71-6717

Tri-State Labs, Inc.
P.O. Box 25578, 224 Commerce St.
Freeport, Texas 77541

PDR

return to

'85 AUG -6 A8:58

3 April 1985 3/6 SS

Director
Nuclear Materials Safety & Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Tri-State Labs, Inc. (Tx Lic.# 11-3802) would like to be registered, in accordance with 10 CFR 71.12(c)(3), as users of the following devices.

Name	Model #	Cert. #	Package I.D. #
Gamma Inds.	6717-B	6717	USA/6717/B
Gamma Inds.	100A	9127	USA/9127/B(U)
Gamma Inds.	C-8	9128	USA/9128/B(U)
Gamma Inds.	50A	9126	USA/9126/B(U)
Gulf Nuclear	20VS & 40VS	9160	USA/9160/B(U)
Source Prod. & Equip. Co.	C-1	9036	USA/9036/B
Tech/Ops	660	9033	USA/9033/B(U)
Tech/Ops	650	9032	USA/9032/B(U)

If you need additional information please contact my office.

Respectfully yours,

TRI-STATE LABS, INC.

Jimmy W. Griffin
Radiation Safety Officer

FEE EXEMPT

25612

DOCKET NO. See ltr

CONTROL NO. 32612

DATE OF DOC. ____

DATE RCVD. ____

FCUF ____

FCAF ____

WM ____

WMUR ____

FCTC ✓

PDR ____

LPDR ✓

I&E REF ____

SAFEGUARDS ✓

OTHER ____

DESCRIPTION:

would like to be registered as users of the following devices)

8/9/85 INITIAL sek

GAMMA INDUSTRIES

250B survey meter

252B survey meter

&

dosimeter calibrator

Instruction Manual

GAMMA INDUSTRIES
A Division of Nuclear Systems, Inc.
2255 Ted Dunham Ave.
P. O. Box 2543 – Telex 586473
Baton Rouge, La. 70821
(504) 388-0600
1-800-535-8132

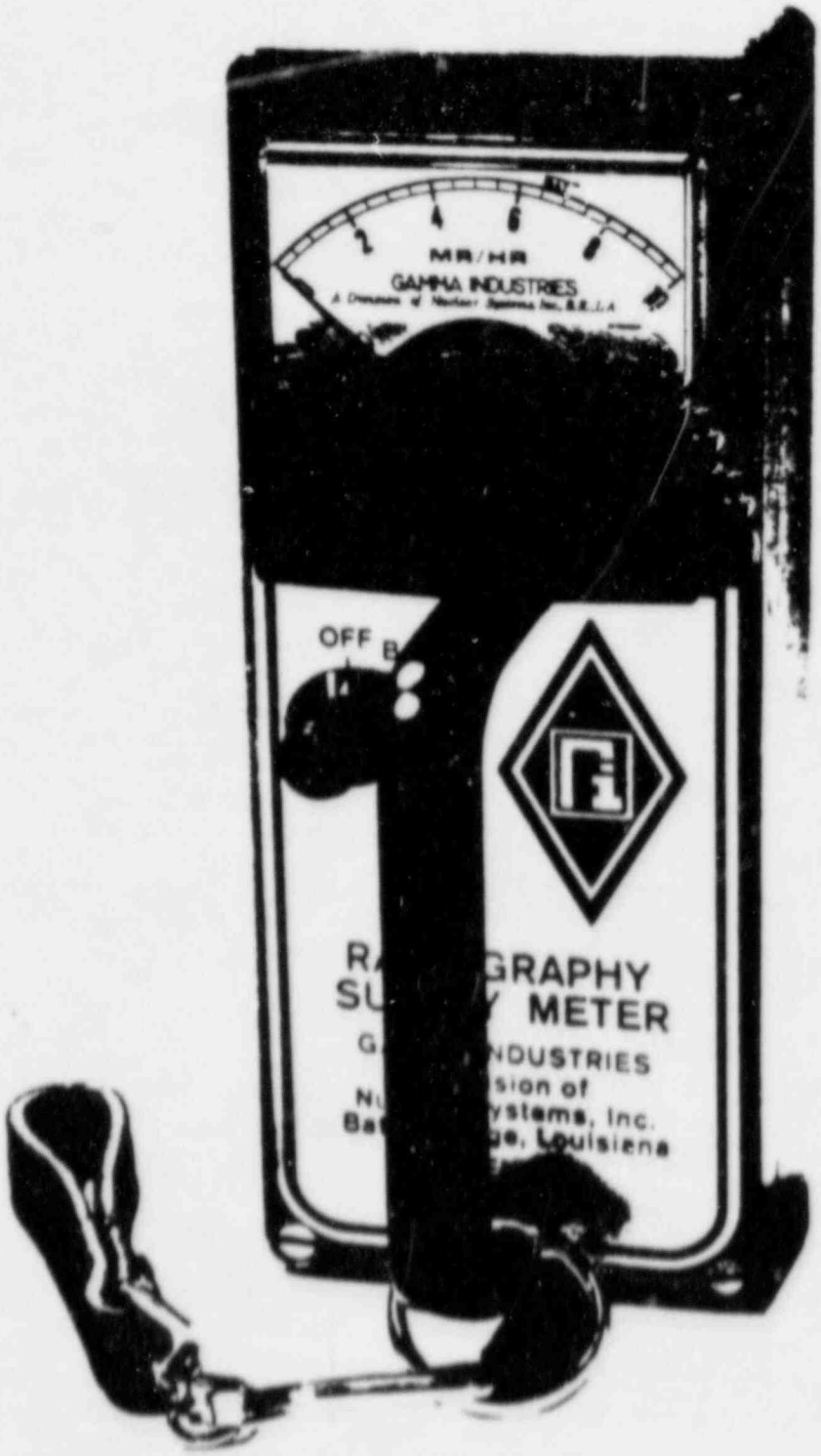


FIGURE 1. RADIOGRAPHY SURVEY METER MODEL 250B

SECTION I

GENERAL

A. PURPOSE

The Gamma Industries Model 250B and 252B Survey Meters are designed to fill the needs and requirements of the industrial radiographer. NRC regulations, size, weight, and reliability were primary considerations in the overall design scheme, while low cost and serviceability were maintained to ensure a practical product for the radiography industry. This effective, yet low cost design, makes the instruments suitable for a variety of applications including nuclear gauging, cobalt therapy, nuclear medicine and education. Elimination of the possibility of reversal in high radiation fields, enhances the versatility of the instruments, particularly in large source radiography applications and cobalt therapy.

B. DESCRIPTION

The 250B and 252B instruments are small, lightweight, rugged geiger counters. Power to the meters is provided by two "D" cells (standard flashlight batteries), which operate from a range of 3.17 volts to 2.76 at 10ma to 3.5ma, resulting in extended battery life. Measurements are displayed on a rugged meter movement, with linear scale marked 0-10 mR/hr. A selector switch provides ranges of 0-10 mR/hr(X1), 0-100 mR/hr(X10), 0-1000 mR/hr (X100). The meters are equipped with three adjustments for accurate calibration on each range. Both models meet the minimum range requirement of 2 mR to 1 R/hr for industrial radiography (10 CFR 34.24) required by NRC and/or agreement states. The 252B is equipped with a built in dosimeter charger.

C. SPECIFICATIONS

1. Detector

a. Fill Gas: NE + Halogen
b. Sensitivity: (Co-60) 1450 CPM @ 3 mR/hr
c. Dead Time: 50 microseconds
d. Housing: 446 SS
e. Operating Voltage: 600 volts

2. Meter

a. Type: 0-100 microamp DC meter
b. Enclosure: Lexan
c. Scale: 0-10 mR/hr

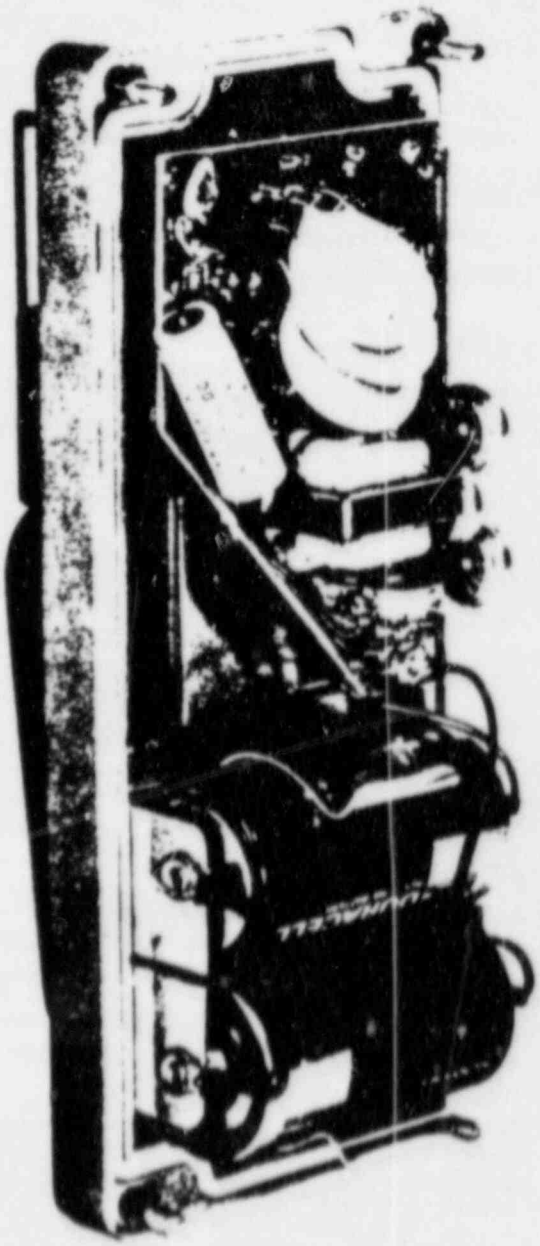


FIGURE 2. MODEL 250B INTERNAL VIEW

3. Mechanical

   a. Weight: 2.5 lbs., 1.133 kilograms
   b. Dimensions: Length - 8", 20.32 cm.
      Height - 4", 10.16 cm.
      Width - 3.25", 8.25 cm.
   c. Case: 1) Fiberglass impregnated polyester
      2) Cover sealed with inlay rubber sponge cord

4. Battery Life

   a. Over 500 hours of continuous usuage with alkaline cells
   b. Varies according to type of batteries used, operating temperature and age of batteries

5. 252B Model

   a. Built in dosimeter charger

SECTION II

OPERATION

A. PREPARATION FOR USE

1. Inspection: The instrument should be checked for physical damage. Open case, make visual inspection, ensure that batteries are securely in place.

