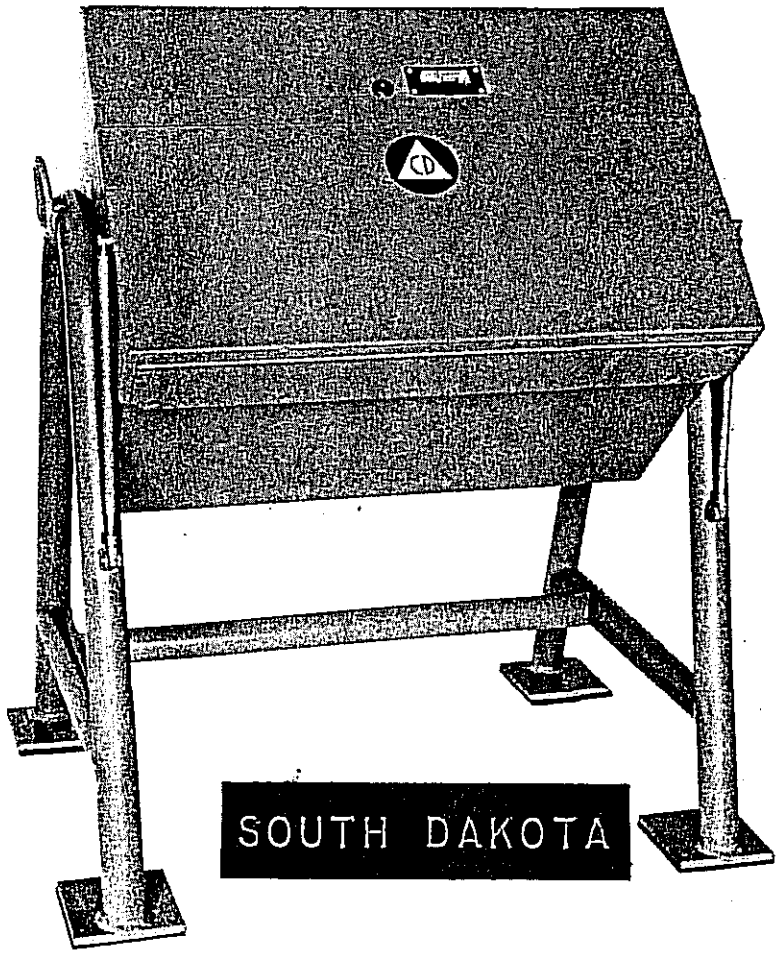
Instruction and Maintenance Manual

RADIOLOGICAL INSTRUMENT CALIBRATOR

OCD Item No. CD V-794, Model No. 2



Technical Operations, Incorporated
RADIATION PRODUCTS DIVISION
Burlington, Massachusetts

(PRELIMINARY)

Instruction and Maintenance Manual

RADIOLOGICAL INSTRUMENT CALIBRATOR

OCD Item No. CD-V-794, Model No. 2

tech/ops

RADIATION PRODUCTS DIVISION
Burlington, Massachusetts
1967

WARNINGS

THE RADIOLOGICAL INSTRUMENT CALIBRATOR CD-V-794 ENCLOSES A 130-CURIE SOURCE OF CESIUM 137 TO PROVIDE A GAMMA RADIATION FIELD FOR CALIBRATING RADIATION DETECTION INSTRUMENTS. IN NORMAL OPERATION THE SOURCE IS FULLY SHIELDED. THE PRESENCE OF THE SOURCE IN THE CALIBRATOR DICTATES STRICT ADHERENCE TO THE FOLLOWING PRECAUTIONS AND INSTRUCTIONS OF THIS MANUAL.

THIS EQUIPMENT SHALL BE OPERATED ONLY BY PERSONS LICENSED AND AUTHORIZED FOR THIS TYPE ACTIVITY BY THE ATOMIC ENERGY COMMISSION OR AN APPROPRIATE STATE LICENSING AGENCY.

UNDER NO CONDITIONS ARE OPERATING PERSONNEL TO ATTEMPT ANY INTERNAL ADJUSTMENTS OR REPAIRS TO THE CALIBRATOR OTHER THAN THE BASIC CORRECTIVE ACTIONS GIVEN BY SECTION V OF THIS MANUAL. MALFUNCTIONS OTHER THAN THOSE ENUMERATED BY SECTION V SHALL BE REPORTED IMMEDIATELY TO THE NUCLEONICS DIVISION, TECHNICAL SERVICES, OFFICE OF CIVIL DEFENSE, DEPARTMENT OF THE ARMY, PENTAGON, WASHINGTON, D.C. 20310.

IN THE EVENT OF A FIRE, PERSONNEL OVEREXPOSURE, RELEASE OF THE RADIOACTIVE MATERIAL, OR OTHER ACCIDENT DESCRIBED IN TITLE 10 OF THE CODE OF FEDERAL REGULATIONS, PART 20, PARAGRAPHS 20.402, 20.403 AND 20.405, IMMEDIATELY NOTIFY THE FOLLOWING BY TELEPHONE OR TELEGRAPH:

1. DIRECTOR OF THE APPROPRIATE AEC REGIONAL COMPLIANCE OFFICE AS GIVEN IN APPENDIX D, TITLE 10, PART 20 OF THE CODE OF FEDERAL REGULATIONS OR THE APPROPRIATE STATE LICENSING AGENCY. (SEE PAR. 2.7)
2. NUCLEONICS DIVISION, TECHNICAL SERVICES, OFFICE OF CIVIL DEFENSE, DEPARTMENT OF THE ARMY, PENTAGON, WASHINGTON, D.C. 20310, PHONE: AREA CODE 202 OX 5-2519.
3. RADIOLOGICAL DEFENSE OFFICER OF THE APPROPRIATE OCD REGIONAL OFFICE.

WARNINGS

UNDER NO CIRCUMSTANCES ARE OPERATOR PERSONNEL TO IRRADIATE OBJECTS OR SUBSTANCES OTHER THAN AS PRESCRIBED BY THE DIRECTOR, OCD.

WHEN INSTALLED, THE CALIBRATOR SHALL BE WIPE TESTED AT INTERVALS NOT TO EXCEED SIX MONTHS IN ACCORDANCE WITH RADIOLOGICAL SAFETY INSTRUCTIONS GIVEN BY SECTION 2.2 OF THIS MANUAL. WHEN IN STORAGE, THE CALIBRATOR SHALL BE INSPECTED AS FOLLOWS AT INTERVALS NOT TO EXCEED 6 MONTHS:

1. SURVEY THE CALIBRATOR WITH A CD-V-700 TYPE METER. IF EXPOSURE RATES AT THE SURFACE EXCEEDING 2 MR/HR ARE ENCOUNTERED TAKE IMMEDIATE CORRECTIVE ACTION IN ACCORDANCE WITH SECTION 2.2 OF THIS MANUAL.
2. MAINTAIN A PERMANENT RECORD OF THESE INSPECTIONS.

THE CALIBRATOR MAY BE OVERTURNED IF TILTED BEYOND 25°. WHEN MOUNTED ON A VEHICLE OR ROLLING PLATFORM THE CALIBRATOR SHOULD BE MOVED ONLY IN THE DIRECTION OF ITS LONG BASE DIMENSION.

THE CALIBRATOR CONTAINS A SAFETY INTERLOCK WHICH PREVENTS OPENING THE CALIBRATION CHAMBER WHEN THE SOURCE IS NOT FULLY SHIELDED. STRICT ADHERENCE TO THE CAUTION AND WARNING INSTRUCTIONS ON THE EQUIPMENT AND IN THIS MANUAL IS MANDATORY.

THE CALIBRATOR SHOULD BE LOCKED WHEN UNATTENDED.

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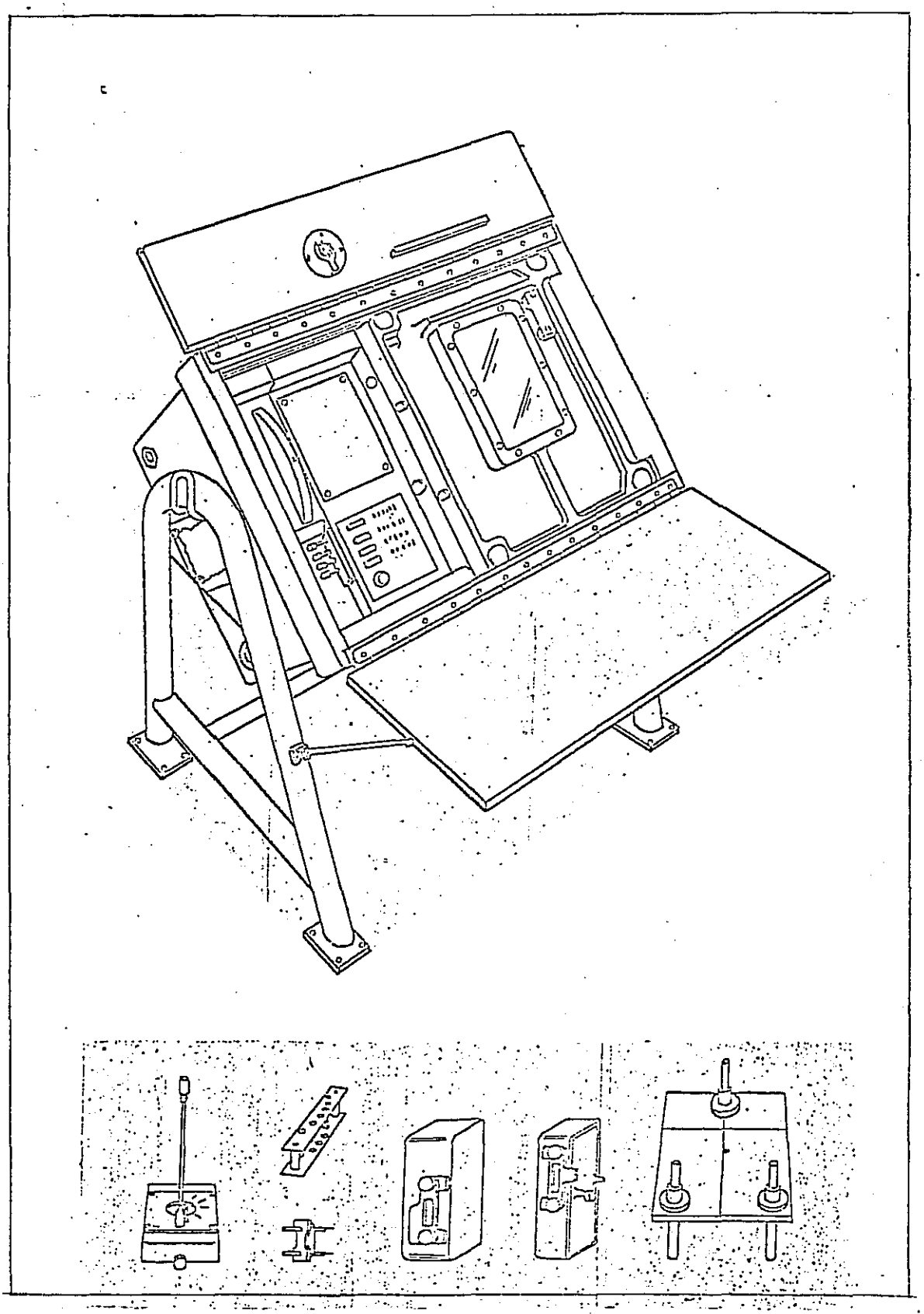


Figure 1-1. Radiological Instrument Calibrator, CD-V-794, Mark IV, and Accessories

SECTION I

EQUIPMENT DESCRIPTION

1-1. GENERAL

1-2. The calibrator, CD-V-794 Model No. 2 , shown in figure 1-1, contains a gamma-radiation source that provides four intensity levels for calibrating radiation survey meters. Inside the calibrator, the radiation source has a fixed position relative to the survey meter under test. The specific strength of the radiation field in the exposure chamber is controlled through a rotary attenuator. While a meter is in the radiation field, calibration is done via remote controls and meter readings observed directly through the lead-glass window of the chamber door. Meters are properly set in the chamber by the aid of fixtures. The meters that may be calibrated are listed in Figures 4-1 and 4-2.

1-3. The nominal accuracy of the calibrator is maintained by the periodic adjustment of a decay compensator. The initial radiation intensity of the source is adjusted at the manufacturer's facility.

1-4. FUNCTIONAL DESCRIPTION

1-5. Main components of the Calibrator are illustrated in Figure 1-2. The primary shield housing is the principal unit. It contains the source in a shield that attenuates radiation to a safe level when the source is unexposed, and supports the mechanical and electrical mechanisms for using and controlling the source's radiation. The source is Cesium 137. It emits radiation, beamed by the shielding design, into the exposure chamber. Interposed in the radiation-beam path is the attenuator disc by means of which radiation levels of .004, .4, 4, 40, and 400 R/hr are produced in the exposure chamber. Rotation of the selector wheel turns the attenuator disc, moves an electrical wiper and actuates a limit switch that illuminates a lamp indicating a value of radiation level which corresponds to the one marked on the selector wheel. The decay compensator disc maintains nominal radiation strength of the source within ± 2.5% when adjusted every two years.

1-6. The exposure chamber is a special shielded compartment for calibrating and testing OCD radiation meters. It is closed by a door that protects against the radiation levels in the chamber and provides direct visual observation during meter calibration. For access into the exposure chamber, the door is rolled to the left. A mechanical interlock prevents it from being moved unless the source is safely shielded.

