and operation of the CD V-781 Aerial Survey Meter. It is recommended that the precautions listed in Section 1 be reviewed carefully before proceeding.

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SECTION 1

PRECAUTIONS

1-1. STORAGE

The CD V-781 Aerial Survey Meter includes sensitive electronic circuitry and components, and should be protected against severe shock and exposure to extremes of weather. All components of the instrument system require sheltered storage in relatively dry areas at temperatures between 32°F and 100°F. Instruments cases should be securely closed at all times during storage and batteries must be removed. Use of the plastic bags provided with the instrumentation during shelf storage together with desiccant packets (reactivated, as necessary) is mandatory.

1-2. INSTALLATION

Installation of this instrument can constitute a modification of the aircraft and care must be exercised accordingly. Holes must not be drilled in structural members. With the instrument installed in place and turned on, existing control, electrical, navigation and communication systems should be checked for proper operation. Interconnecting cables should be clear of sharp edges or cramped bends, and only a 12-volt aircraft electrical system may be used to supply power. A fuse or circuit breaker at the point of interconnection with the aircraft electrical system is recommended.

1-3. BATTERIES

Auxiliary power supply batteries included with the instrument system must be removed except during actual operation, and must be checked periodically for leakage and adequate voltage level. If battery leakage is observed, the batteries should be removed

and discarded immediately and the battery contacts thoroughly cleaned.

1-4. HIGH VOLTAGE CIRCUITS

The Geiger-Mueller tubes used as radiation detectors in the CD V-781 Aerial Survey Meter require high voltage for proper operation. Care should be exercised to avoid contact with any exposed portions of the circuitry, and the power switch must be in the OFF position when the case is opened for insertion or removal of batteries.

1-5. MAINTENANCE

Because of the sensitivity of the equipment and the fragility of the Geiger-Mueller detector tubes, circuit boards should be removed with great care, and other internal features should not be disturbed during periodic inspection. In case of malfunction, repair and correction should be performed by specially *qualified personnel only.*

SECTION 2
GENERAL DESCRIPTION

2-1. INTRODUCTION

The CD V-781 Aerial Survey Meter is a system of coordinated instrument components with three ranges of detection, 0-0.1 R/hr, 0-1.0 R/hr, and 0-10 R/hr. This device permits the monitoring of ground level radiation intensity of radioactive fallout from low flying (less than 1,000 ft) aircraft. The system is designed to resist the shock and vibration associated with normal aircraft operation, and will operate at altitudes up to 20,000 feet. It will withstand temperature variations from -20°F to 110°F with a relative humidity of up to 95%. This system can be calibrated to an accuracy within 10% of the true exposure level for Cs-137 gamma radiation incident to the bottom of the detector case. After over-exposure to radiation intensity as high as 1,000 R/hr, the system recovers within 1 minute. These environmental extremes are cited to define the limitations of the system and not as a guide to operation. The CD V-781 Aerial Survey Meter is intended for operation within a normal aircraft cockpit environment at radiation intensity levels within its metering range.

The instrument system comprises a detector unit, a metering unit, a simulator unit, a tape recorder with remote control switch and throat microphone, headphones, and interconnecting cables (Figure 2-1). In operation, the radiation level is measured by the detector unit, and a corresponding value of electrical current is fed to the metering unit which is usually mounted above the aircraft instrument panel for convenient observation. The metering unit indicates radiation level directly in R/hr on three independent meters. It also generates an audio signal with frequency controlled by the indicated radiation level.

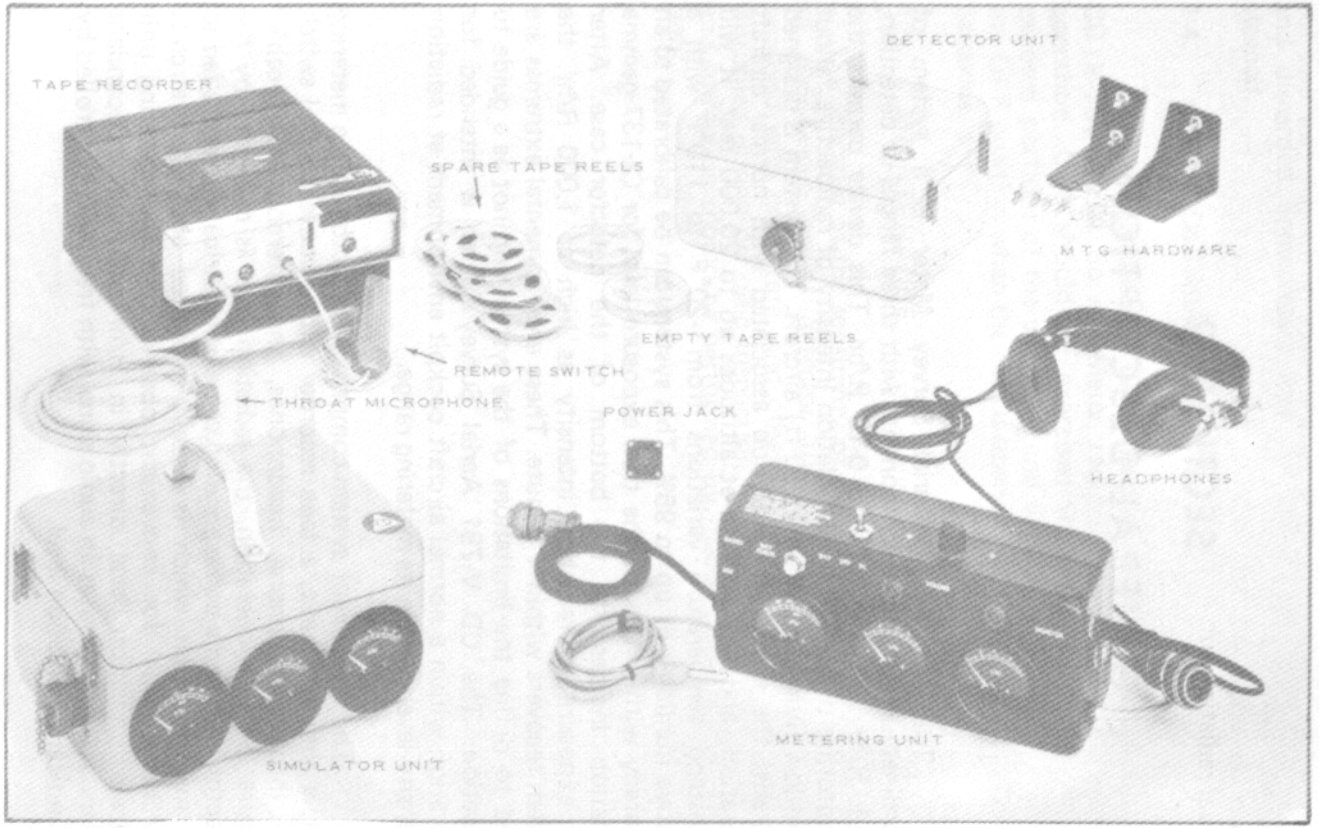

Figure 2-1. Aerial Survey Meter CD V-781

The simulator unit is used in place of the detector unit for training purposes. It enables an instructor to insert pre-selected radiation level indications into the metering unit, simulating an actual radiation survey mission under emergency conditions.