B. OPERATING THE INSTRUMENT

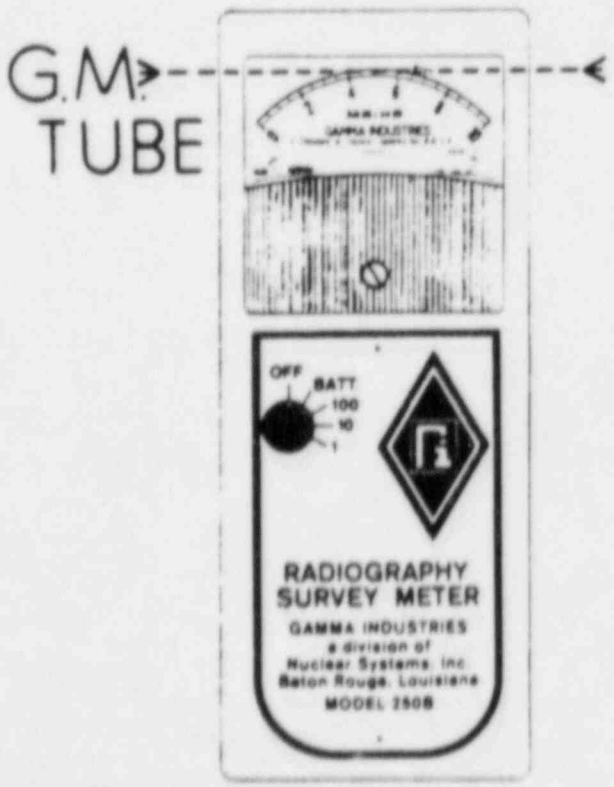
1. Starting: Turn switch to battery check (circuit check) position. The meter should indicate above the check position (to the right). Allow 10-30 seconds for energy to travel through circuits.

2. Select the desired range, use a check source to ensure instrument is operating, if available.

C. READING SCALES

The scales are marked 0-10 mr/hr with a multiplier as selected by the selector switch. Simply read the measurement indicated on the linear scale and multiply by selected number.

The geiger tube is mounted at the extreme front centerline of the meter. For most accurate results, hold the instrument level and perpendicular to the source of radiation.



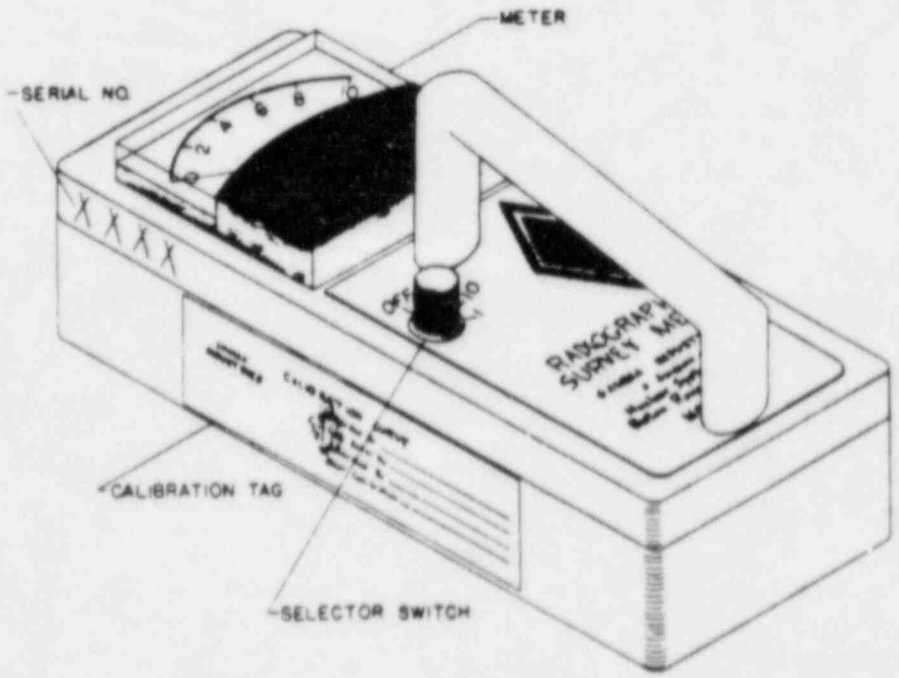


FIGURE 3. OPERATING CONTROLS

SECTION III

THEORY OF OPERATION

A. HIGH VOLTAGE POWER SUPPLY

To provide the H. V. desired to power the geiger tube, a blocking oscillator DC-DC Converter was selected. When power is applied to this circuit, the bias on Q_1 is established through R_2. Initially the collector current of Q_1 passes through the primary of T_1 creating a magnetic flux. This increasing flux induces a voltage in the low voltage secondary of the transformer. Resistor R_1 and C_2 establish a phase shifting network to increase base current in Q_1. This action is regenerative causing a rapid increase in Q_1 collector current until saturation of T_1 occurs. With the characteristic square hysteresis curve of this transformer, when saturation is reached, the low voltage secondary no longer provides the base current of Q_1 and collector current decreases. The decreasing flux in the low voltage winding drives the base of Q_1 negative, forcing it into cutoff. The transistor remains cutoff until the voltage on C_2 decays through R_1 and R_2 at which time the base current again increases. The cycle is repeated and a blocking oscillator is formed with a frequency of about 1000 H_z. C_1 ensures that the oscillator does not lock into high frequency oscillation. This effect induces a high voltage wave form into the high voltage secondary, this is rectified, filtered and trippled to provide the high voltage for operation. Regulation of the high voltage is attained using a corona discharge VR tube. This tube is conducting when the applied voltage reaches 600 V.

B. COUNTING CIRCUIT

As high energy particles pass through GM detector GM_1, ionization of the gas mixture within the tube occurs. This causes a pulse of approximately 4 volts peak to peak to trigger the input (Pin 8) of monostable multivibrator U_1. U_1 converts this stream of pulses from the GM tube into square wave pulses at its output (Pin 10). These square wave pulses vary in length according to the time constant chosen by selector switch S_1B (R_5 giving the shortest duration, R_7 the longest). Resistors R_8, R_9, and capacitor C_8 form an integrator which provide a linear analog reading across meter M_1. Capacitor C_7 acts as a bandpass to ensure linearity of the integrator for high scale readings of meter M_1.

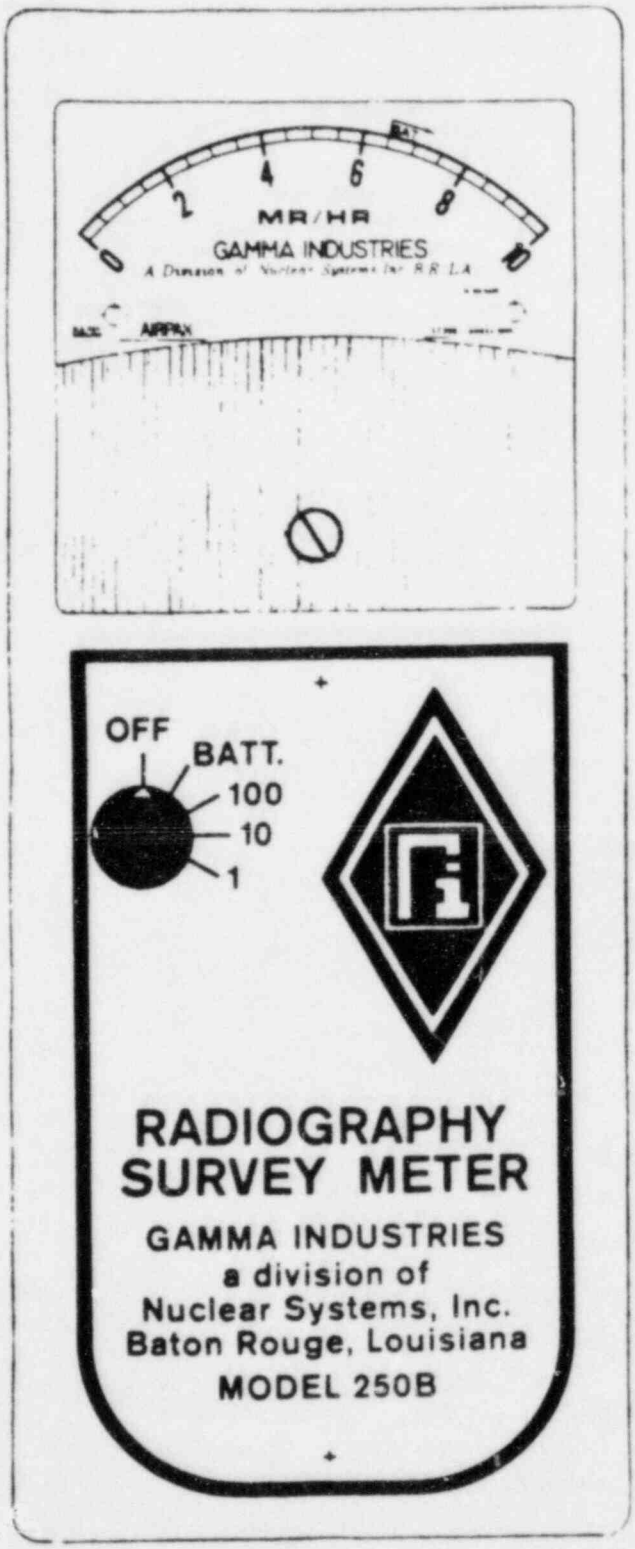


FIGURE 5. SELECTOR SWITCH AND SCALE

SECTION IV

MAINTENANCE

A. CALIBRATION

When the survey meter is shipped from the factory, new batteries are installed and the instrument is calibrated. The date of calibration is stamped on the calibration card and attached to the meter. Barring any damage in shipment, the instrument is ready for use.

When the instrument requires re-calibration, turn the function selector to the X1 position and place the instrument in a known field of radiation, 3 mr/hr and 7 mr/hr and adjust the calibration control for the proper readings. Clockwise rotation will increase the reading and counter-clockwise rotation will decrease the reading. Once the instrument has been calibrated on the X1 scale repeat for the X10 scale and X100 scale with the instrument in a known field of radiation of 30 mr/hr and 70 mr/hr for X10 and 300 mr/hr and 700 mr/hr for X100. The NRC requires that all survey meters be checked and calibrated every 90 days.

If it is found that H.V. is not at or near 600 V, install a milliamp meter in series with the battery line. Turn selector switch to X1, X10, or X100, set current drain at 10ma DC. This should be done with new batteries.