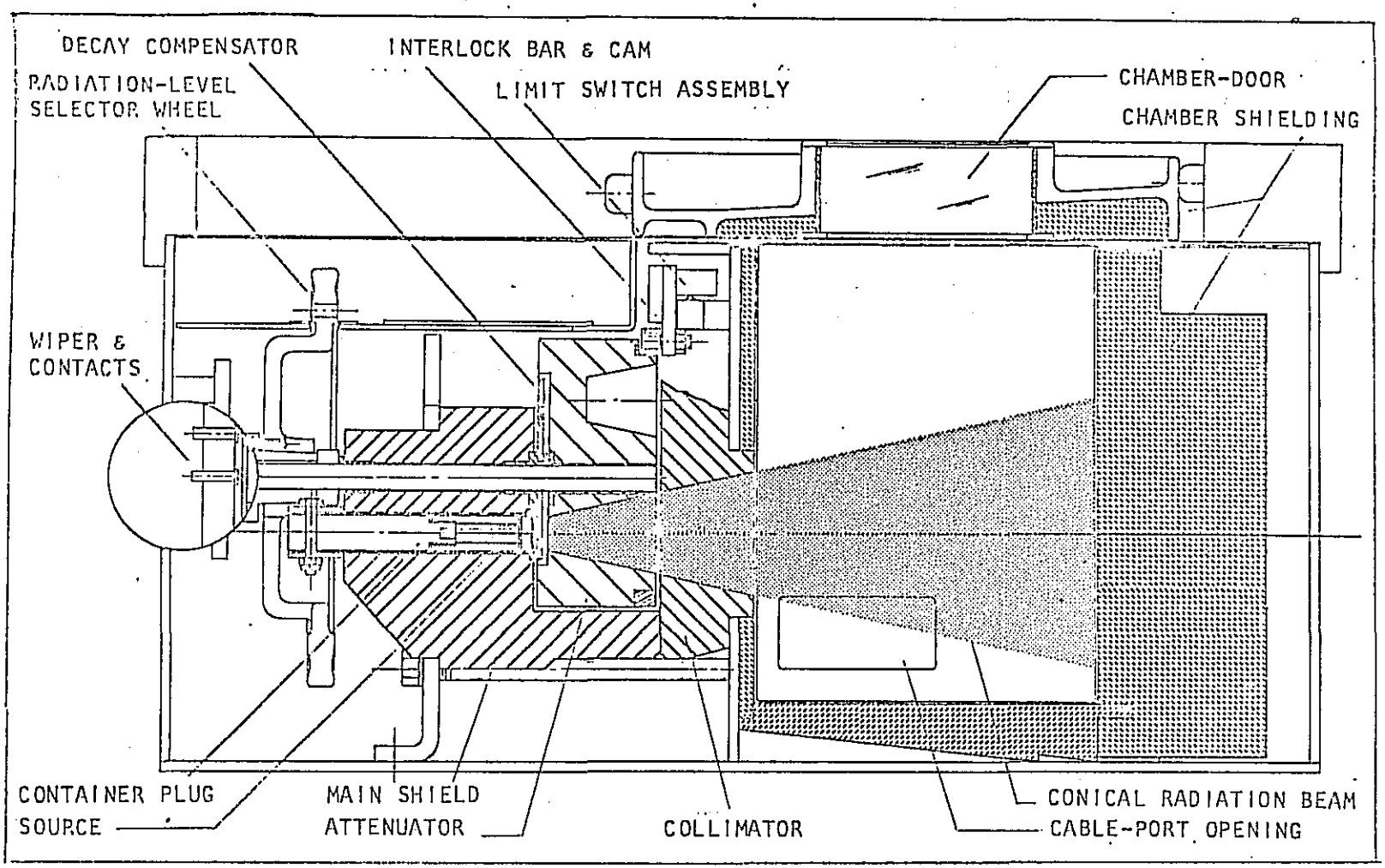


Figure 1-2. Main Components

1-7. Calibration of survey meters is accomplished via the control panel. The panel contains the radiation-level selector wheel, the radiation-level indicators, and the remote controls. The turning of the selector wheel rotates the attenuator disc and interposes in the radiation path an absorber that reduces the intensity to the selected level. The selector wheel also actuates the electrical circuit that turns on the proper signal light. While a meter is in the radiation beam it can be adjusted by the remote controls. Four controls are used to adjust the meter's potentiometers and one control to switch the meter's range.

1-8. The electrical circuits incorporated in the Calibrator are for signalling and illumination. On the left side of the cabinet, a green indicator glows when 115-volt power is turned on. At that time the exposure chamber is illuminated and the green radiation-level indicator glows on the control panel if the radiation source is fully shielded (SAFE position on the selector wheel). The four other radiation-level indicators glow red as the intensity is changed to specific levels of 0.4, 4,40,and 400 R/hr. Each lamp indicates which meter-sensitivity remote control must be used to calibrate the meter in the exposure chamber.

1-9. Fixtures and a jig are devices that facilitate calibration of various radiation survey meters. Before a meter is placed in the exposure chamber, appropriate fixtures must be attached to it. The fixtures are an aid for setting a meter's detecting volume into the radiation reference plane and for remotely changing a meter's range and adjusting its potentiometers. The jig pre-aligns a fixture with the meter's potentiometers so that they will be in line with the remote-control screwdrivers.

1-10. As indicated in figure 1-2, adequate shielding is provided on all sides of the radioactive source and exposure chamber. The shielding reduces the exposure rate on external surfaces to 2 mR/hr maximum.

1-11. DESCRIPTION OF MAJOR COMPONENTS

1-12. STAND. The stand (figure 1-3) consists of two, tubular-steel, oval A-shaped frames joined by a tubular cross-member. Stand rigidity is achieved with the cabinet bolted to a gusset on each A frame. Leg spread stabilizes the calibrator and leg pads distribute floor loading. The leg pads accommodate casters.

1-13. CABINET. The cabinet (figure 1-3), a rectangular steel box, encloses all the calibrator's basic parts. It is assembled to the stand with mounting bolts. A steel plate divides it into two compartments. The right-side

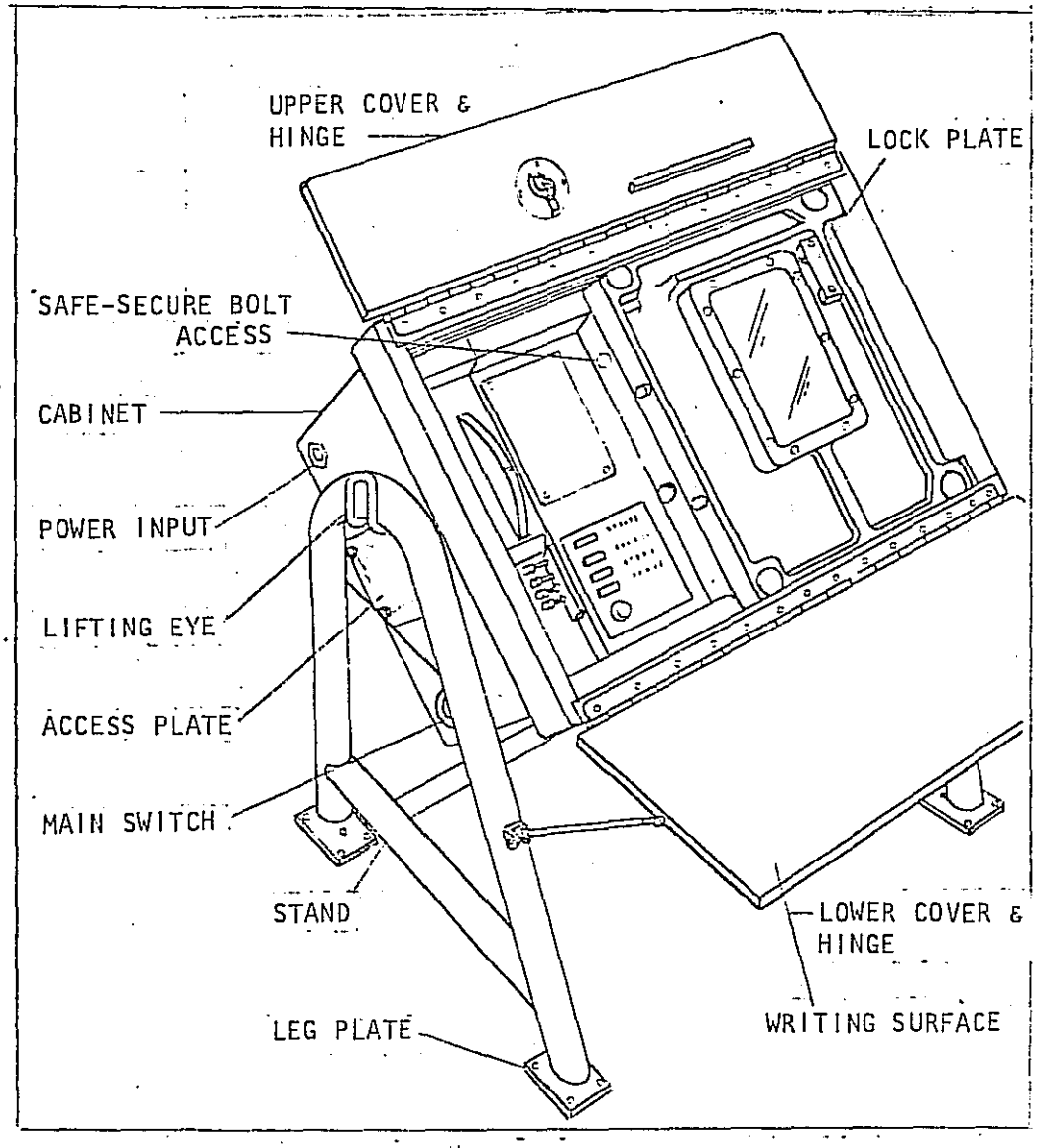


Figure 1-3. Calibrator Parts

compartment contains the exposure chamber. The left-side compartment contains the primary shield housing, the mechanical interlock, the remote controls, the electrical circuitry, and the control panel. A rail assembly is fitted flush on top of the cabinet and encases it. Two covers, hinged to the rail assembly, are joined when closed. They protect the controls, window and door of the calibrator and, when locked, prevent unauthorized use.

1-14. PRIMARY SHIELD HOUSING. The primary shield housing (figure 1-2) is depleted uranium metal cast in three parts: main shield, attenuator disc, collimator. The configuration of the housing attenuates radiation to 2 mR/hr at every accessible surface except the radiation path into the exposure chamber. Bored into the main shield are two, parallel, cylindrical holes. The attenuator-disc shaft is fitted into the upper hole and the source is confined in the lower hole.

1-15. The attenuator disc (figure 1-2) is a radiation shield which is set in the recess between the main shield and the collimator. The disc has five, circular, equally-spaced, absorption areas near its circumference. Each area is cast conically to a different depth leaving a metal thickness that produces a specific intensity level in the exposure chamber. The areas have corresponding detents on an index ring at the circumference of the disc. The detents are used for controlling the radiation-level indicators and the exposure-chamber door lock, and for centering the absorption areas on the radiation beam.

1-16. The collimator mounted in front of the attenuator disc has a cast conical hole that defines the radiation beam entering the chamber. The chamber side of the collimator hole has a shoulder around it which fits into a mating hole in the divider plate and in the adjacent lead shield of the exposure chamber.

1-17. SOURCE. The source is compressed, pelleted, cesium chloride encapsulated in a double stainless steel jacket (figure 1-3a). It is sealed in a cylinder-shaped tungsten plug which is inserted, bolted and safety wired into a stainless steel tube within the main shield. The source is rigidly positioned and not subject to damage by outside forces.

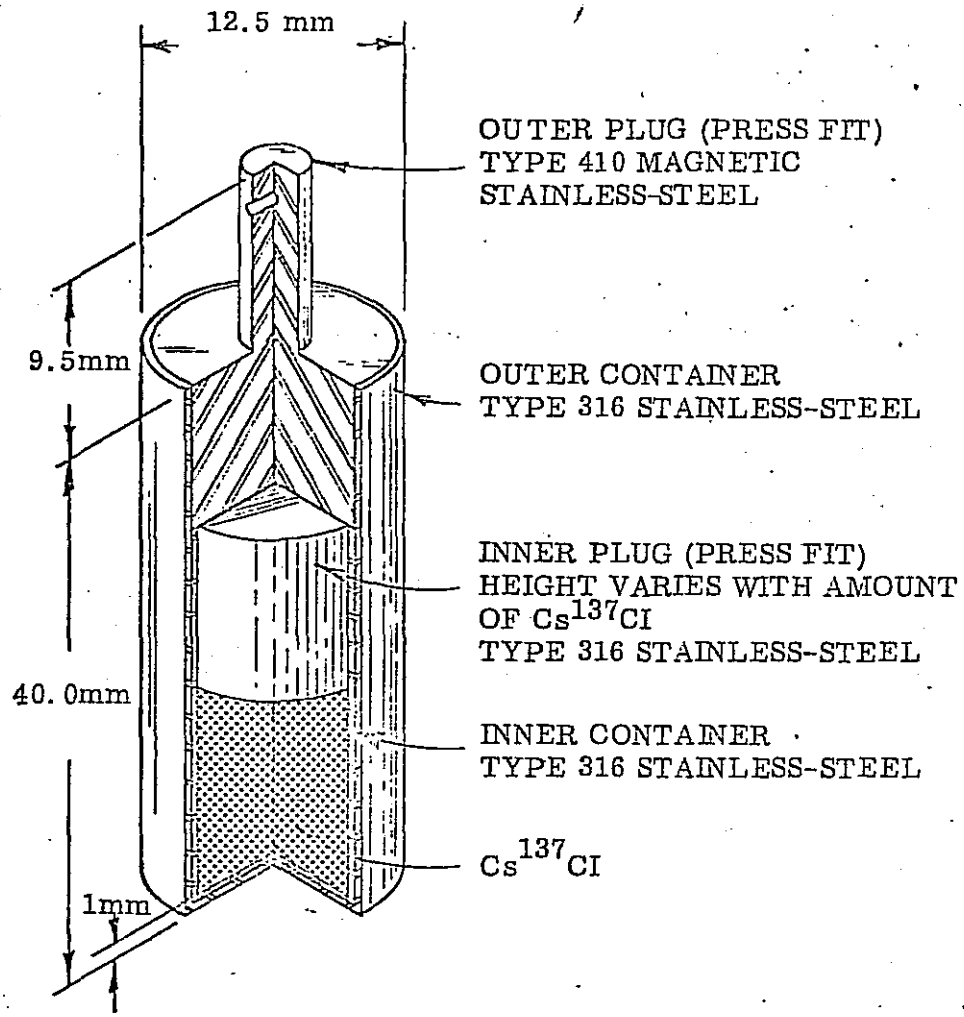


Figure 1-3a. Pelleted Cs^{137} Gamma Source

1-18. DECAY COMPENSATOR. The decay compensator (figure 1-2) is a tungsten disc with eight equally spaced absorption surfaces and eight locking holes near its circumference. It is mounted on the attenuator-disc shaft between the attenuator and the source, and its bored surfaces are coaxial to the radiation-beam path.The several bored areas are machined to diminishing successive thickness each equivalent to source decay for consecutive two-year intervals. The compensator is rotated one locking hole every two years and is retained in place by a spring-loaded lock pin.