2-2. SYSTEM COMPONENTS

The major components of the CD V-781 Aerial Survey Meter instrument system are the Detector Unit, the Metering Unit, the Tape Recorder, and the Simulator Unit.

2-2.1 DETECTOR UNIT

The detector unit includes three Geiger-Mueller (G-M) tubes, each responding to a decade portion of the total 0-10 R/hr radiation level range of the instrument, associated count-rate circuitry, a regulated high-voltage power supply circuit, and auxiliary D-cell batteries. The nine batteries in this supply are capable of operating the system for approximately 100 hours.

The unit functions to measure diffused gamma radiation in the 70 kev to 1.2 Mev spectrum, and to convert the measured intensity level to a corresponding current to drive the metering unit. All circuits are transistorized and circuit boards are removable without disconnection of the circuits to facilitate maintenance. Sensitivity adjustments are provided in the count rate circuits for calibration.

The entire unit is contained in an aluminum case (painted yellow), 9 inches wide by 4-5/8 inches high by 7 inches deep, with a cover secured by four snap-type pull catches. Other external features of the detector unit include a 10-pin connector to mate with the metering unit cable, and location marks to indicate the orientation of the Geiger-Mueller tubes within the case for calibration purposes. The entire unit, including batteries, weighs approximately 6 pounds.

2-2.2 METERING UNIT

The metering unit includes three indicating meters with associated indicator lamps, an audio tone generating circuit, a

low-voltage regulating circuit, and provision for interconnection of the unit with the aircraft electrical and radio systems as well as the detector unit. It functions as the read-out portion of the instrument system, giving both audio and visual indications of prevailing radiation levels. As in the detector unit, all circuits are transistorized and circuit boards are removable without disconnection to facilitate maintenance or repair.

Principal external features are:

a. Three meters and two associated indicator lights, located on the front of the unit.

b. A control knob for regulating the volume of the audio radiation-level monitoring signal, located on top of the unit.

c. A battery/plane check pushbutton located on the front of the unit above the 0-0.1 R/hr meter.

d. A three position power switch with OFF, BAT (battery), and PL (plane) positions, located on top of the unit.

e. Two headphone jacks located on the left end of the unit; one for radio reception only, and one for mixed aircraft radio and audio radiation-level monitoring signal.

f. A monitor headphone jack for audio radiation-level signal only, located at right end of the unit.

g. Interconnecting cables emerging from the left end of the unit; one to the aircraft electrical system (3 feet long) and one to the aircraft radio (6 feet long).

h. An interconnecting cable to the detector unit (9½ feet long) emerging from the right end of the unit.

The meter indicator lamps, one amber and one red, serve to direct the observer's attention to the correct meter for reading the existing radiation level. The lamps are equipped with mechanical

dimmers which operate by twisting the knurled lamps base. The meter indicator lamps do *not* light when the system is operating on its own auxiliary battery power, a design provision to minimize battery drain.

A set of magnetic headphones is also supplied with the metering unit, and it should be noted that more than one set of headphones may be plugged into the unit at the same time. With additional headphones in use, if one set is plugged into the MIX jack at the left end of the unit, the MONITOR jack at the right end of the unit also becomes a mix jack.

The unit is contained in an aluminum case, 10 inches wide by 4-1/4 inches high by 3-3/8 inches deep. The back of the black case is secured by two snap-type pull catches. Provision is made to attach the case to two special mounting brackets. These brackets are to be mounted in a convenient location above the instrument panel. Four quick-release fasteners are used so that the mounting brackets, with the metering unit attached, can be easily removed from the aircraft. Total weight, including cables and connectors, is approximately 4 pounds.

2-2.3 SIMULATOR UNIT

The simulator unit is a training device intended to substitute for the detector unit on training missions. It includes an eight D-cell auxiliary battery power supply, and provides for interconnection with the metering unit in the same manner as the detector unit. Instead of the G-M tubes and count-rate and high-voltage circuitry however, it contains a simple externally controlled circuit enabling an instructor to insert predetermined readings into the metering unit. A set of three meters, identical to those on the metering unit, indicate what readings are being generated, and the metering unit responds to the same radiation level established on the simulator unit. The meter driving circuit is transistorized, and the circuit board is removable without disconnection. Adjustments are provided to make the simulator unit meter readings track properly.

The unit is contained in an aluminum case (painted green), 9 inches wide by 4-5/8 inches high by 7 inches deep. The entire unit, including batteries, weighs approximately 6-1/2 pounds.

2-2.4 TAPE RECORDER UNIT

The tape recorder provides for oral recording of radiation level data observed in the course of a mission, together with correlated position fixes and altimeter readings. After completion of the aerial survey mission, the data is evaluated and used to plot corresponding ground level dose values for the area covered by the mission. A remote switch is provided to control the tape drive. The throat microphone can be worn by the pilot without interfering with normal radio communications. The entire recorder weighs approximately 8-1/2 pounds.

SECTION 3

THEORY OF OPERATION

3-1. INTRODUCTION

In operation, the CD V-781 Aerial Survey Meter is an instrument system comprising the necessary elements to detect radiation, process the information, provide read-out to the operator, and permit recording of observations for evaluation at the end of the survey mission. If required, the system can be operated by the pilot alone, but two-man operation (pilot and monitor) is recommended.

The block diagram in Figure 3-1 shows the major elements of the system in operating relationship. Alternate use of the simulator unit in the system is indicated by dotted lines.

3-2. GEIGER-MUELLER TUBES

Three G-M tubes are mounted on one circuit board in the detector unit. Each tube is independently shielded to obtain approximately uniform sensitivity to gamma radiation over the 70 kev to 1.2 Mev energy spectrum. Together, they provide continuously linear response over the .01 to 10 R/hr radiation intensity range. Detector GM-1 detects the 0-0.1 R/hr range, GM-2 the 0.1-1.0 R/hr range, and GM-3 the 1-10 R/hr range. The tubes are of the halogen self-quenching type, operate at 575 volts, and are shock mounted to the printed circuit board.

3-3. COUNT RATE CIRCUITS

Three transistorized count rate circuits in the detector unit, one for each of the G-M tubes, quantitize the random pulses from the detector tubes to generate direct currents analogous to the radiation intensity (dose level) impinging on the detector tubes.

Circuit sensitivity is such that reaction to low counting rates (normal background) is eliminated. During over-exposure, current output is sufficient to produce full scale readings on all three meters on the metering unit. Each count rate circuit drives a separate meter, and includes a variable resistor to permit adjustment of the output current for calibration.