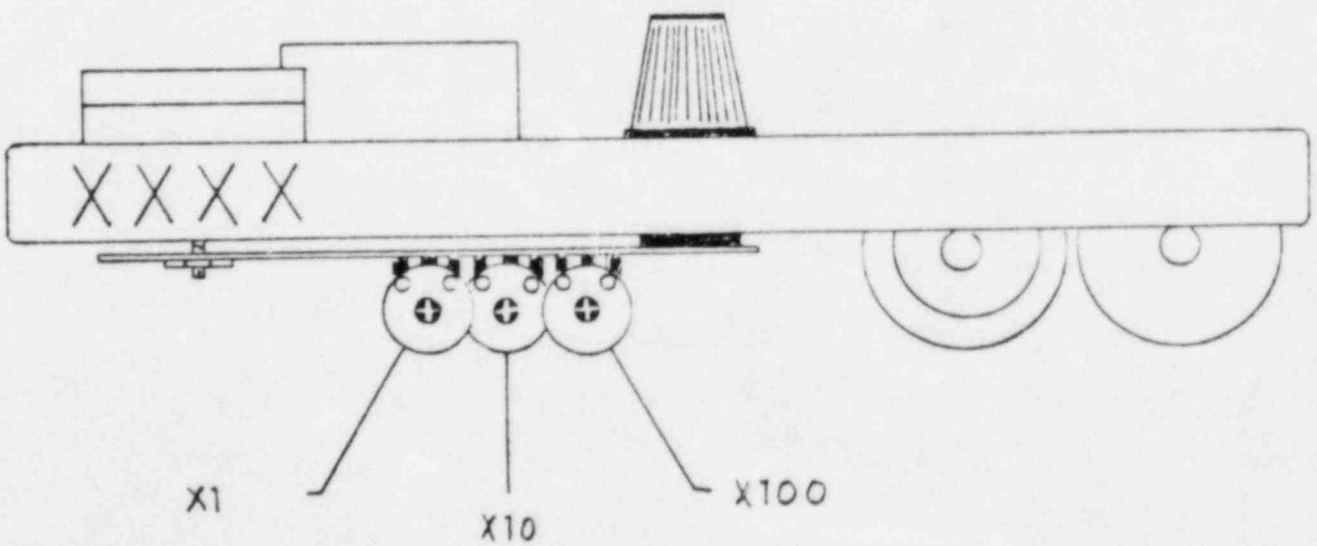


FIGURE 6. CALIBRATION

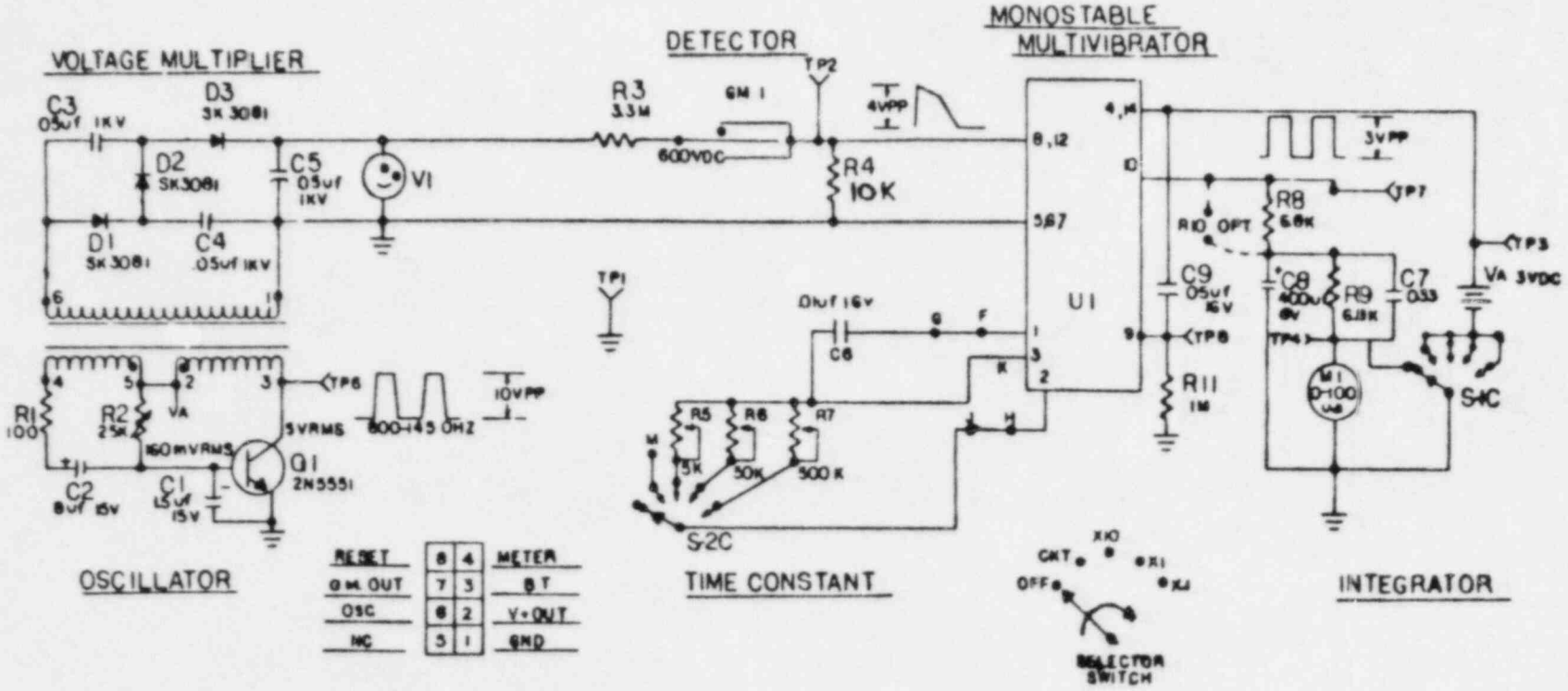
B. Trouble Shooting

** Caution** This meter employs CMOS circuitry. Only Qualified servicemen should be allowed to trouble shoot.

To discharge high voltage, with switch off, connect jumper momentarily from negative side of battery to positive side of V2 (+600). Do not short directly across V2 as this will result in component damage.

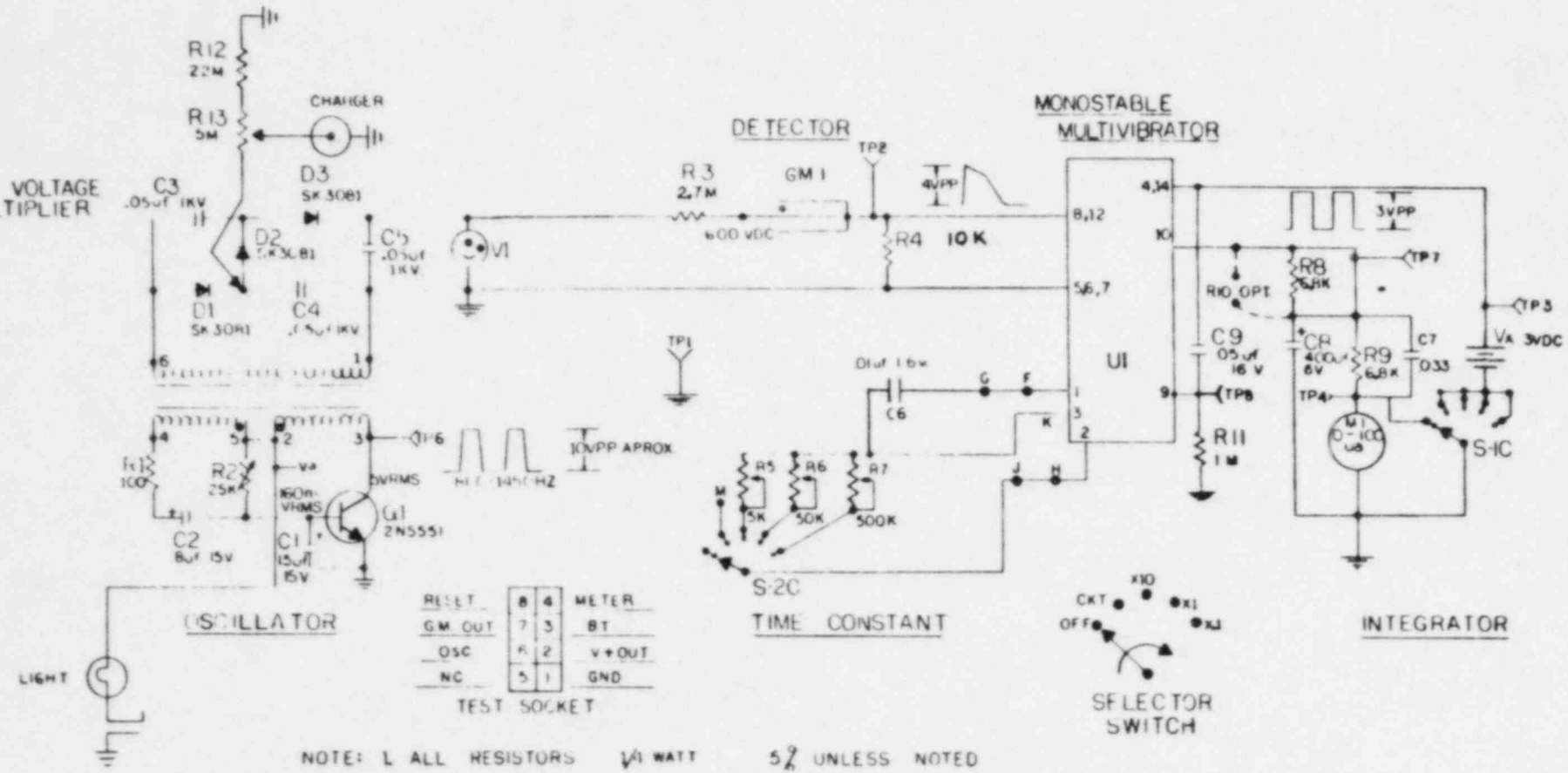
SITUATION		INDICATION		SOLUTION
1. Battery/CKT Check Shows	A.	Indication but Less than Full Scale	A.	Replace Battery
	B.	Slow response 30 Sec to Full Scale	B.	H.V. Adjust
	C.	No Response	C.	1. Check Battery Connections 2. H.V. Adjust 3. V_2 4. GM Tube 5. Meter Movement 6. Switch
2. Instrument operates on check but no all ranges	A.	No Indication any range	A.	Replace Switch S_1
	B.	One or more ranges operating	G.	Check R_5-R_6-R_7 and replace as required
3. Instrument on any range	A.	Erratic Indication	A.	Check Tightness of Meter Lugs
	B.	Meter Reads Less Than Zero	B.	With Instrument off adjust mechanical zero

NOTE - -
This instrument should be serviced by qualified personnel with proper tools and training. Identical components must be used for replacement to insure proper operation.