1-19. EXPOSURE CHAMBER. The exposure chamber (figure 1-4) is the shielded area in which the meters are placed for exposure to the calibrated radiation beam. The beam enters the chamber from the left through the aluminum liner. The chamber, which is completely enclosed by lead shielding, is equipped with a cable port, a fixture adapter, a lamp and lamp guard, and remote-control stations for calibration of meters.

1-20. The cable port, a lead-shielded passage, opens into the upper part of the chamber. Meter cables may be routed through the port. The chamber's fixture adapter is a clamp device and a remote-control station. Meters held by special fixtures may be anchored to it. The adapter houses the screwdrivers for adjusting survey meters' potentiometers. The meter-range remote-control station is a spline connector in the left wall of the chamber. The flexible shaft of the range fixture must be connected to it during calibration. A bayonet type, oblong lamp, protected by a plastic guard is installed along the upper side of the chamber to illuminate the face of the survey meters evenly.

1-21. CONTROL PANEL. The control panel (figure 1-4) consists of two aluminum panels, each independently removable. The left panel contains a slot for the radiation-level selector wheel, a recessed section for manipulation of the meter-sensitivity remote controls, and the meter-sensitivity controls. On the right panel are the radiation-level indicators assembly, the meter-range control, the nomenclature plate, and the access hole for the safe-secure bolt that fixes the interlock mechanism in the SAFE notch position (see figure 1-3).

1-22. The Radiation-Level Selector Wheel (see figure 1-2) is cast aluminum and protrudes through the control panel surface. The wheel rim is recessed for sure-grip manipulation and marked to indicate the radiation

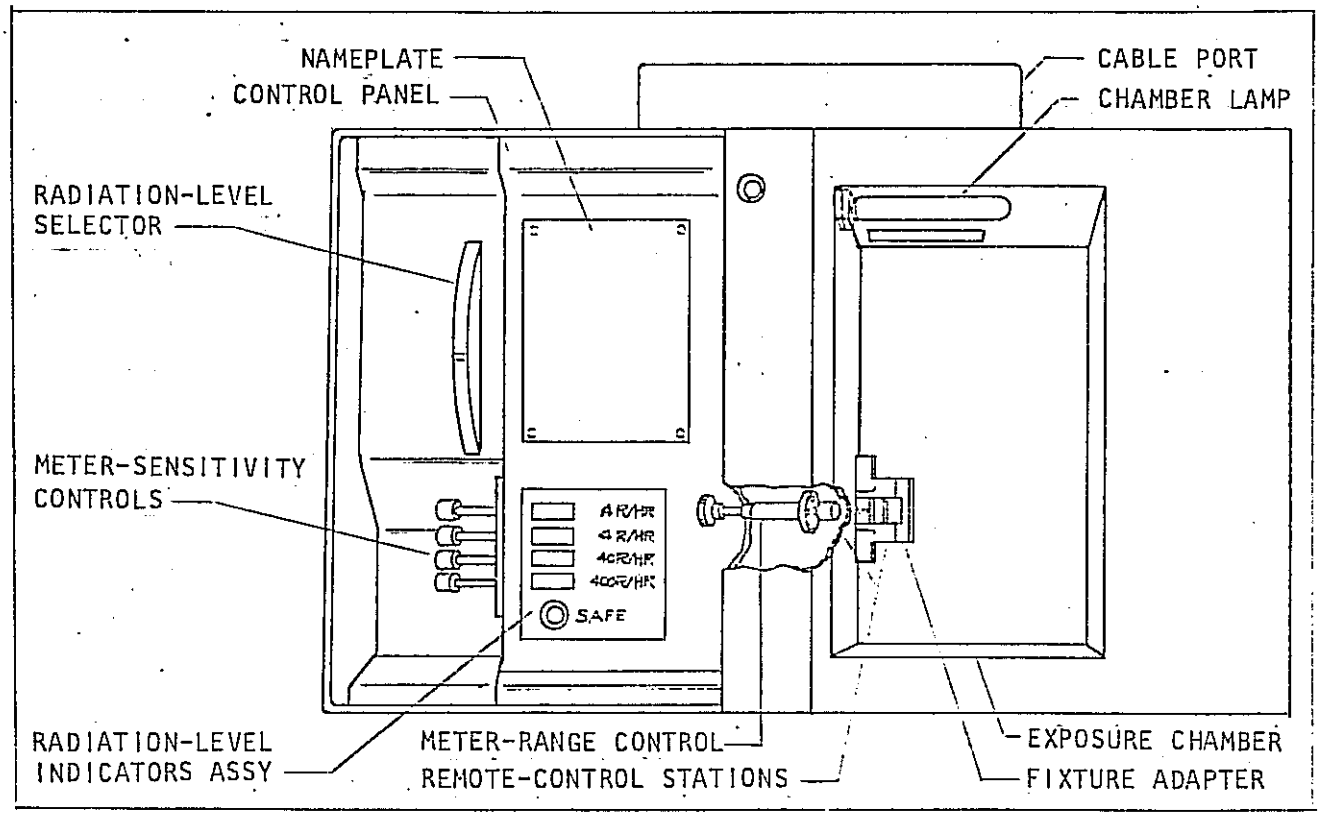


Figure 1-4. Exposure-Chamber and Control-Panel Detail

level in the chamber. Holes in the radial surface are situated flush to the panel to permit locking at a selected radiation level. The wheel is directly coupled to the attenuator disc via the sleeve-bearing shaft. A triangular cutaway near the wheel hub provides direct access to the source in the main shield.

1-23. DOOR AND RAIL ASSEMBLY. The chamber door is cast bronze with lead shielding bonded to its tapered panels, and a 2-inch-thick lead-glass window framed in its sash. Two roller bearings at right angles at each corner (see figure 1-5) permit the door to roll in grooved, hard-coated, aluminum rails along the length of the cabinet top. Both rails are bolted to side, end-travel bars and to the cabinet thereby encasing it. Two hinged covers for the cabinet are fastened to the rail bars. The lower cover when opened provides a writing surface. In open position the top cover rests against two bumper stops bolted to the top rail bars. For securing the calibrator, the top cover has a chamber-door lock bar which holds the chamber door in place over the control panel, and a tumbler lock which engages a lock plate in the chamber door.

1-24. CHAMBER-DOOR INTERLOCK. The interlock mechanism (figure 1-5) is a spring-loaded lock pin forced in and out of the door's locking hole by the lever bar as its cam roller tracks the index ring. The door is unlocked only when the cam rolls into the SAFE registration detent, the deepest notched position corresponding to maximum attenuation interposed in the beam path. The lock-pin spring constrains the cam roller in the notches. A barrier strip along the door undersurface prevents the cam from rising out of the SAFE detent unless the door is fully closed.

1-25. Connected to the lever bar is an arm link allowing the angular displacement of the absorbers' center point relative to the axis of the radiation beam path. This is adjusted at assembly to assure proper alignment of the attenuator absorption surfaces with the radiation beam path.

1-26. REMOTE CONTROLS. The remote controls are two assemblies, the meter-sensitivity control and the meter range control. As mechanical links between the control panel and the exposure chamber, they are used to adjust the calibration potentiometers and the range switch of the meters while they are exposed to the radiation field.

1-27. The meter-sensitivity control (figure 1-6) is a set of four screwdrivers incorporated within the fixture adapter. Each screwdriver is a

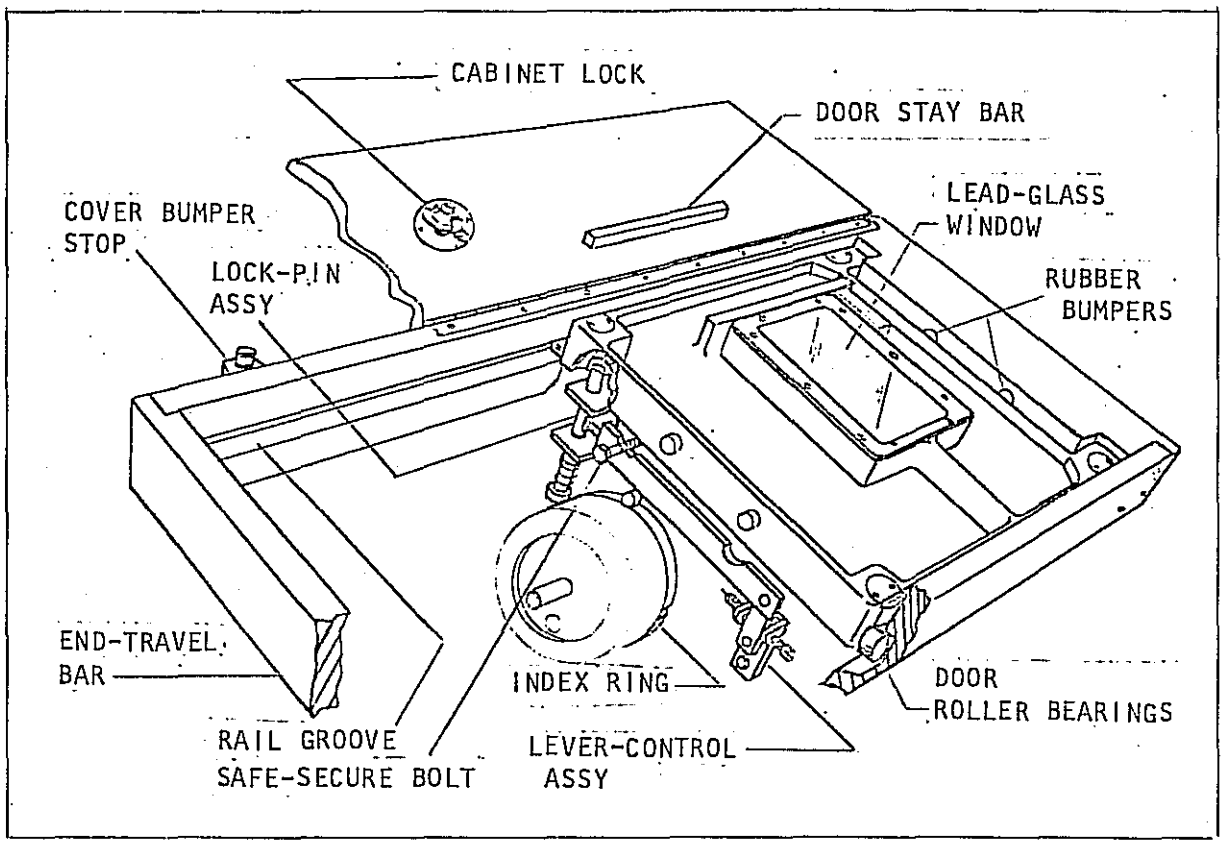


Figure 1-5. Rail, Door, and Door-Interlock Detail.

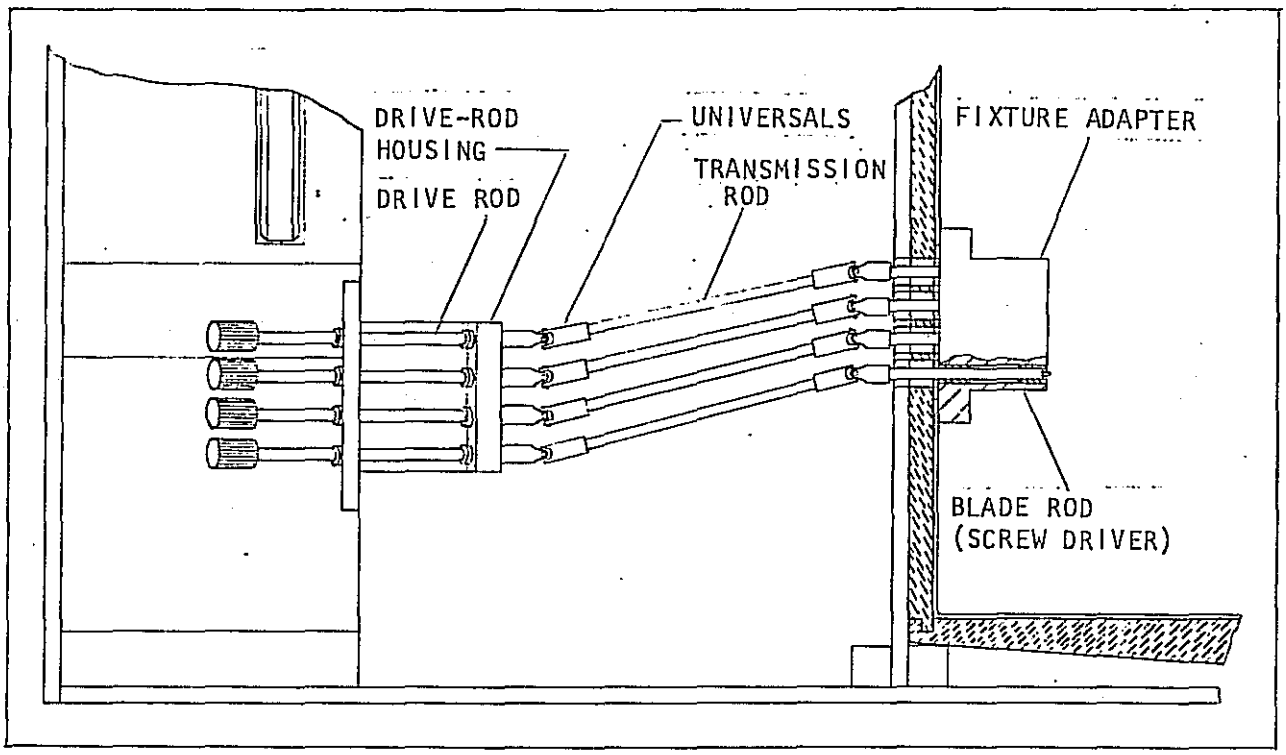


Figure 1-6. Meter-Sensitivity Remote-Control Mechanism.

rigid-shaft device composed of three rods linked by universal joints. Long sleeve bushings contain the drive and the blade rods to facilitate rotation, protrusion and retraction of the device. A plastic, knurled knob is attached to each drive rod at the control panel.

1-28. The meter-range control (see figure 1-4) is a captive rod with a control knob on one end and a coupling spline on the other. The rod is captive in a special bearing which recesses the spline within the exposure chamber walls. The knob is on the right control panel.