3-4. METERING UNIT

The metering unit contains in addition to the meters, the indicator lamp switching circuit, the audio radiation-level signal generating circuit, and the low-voltage power supply regulator. Meters M1 and M2 are interlocked to hold meter M1 at full scale, should GM-1 become paralyzed in a high radiation field.

Also responsive to the output from the count rate meter circuits is the audio signal generator. As the detected radiation rate increases, the basic 250 cps frequency increases to approximately 2,000 cps (a three octave increase) at 10 R/hr. This audio tone which corresponds in pitch to the radiation level, serves as a back-up to visual meter observation.

An amber indicator lamp is located above the 0-1 R/hr meter, and turns on when the 0-0.1 R/hr meter reaches approximately 85% of full scale reading. A red indicator lamp is located above the 0-10 R/hr meter and turns on when the 0-1 R/hr meter reaches 85% of full scale. To prevent ambiguity of reading, these lights are interlocked so that the amber light turns off when the red light turns on. They do not operate when the system is operating on auxiliary internal battery power in order to conserve battery life.

3-5. HIGH VOLTAGE POWER SUPPLY

A regulated high-voltage power supply circuit provides the 575 volt dc potential required for the G-M tubes. Designed to operate on input voltage from either the aircraft electrical system or the internal batteries, it is located in the detector unit to eliminate the necessity for high voltage interconnection between the elements of the instrument system.

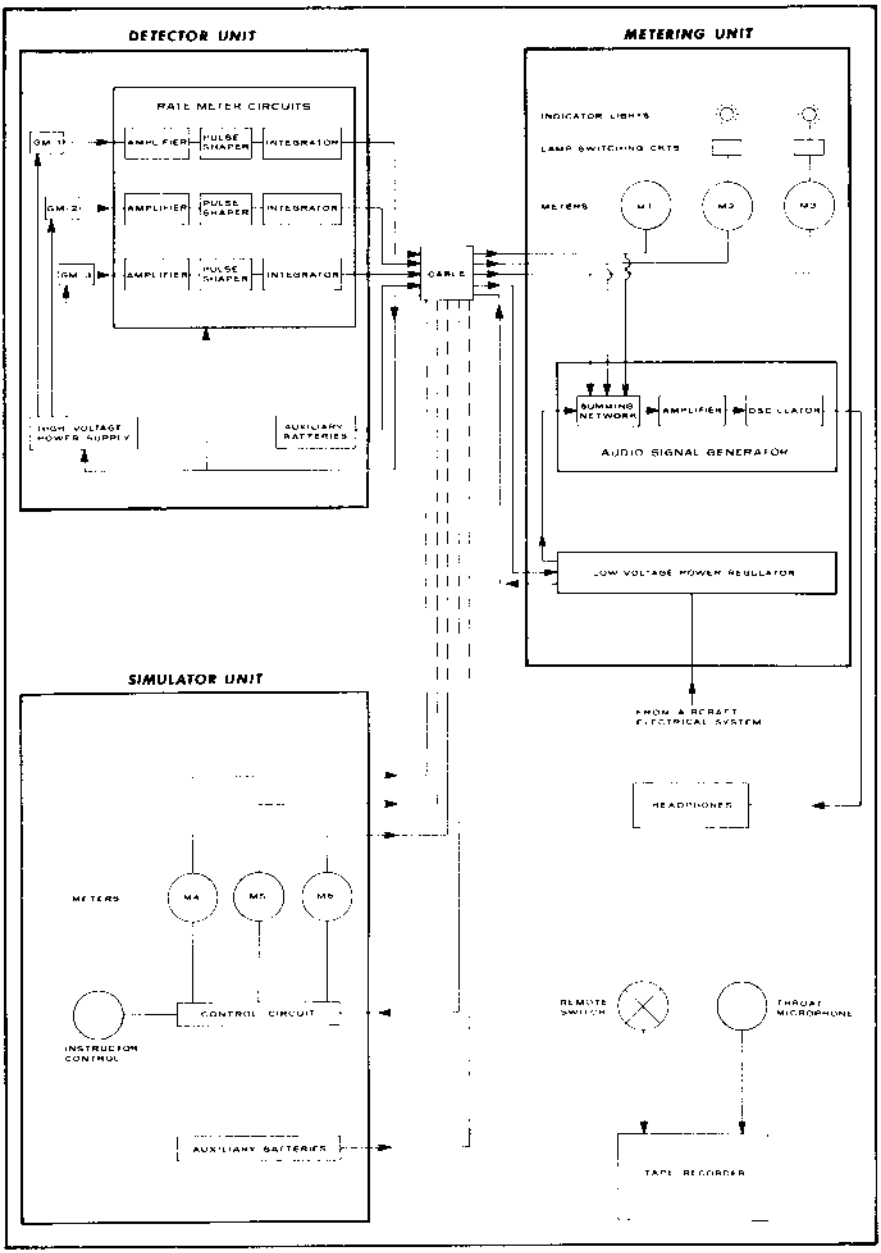

Figure 3-1. Simplified Block Diagram

3-6. SIMULATOR UNIT

The simulator unit is used in place of the detector unit on training missions. By means of a variable resistor, the instructor controls the current inserted into the metering unit and produces any desired sequence of simulated meter readings and audio signal frequency changes. The radiation levels being simulated are also indicated by the meters on the front of the simulator unit. Abrupt or gradual changes in radiation intensity levels may be simulated, and all responses of the metering unit (meters, indicator lamps and audio signal) are activated as they would be if the detector unit were in use on an actual survey mission.

3-7. TAPE RECORDER

The tape recorder operates independently of the other components in the system from its own battery supply. It is not connected with the other units of the aerial survey system or with the aircraft, either electrically or mechanically. A remote switch is provided to control the tape drive.

SECTION 4

INSTALLATION

4-1. INTRODUCTION

The CD V-781 Aerial Survey Meter is intended to be in the aircraft only during an actual survey or training mission. At other times it should be stored in a sheltered area. Accordingly, installation consists primarily of preparation of the aircraft so that the units may be quickly and properly secured in place immediately prior to a mission. Figure 4-1 shows a typical installation in a four-place light aircraft. Additional guidance on equipment mounting is contained in FG-E-5.9.1, Handbook For Aerial Radiological Monitors, pages 14-16.

4-2. SUGGESTED MOUNTING FOR DETECTOR UNIT AND TAPE RECORDER

The detector unit (or simulator unit, depending upon the nature of the mission) and the tape recorder may be secured wherever convenient within the limits of the interconnecting cables and controls. It is only necessary that they be held down in some fashion to prevent damage as the result of aircraft maneuvers. If spare seating room is available in the aircraft, the tape recorder may be secured by means of seat belts to a seat. The monitor or instructor may also hold the tape recorder or the simulator unit on his lap. The detector unit must be placed on the floor of the aircraft and may be secured by the monitor's feet. It is imperative that the detector unit be mounted on the floor of the aircraft, and as near to the outside skin as possible.