NOTE: 1 ALL RESISTORS 1/4 WATT 5 UNLESS NOTED
2 ALL VOLTAGES MEASURED TO GROUND
3 HIGH VOLTAGE SHOULD BE MEASURED WITH H.V. PROBE

GAMMA INDUSTRIES B.R.L.A.	
NONE / 9-25-78	KH
SCHEMATIC, SURVEY METER	
MODEL 250B	

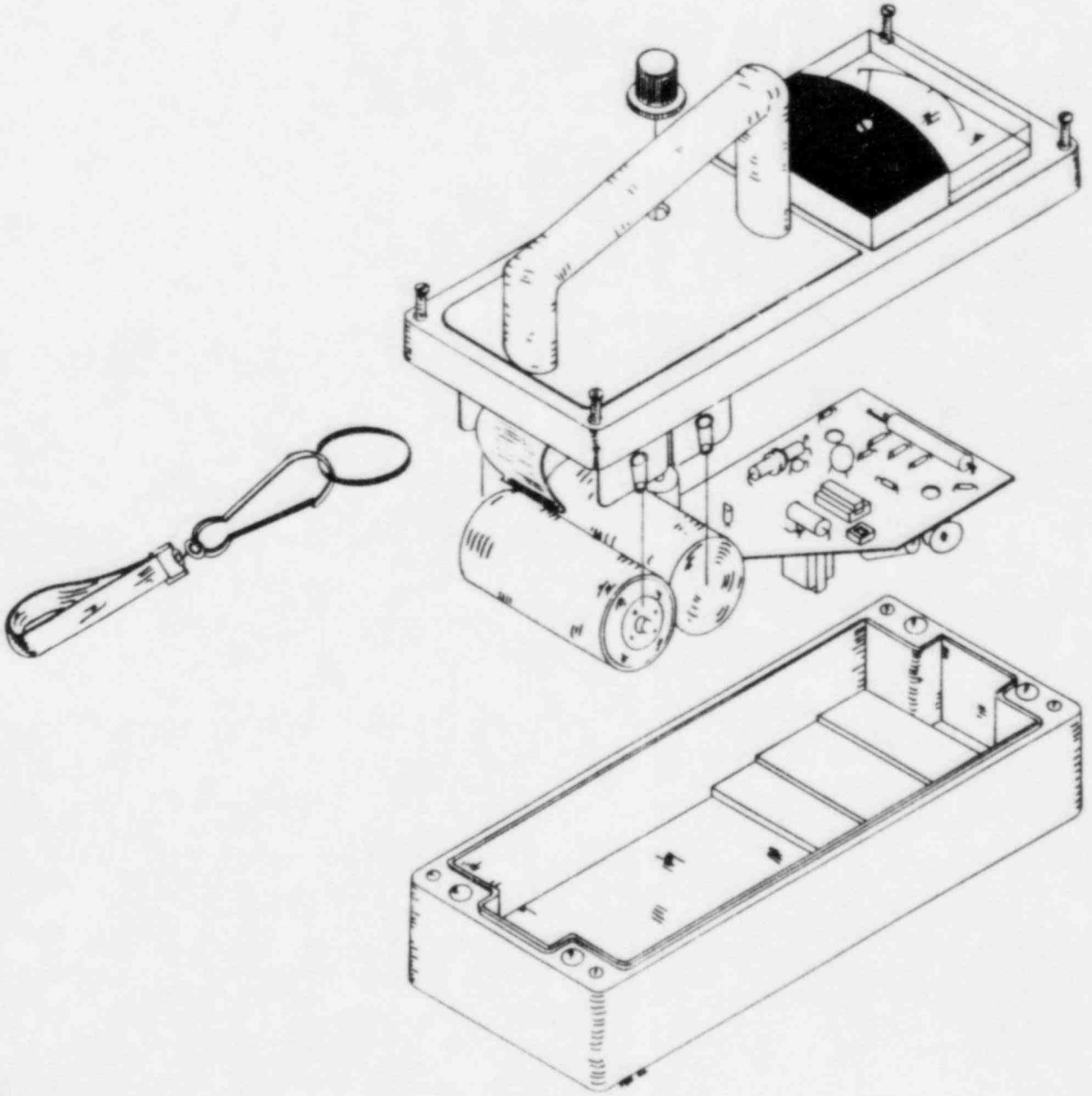


NOTE: 1. ALL RESISTORS 1/4 WATT 5% UNLESS NOTED

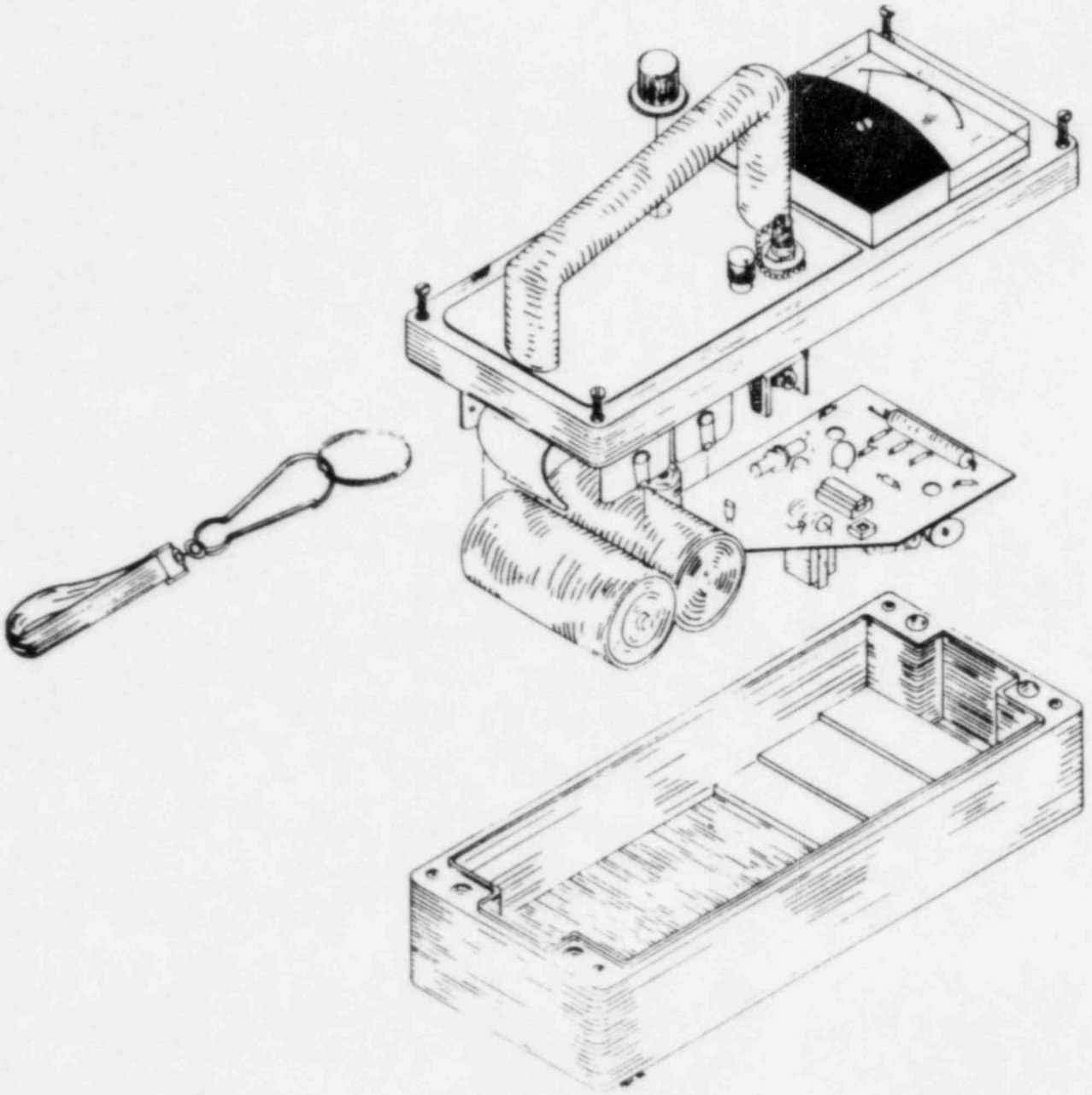
2. ALL VOLTAGES MEASURED TO GROUND

3. HIGH VOLTAGE SHOULD BE MEASURED WITH H.V. PROBE

GAMMA INDUSTRIES B.P. LA.	
SCALE NONE	DRAWN BY L. Ian Riddell
DATE 9-25-78	CHECKED BY K.H.
SCHEMATIC, SURVEY METER	
MODEL 252B	DRAWING NO. 6010-050



GAMMA INDUSTRIES	B.R.L.A.
NONE	FRED
5-27-80	ORIG.
SURVEY METER	
MODEL 250B	601-700-025



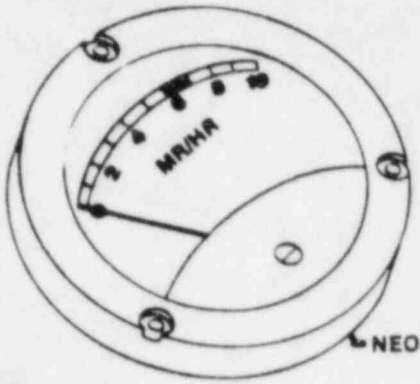
GAMMA INDUSTRIES B.R.L.A.		
NONE		FRED
5-27-80		DRG
SURVEY METER		
MODEL 252B		607-100402A

G. E. Smith & Associates
919 HERBERT • PASADENA, TEXAS 77506 • 713 / 475-2986

MODEL GS-2000

RUGGED, WATERPROOF AND DUSTPROOF RADIOGRAPHIC SURVEY METER

MODEL GS-2000
WATERPROOF AND DUSTPROOF SURVEY METER ENCLOSURE



RUGGEDIZED TRIPLET METER INDICATOR CONFORMS TO MILITARY SPEC. NO. MIL-M-10304.

NEOPRENE GASKET.

MONEL MOUNTING SCREWS CAPTIVATED IN COVER.

ROTARY SHAFT SEAL
MILITARY SPEC. NO. MIL-B-5423/09-02

BRASS RANGE SWITCH SHAFT

NEOPRENE O-RING

FIBERGLASS REINFORCED POLYESTER RESIN

YARDLEY BRASS INSERT

O-RING NEOPRENE GASKET

G. E. Smith & Associates

919 HERBERT · PASADENA TEXAS 77506 · 713 / 475-2986

.MODEL GS-2000.