1-29. ELECTRICAL CIRCUITRY. The electrical circuit, (see figure 1-7) provides illumination in the exposure chamber and signal lamps for monitoring the status of the calibrator. 115-volt power is connected to the calibrator via the 10-ft extension cord and is fused (1 ampere) before wiring it to the power switch. From the switch, 115 volts are transmitted to the chamber lamp and a 6.3-volt stepdown transformer. The other lamp circuits are operated at 6.3-volt level, including the input power pilot lamp. The radiation-level signal lamps indicate the level of radiation intensity in the chamber. The appropriate indicator lamp is selected by a wiper-contact system on the end of the attenuator-disc shaft, and the circuit is closed by a limit switch when the cam roller drops into a notch in the attenuator index ring. Each radiation-level indicator is mounted opposite the corresponding meter-sensitivity remote control.

1-30. FIXTURES. The calibrator fixtures, 715, 717, universal, and 781 (refer to figure 1-8) are devices for positioning the detector volume of the different OCD radiation survey meters in the radiation-beam reference plane inside the chamber. Fixtures 715 and 717 are also designed for remote-control calibration of the 715 and 717 meters. Since the 715 and 717 fixtures are modified meter cases, the meter mechanisms are transferred and attached to the fixtures which make the potentiometers attainable by remote control screwdrivers.

1-31. The universal fixture is a metal stand consisting of a platform on three legs and a U-shaped bracket that holds the meters. Both parts are adjustable. Before the stand is inserted into the chamber and locked in place, the height of the platform may be adjusted and the holding bracket set to the indicated marks for the particular meter under test. Meters other than those listed in figure 4-2 may also be calibrated on the universal fixture.

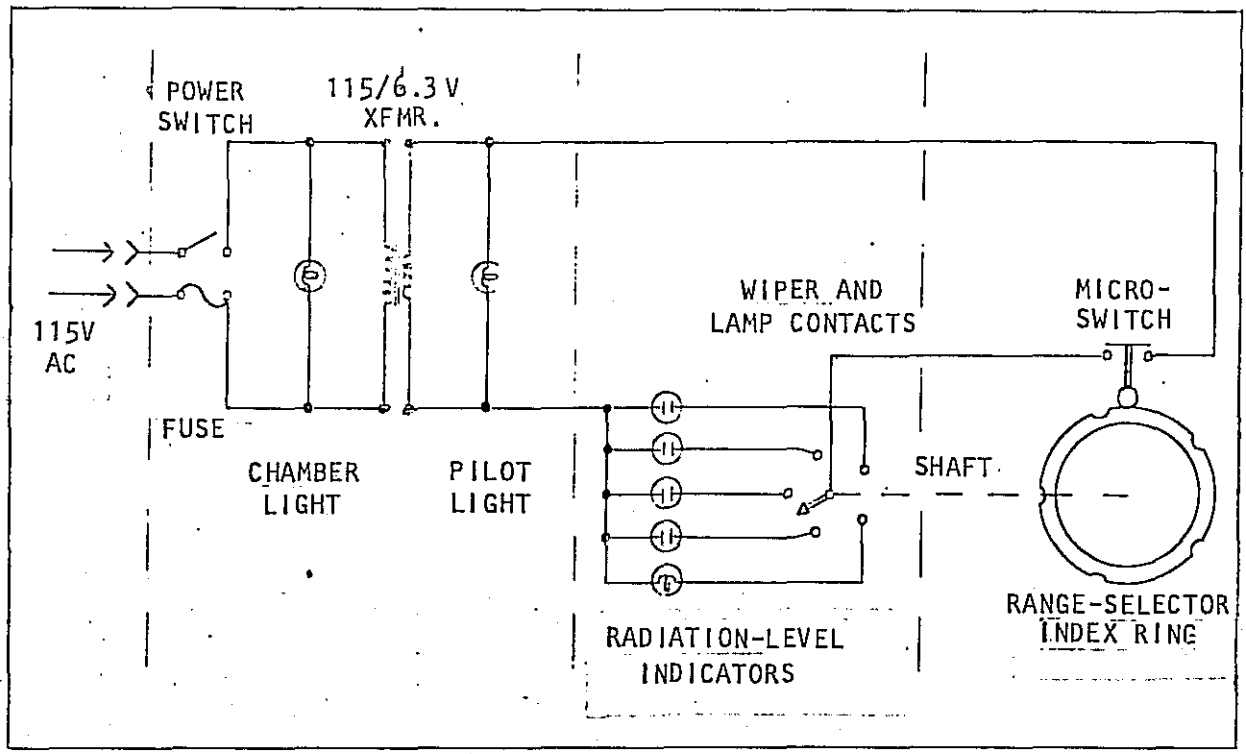


Figure 1-7. Electrical-System Diagram.

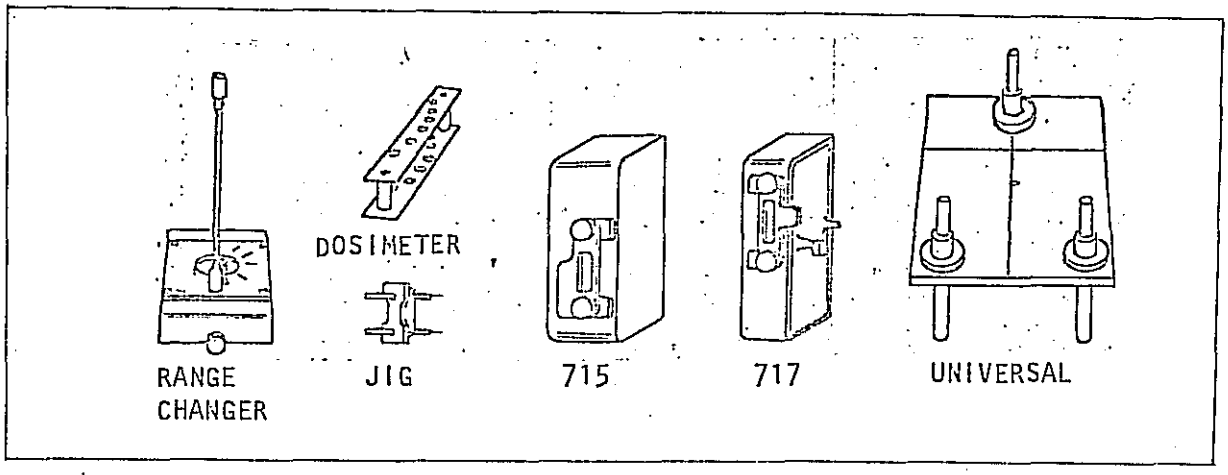


Figure 1-8. Calibrator Fixtures.

1-32. The 781 fixture is a locating shoe into which the detector unit of the aerial monitor is placed. The shoe provides two height positions to assure complete calibration of the meter's detector volume. The second position is obtained through a hinged elevation plate on which the meter is set.

1-33. The range-changer fixture is a geared device through which the range-control of the 715, 717, 720-3 and 720-3A meters can be turned remotely. The gearing mechanism is housed in a plate that fits on the meters and holds the range knob in a rotatable slot. Connecting the plate's flexible cable to the spline of the range-changer remote control completes the remote-control path from the fixture to the calibrator control panel.

1-34. The jig is a fixture that fits into the 715 and 717 fixture-adapter socket. The jig aligns the socket with the meter's potentiometers. When the socket is pressed and clamped onto the chamber fixture adapter, the potentiometers are positioned in line with the remote-control screw-drivers.

1-35. LEADING PARTICULARS

Contract Number and Date: OCD-PS-66-149, June, 1966.

Contractor: Technical Operations, Inc., South Avenue, Burlington, Massachusetts 01803

Cognizant Inspector: Office of Civil Defense, Office of the Secretary of the Army, Washington, D.C.

Calibrator:

Nomenclature - Calibrator for Radiological Survey Meters and Dosimeters, OCD Item No. CD-V-794, Model No. 2

Unit Size - 24" x 30½" x 32" (Covers closed)

Unit Weight - 1100 lbs.

Center of Gravity - (approx.)

Floor Loading - 185 lb psf (approx.)
psi (to be submitted)

Source:

Nomenclature - Cesium 137

Activity - 130 curies ± 10% as of date stamped on calibrator nameplate

Type of Radiation	–	Gamma rays
Half-life	–	29.68 years
Decay Adjustment	–	Every two years as of date stamped on calibrator nameplate

Shield:

Type	–	Uranium 238
Weight	–	180 lb.

Exposure Rate:

Inside Chamber	–	< 4 mR/hr
	–	0.4 R/hr (X.1 meter range)
	–	4 R/hr (X1 meter range)
	–	40 R/hr (X10 meter range)
	–	400 R/hr (X100 meter range)
Ext. Surface of Unit	–	< 2 mR/hr

Power Requirements:

Voltage	–	110 volts a.c. or d.c.
Current	–	1 ampere

Equipment Supplies:

Accessory Box	–	One (1)
Fixtures	–	Six (6)
Manual	–	One (1)
Extension Cord	–	One (1)
Spare Fuses	–	Five (5)
Spare Lamps	–	6S6 D.C. (2) "Chilco"
	–	31-2111T (2) "Leecraft"

SECTION II

SAFETY AND HANDLING PRECAUTIONS

2-1. GENERAL

2-2. The basic service of the CD-V-794 in providing a calibration and test chamber for CD meters has two inherent potential hazards to the operator: RADIOLOGICAL and ELECTRICAL.

NOTE

IT IS MANDATORY THAT THE OPERATOR BE FAMILIAR WITH THE POTENTIAL HAZARDS AND THE PRECAUTIONARY MEASURES DIRECTED BY THIS SECTION.

2-3. The following subsections describe these hazards and the necessary operator actions. Precautions are also outlined regarding FIRE and DAMAGE by accidents.

2-4. RADIOLOGICAL HAZARDS

1. DESCRIPTION OF THE HAZARDS. Two potential hazards arise from the 130-curie, cesium-137 source confined in the main shield. The principal hazard is external gamma radiation which would be caused by partial or complete loss of uranium or lead shielding. The second hazard is a radioactive contamination which would be caused by the escape of cesium material from the source capsule or by uranium material from the shield housing.

2. PROTECTION. The Calibrator is designed to reduce to a minimum the probability of either hazard occurring. The design safeguards are supplemented by personnel and equipment monitoring procedures given by this section.

3. PERSONNEL MONITORING. Personnel monitoring equipment (e.g. film badges or CD-V-138 pocket dosimeters) must be supplied to each calibrator operator and utilized in accordance with procedures to be established by the cognizant Health Physicist or Radiation Protection Officer. The procedures must satisfy all the requirements of Title 10, Part 20 of the Code of Federal Regulations.

2-5. SURVEYING THE AREA. In accordance with procedures to be established by the cognizant Health Physicist or Radiation Protection Officer, the

general working area where the Calibrator is located must be periodically surveyed for external exposure rate levels. A permanent record must be maintained of this data. If dose rates above 2 mR/hr at the surface of the Calibrator are encountered, the procedures 2-7.1 must be followed immediately.

2-6. MARKING THE AREA. The area where the Calibrator is located must be marked AT ALL TIMES by signs bearing the words CAUTION-RADIOACTIVE MATERIAL, 130-CURIES CESIUM 137, and displaying the purple or magenta standard radiation symbol on a yellow background. Signs of this type are supplied with each Calibrator.

2-7. PRECAUTIONARY PROCEDURES

1. RADIATION EXPOSURE RATE CHECK. The external radiation hazard is controlled by the system of shields and interlocks described in Section I of this manual. The following procedure for checking the exposure rates is to ascertain that the shielding is unimpaired. This check must be performed when shipping and installing the Calibrator (paragraphs 3-3.1 and 3-2.2), after an incident which could affect shielding integrity has occurred (Fire - paragraph 2-4, and Accidents - paragraph 2-5), and when otherwise specified by the Radiation Protection Officer. The check must be conducted by (or under the direction of) a Radiological Protection Officer or qualified Health Physicist.

a. Enter the Calibrator area with a CD-V-700 type survey meter and approach the Calibrator.

b. IF EXPOSURE RATES ABOVE 2 MR/HR ARE ENCOUNTERED ONE FOOT OR MORE FROM THE CALIBRATOR IMMEDIATELY TAKE THE FOLLOWING STEPS:

(1) CLEAR THE CALIBRATOR AREA OF PERSONNEL. MAKE A SURVEY OF THE AREA TO ESTABLISH THE 2 MR/HR ISODOSE LINE. ISOLATE THE AREA WITH BARRIERS, ROPES, LOCKED DOORS AND POST RADIATION WARNING SIGNS IN ACCORDANCE WITH TITLE 10, PART 20 OF THE CODE OF FEDERAL REGULATIONS. IF NECESSARY POST GUARDS TO INSURE THAT NO ONE ENTERS THE AREA.