For greater convenience, a simple hold-down bracket may be affixed to the floor of the cockpit to permit clamping the detector

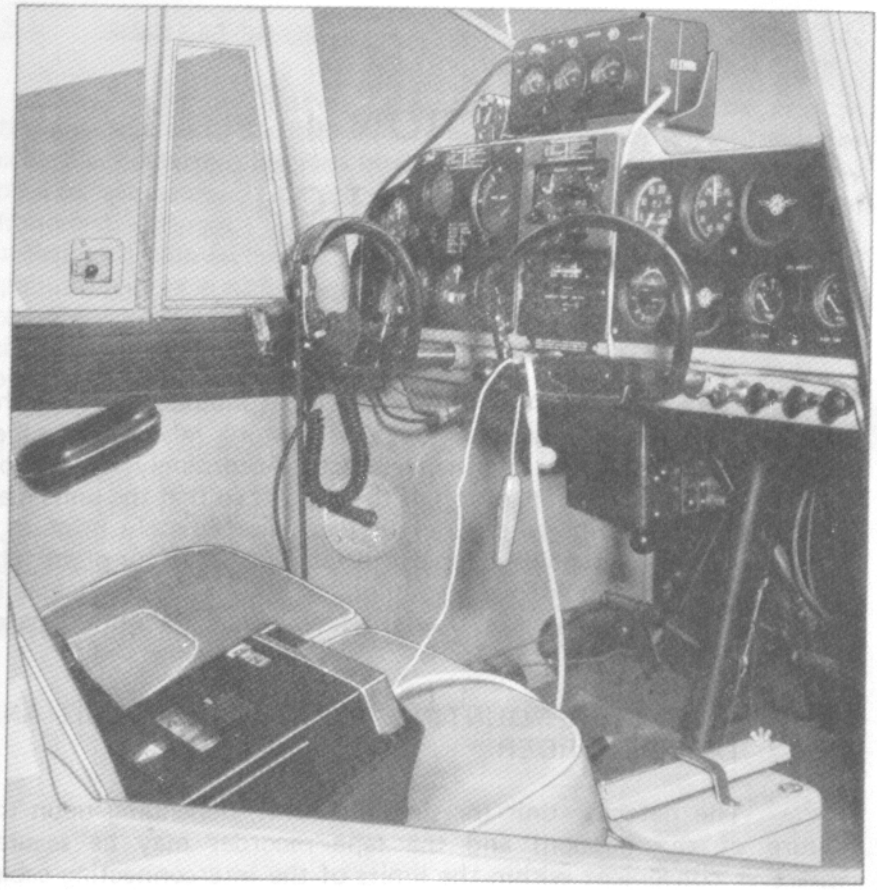

Figure 4-1. Typical Installation of CD V-781 Aerial Survey Meter

unit down in the desired location (see Figure 4-2). A plate may be dimpled as shown, and a captive ¼-20 nut can be fastened to the bottom side of each dimple. The two ¼ inch diameter threaded rods will then secure to the plate, and the detector unit can be clamped by means of wing nuts and the padded hold-down bar passed through the handle of the unit. If this method is used, care must be exercised to avoid drilling through a structural member of the aircraft and to

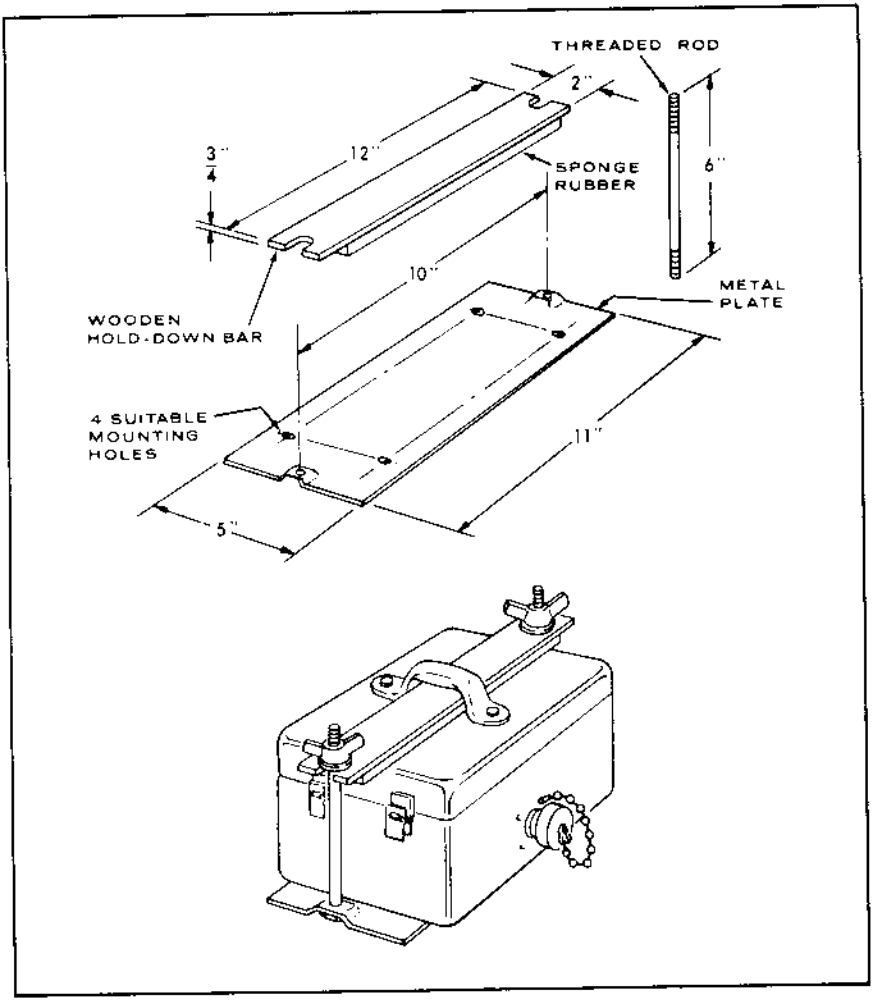

Figure 4-2. Suggested Bracket for Mounting Detector Unit

pad the secured unit against contact with the hold-down brackets. Under no circumstances may holes be drilled in any of the instrument cases.

4-3. MOUNTING METERING UNIT

Special brackets and quick-release fasteners are provided for installing the metering unit on the aircraft. The unit is normally installed on the cowl above the instrument panel. The unit should be installed as far away from the magnetic compass as practical to avoid compass deviation due to the magnets in the meters. Four possible arrangements of the brackets are possible by reversing the position of the brackets on the cover of the metering unit, and by reversing the position of the cover itself. Each of these can be used to advantage depending on the characteristics of the available space in the aircraft (see Figure 4-3).