The Model GS-2000 is a rugged, **Waterproof** and **Dustproof** Survey Meter for Field use in Industrial Radiography and Similar Applications. This Unit is Specifically Designed to Insure Long Meter Life in all Types of Environment.

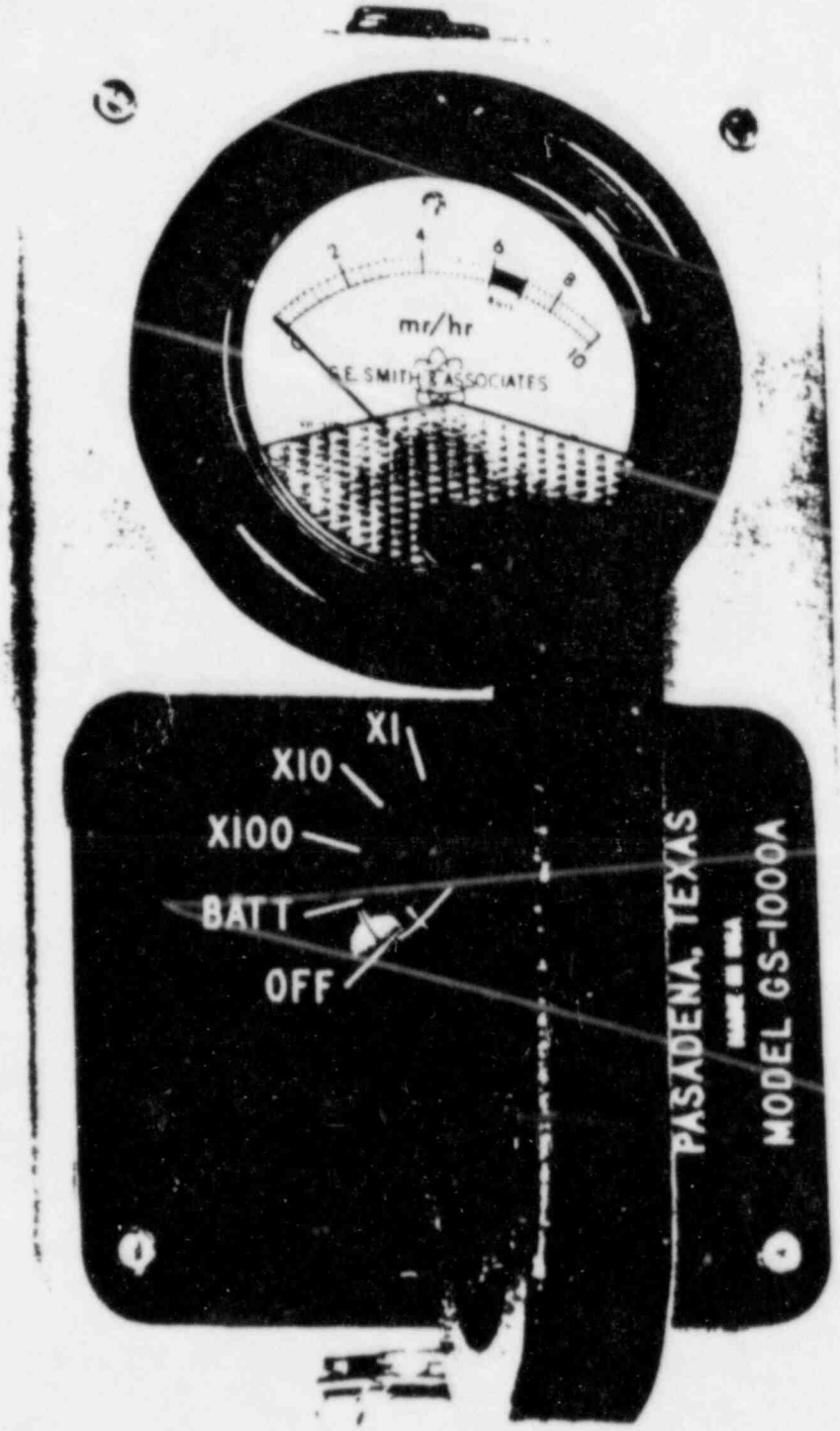
• FEATURES •

- A Rugged, Two-Piece Fiberglass Reinforced Polyester Resin Case with a Neoprene O-Ring Gasket
- Large Mill. Spec. Ruggedized Meter Indicator
- Shock Mounted Geiger Tube
- Fully Transistorized
- Corrosion Resistant
- Regulated High and Low Voltages Insures Stable, Dependable Results

• SPECIFICATIONS •

Ranges:	0-1000, 0-100, 0-10 mr/hr.
Precision:	Within 10% of Full Scale at Standard Temperature Over Operating Range.
Calibration:	Within 10% When Calibrated With Cesium-137.
Radiation Detected:	Gamma and X-Ray
Environmental Effects:	Waterproof and Dustproof. Temperature Limits -30° to +50°C. Excluding Batteries.
Detector:	Shock Mounted Halogen Quenched Geiger Mueller Tube. Effective Length: 0.625 Inches. Effective Diameter: 0.194 Inches Wall Thickness: 30 mg/cm^2.
Energy Dependence:	Within 20% From 80-1500 KeV.
Saturation:	In Excess of 1000 R/hr When Calibrated and Maintained Properly.
Controls:	Five Position Rotary Switch: Off, Battery Check, X-100, X-10, X-1.
Calibration Controls:	Individual Calibration Potentiometers Are Provided For Each Range.
Response Time:	90% of Final Reading Within 10 Seconds.
Geotropism:	Within 2% of Full Scale in Any Orientation.
Display:	3 Inch Ruggedized Meter Indicator.
Battery Complement:	Two "D" Size Cells.
Battery Life:	Over 150 Hours of Continuous Service. Non Alkaline.
Dimensions:	43/8 in. Wide x 73/4 in. Long x 6 in. High Including Handle.
Weight:	4 Pounds 2 Ounces Including Batteries.
Price F.O.B. Pasadena, Texas	

The Model GS-2000 Was Factory Tested Successfully Under Two Feet of Water.



MODEL GS-1000A

G. E. Smith & Associates
Pasadena, Texas

TECHNICAL DATA

G.E. Smith & Associates
919 HERBERT • PASADENA, TEXAS 77506
(713) 475-2986

MODEL GS-1000 A

SURVEY METER FOR FIELD OR LABORATORY USE

FEATURES

Simplicity

•

Lightweight, Rugged, Two-Piece Aluminum Case Construction

•

Large 3½" Ruggedized Meter Indicator

•

Battery Test Position, Internal Mounted Geiger Tube

•

Reliability and Accuracy — Regulated High and Low Voltages Insures Stable, Dependable Results

SPECIFICATIONS

Ranges	0-1,000, 0-100, 0-10 mr/hr
Precision	within 10% of full scale at standard temperature over operating range.
Calibration	within 10% when calibrated with Cesium-137.
Radiation Detected	Gamma and X-Ray
Environmental Effects	Temperature Limits – 30° to + 50°C Excluding Batteries. Humidity Limits 0-99% non-condensing.
Detector	Halogen Quenched Geiger Mueller Tube. Effective Length: 0.625 inches Effective Diameter: 0.194 inches. Wall Thickness: 30 mg/cm²
Energy Dependence	Within 20% from 80-1,500 KeV
Controls	Five Position Rotary Switch: Off, Battery Check, X-100, X-10, and X-1.
Battery Complement	Two "D" size cells
Battery Life	Over 150 hours of continuous service.
Dimensions	4¾ in. wide x 7⅝ in. long x 6 in. high, including handle
Weight	3 pounds 9 ounces including batteries

The GS-1000 A offers an economical and rugged solution to health physics survey problems for gamma and x-rays in industrial radiography.

Price F.O.B. Pasadena, Texas

MODEL M-1000A

G. E. Smith & Associates

Pasadena, Texas

TECHNICAL DATA

G.E. Smith & Associates
919 HERBERT • PASADENA, TEXAS 77506
(713) 475-2986

MODEL M-1000 A

SURVEY METER FOR FIELD OR LABORATORY USE

FEATURES

Simplicity

•

Can Be Worn on Belt, Hand Held, or Laid on Ground

•

Lightweight, Rugged, Two-Piece Aluminum Case Construction

•

Ruggedized Meter Indicator, Built-in Audio Speaker

•

Battery Test Position, Internal Mounted Geiger Tube

•

Reliability and Accuracy — Regulated High and Low Voltages Insures Stable, Dependable Results

SPECIFICATIONS

Ranges	0-1,000, 0-100, 0-10 mr/hr
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Radiation Detected	Gamma and X-Ray
Environmental Effects	Temperature Limits −30° to +50°C Excluding Batteries. Humidity Limits 0-99% non-condensing.
Detector	Halogen Quenched Geiger Mueller Tube. Effective Length: 0.625 inches Effective Diameter: 0.194 inches. Wall Thickness: 30 mg/cm^2
Energy Dependence	Within 20% from 80-1,500 KeV
Controls	Five Position Rotary Switch: Off, Battery Check, X-100, X-10, and X-1.
Battery Complement	Two "C" size cells
Battery Life	Over 100 hours of continuous service.
Dimensions	4$^3/_4$ in. wide x 4$^1/_4$ in. long x 2$^1/_2$ in. high
Weight	24 ounces including batteries
Audio	Built-in Audio-Tone Transducer

The M-1000 A offers an economical and rugged solution to health physics survey problems for gamma and x-rays in industrial radiography.

Price F.O.B. Pasadena, Texas

G.E. Smith & Associates
919 HERBERT • PASADENA, TEXAS 77506
(713) 475-2986

General Descripton

The Model GS-1000A and M-1000A is a sensitive portable pulse count ratemeter and power supply, and will detect gamma and X-Ray radiation. The instrument utilizes the latest design in solid state circuitry, and contains no vacuum tubes, resulting in a rugged, and reliable device. This design allows the instrument to operate on only two "D" cells, and yet give a battery life of over 100 hours with continuous operation, and longer with intermittent use.

The instrument (GS-1000A) case utilizes an aluminum top and a drawn aluminum bottom, being waterproof, with two manually operated pull catches for closure. Visual readout is provided by a rugged, military type, waterproof, 3 1/2 in. meter. The case top also contains the operating control; the function switch has a battery check position and three range positions.