(2) IMMEDIATELY NOTIFY THE FOLLOWING BY TELEPHONE OR TELEGRAPH:

A. NUCLEONICS DIVISION
TECHNICAL SERVICES
OFFICE OF CIVIL DEFENSE

DEPARTMENT OF THE ARMY
PENTAGON, WASHINGTON, D. C. 20310
Phone: Area Code - 202 OX 5-2519

B. RADIOLOGICAL DEFENSE OFFICER OF THE APPROPRIATE OCD REGIONAL OFFICE

c. If exposure rates at a distance of one foot from the Calibrator are not greater than 2 mR/hr proceed with the check of the Calibrator.

d. Place the detector of the CD-V-700 on the external surface of the Calibrator. The radiation exposure rate must not exceed 2 mR/hr at any point on the external surface for any position of the RADIATION-LEVEL SELECTOR wheel. If surface exposure rates of 2 mR/hr or above are encountered, immediately notify (2) A and B above.

e. Record all data on the Exposure Rate Log Sheet

2. WIPE TEST. The contaimination hazard is controlled by containing the cesium source within a system of sealed vessels as described by Section I of this manual. The following wipe test procedure is established to ascertain that sealing has not been impaired. Wipe test smears must be taken of the unsealed end of the source confinement cylinder at intervals of not more than six months. The test must be conducted by (or under the direction of) a Radiological Protection Officer or qualified Health Physicist. The following procedure must be followed:

a. Lock Radiation-Level Selector Wheel in SAFE position. Observe SAFE green indicator.

b. Remove extension power cord from power plug on left end of cabinet.

c. Remove access cover on left side of cabinet (ref. figure 1-3).

d. Place detector of CD-V-700 near open access port. PERFORM RADIATION EXPOSURE RATE CHECK AS DESCRIBED IN SECTION 2-4.1 ABOVE.

e. Using Whatman No. 50 (or equivalent) filter paper, smear the protruding portion of the source plug container (ref. figure 1-2).

f. Evaluate the smear with an appropriate G-M counter or a gas flow proportional counter at a known counting efficiency, E cpm/dpm (counts per minute/disintegrations per minute). Convert net count rate to units of microcuries using the appropriate E factor. Compare the results with the allowable limit of 0.005 microcurie activity. If 0.005

MICROCURIE OR MORE OF GROSS BETA GAMMA ACTIVITY IS DETECTED IMMEDIATELY NOTIFY BY TELEPHONE OR TELEGRAPH, THE NUCLEONICS DIVISION OF THE OFFICE OF CIVIL DEFENSE AND THE RADIOLOGICAL DEFENSE OFFICER OF THE APPROPRIATE OCD REGIONAL OFFICE. THE CALIBRATOR AREA MUST BE CLEARED OF PERSONNEL AND IMMEDIATELY CHECKED FOR CONTAMINATION. ALL CONTAMINATED AREAS MUST BE RESTRICTED FROM USE UNTIL CLEANED UNDER THE SUPERVISION OF A QUALIFIED HEALTH PHYSICIST, AND ALL REQUIREMENTS OF TITLE 10 PART 20 OF THE CODE OF FEDERAL REGULATIONS ARE SATISFIED.

g. When it is necessary for personnel to enter the area prior to the institution of and during decontamination operations, protective clothing, gloves and footwear should be utilized. If airborne Cs 137 contamination above 1×10^{-8} microcurie per milliliter is present, dust respirators or supplied-air masks should be worn. Contamination control procedures to prevent the spread of radioactive contamination should be utilized with established buffer zones for the changing of contaminated, protective clothing. Ventilation of the radioactive contaminated area should not be performed without control of the effluent air to prevent spread of the contamination. All operations must be carried out under the direct supervision of a qualified health physicist.

h. The disposition of a Calibrator with a leaking radioactive source must be handled directly by the Office of Civil Defense. No attempt to stop the leakage or to dispose of the source shall be made without the written approval of the Radiation Protection Officer of the Office of Civil Defense.

i. Record all Wipe Test results in the permanent Wipe Test Record of the Calibrator, and replace the access cover and safety wire the bolts.

2-8. ELECTRICAL HAZARDS

1. DESCRIPTION OF THE HAZARD. Since the calibrator is connected to 115-volt power, it possesses the same shock and burn hazards common to all electrically-powered equipment. The hazards are controlled by grounding the calibrator frame to the ground wire in the extension cord and by fusing one side of the power at the cabinet main switch.

2. PROTECTION. When maintenance is performed inside the cabinet, the following procedures should be observed:

a. If maintenance is related to the radiation source or to a mechanical difficulty, remove power cord from the input power plug at the

left end of the cabinet.

b. If maintenance is troubleshooting the electrical circuit, keep power ON only as required. When power is ON, precautions of safe electrical-troubleshooting procedures should be followed.

2-9. FIRE ACCIDENTS

1. DESCRIPTION OF THE HAZARD. Building fires ordinarily do not produce sufficient temperatures to melt or ignite the uranium shield. However, a calibrator exposed to a prolonged fire may be damaged mechanically and electrically. Since it is difficult to determine how damage to the steel structure or other mechanisms will diminish source shielding, the instructions below should be followed:

IN THE EVENT OF FIRE OR EXPOSURE TO ELEVATED TEMPERATURES:

a. KEEP THE CALIBRATOR AS COOL AS POSSIBLE DURING EXPOSURE

b. THE CALIBRATOR AREA MAY BE A RADIOLOGICAL HAZARD AREA DURING AND AFTER FIRE OR HEAT EXPOSURE.

c. RE-ENTER THE AREA WITH EXTREME CAUTION ONLY AFTER AN EXPOSURE RATE CHECK AND CONTAMINATION CHECK IN ACCORDANCE WITH PAR. 2-4 and 2-7.

d. IMMEDIATELY NOTIFY THE FOLLOWING BY TELEPHONE OR TELEGRAPH:

A. RADIOLOGICAL DEFENSE STAFF
TECHNICAL SERVICES
OFFICE OF CIVIL DEFENSE
DEPARTMENT OF THE ARMY
PENTAGON, WASHINGTON, D.C. 20310
Phone: Area Code: 202 OX 5-2519

B. RADIOLOGICAL DEFENSE OFFICER OF THE APPROPRIATE OCD REGIONAL OFFICE

C. LOCAL CD DIRECTOR OR EQUIVALENT

D. APPROPRIATE AEC COMPLIANCE OFFICE

e. WITHIN 30 DAYS, SUBMIT A WRITTEN REPORT TO:

THE DIRECTOR,
DIVISION OF MATERIAL LICENSING,
U.S. ATOMIC ENERGY COMMISSION,
WASHINGTON 25, D.C. (ALSO SEE DIRECTIONS PAR. 2-11)

2. PROTECTION. Adequate fire protection can be planned for, in large measure, during site selection and calibrator installation. Site selection should be made in accordance with the provisions of par. 3-4. The calibrator itself is not constructed of flammable materials and, with the exception of its painted surfaces, will not support combustion. Local fire prevention personnel should be informed of the radiological hazards.

2-10. TRANSPORTATION ACCIDENTS

1. DESCRIPTION OF THE HAZARD. During shipment and installation, a calibrator might be severly jolted and dropped. IMMEDIATELY CLEAR THE AREA OF PERSONNEL AND CHECK EXPOSURE RATES IN ACCORDANCE WITH THE INSTRUCTIONS OF PAR. 2-7.1. This check will determine whether faults have occurred in the shielding through which significant gamma radiation is emitted.

2. PROTECTION. The Calibrator is designed and constructed to withstand the shock and vibration. Normal in-transit shock and vibration would not be expected to cause shielding or structural failure. Precautionary exposure rate checks must be conducted, however, in accordance with the instructions of this manual, after shipment or other shock and vibration exposure. No attempt should be made to service the instrument until authorized by the Radiological Defense Officer of the appropriate OCD Regional Office.

2-11. ADDITIONAL REPORTING REQUIREMENTS

In addition to the reports required by paragraphs 2-7,and 2-9 above, notifications and reports as specified in Title 10, Part 20 of the Code of Federal Regulations, paragraphs 20.402 and 20.403 must be made immediately or within 24 hours as required to (1) The Director of the appropriate AEC Regional Compliance Office or the appropriate State Licensing Agency, (2) Nucleonics Division, Technical Services, Office of Civil Defense, Washington, D.C. 20310, Phone: Area Code 202, OX 5-2519 and (3) The Radiological Defense Officer of the appropriate OCD Regional Office.

2-12. Also, a written report must be made within 30 days to the Division of Material Licensing, U.S. Atomic Energy Commission, Washington 25, D.C. with a copy to the Director of the appropriate AEC Regional Compliance

Office under paragraphs 20.403 and 20.405 of 10 CFR 20. If a wipe test on the calibrator indicates the presence of 0.005 microcurie of gross beta-gamma activity, the Division of Material Licensing must be notified with a copy to the appropriate AEC Regional Compliance Office.

SECTION III

SHIPMENT AND INSTALLATION

3-1. SHIPMENT

3-2. When the calibrator must be moved, reshipped, or relocated, the Radiological Defense Officer of the appropriate OCD Regional Office must be notified in writing immediately. In addition to instructions for shipment and special handling at destination, the paragraphs below outline steps to be followed when preparing the calibrator for shipment.

3-3. CALIBRATOR PREPARATION. When preparing the calibrator for shipment, follow the steps of this procedure:

a. Perform wipe test and record data. Refer to procedure outlined in paragraph 2-7.2.

b. Remove interlock-mechanism, safe-secure bolt from the accessory box.

c. Fix interlock mechanism in SAFE position with the safe-secure bolt (see figure 1-5). Check that Radiation-Level Selector wheel can be oscillated but not rotated. Safety wire safe-secure bolt.

d. Roll chamber door leftward and place it over the control panel. Block door in place; see figure 3-1 (B).

e. Close lower cabinet cover.

f. Close upper cabinet cover and lock. Mail keys separately by registered mail.

g. Wire seal cabinet covers and radiation-source access port (via hole in bolt heads).

h. Check that the accessory box contains one instruction manual, wipe test and exposure-dose-rate records, extension power cord, calibrator fixtures, sign, spare fuse and replacement lamps.

3-4. PACKAGING PREPARATION. The shipping container for transporting the calibrator must be a sturdy wooden frame.

NOTE

Services of professional movers/riggers should be obtained for crating and moving the calibrator.

a. Prepare platform and crate enclosure. Refer to figure 3-1 (B).

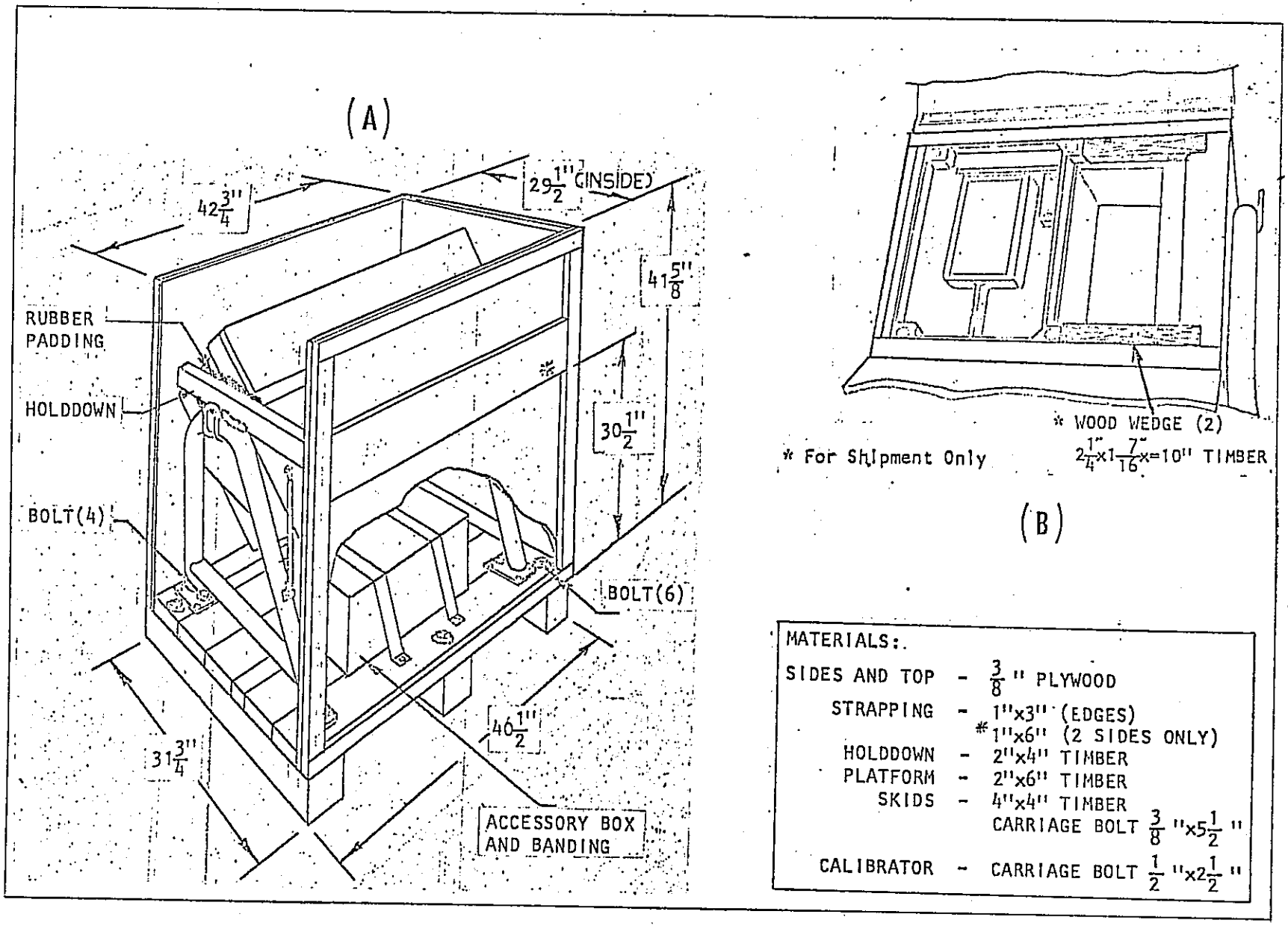


Figure 3-1. Construction Data-Calibrator Shipping Container.

b. Place calibrator on platform and bolt stand legs to platform.

c. Secure accessory box to platform.

d. Cover calibrator and accessory box with a waterproof material.

e. Block the calibrator within the crate as depicted in (A) of figure 3-1.

3-5. SHIPPING INSTRUCTION:

a. The Consignor should utilize only carriers licensed and insured to ship the radioactive materials.

CAUTION

EXTREME CARE MUST BE TAKEN WHEN MOVING OR MOUNTING THE UNIT ON A MOVING VEHICLE. ALWAYS SECURELY BLOCK AND STRAP THE UNIT ON A MOVING VEHICLE.

b. SHIPMENT OF THIS ITEM MUST BE IN ACCORDANCE WITH AEC AND ICC REQUIREMENTS. ICC Regulations applying to the shipment of this Calibrator are published by the ICC Bureau of Operations and Compliance, as 49 CFR, 71-79, Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles. Labels must conform to figure 3-2 in size and data content. The Bureau of Operations and Compliance, Permit Number assigned by the Bureau of Operations and Compliance to this calibrator must be affixed to the equipment and to its shipping container. Samples may be obtained from the Bureau of Operations and Compliance, Washington, D.C. 20423.

c. The Consignor should also assure himself that the Consignee is appropriately licensed to receive the Calibrator (receipt of requested copy of consignee's license prior to release of shipment).