To accommodate these brackets, four holes must be drilled in the cowl where the brackets are to be mounted. The details of arrangement, size and preparation of these required holes is shown in Figure 4-4. The spacing of the holes is identical regardless of the bracket arrangement. The preparation of the holes depends on the thickness of the cowling material, as illustrated in the figure. After these holes have been prepared, the receptacle portions of the four quick-release fasteners supplied with the bracket are inserted and secured in place by means of nuts, also supplied. The mounting brackets may be then mounted or dismounted quickly by pushing down on the fastener buttons to lock or unlock the fasteners. The metering unit itself is attached to the mounting bracket by means of four thumb screws. It is not necessary to disassemble the metering unit from the mounting bracket when mounting or dismounting the assembly in the aircraft.

4-4. AIRCRAFT ELECTRICAL SYSTEM CONNECTIONS

To operate the aerial survey meter from the aircraft electrical system, recommended whenever possible, the power take-off jack supplied must be installed within three feet of the metering unit location. Only 12 volt aircraft electrical systems can be used to operate this instrumentation. The operating voltage range of

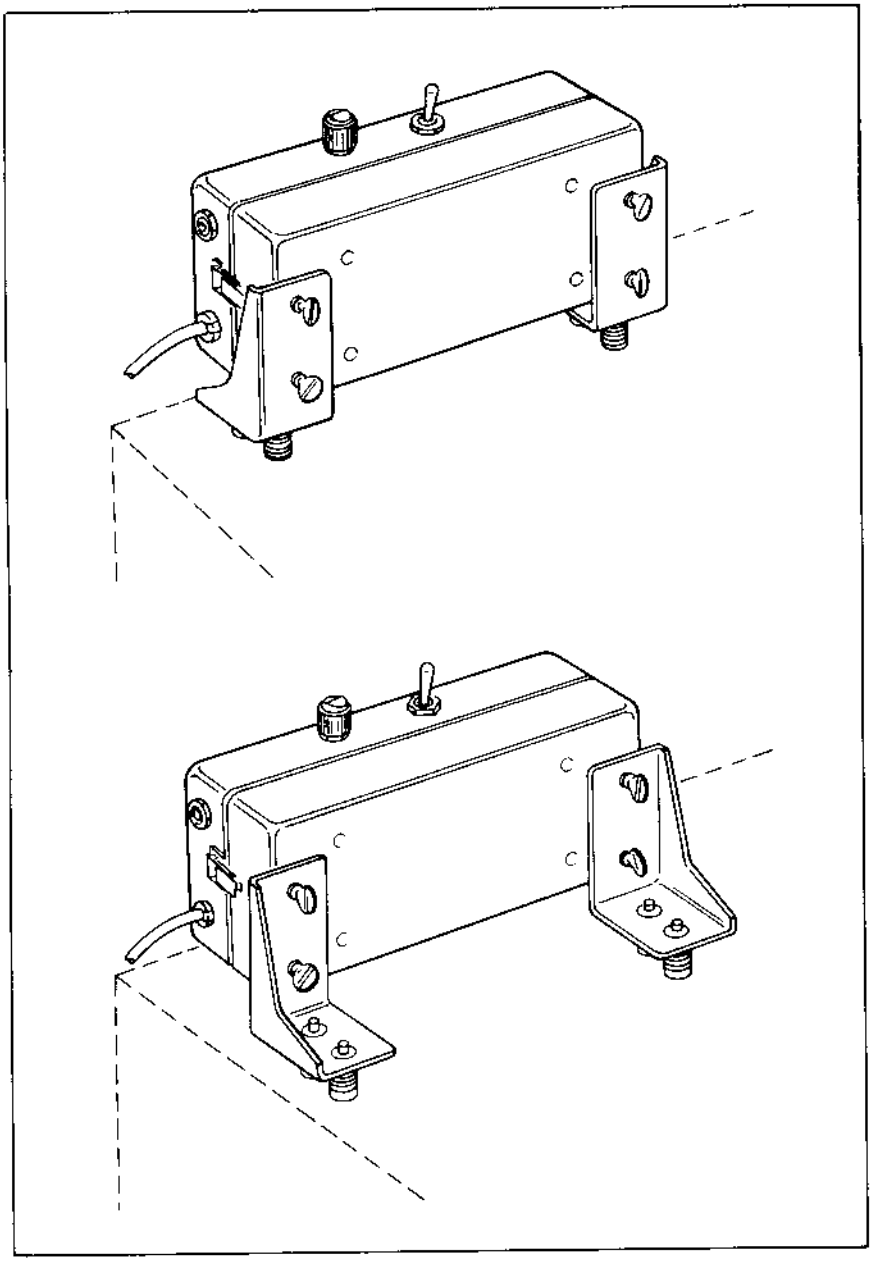

Figure 4-3. Metering Unit Mounting Arrangements

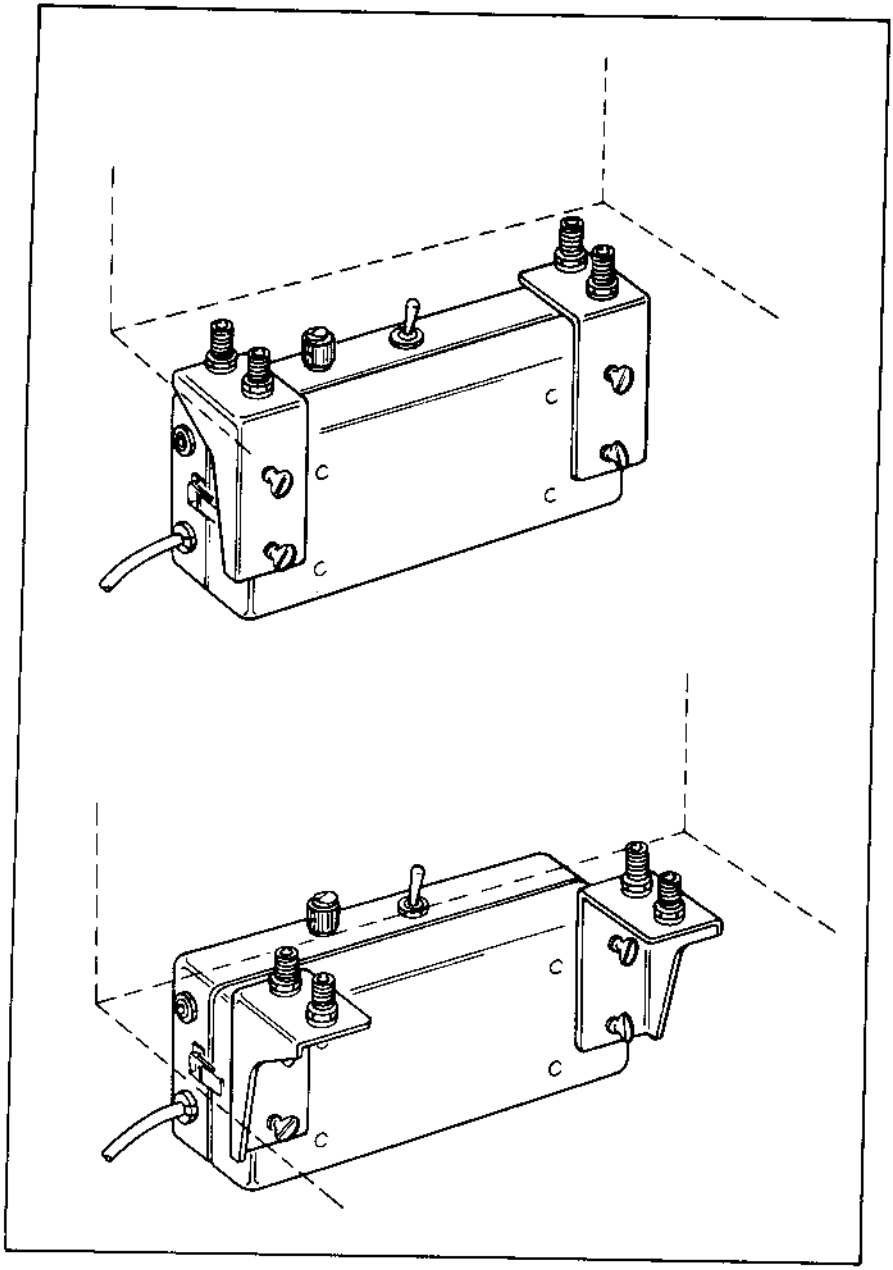

Figure 4-3. Metering Unit Mounting Arrangements (continued)

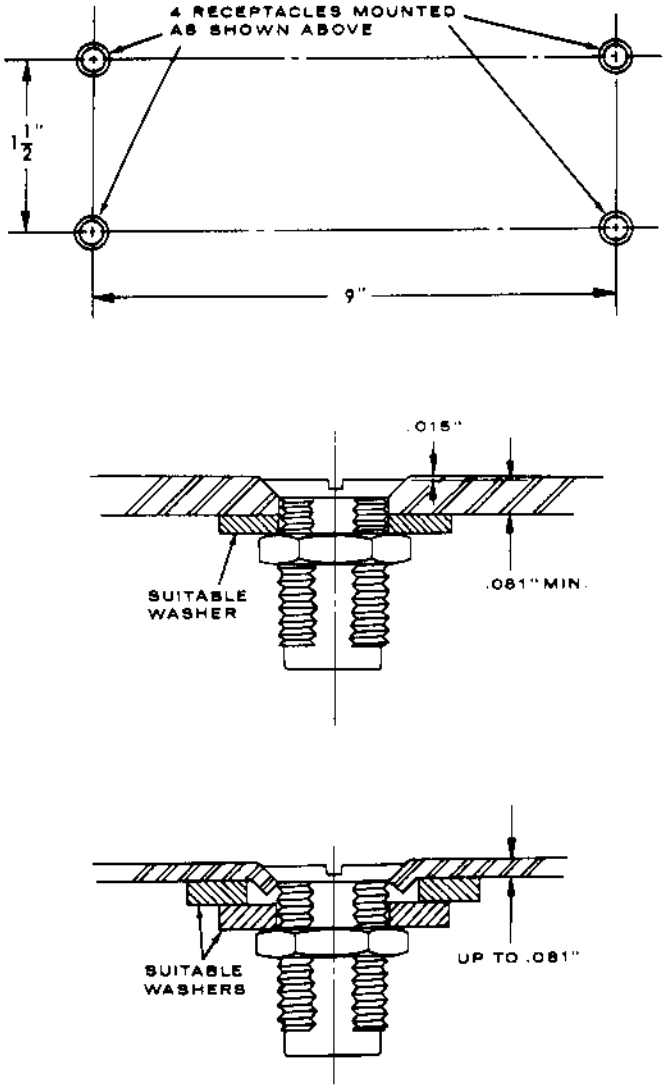

Figure 4-4. Mounting Details for Metering Unit