POWER SUPPLY

The high voltage power supply is a blocking oscillator driven "fly-back" type circuit. The blocking oscillator portion of the circuit consists of transistor Q3, windings, 3-4 and 5-6 of transformer T1, and resistor R17, and the batteries. C8 serves only to suppress high frequency parasitic oscillation caused by the transistor parameters. The high voltage power supply portion of the circuit consists of winding 1-2 of T1, rectifier CR5, the associate resistors and capacitors, and Zeiner diodes Z1, Z2, and Z3. The low voltage section is comprised of winding 5-6 of T1, diode CR4 and C7. The operation of the power supply is as follows= When the instrument is turned on Q3 conducts and an increasing current flows through winding 3-4 and the collector of Q3. This current induces a voltage in winding 5-6 of such polarity as to sustain and increase the conduction of Q3. The collector current continues to ncrease until Q3 and winding 3-4 becomes constant. When the current

in winding 3-4 becomes constant, the induced voltage in winding 5-6 falls to zero which causes the base current to drop, which inturn, causes the current flowing through the collector and winding 3-4 to drop. This decreasing current induces a voltage in winding 5-6 of such polarity as to turn off the transistor. Insofar as this is a regenerative action the transistor turns off extremely fast, causing the flux in the transformer to collapse suddenly. This latter is the fly-back action, which induces high voltage on all of the windings, the magnitude of the voltage being proportional to the number of turns on the winding. The voltage induced on winding 1-2, which is extremely high owing to the large number of turns, is rectified by CR5 and filitered by C9 and R13, after which it is regulated to 600 volts by Z1,Z2, and Z3. The regulating action of Z1, Z2, and Z3 is reflected back through the transformer, and thus the voltage induced at the other winding is also regulated. This is taken advantage of at winding 5-6 where the induced voltage is rectified by CR4 and used to power the rest of the instrument. The induced voltage at the base then returns to zero, allowing the transistor to conduct again and thus repeating the cycle, the rate of repetition being controled by R17.

MONOSTABLE MULTIVIBRATOR

The monostable multivibrator circuit consists of Q1, Q2, calibration Pots R3, R4, R5, C (range switch), and associated components. Its function is to provide a uniform current pulse output for each pulse input, regardless of the shape or magnitude of the input pulse.

METER and TIME CONSTANT CIRCUIT

The metering circuit consists of M1, the meter, R7 and C2 the intergating capacitor. When a pulse causes Q1 to conduct, the collector current passes through the intergating capacitor leaving it charged. It is then discharged through the meter causing it to deflect. The amount of deflection is proportional to the amount of charge, which in turn, is proportional to the average current. Thus the meter reads the average current through Q1, which is proportional to the pulse rate and width. The response time of the system is a function of the size of capacitor C2, the larger the capacitor the longer it takes to charge and discharge, and thus the response time can be altered by changing the amount of capacity in the circuit.

SELECTING RANGE and TAKING READING

Turn the instrument on, to the battery check position, and see that the meter reads in the indicated zone. Now, turn the switch to the X100 (0-1000 MR/HR) range and place the instrument in the location to be measured. If the reading is less than 10% of full scale, rotate the switch to the X10 (0-100 MR/HR) range, if the reading is still less than 10% of full scale rotate to the X1 (0-10 MR/HR) range or most sensitive range. The meter reading should always be multipied by the range switch setting.

CALIBRATION

The calibration source must constitute the sole source of radiation when calibration is performed. Calibration must not be undertaken when the background is above normal or when the instrument is in a radiation field other than that produced by the known calibration source used.

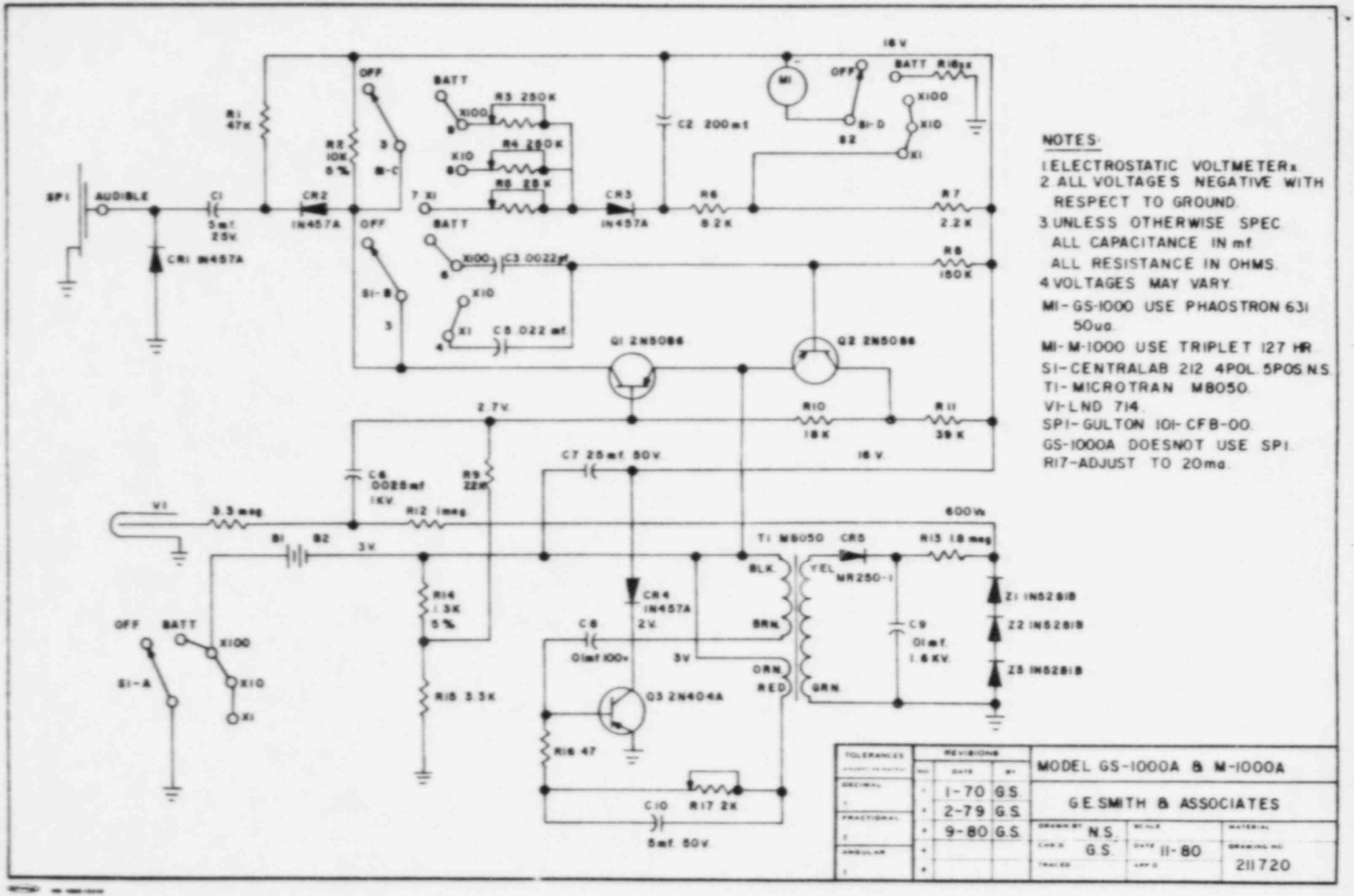
There are three calibration potentiometers located at the rear of the circuit board, from left to right, X1, X10, X100. To calibrate place the instrument in a known radiation field for each of the three ranges and when necessary adjust the corresponding potentiometer.

DETECTOR

The detector used in this instrument is a halogen quenched geiger mueller tube. Effective length is 0.625 inches and the effective diameter is 0.194 inches. The wall thickness of the tube is 30 mg/cm squared. It will detect Gamma and X-Ray radiation from 80-1,500 KeV within 10%.

MODEL M-1000A

The Model M-1000A survey meter utilizes the same electronics and detector tube as the Model GS-1000A. The only difference between the two is the meter size, case design , and the battery size. The meter is a ruggedized 1 1/2 in. large scale and the batteries used are "C" cells. The battery life is shorter with the "C" cells. The case is of two piece aluminum construction and has loops on the back for wearing on a belt. The M-1000A also has a built-in audio speaker for aural monitoring.



NOTES:

1. ELECTROSTATIC VOLTMETER.
2. ALL VOLTAGES NEGATIVE WITH RESPECT TO GROUND.
3. UNLESS OTHERWISE SPEC. ALL CAPACITANCE IN mf. ALL RESISTANCE IN OHMS.
4. VOLTAGES MAY VARY.

M1 - GS-1000 USE PHAOSTRON 631 50ua.
M1 - M-1000 USE TRIPLET 127 HR.
S1 - CENTRALAB 212 4POL. 5POS. N.S.
T1 - MICROTRAN M8050.
V1 - LND 714.
SP1 - GULTON 101-CFB-00.
GS-1000A DOESNOT USE SP1.
R17 - ADJUST TO 20ma.

TOLERANCES	REVISIONS			MODEL GS-1000A & M-1000A
DECIMAL	NO.	DATE	BY	G.E.SMITH & ASSOCIATES
FRACTIONAL	1	1-70	G.S.	
ANGULAR	2	2-79	G.S.	
	3	9-80	G.S.	
	4			
	5			