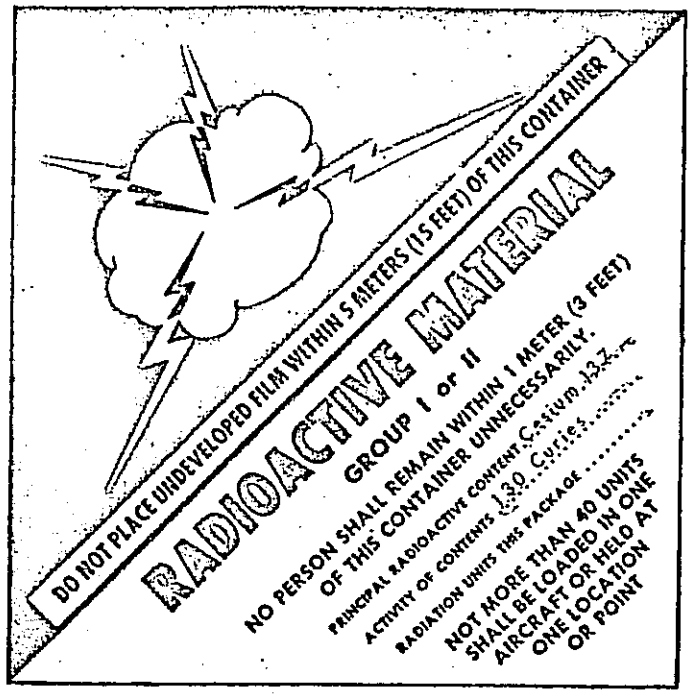
3-6. UNPACKING AND HANDLING PROCEDURES. At destination the calibrator should be unpacked, checked, and moved only in the presence of an authorized health physicist. The instructions and procedures of the following paragraphs assure safe handling.

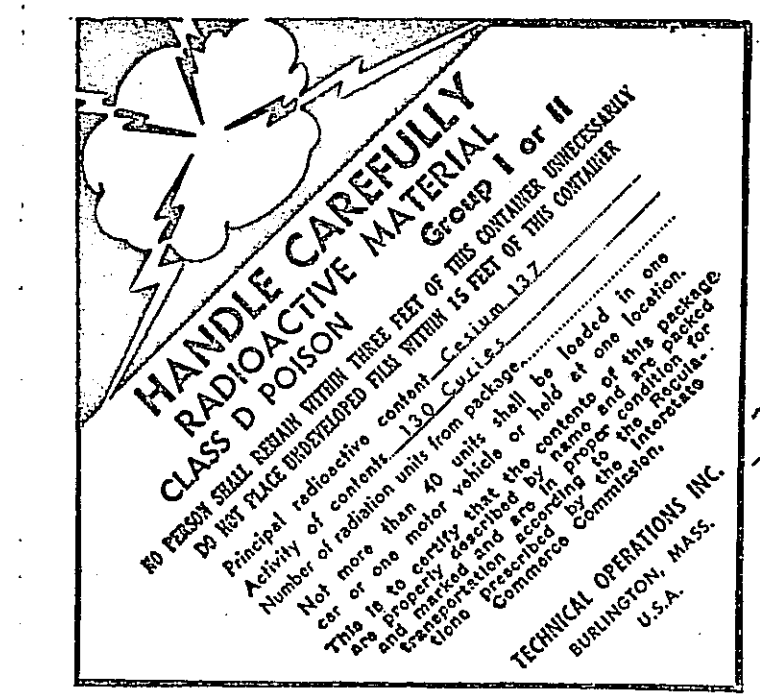
NOTE

An authorized health physicist or radiation officer should receive shipment of the equipment and check it as though the entire unit is a consignment of radioactive materials.

NOTE

Shipping labels to be superseded by the amendment to F.R. 73.414 when approved.





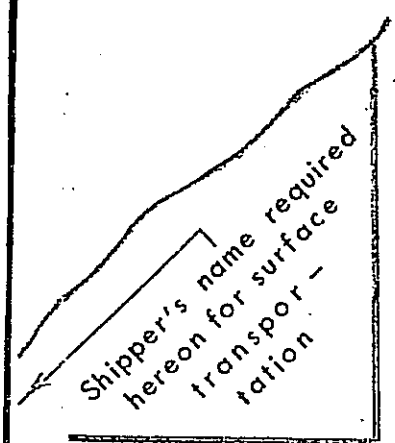


Figure 3-2. Shipping Container Labels.

/WARNING/

IMMEDIATELY UPON ARRIVAL, THE EXPOSURE RATES AT CONTACT WITH THE CRATE MUST BE MEASURED. A CD-V-700 METER MAY BE USED. EXPOSURE RATE AT CONTACT WITH THE CRATE MUST NOT EXCEED 2 MR/HR. IF FOUND TO BE HIGHER, IMMEDIATELY NOTIFY THE APPROPRIATE OCD PERSONNEL AS REQUIRED BY PAR.2-7.1.

a. Uncrate the unit but do not remove from its platform. Store shipping crate - crate can be re-used.

b. Visually check the calibrator for damage and check that the wire-seals are intact. Investigate any discrepancies immediately.

c. Calibrator may be moved by inserting the tines of a forklift under the wooden platform. Exercise greater caution when moving the calibrator in the direction of its short base dimension.

d. Do not transport calibrator to installation site until incoming inspection is completed.

3-7. INCOMING INSPECTION

1. RADIATION INSPECTION:

a. Conduct a complete exposure rate survey in accordance with paragraph 2-7.1.

b. Break wire seal of calibrator cabinet covers and open the covers.

c. Remove wood shipping blocks wedging chamber door.

d. Roll chamber door rightward and place it over exposure chamber. Repeat step a. above. Record data on chart shipped in accessory box.

e. Break wire seal of access cover on left side of cabinet. Remove cover and perform a wipe test on end of source plug container. Refer to procedure outlined in paragraph 2-7.2. Record data on chart in accessory box.

If exposure rates are acceptable, proceed to mechanical and electrical inspection.

2. MECHANICAL AND ELECTRICAL INSPECTION:

a. Check cover lock and handle. Check top cover bumper stops.

b. Open and close covers. Covers should swing smoothly on the hinge. All hinge screws should be tight.

c. Roll chamber door on its rails. A slight force should move it. No binding should be evident.

d. Check cabinet, control panel, and exposure chamber for loose parts.

e. If a mechanical defect is indicated refer to Section V for corrective action.

CAUTION

CONNECT CALIBRATOR TO A 115-VOLT POWER OUTLET ONLY. CALIBRATOR MUST BE GROUNDED. If convenient, use power cord in accessory box.

f. Turn on power at cabinet main switch. Check that main power indicator (green), SAFE radiation-level indicator (green), and chamber lamp are ON.

g. Remove interlock-mechanism, safe-secure bolt and place it in the accessory box.

h. With chamber door in position over exposure chamber, rotate selector wheel to first radiation level indicated (400 R/hr). Check for binding or rubbing. Check that 400 R/hr RADIATION-LEVEL INDICATOR glows.

i. Standing well to the control panel side of the calibrator, try to roll chamber door toward the control panel. It should not roll.

/WARNING/

IF THE DOOR ROLLS OPEN, THE SAFETY INTERLOCK MECHANISM IS DEFECTIVE. PLACE DOOR OVER CHAMBER. TURN SELECTOR WHEEL TO SAFE POSITION. POST A "DO NOT OPERATE" SIGN ON THE EQUIPMENT AND FOLLOW THE CORRECTIVE MAINTENANCE PROCEDURES OF SECTION V.

j. Repeat steps i and j for the 40, 4, and 0.4 R/hr positions of the selector wheel.

k. Re-secure calibrator.

3-8. INSTALLATION

1. SITE SELECTION:

NOTE

THE SITE SHOULD BE SELECTED WITH CONSIDERATION FOR EMERGENCY MEASURES. HAZARDS MAY BE CAUSED BY EXPOSURE OF THE CALIBRATOR TO FIRE OR HEAT (See paragraph 2-9). ORDINARY SAFETY REGULATIONS SHOULD BE IMPLEMENTED DURING SITE SELECTION.

a. The following environmental conditions are desirable but not necessary for calibrator emplacement:

(1) A location in which only work associated with this or similar equipment is performed.

(2) A corner of the room away from entrance and exit.

(3) An overhead sprinkler system.

(4) Availability of decontamination facilities.

b. Installation requirements that provide for safe storage and operator comfort and efficiency:

(1) A work area of two feet on right side and 4 feet in front of calibrator should be made available.

(2) Floor construction must be even and capable of sustaining 1500 lb. dead weight. It should be rated to support the psi loading of each leg pad. (Refer to par. 1-35.)

(3) A source of 115-volt one-ampere power must be available. A grounding type receptacle is required for grounding cabinet to building ground.

(4) Overhead glare-free illumination should be provided.

2. PREPARATION FOR USE:

a. Unbolt the stand from the platform.

b. Remove the calibrator from the platform and place it in the selected area. Check that the calibrator cannot be rocked.

c. Connect extension power cord to cabinet input jack and then to wall outlet. With an ohmmeter, check for continuity between cabinet and building ground.

SECTION IV

OPERATION INSTRUCTIONS

4-1. GENERAL

4-2. Calibrator CD-V-794 Model 2 allows calibration of the four radiation-level ranges for the meters listed in figures 4-1 and 4-2. The instruments are checked at 80% of full scale for each range setting. Because the meters and fixtures require special preparation before emplacement in the exposure chamber, rapid meter calibration is a two-man operation. Refer to figures 4-1 and 4-2 for preparation instructions of the specific meters and fixtures. Good overhead illumination will facilitate the task.

4-3. Before using a new calibrator, verify that the inspection procedures in paragraph 3-7 have been complied with and that the equipment has been properly serviced. The operator should always refer to the calibrator's Instruction and Maintenance Manual as the guide to using and servicing the calibrator. Figure 4-3 is a sample of the worksheet on which calibration results are recorded.

4-4. CALIBRATOR PREPARATION

NOTE

Before proceeding, refer to calibrator manual, Maintenance Instruction, paragraph 5-2. Perform calibration preparation and maintenance concurrently.

If the calibrator has been secured, start at Step a; if not, do steps b, d, e, f, g.

a. Unlock cabinet and open covers.

b. Roll chamber door rightward and place it over exposure chamber.

c. Remove extension cord from accessory case and connect it to the cabinet input jack and then to wall socket.

d. Turn on power at cabinet switch. Check that power ON lamp glows, radiation-level SAFE lamp glows, and chamber lamp is ON.

e. Check all radiation-level indicators by rotating the RADIATION-LEVEL SELECTOR to the 0.4, 4, 40, and 400 R/hr settings. Check that all lamps are ON.

f. Remove required fixtures from accessory case and place on working surface provided.

g. Check that operator maintenance has been accomplished.

4-5. INSTRUMENTS PREPARATION

4-6. The information outlined in figures 4-1 and 4-2 are procedures for preparing meters and fixtures prior to emplacement into the calibrator chamber. The exposure chamber can accommodate meters of different construction. By attaching special fixtures to the meters, proper positioning of the detecting volume is assured. Meters are divided into two categories: meters calibrated via the remote controls (figure 4-1) and meters calibrated via the approximation method (figure 4-2). These figures should be referred to during the calibration process.

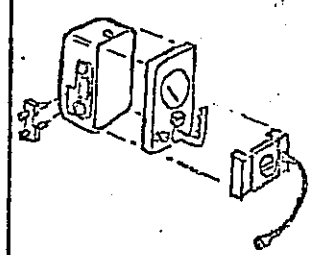
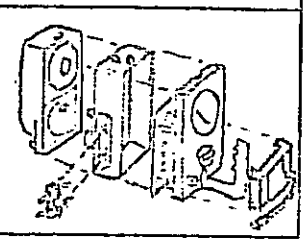
Meter	Procedure	Meter-Fixture Assembly
Lionel 715-1 Landers 715-1A Victoreen 715-1B Victoreen 715-1A	a. Zero meter. b. Perform meter Circuit Check. If not within tolerance, replace batteries and repeat step a. and Circuit Check. c. Remove meter from its case. d. Place and secure meter into its 715 fixture. e. Line up fixture bracket with Jig. (Lay assembly on side opposite bracket.) f. Set range fixture in place. g. Grasp assembly by the handle and place it in the exposure chamber. See step 4-7.1.b.	
Victoreen 717	Except that the meter and the detecting volume are attached separately to the 717 fixture, refer to the procedure outlined for the 715 meter series.	

Figure 4-1. Preparation of Meters Calibrated by Remote Control

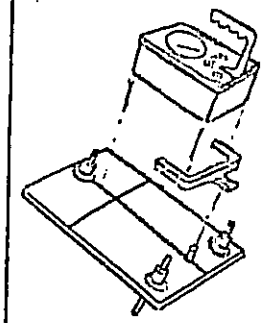
Meter	Procedure	Meter-Fixture Assembly
	1. UNIVERSAL FIXTURE GROUP	
Jordan 710-2 Jordan 710-4 Victoreen 710-3 Victoreen 710-5 Chatham 720 Victoreen 720-2	a. Zero meter. b. Perform Meter Circuit Check. If not within tolerance, replace batteries and repeat step a. and Circuit Check. b. Zero meter. c. Adjust platform leg height. Refer to platform leg-height chart for a meter's required platform height. d. Stand platform on table and loosely tighten fixture shoe to platform. e. Place meter into shoe. f. Center meter's detector volume with platform's beam and center lines (℄'s). NOTE Steps c,d,e,f, and g assure placement of detector volume in center of chamber's radiation zone. g. Tighten shoe in place. h. Remove meter. i. Insert universal fixture into chamber. See NOTE for step 4-10.1.	 Platform Leg-Height Setting Meter / Leg-Adjust Notch 710-2 710-4 710-3 710-5 720 720-2

Figure 4-2. Preparation of Meters Calibrated by Approximation Method (Sheet 1 of 3)

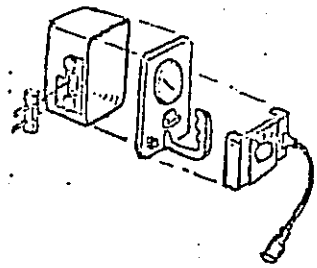
Meter	Procedure	Meter-Fixture Assembly
	2. 715 FIXTURE GROUP	
Landers 720-3 Victoreen 720-3 Victoreen 720-3A	a. Zero meter. b. Perform Meter Circuit Check. If not within tolerance, replace batteries and repeat step a. and Circuit Check. c. Remove meter from its case. d. Place and secure meter into its 715 fixture. e. Line up fixture-adapter socket with jig. (Lay assembly on side opposite socket.) f. *Set range-changer fixture in place. g. Grasp assembly by the handle and place it in the exposure chamber. See step 4-10.2.b. * For preliminary check only.	
	3. 781 FIXTURE	
	To be supplied.	
	4. UNIVERSAL FIXTURE-OTHER METERS	
Unlisted Meters	a. Zero meter. b. Perform Meter Circuit Check. If not within tolerance, replace batteries and repeat step a. and Circuit Check.	