this instrumentation is from 11.5 to 15 VDC. A ½ ampere slow-blow fuse or circuit breaker, installed between the aircraft battery and the power take-off jack, is also recommended. If a spare fuse or breaker is not available on the aircraft, the radio fuse or breaker can be used to also protect the instrumentation. A typical wiring schematic for connecting the aircraft power take-off jack is shown in Figure 4-5, and mounting dimensions are shown in Figure 4-6.

4-5. INTERCONNECTION OF METER ELEMENTS

After the aircraft has been prepared to accommodate the CD V-781 Aerial Survey Meter as described in Sections 4-1 through 4-4, the units of the instrument system are secured aboard the aircraft and made ready for operation as follows:

a. Install batteries in either the detector or simulator unit (see Figure 4-7) if battery power is to be used. To install batteries, set the power switch on the metering unit to OFF. Remove the cover of detector or simulator unit case, pull out the battery plate, open the nylon battery boxes, and place batteries in the boxes as indicated by polarity markings on the boxes. One battery in the detector unit is mounted in an open battery holder between two of the battery boxes. Ensure that the positive pole of this battery is placed in the red polarizing washer of this battery holder.

b. Install batteries in the tape recorder by opening the bottom cover on its case, opening the battery boxes, and placing the batteries in the boxes as indicated by polarity markings on the boxes (see Figure 4-8).

c. Connect the throat microphone to the MIC jack, and the remote switch to the REMOTE jack on the tape recorder. Select the tape speed by means of the slide switch inside the top cover of the recorder. Install a fresh reel of tape in the recorder on the left spindle and an empty reel on the right spindle. Thread the tape through the recorder.

d. Plug radio cable from metering unit into plane radio phone jack.