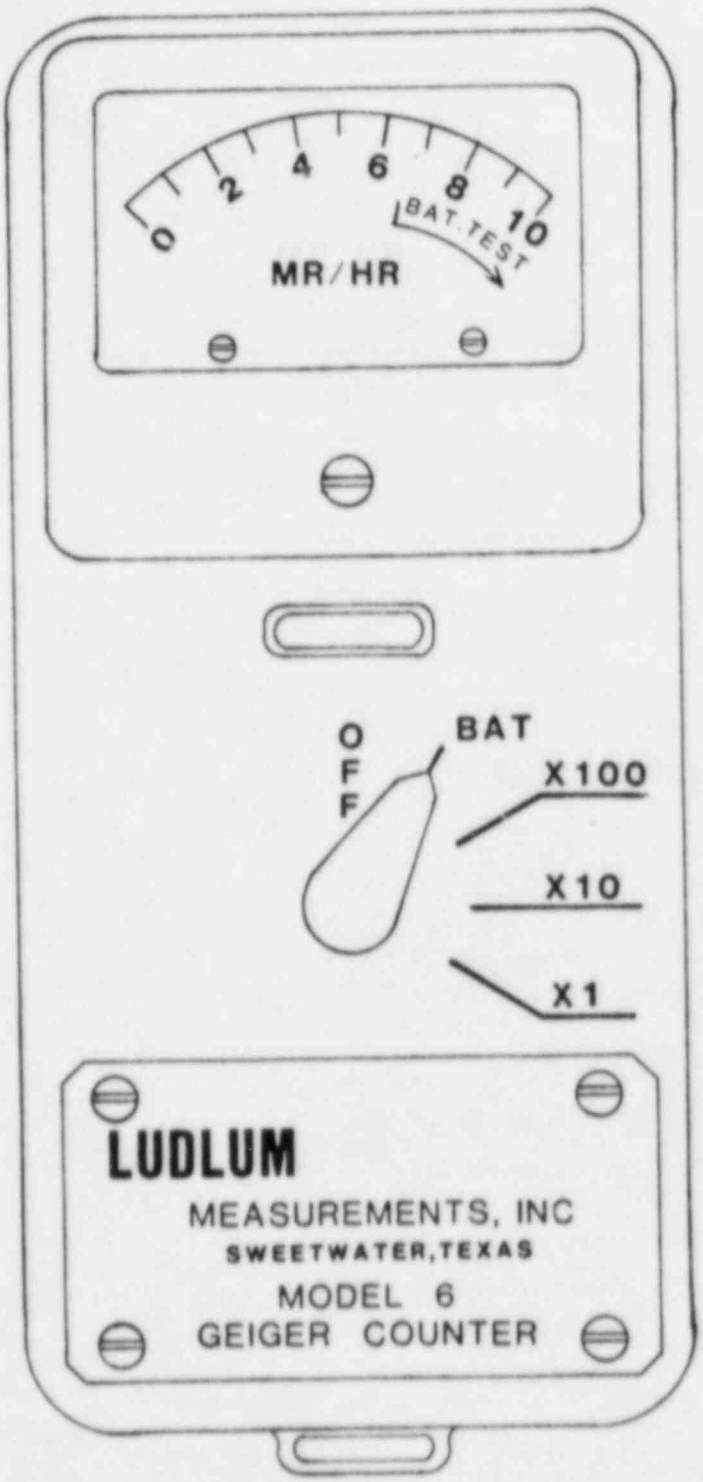
DRAWN BY	SCALE	MATERIAL
N.S.		
CHK'D G.S.	DATE 11-80	DRAWING NO. 211720
TRACED	APP'D	

Instruction Manual

MODEL 6 GEIGER COUNTER

LUDLUM MEASUREMENTS, INC.
501 OAK 915 - 235-5494 P. O. BOX 248
SWEETWATER, TEXAS, U.S.A., 79556

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial
INSTRUMENTS


0
2
4
6
8
10
BAT. TEST
MR/HR
OFF
BAT
X100
X10
X1
LUDLUM
MEASUREMENTS, INC
SWEETWATER, TEXAS
MODEL 6
GEIGER COUNTER

4/81

LUDLUM MODEL 6 GEIGER COUNTER

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APRIL 1982

LUDLUM MODEL 6 GEIGER COUNTER

1. GENERAL

The Model 6 Geiger Coounter is a radiographic survey meter designed specifically for the utility monitor. A cast housing features a compartment battery box that is accessible from the front panel. A two-piece, gasket-sealed, cast-aluminum meter bezel insures long meter life in all types of environment.

2. SPECIFICATIONS

POWER: two standard "D" size batteries

THREE LINEAR RANGES: from 0 to 1 R/Hr; meter scale presentation - 0 to 10 MR/Hr with range multiples of X1, X10, X100

DETECTED RADIATION: gamma; X-ray, if special precautions are used to avoid overexposure

LINEARITY: plus or minus 5% full scale

CALIBRATION STABILITY: less than 15% variance to battery end-point

METER: 50 micro-amp, 2 1/2-inch scale with pivot-and-jewel movement

DETECTOR: internally-mounted LND 714 tube

SIZE: 3.4 x 3.5 x 7.0 inches (H x W x L exclusive of handle)

WEIGHT: 3 pounds

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

Range Multiplier Switch is a 5-position switch marked OFF, BAT, X100, X10, X1. Turning the range selector switch from OFF to BAT position provides the operator a battery check of the instrument. A BAT check scale on the meter provides a visual means of checking the battery status. Moving the range selector switch to one of the range multiplier positions (X1, X10, X100) provides the operator with an overall range of 0-1R/Hr. Multiplying the scale reading by the multiplier determines the actual reading.

Range Calibration Adjustments are recessed potentiometers located on line with each multiplier position. These adjustment controls allow individual calibration for each range multiplier.

4. OPERATING PROCEDURES

4.1 Remove the battery lid and install two "D" size batteries. Note (+) (-) marks on inside of the lid. Match the battery polarity to these marks.

NOTE: Center post of flashlight battery is positive.

Replace the battery lid.

4.2 Turn the instrument range switch to BAT. The meter should deflect to the battery check portion of the meter scale. If the meter does not respond, recheck that the batteries have proper polarity.

4.3 Turn the range switch to X1. Expose the instrument to a radiation check source. The meter should respond.

4.4 Check calibration and proceed to use the instrument.

5. CALIBRATION

5.1 For detector operating point, remove the instrument housing and adjust R3 (Drawing No. 206X5) for 550 volts. Use a voltmeter with 100 megohm resistance, or greater.

NOTE: If an electrostatic voltmeter is not available, use an ordinary volt-ohm-milliampmeter with an attenuator to provide at least 20,000 ohms-per--volt meter resistance. Select the appropriate scale and then adjust the high voltage to read 550 volts.

Do not use a vacuum, tube-type voltmeter for this adjustment unless an external high voltage multiplier probe is used.

Replace the instrument housing.

5.2 Turn the instrument range multiplier switch to X100. Expose the detector to a calibrated gamma field and adjust the respective range potentiometer for proper reading.

5.3 Repeat the above procedure for the other scales.

6. MAINTENANCE

NOTE: NEVER STORE THE INSTRUMENT OVER 30 DAYS WITHOUT REMOVING BATTERIES. ALTHOUGH THIS INSTRUMENT WILL OPERATE AT VERY HIGH AMBIENT TEMPERATURES, BATTERY SEAL FAILURE CAN OCCUR AT TEMPERATURES AS LOW AS 100 DEGREES FAHRENHEIT. NEGLECTED BATTERY SEAL FAILURE WILL SURELY CAUSE ONE AWFUL MESS!

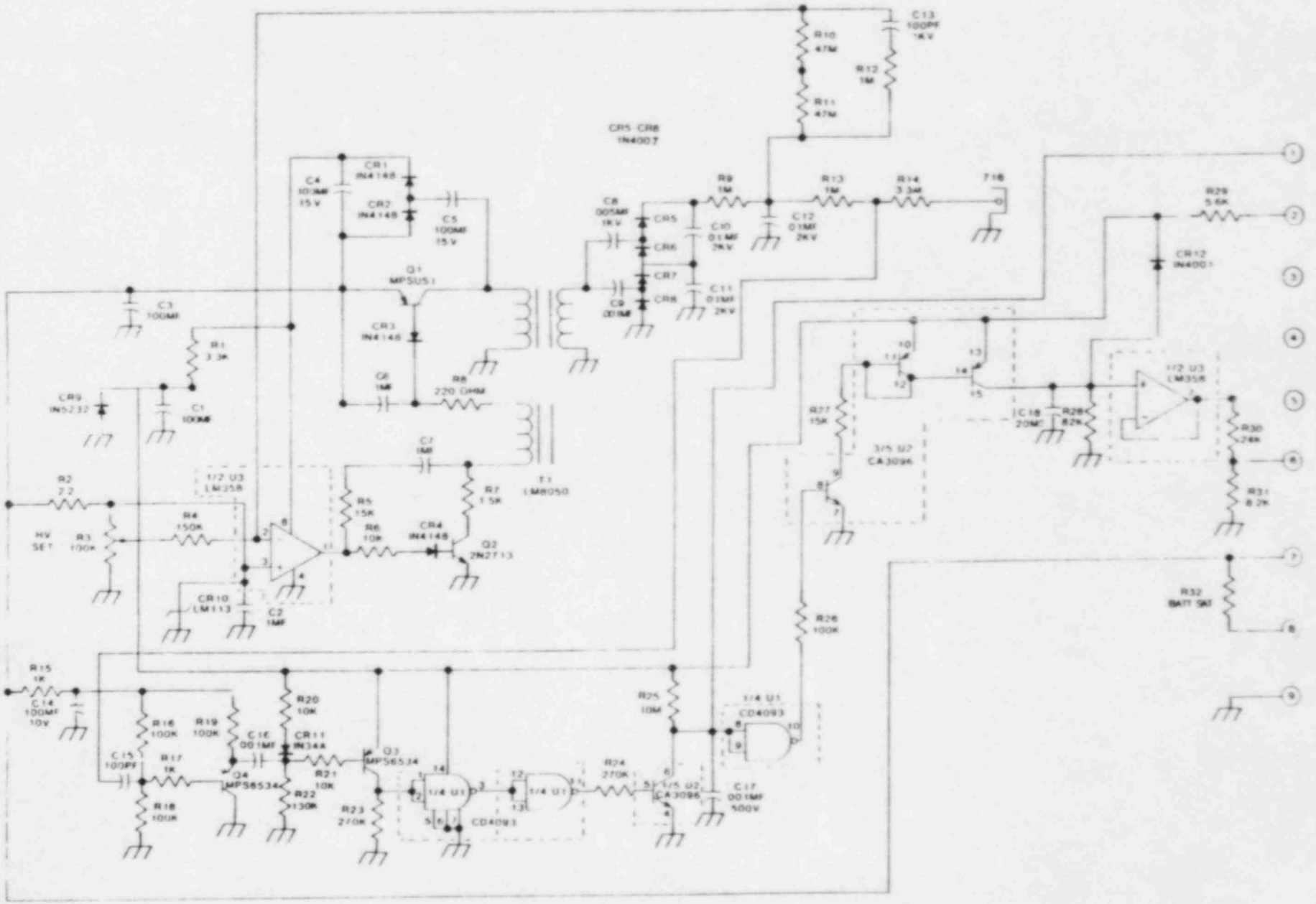
Instrument maintenance consists of keeping the instrument clean and periodically checking batteries and calibration. Once initial calibration is performed, recalibration should not be required if batteries are maintained in good condition.

An instrument operational check should be performed prior to each use by exposing detector to a known source and confirming proper reading on each scale.

Under certain conditions, NRC requires instrument recalibration every three months. Check the appropriate regulations to determine recalibration schedule.

Also at three month intervals, the batteries should be removed and the battery contacts cleaned of any corrosion. If the instrument has been exposed to very dusty or corrosive atmosphere, more frequent battery servicing should be used.

Use a spanner wrench to unscrew the battery contact insulators, exposing internal contacts and battery spring. Removing the handle will facilitate access to these contacts.