Figure 4-2. Preparation of Meters Calibrated by Approximation Method (Sheet 2 of 3)

Meter	Procedure	Meter-Fixture Assembly
	NOTE The distance, d_m, from center of detector volume to back of meter case determines the height of the platform. Refer to (a), (b) and (c) of diagram. c. Set universal fixture on table. d. Set height of platform by adjusting each leg. Refer to diagram part (b) and (c). e. If d_m is unknown, remove meter from case and measure distance from center of detector volume (see (a) of diagram) to back of case. f. Restore meter to case and do step d. g. Center meter's detector volume with platform's beam and center lines (℄'s). Use fixture shoe if applicable. h. Tighten shoe (if applicable). i. Remove meter from platform. j. Insert universal fixture into chamber. See NOTE for step 4-10.1.	

Figure 4-2. Preparation of Meters Calibrated by Approximation Method (Sheet 3 of 3)

METER & SERIAL NO.	RANGE	METER READING		REMARKS
		ACTUAL	CORRECTED	

Figure 4-3. Sample Worksheet.

4-7. METER CALIBRATION

4-8. Testing and adjusting meters with the calibrator is accomplished in two ways, by remote control and by approximation. The 715 and 717 meters are attached to fixtures by which remote controls have a direct path to the meters' potentiometers and range-control knob. Any other survey meters must be set in the chamber, checked and removed for an approximate adjustment, and then rechecked for accurate scale reading. The process is repeated until a meter is calibrated in all ranges. The paragraphs below outline the calibration method for each process.

4-9. METERS CALIBRATED BY REMOTE CONTROLS. The steps below indicate the procedure for calibrating meters with the remote controls.

a. Prepare worksheet (See sample, figure 4-3)

b. Meters of figure 4-1 are emplaced in the exposure chamber by pressing the meter's fixture-adapter socket into the fixture adapter.

c. Connect flex cable of range-changer fixture to meter-range, remote-control station.

d. Roll chamber door to the right and place it over exposure chamber.

e. By the METER-RANGE CONTROL, set meter range switch to 400 R/hr position. (Observe operation through chamber-door window.)

f. By pulling downward, rotate RADIATION-LEVEL SELECTOR wheel to 400 R/hr position. Observe that 400 R/hr RADIATION-LEVEL INDICATOR glows (red).

g. Through chamber-door window, read needle deflection value on meter scale. Record value on worksheet.

h. Using the METER-SENSITIVITY CONTROL indicated by the radiation-level indicator, set the meter needle on 4 of the scale (80%). Record setting on worksheet.

i. Rotate RADIATION-LEVEL SELECTOR wheel to 40 R/hr position. Observe that 40 R/hr RADIATION-LEVEL INDICATOR glows (red).

j. Set meter-range switch to 40 R/hr.

k. Read needle deflection value on meter scale. Record value on worksheet.

l. Repeat step (h).

m. For radiation-levels of 4 R/hr and 0.4 R/hr, repeat steps i thru l.

n. Rotate selector wheel to SAFE position. Observe that SAFE

radiation-level indicator glows (green).

o. Roll chamber door to the left and place it over control panel.

p. Disconnect flex cable from remote station and depress fixture-clamp lever to release and remove meter from chamber.

q. Restore meter into its case.

r. At end of calibration, secure calibrator as prescribed. Refer to subsection 4-11.

4-10. METERS CALIBRATED BY THE APPROXIMATION METHOD. The subparagraphs below indicate the procedures for calibrating meters that cannot be adjusted by the remote controls.

1. METER CALIBRATION WITH THE UNIVERSAL FIXTURE

NOTE

Prepare universal fixture. It must be emplaced in the chamber before setting the appropriate meter on it. Refer to procedure no. 1 or no. 4 of figure 4-2.

a. Prepare worksheet. (See sample, figure 4-3.)

b. Turn meter-range knob to X100.

c. Set meter in place on the universal fixture.

d. Roll door rightward and place it over exposure chamber.

e. By pulling downward, rotate RADIATION-LEVEL SELECTOR wheel to 400 R/hr position. Observe that 400 R/hr RADIATION-LEVEL INDICATOR glows (red).

f. Through chamber-door window, read needle deflection value on meter scale. Record value on worksheet.

g. If meter indicator is on 4 of the scale (80%), record value on worksheet with appropriate remark and proceed to step m. If not, proceed to step h.

h. Return RADIATION-LEVEL SELECTOR wheel to SAFE position. Observe that SAFE RADIATION-LEVEL INDICATOR glows (green).

i. Roll door leftward and place it over control panel.

j. Remove meter from chamber.

k. Remove meter mechanism from its case and make an approximate adjustment to potentiometer for the X100 range. Restore meter in its case.

l. Repeat steps c thru k until meter is calibrated. When meter reading is correct, record value on worksheet with appropriate remark, then proceed to step m.

m. Return RADIATION-LEVEL SELECTOR wheel to SAFE position. Observe that SAFE radiation-level indicator glows (green).

n. Roll door leftward and place it over control panel.

o. Turn meter range knob to X10 position and do steps d thru n as required.

NOTE

In step e. the RADIATION-LEVEL SELECTOR wheel must be rotated to the 40 R/hr position. RADIATION-LEVEL INDICATOR 40 R/hr glows (red).

p. Repeat steps m, n, and o for ranges X1 and X.1 with the corresponding radiation levels of 4 R/hr and .4 R/hr.

q. When the meter is calibrated, remove meter from the chamber and complete record in worksheet.

r. At end of calibration, secure calibrator as prescribed. Refer to subsection 4-11.

2. METER CALIBRATION WITH THE 715 FIXTURE

NOTE

Range-changer fixture is used during preliminary check only. Do not use during calibration.

a. Prepare worksheet. (See sample, figure 4-3.)

b. Prepare meter (see figure 4-2 procedure no. 2) and emplace assembly in the exposure chamber by pressing the meter's fixture-adapter socket into the fixture adapter.

c. Connect flex cable of range-changer fixture to meter-range, remote-control station.

d. Roll chamber door rightward and place it over exposure chamber.

e. By the METER-RANGE CONTROL, set the meter range switch to 400 R/hr position. (Observe operation through chamber-door window.)

f. By pulling downward, rotate RADIATION-LEVEL SELECTOR wheel to 400 R/hr position. Observe that 400 R/hr RADIATION-LEVEL INDICATOR glows (red).

g. Through chamber-door window, read needle deflection value on scale. Record value on worksheet.

h. Repeat steps f, e and g (in that order) for ranges X10, X1, X.1 and their corresponding radiation levels 40, 4 and .4 R/hr.

i. Set meter range to X100 and return RADIATION-LEVEL SELECTOR to SAFE position. Observe that SAFE radiation-level indicator glows (green).

NOTE

If any meter range needs adjusting, follow steps m thru x. For meters requiring no adjustment, do steps j,k,l,w, and x.

j. Roll chamber door to the left and place it over control panel.

k. Disconnect flex cable from remote station. Depress fixture-clamp level to release and remove meter from chamber.

l. Remove range-changer fixture from meter

m. Remove meter mechanism from fixture, make an approximate adjustment to potentiometer for range out of calibration or for one of the ranges out of calibration, starting with highest range, and re-attach meter to fixture.

n. Emplace assembly onto the fixture adapter

o. Roll chamber rightward and place it over chamber.

p. By pulling down, rotate the RADIATION-LEVEL SELECTOR wheel to the radiation level that corresponds to the meter range under calibration.

X100 - 400 R/hr
X10 - 40 R/hr
X1 - 4 R/hr
X.1 - .4 R/hr

q. Through door window, read needle deflection on meter scale. Record value on worksheet.

r. If meter needle does not indicate 4 on scale (80%), repeat steps i thru q except l until range is calibrated.

s. Repeat steps i thru q except l for all uncalibrated ranges until meter is calibrated.

t. Set meter range to X100 and return RADIATION-LEVEL SELECTOR to SAFE position. Observe that SAFE radiation-level indicator glows (green).

u. Roll chamber door to the left and place it over control panel.

v. Remove meter from chamber

w. Remove meter from fixture and restore meter into its case.

x. At end of calibration, secure calibrator as prescribed. Refer to subsection 4-11.

4-11. SECURING THE CALIBRATOR

4-12. An unattended calibrator should be secured. Upon completion of tests and calibration and during tests requiring radiation exposition time, secure the calibrator if it is left unattended. Locking holes in the RADIATION-LEVEL SELECTOR wheel allow pad locking of the wheel at a desired radiation level. To secure the calibrator, follow these steps:

a. Rotate the RADIATION-LEVEL SELECTOR wheel to the SAFE position. Observe that the SAFE radiation-level indicator glows (green).

b. Place the chamber door over the control panel by rolling it to the left.

c. Turn off the main power at the switch on the left end of calibrator. Observe that main-power indicator lamp and chamber lamp are OFF.

d. Close lower and upper covers and lock.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. PREVENTIVE MAINTENANCE

The Calibrator normally requires only the limited operator maintenance given in this Section. Due to the presence of the cesium radioactive source and to certain calibrator parts which have been precisely adjusted for instrument calibration purposes, NO OTHER ADJUSTMENTS OR REPAIRS SHOULD BE ATTEMPTED. Any malfunction not described in this Section must be reported immediately to the Nucleonics Division, Technical Services, Office of Civil Defense, Department of the Army, The Pentagon, Washington, D.C. 20310.

5-2. OPERATOR MAINTENANCE. Operator maintenance assures longer, uninterrupted calibrator service. Routine inspection and calibrator care, as outlined in figure 5-1, is suggested as a step preceding the daily use of the calibrator.

Procedure	Corrective Action
NOTE All parts are designed for smooth operation. Apply gentle force when handling controls and chamber door.	
1. Inspect cabinet and stand for paint chips, scratches, rust, loose parts and broken parts	1. Tighten and secure loose parts. Report paint chips, scratches, rust, or broken parts to Maintenance Supervisor.
2. Check power cord for cracks and fraying.	2. Replace.

Figure 5-1. Operator Routine Maintenance (Sheet 1 of 2)

Procedure	Corrective Action
3. Check for defective lamps.	3. a. Replace: chamber lamp power indicator lamp SAFE lamp b. Report for repair: radiation-level indicator lamps other than SAFE.
4. Dust and clean the calibrator	4. a. With a dry lint-free cloth wipe control panel, chamber, covers, rail grooves, and outside surfaces. b. Wash writing surface of lower cover with mild soap. (Any other surface except lead-glass window and rail grooves may be carefully washed with mild soap.)
5. Clean accumulated dirt in rail grooves.	5. Clean rail grooves with trichloroethylene or other approved solvent.
6. Clean soiled plexiglas window.	6. Wash with mild soap solution.
7. Inspect calibrator fixture for damage or missing parts.	7. Report defective and damaged parts to Maintenance Officer for repair. Replace missing parts. Refer to Parts List.

Figure 5-1. Operator Routine Maintenance (Sheet 2 of 2)

5-3. PERIODIC MAINTENANCE. Periodic Maintenance assures personnel safety and equipment operational readiness.

1. RADIOLOGICAL PROTECTIVE PROCEDURES. Wipe tests must be made on the equipment at intervals not to exceed six months. This test is normally conducted by a trained radiological technician according to the procedures given by the preceding paragraph 2-7.2.

2. 2-YEAR ADJUSTMENT OF DECAY COMPENSATOR. Every two years a technician will change the decay disc setting to diminish attenuation in radiation beam path.

a. Place CD-V-715 meter in exposure chamber and close chamber door.

b. Rotate RADIATION-LEVEL SELECTOR wheel to 400 R/hr and record in permanent log radiation level of chamber.

c. Remove calibrator nameplate on the control panel.

d. Refer to chart on back of nameplate for disc setting data.

e. Pull back lock pin and rotate disc clockwise enough to clear hole.

f. Release lock pin and rotate disc until pin engages next hole.

g. Check new hole number against chart data.

h. Read meter in chamber to verify that radiation level has increased approximately 5 percent. Record reading in permanent log.

i. Replace nameplate on the control panel.

5-4. CORRECTIVE MAINTENANCE

5-5. Corrective action listed in figure 5-2 is calibrator maintenance that should be performed only by a qualified technician. A parts list in Section VI is provided for identification and procurement of parts needing replacement.

CAUTION

THE OPERATOR/TECHNICIAN IS PROHIBITED FROM ATTEMPTING ANY CORRECTIVE MAINTENANCE NOT GIVEN IN THIS TABLE. IN THE EVENT OF MALFUNCTIONS NOT LISTED, NOTIFY THE NUCLEONICS DIVISION, TECHNICAL SERVICES, OFFICE OF CIVIL DEFENSE, DEPARTMENT OF THE ARMY, THE PENTAGON, WASHINGTON, D.C. 20310.

Trouble	Probable Cause	Corrective Action
1. All or any lamps OFF.	1. No power. Power not connected. Faulty extension cord. Burned fuse. Faulty main switch. Faulty limit switch. Poor electrical connections.	1. a. Replace lamps, fuse and extension cord as required. b. Troubleshoot electrical circuitry. NOTE Main switch plate and RADIATION-LEVEL INDICATORS plate are removed by unscrewing bolts. Wiper-contact assembly can be reached by removing calibrator access cover. To service limit switch, chamber door must be removed. Refer to procedure below, step 2.a to 2.h except 2.e.
2. Soiled chamber-door window (chamber side).		2. Clean window. NOTE Door must be removed a. Place RADIATION-LEVEL SELECTOR wheel to SAFE position.

Figure 5-2. Trouble Analysis Procedure (Sheet 1 of 6)

Trouble	Probable Cause	Corrective Action
2. Soiled chamber-door window. (Continued)		WARNING A RADIATION HAZARD EXISTS IF DOOR IS REMOVED WITHOUT SAFE SECURING THE INTERLOCK MECHANISM 2. b. Secure interlock mechanism by screwing safe-secure bolt in place through access hole in the control panel. c. Remove rail-assembly end-travel bar on control panel side. CAUTION DOOR WEIGHS 70 lb. BE CAREFUL NOT TO SOIL OR DAMAGE LEAD GLASS WHEN HANDLING CHAMBER DOOR. d. Remove chamber door from rail assembly. e. Avoid touching the glass. Wash glass with either distilled water, carbon tetrachloride, or alcohol. As a final operation always wash glass with distilled water. Do not allow a cleaning agent to remain on glass surface for any length of time. To clean surface under plexiglas shield, remove plexiglas.