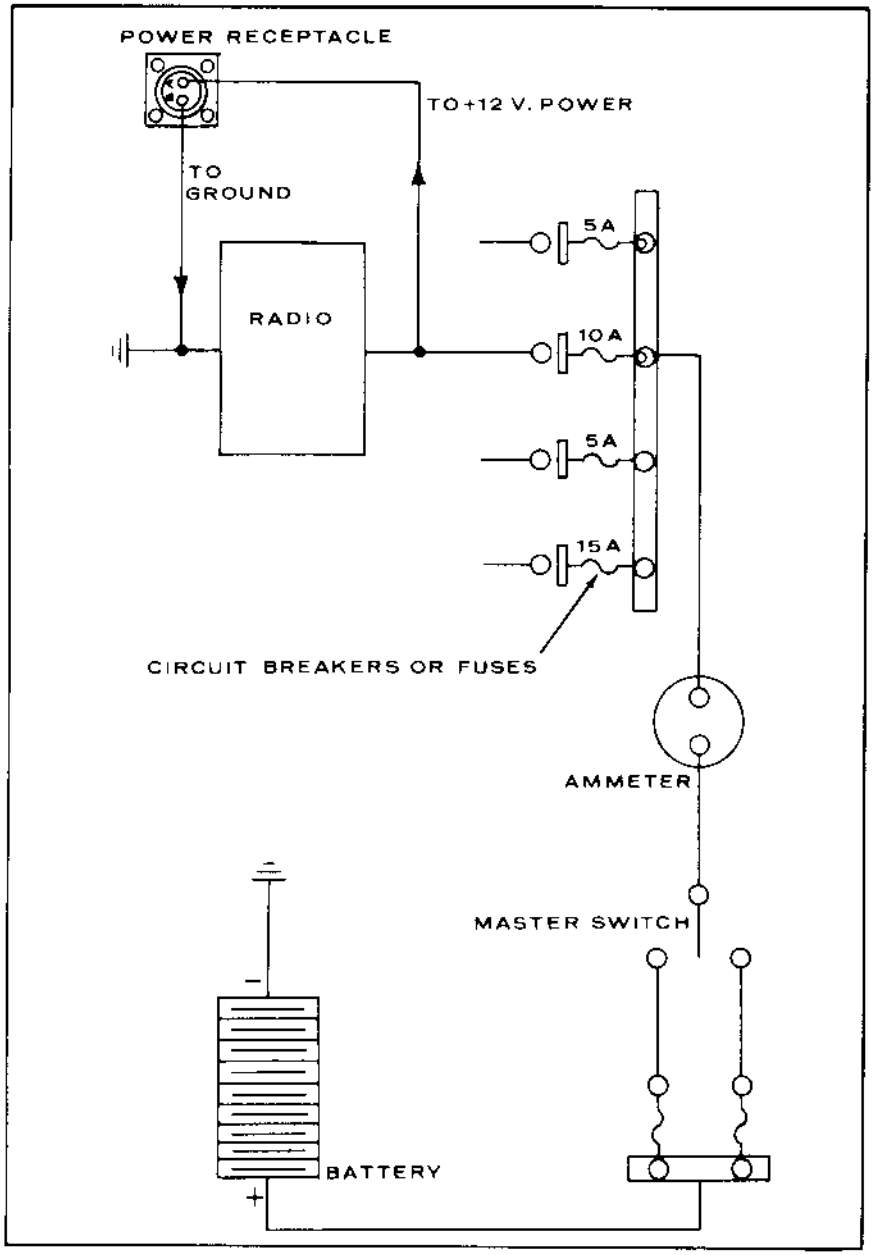

Figure 4-5. Typical Power Connections

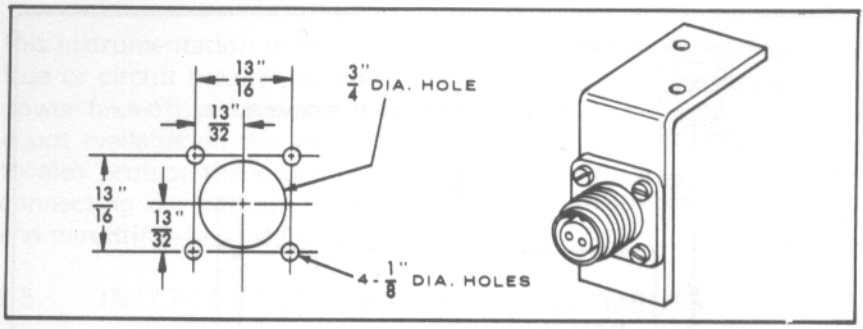

Figure 4-6. Mounting Details for Power Jack

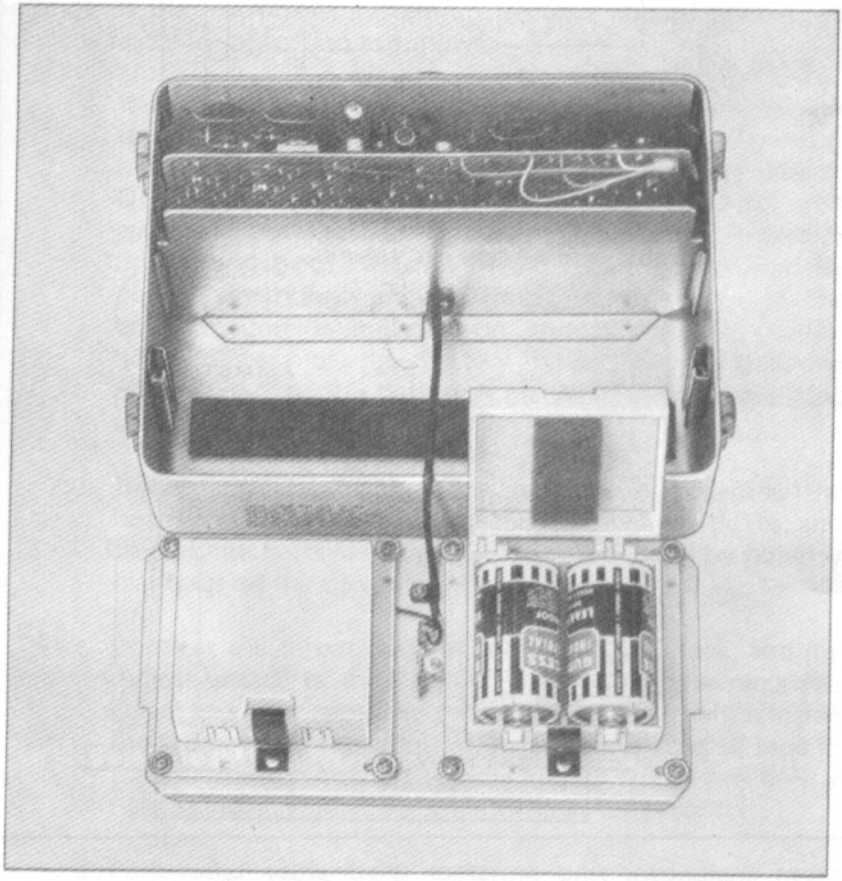

Figure 4-7. Installing Batteries in Detector or Simulator Unit

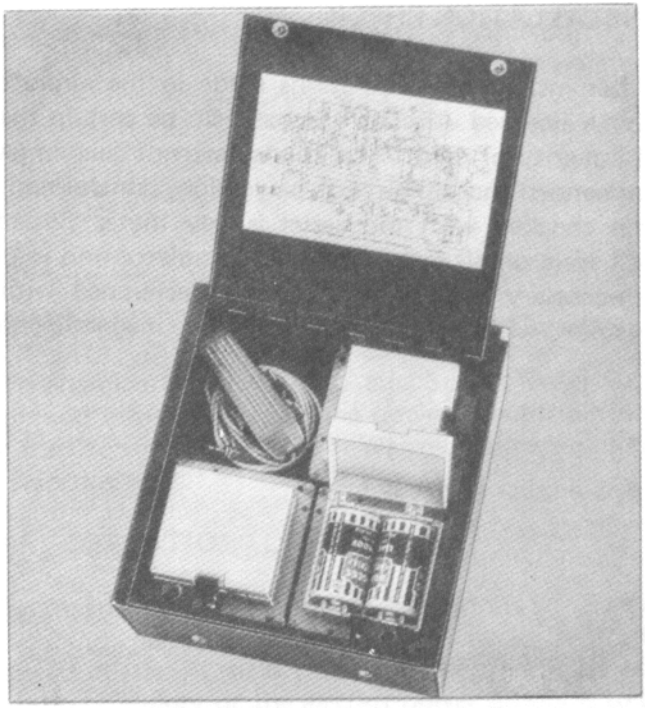

Figure 4-8. Installing Batteries in Tape Recorder

e. Connect power cable from metering unit to plane electrical system power take-off jack.

f. Connect metering unit signal cable to detector unit or simulator unit, whichever is in use. Power switch on metering unit should be in OFF position when this connection is made.

g. Plug headphones into one of the three phone jacks located on the metering unit, depending on the output desired.

4-6. INSTALLATION CHECK

After installation, alterations made in the aircraft must be checked by a licensed Aircraft Mechanic to be certain that aircraft structural integrity or control functions have not been impaired. It is also recommended that all aircraft navigation, control and electrical systems be checked with the aerial survey meter turned on and reading full scale on all meters with the simulator unit in place. This check is necessary to detect possible interference with existing aircraft systems, with special attention to the magnetic compass and altimeter.

SECTION 5

OPERATION

5-1. WARM-UP

To energize the CD V-781 Aerial Survey Meter System, after installation and interconnection, the power selector switch is moved to either the PL or BAT position. Warm-up time required will not exceed 2 minutes.

5-2. PRE-OPERATIONAL CHECK

To insure proper functioning of all units of the system, the operator should perform the following checks with the power selector switch in the PL or BAT position depending on whether the auxiliary battery supply or the aircraft power supply is to be used to operate the instrumentation. The pre-operational check sequence is the same for either detector or simulator mode operation, except that in simulator mode the instructor may insert a test signal to check meter tracking, indicator lamp operation, and audio radiation level signal response.

a. Plug headphones into the MIX jack to observe generation of basic 250 cps audio radiation level signal, and mixing with radio reception. Volume of audio signal may be adjusted at this time.

b. To check the condition of the auxiliary battery supply, put the three position power selector switch in the BAT position and depress the battery/plane check switch. If the battery supply is providing adequate input voltage, the indicating needle on meter M 1 will read at or above the battery check mark on the meter scale. Using aircraft power, the input voltage from the aircraft can be checked

by placing the power selector switch on PL and depressing the battery/plane check switch. If the aircraft power system is providing adequate input voltage to properly operate the instrumentation, the M 1 indicating needle will read at or above the check mark. If the reading obtained is too low, the batteries should be replaced, or the aircraft power system checked (and serviced if necessary), or the CD V-781 system should be checked (and serviced if necessary - refer to section 6-6).

c. Observe meter readings. Under normal radiation background conditions, the reading should be zero on all three meters. With radioactive fallout present, readings may be detected but they should decrease with altitude after take-off. Unless this initial ground level reading decreases as altitude increases, under attack conditions, the aircraft or instrument should be inspected for possible contamination.

d. Turn tape recorder on, adjust throat microphone, and record a sample data insertion by means of the tape recorder remote control. Play back and make necessary adjustments to throat microphone position and recorder gain.

If any abnormality of operation is detected during this checking procedure, no attempt at correction beyond readjustment of the interconnections should be attempted by the monitor. If the malfunction cannot be corrected by these readjustments, the aerial survey meter system should be returned to the appropriate maintenance shop for repair. When returning the system for repair, all components including the tape recorder should be returned.

5-3. METER READING

Operational procedures for both detection and training missions are discussed in other OCD Aerial Radiation Survey publications. During a radiation survey, a slight delay in response to large abrupt changes in the radiation rate may be observed. This is inherent in the circuitry of the detector unit. In a constant radiation

field, the meters will fluctuate due to the statistical nature of the operation of the detector tubes and count rate circuits. This fluctuation will not exceed ±5% of the average true reading, and the monitor should estimate the mean position of the pointer to determine an average reading. Meter response in simulator mode operation is virtually instantaneous, and the instructor, by means of simulator control manipulation, can simulate the fluctuation that occurs during actual radiation survey.

SECTION 6

OPERATOR'S MAINTENANCE

6-1. PROTECTION

Protection of the equipment against operational hazards is primarily the operator's responsibility. These hazards include rough handling, unnecessary exposure to the environmental extremes, improper installation in the aircraft, and improper use.

Although designed for field use, the components of the instrument system include fragile electronic devices and proper handling is required. Exposure to excessive heat or cold, or rapid changes in temperature which may give rise to condensation should be avoided. Plastic bags should be used during shelf storage together with desiccant packets (reactivated, as necessary). If condensation is observed, the instrument should not be operated until it has an opportunity to normalize at the ambient operating temperature and the moisture has evaporated. Installation should be in accordance with Section 4 of this manual, with particular attention to securing the units in place, and the instrument should be used only for its intended purpose.

6-2. DECONTAMINATION

Under emergency conditions, the unit may become contaminated by radioactive debris. If this occurs, the *outsides* of the instrument cases may be brushed or cleaned with detergent and water, using care to prevent the solution from entering the cases.

6-3. BATTERY REPLACEMENT

Since batteries should be installed only when the instrument is to be operated, it is the operator's responsibility to remove

batteries when the instrument is not in use, check battery condition and replace batteries when necessary (see Section 4-5 a, b). If battery leakage is detected, battery terminals should be inspected for corrosion and cleaned immediately using a damp cloth. The faulty batteries should be replaced.

6-4. PERIODIC INSPECTION

At intervals, determined by use and storage conditions, each aerial survey meter should be removed from storage and subjected to the complete pre-operational check as outlined in Section 5-2. In addition, by means of a low level radioactive source, operation of the detector tubes should be checked. For this purpose the detector board may be removed from the unit and the check source placed in close proximity to each detector tube. If a source of several millicuries in activity is used (such as a CD V-784), the source should be placed against the check points marked on the bottom of the detector unit case without removing the detector board to obtain the desired G-M tube response. Indicator lamps should also function when the unit is energized by the external power supply.

6-5. SIMULATOR INSPECTION

During periodic preventive maintenance checks, range agreement between meters on the simulator unit and also those on the metering unit should be observed. If adjustment is required, the instrument should be returned to the appropriate maintenance shop for servicing.

6-6. OBSERVATION OF MALFUNCTION

If any malfunction or abnormality is observed during installation, checking or operation, the instrument should be returned to the appropriate maintenance shop for repairs. No corrective action other than battery replacement or checking cable connections should be attempted by the operator.