Figure 5-2. Trouble Analysis Procedure (Sheet 2 of 6)

Trouble	Probable Cause	Corrective Action
2. Soiled chamber-door window. (Continued)		2. f. Replace door in rail assembly. g. Replace end-travel bar and bolt in place. h. Remove and store safe-secure bolt.
3. Broken chamber-door window.	3. a. Crack in lead glass.	/WARNING/ A CRACKED GLASS IS A POTENTIAL HEALTH HAZARD. BEFORE USING CALIBRATOR DO AN EXPOSURE RATE CHECK ON ITS EXTERIOR SURFACE. 3. a (1) If a radiation level is safe on exterior surface, the calibrator may be used; if not, secure the calibrator. (2) Contact Radiological Defense Staff, Office of Civil Defense, Pentagon, Washington, D.C.
	3. b. Missing glass fragments.	/WARNING/ CRACKED GLASS THAT IS CHIPPED OR A GLASS THAT HAS PIECES MISSING MAY BE A RADIOLOGICAL HAZARD. 3. b (1) By an exposure rate

Figure 5-2. Trouble Analysis Procedure (Sheet 3 of 6)

Trouble	Probable Cause	Corrective Action
3. Broken chamber-door window. (Continued)		3. b (1) check, see par. 2-7.1, determine if radiation level is safe; if not, secure calibrator. (2) Contact Radiological Defense Staff, Office of Civil Defense, Pentagon, Washington, D.C.
4. Chamber door does not roll easily.	4. a. Dirt in rail grooves.	4. a (1) Remove door. Refer to steps 2.a to 2.d above. (2) Clean rail grooves using a soft lint-free cloth and tricloro-ethylene or other suitable solvent. (3) Install door Refer to steps 2.f to 2.h above.
	4. b. Dirt on roller bearings.	4. b (1) Remove door (2.a to 2.d above). (2) Check that all bearings turn. (3) Clean surface of roller bearing. Use solvent sparingly and a soft lint-free cloth. (4) Install door (2.f to 2.h above).
	4. c. Damaged bearing.	4. c (1) Remove door (2.a to 2.d above). (2) Check that all bearings turn.

Figure 5-2. Trouble Analysis Procedure (Sheet 4 of 6)

Trouble	Probable Cause	Corrective Action
4. Chamber door does not roll easily. (Continued)		4. c (3) With a screwdriver, unscrew damaged bearing and replace with a new one. (4) Install door (2.f to 2.h above).
5. Handwheel turns when chamber door is partially open.	5. Broken or disconnected parts. Damaged interlock mechanism.	WARNING A POTENTIAL HEALTH HAZARD EXISTS SINCE DOOR MAY BE OPENED WHEN THE HIGH RADIATION INTENSITIES ARE BEAMED INTO CHAMBER. 5. Place chamber door over chamber. Perform a radiation check according to paragraph 2-7.1. Follow all directions. Contact Radiological Defense Staff, Technical Services, Office of Civil Defense, Pentagon, Washington, D.C.
6. Chamber door can be opened when radiation level in chamber is other than SAFE.	6. Damaged interlock mechanism.	WARNING POTENTIAL HEALTH HAZARD 6. Place RADIATION-LEVEL SELECTOR wheel to SAFE position. Observe SAFE indicator ON. Perform a radiation check according to paragraph 2-7.1. Follow all directions. Secure the calibrator if radiation levels are above normal.

Figure 5-2. Trouble Analysis Procedure (Sheet 5 of 6)

Trouble	Probable Cause	Corrective Action
7. Rubbing or binding.		7. Any rubbing or binding in the mechanisms of the calibrator should be investigated. Avoid prolonged use of calibrator under these circumstances. Take necessary corrective action.

Figure 5-2. Trouble Analysis Procedure (Sheet 6 of 6)

SECTION VI

PARTS LIST

6-1. GENERAL

6-2. The following parts lists provide a comprehensive identification of the Calibrator components. The list includes numerous items which are directly related to calibration accuracy and to the gamma radiation shields. These items are marked with an asterisk and MUST NOT BE ADJUSTED OR REPLACED EXCEPT AS SPECIFICALLY DIRECTED BY THE RADIOLOGICAL DEFENSE STAFF, TECHNICAL SERVICES, OFFICE OF CIVIL DEFENSE, DEPARTMENT OF THE ARMY, PENTAGON, WASHINGTON, D.C.

6-3. When ordering a part, give part name and part number. Table 6-II lists the manufacturers' names and addresses for procurement of commercial items.

TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
D79406-1		STAND*	1
		Leg plate pad	4
D79400		CABINET ASSEMBLY	1
E79401-1		Cabinet	1
B79406-7		Access plate	1
		Cable Port Assembly	1
B79400-9		Cable port	1
		Cable port cover	1
C79401-1A		Divider Plate Assembly*	1
C79401-1B		Divider plate	1

* NOT TO BE ADJUSTED OR REPLACED WITHOUT SPECIFIC INSTRUCTIONS OF THE NUCLEONICS DIVISION, TECHNICAL SERVICES, OFFICE OF CIVIL DEFENSE, DEPARTMENT OF THE ARMY, PENTAGON, WASHINGTON, D.C. 20310.

TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
C79401-1C		Divider plate bar	2
A79401-1D		Liner Support	2
A79400-1D		Limit-switch spacer	1
		Interlock-mechanism assembly*	1
D79400-4		Lock-pin-guide bracket	1
B79400-8		Lock pin	1
	1262-FF	"Thompson" nylon bushing	2
		Spring	
B79410-2		Lever bar and pin	1
B79400-5		Limit-switch actuator	1
	CFH-3/4-3	"McGill" cam roller	1
B79410-3		Arm Link	1
B79410-1		Arm-link pivot	1
	A-62	"Vlier" spring plunger	1
	B812-6	"Boston Gear" bronze bearing	1
D79403		Primary Shield Housing Assembly*	1
D79403-1		Main Shield	1
B79403-2		Collimator shield	1
		Attenuator-disc assembly	1
B79403-3		Attenuator disc	1
B79403-6		Attenuator-disc shaft	1
C79403-4		Attenuator-disc index ring	1
B79403-5		Decay compensator disc*	1
C79405		Decay compensator lock assembly*	1
C79405-1		Shield clamp	1
C79405-2		Lock-pin housing	1
C79405-3		Lock pin	1
		Spring	1

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TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
	5100-25	"Truarc" snap ring	1
A79403-11		Thrust washer*	1
C79400-3		Shield-housing bracket*	1
A79400-10		Shield-housing tie rod*	3
		Remote Controls	
		Remote-range control assembly	1
A79414-1		Control knob	1
A79412-2A		Shaft assembly	1
A79414-2B		Bearing	1
	5100-25	"Truarc" snap ring	1
		Remote meter-sensitivity control assembly	1
	116-403	"E.F. Johnson" collect knob	4
A79407-2B		Drive rod	4
	A2-48	"Pic" transmission rod	4
B79407-2A		Screwdriver-blade rod	4
	4BS	Drive-transmission univ. joint (Falcon)	4
A79407-2C		Transmission-blade univ. joint (Falcon-4BS)	4
	B35-4	"Boston Gear" bronze bushing	8
C79407-1		Drive-shaft housing assembly	1
D79400-7		Left Control Panel	1
		Right Control Panel Assembly	1
D79400-6		Right control panel	1
		Calibrator nameplate	1
	A-11	"U.S.Gypsum" Hydrocal	

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TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
D79400-1		Lead Shield*	1
		Chamber Liner Assembly	1
D79400-2		Chamber liner	1
B79408		Fixture-adapter assembly	1
B79408-2		Fixture adapter	1
B79408-1		Fixture-clamp lever	1
B79408-3		Spring	1
	B35-4	"Boston Gear" bronze bearing	
		Chamber-Light Assembly	1
	2423	"Morse" lamp socket	1
	FG648-X	"G.E." lamp	1
B79400-12		Lamp guard	1
D79401		Rail Assembly	1
D79401-2		Door rails	2
D79401-3		Door end-travel bar (chamber side)	1
D79401-4		Door end-travel bar (control panel side)	1
	BH-2096	Rubber bumper	2
D79401-5		Panel support	2
D79401-6		Lever support	2
		Upper cover assembly	1
C79406-2		Upper cover	1
	1704-6T	"Chicago" cabinet lock	1
B79416-1		Chamber-door stay bar	1
		Handle	1
B79406-9		Bumper stop	2
	S-6432	"Bronson" steel hinge	1

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TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
		Lower cover assembly	1
C79406-3		Lower cover	1
B79406-4		Support tube	2
A79406-8		Support tube bushing	2
B79406-5		Support rod	2
A79406-6		Support rod pin	2
	6SS	"Maxwell" collar	2
	S-6432	"Bronson" steel hinge	1
D79402		Chamber-Door Assembly	
D79402-1		Door casting (Mach.)	1
D79402-2		Bezel	1
B79402-3		Window retainer (length)	2
A79402-4		Window retainer (width)	2
A79402-5		Stricker bar	1
A79402-6		Cabinet-lock plate	1
A79402-7		Roller bearing cover	4
	CF-1-3	"McGill" cam roller	8
		"Penberthy" lead-glass window (see Leading Particulars)	1
C79402-10		Window gasket	2
		Lead shot caulking	
A79402-9		Acrylic lead-glass shield	1
A79402-8		Handle	1
	BH-2096	Rubber bumper	2
		Source-Plug Assembly*	1
		Source (see Leading Particulars)	1
B79404-2		Source-plug capsule	1

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TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
B79404-3		Source-plug shields	1
		Spark-plug gasket (15 mm.)	1
		ELECTRICAL CIRCUITRY	
		Radiation-Level Indicators Assembly	1
B79407-3		Face plate	1
	31-211T	"Leecraft" lamp, 115-V, 1/3-W	4
	51-3402-0112-301	"Dialco" lamp holder	1
	6S6 D.C.	"Chilco" miniature lamp, 115-V, 6-W	1
C79413		Power Input and Switch Assembly	1
	4716	"Hubbell" twistlock inlet	1
B79413-1		Face plate	1
	HKP	"Buss" fuse holder	1
	COML	Fuse, 1 ampere	1
	51-3402-	"Dialco" lamp holder	1
	0112-301		
	6S6 D.C.	"Chilco" miniature lamp, 115-V, 6-W	1
	81024GB	"Arrow-Hart" toggle switch	1
		Extension cord assembly	1
	575	"Cornish" plug (or equivalent 3-prong plug)	1
	4730	"Hubbell" twistlock plug	1
	COML	10-ft., 3-wire, 18 AWG, rubber covered, power cord	1
		Wiper-Contact Assembly	1
B79415		Contact support block	1
	MOD833	"Ostby & Barton" contacts	6

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TABLE 6-I PARTS LIST

Drawing Number	Mfg. Part Number	Nomenclature and Description	Units Req'd.
B79415-4		Support-block spacer	2
B79415-2		Wiper disc	1
	6PL41	Limit Switch, "Micro"	1
		FIXTURES	
D79414		Range-Changer Fixture	
B79414-5		Housing Assembly	1
A79414-5B		Clamp	1
	LC-018A-3	"Lee" spring	1
		Drill rod, 1/6" dia. X 1" long	1
A79414-4		Gear Assembly	1
A79414-6		Drive gear	1
B79414-3		Gear retainer cover	1
A79414-7		Flexible shaft	1
C79417		715 Fixture	1
C79417-1		Case	1
B79417-2		Fixture-adapter socket	1
A79417-3		Knurled nut	2
A79417-4		Washer	2
A79417-6		Screw	2
		Dowel pin, 3/32" dia. X 1" long	2
B79412		Socket Alignment Jig	1
A79412-2		Alignment block	1
B79412-1		Alignment pin	2
	5100-25	"Truarc" snap ring	2

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TABLE 6-II LIST OF MANUFACTURERS

Identifier	Manufacturer	Address
"Arrow & Hart"	Arrow, Hart & Hegman	Hartford, Connecticut
"Boston Gear"	Boston Gear Works	Quincy 17, Mass.
"Bronson"	Homer D. Bronson	Beacon Falls, Conn.
"Buss"	Bussman MFG. Division	St. Louis, Mo.
"Chilco"	Chicago Miniature Lamp Co.	Chicago 10, Illinois
"Chicago"	Chicago Lock Co.	4311 W. Belmont Avenue Chicago, Illinois
"Dialco"	Dialight Corporation	60 Stewart Avenue Brooklyn 37, New York
"E. F. Johnson"	E. F. Johnson Company	299 10th Avenue SW. Waseca, Minnesota
"Falcon"	Falcon Machine & Tool Co., Inc.	150 Ballardvale St. N. Wilmington, Mass.
"G.E."	General Electric Co.	Nela Park Cleveland 12, Ohio
"Hubbell"	Harvey Hubbell, Inc.	Bridgeport, Connecticut
"Lee"	Lee Spring Company	30 Main Street Brooklyn, N. Y. 11201
"Leecraft"	Leecraft Mfg. Co.,Inc.	21-16 44th Road Long Island City, N.Y.
"Maxwell"	The R.D. Maxwell Co.	Winchester, Mass.
"McGill"	McGill Mfg. Co.	Valporaiso, Indiana
"Micro"	Micro Switch Comapny	Freeport, Illinois 61032
"Morse"	Frank W. Morse Co.	354 Congress Street Boston, Mass. 02210
"Ostby & Barton"	Ostby & Barton Co.	P.O. Box 6267 Providence 4, R.I.
"Penberthy"	Penberthy Instrument Co.	4301 6th Ave. S. Seattle 8, Washington
"Pic"	Pic Design Corporation	E. Rockway Long Island, N.Y.
"Thompson"	Thompson Industries, Inc.	Manhasset, New York
"Truarc"	Waldes Kohinoor, Inc.	Long Island City,N.Y.
"U.S. Gypsum"	U.S. Gypsum Company	101 South Wacke Drive Chicago, Illinois 60606
"Vlier"	Vlier Engineering Corp.	8900 Santa Monica Blvd. Los Angeles,Calif.90069