MODEL 6

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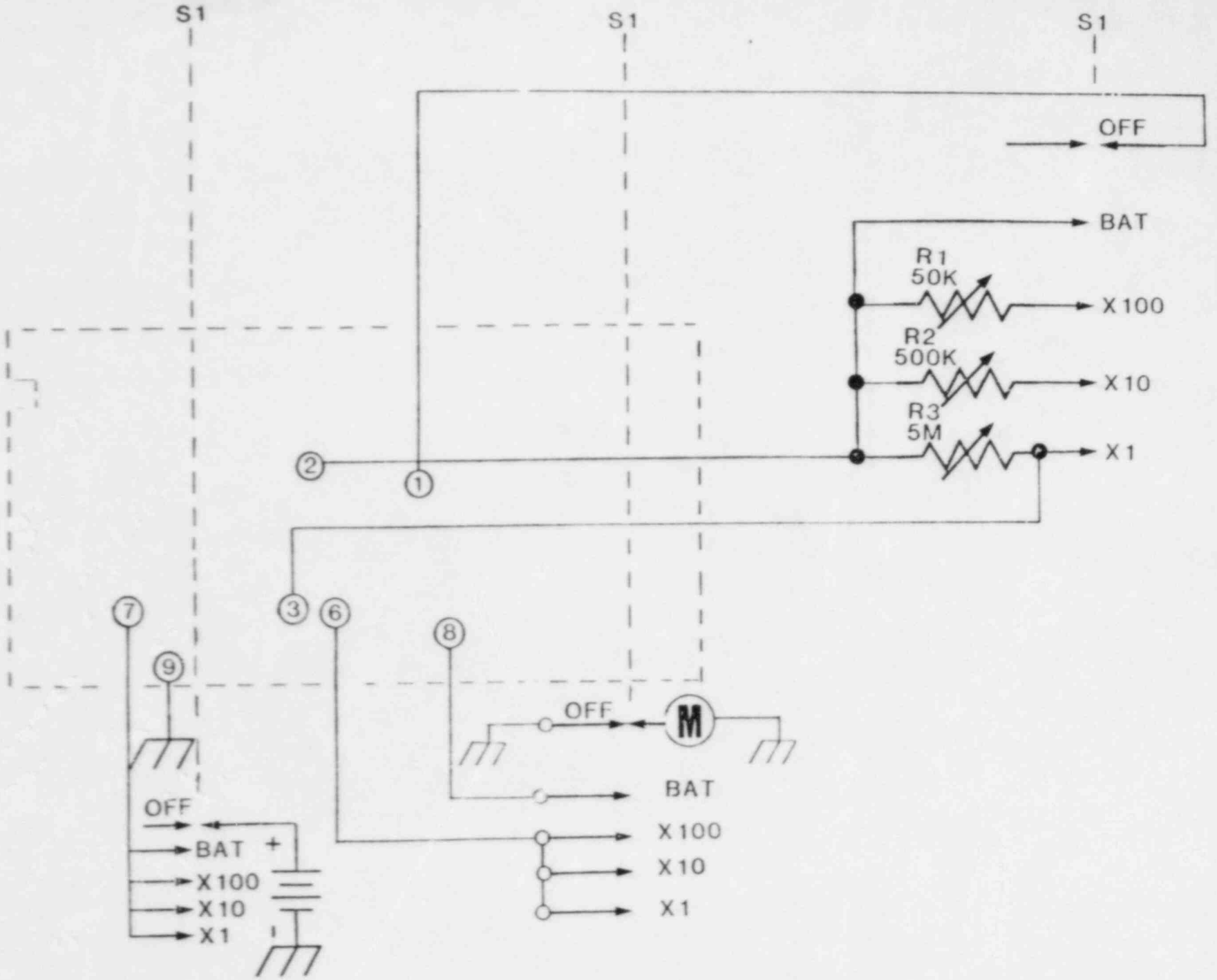


5/81

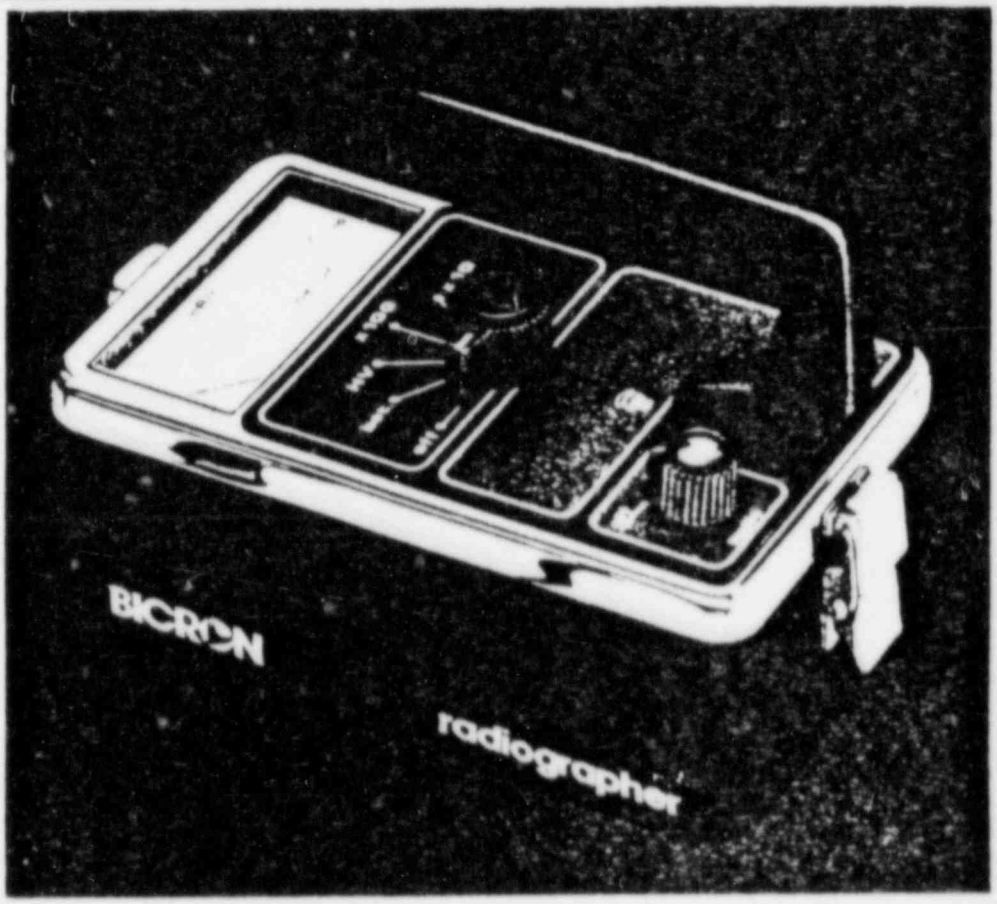
MODEL 6 WIRING
DWG 206 X 13

BICRON Portable Survey Meter*

for industrial radiography

Features

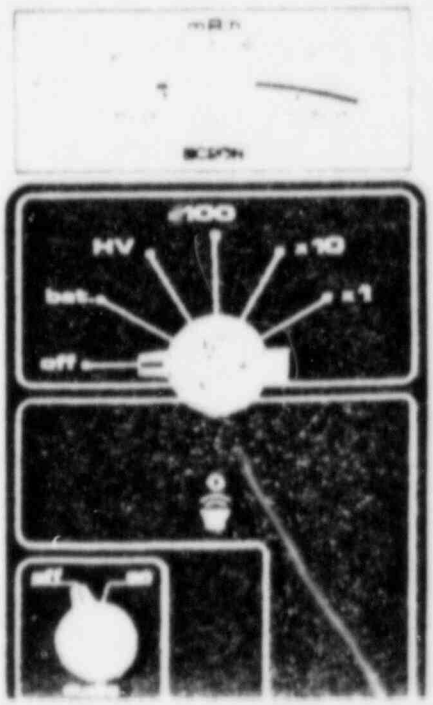
- Ruggedized metal construction for roughest service.
- Lightweight, human-engineered design for all-day portability.
- Energy and temperature corrected.
- High-torque, recessed meter movement under wide-view window.
- Audible/visual alarms and other exclusive options.
- Meets all requirements of the USNRC Regulation 10CFR34 for industrial radiography.



General. The all-new Bicron Radiographer I is a lightweight, breakthrough design in high-quality survey meters for gamma radiography. Ranges are 10, 100 and 1,000 mR/h full scale.

Applications. A top-of-the-line instrument, the Bicron Radiographer embodies the unique experience of Bicron acquired over many years in supplying medical, high-energy physics and research establishment systems for radiation detection and measurements. It is ideal for all field work in industrial radiography where no compromises can be tolerated.

Physical Features. Ergonomically designed, the instrument is balanced so as to be easy to carry; the recessed movement is large and easy to read. Range switching is a thumb and finger operation achieved with one hand only. All components are ruggedized to withstand weather, shock and impact for maximum reliability in the field or laboratory.



BICRON

BICRON Specifications

Radiation Detected: Gamma and X-ray.

Operating Range: 0-10, 0-100, and 0-1,000 mR/h in three linear ranges.

Accuracy: Within 15% of reading for ^{137}Cs between 25% and 100% of full scale on any range.

Detector: Halogen-quenched, energy-compensated GM tube mounted internally.

Energy Dependence: ± 20% from 40keV to 1.2MeV.

Warmup Time: None.

Exposure Rate Limitations: Instruments typically read off scale in fields as high as 1,000 times the upper detection limit.

Response Time: Optimized for each range. 0-90% of final reading as follows:

Range	Time
10mR/h	5 sec
100mR/h	2 sec
1R/h	1 sec

Environmental Effects: Temperature: less than ± 10% change in reading from -20°C to +50°C using alkaline batteries.

Humidity: less than ± 5% change in reading from 10% to 95% R.H.

Power Requirements: Single 9-volt battery. Mallory MN1604 or equal. Life: greater than 100 hours standard and up to 200 hours with Option B.

Controls: Rotary switch for power and range functions located conveniently under the handle. Standard positions are OFF, BAT, x100, x10, X1. Option H positions are OFF, BAT, HV, X100, x10, X1. With option S, a rotary ON-OFF switch controls the audio.

Readout: Ruggedized, recessed high-torque 1 mA meter with 3.35 inch (8.51cm) scale marked 0-10 mR/h. 'Bat ok' band is included. Option H adds 'HV ok' band. Meter protected by impact-resistant Lexan® polycarbonate window.

Geotropism: Within ± 2% of full scale.

Shock: 100g per lightweight machine of MIL-STD 202C, method 202B.

Vibration: 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33Hz.

Construction: Splash-proof, shock proof, two-piece all-metal case. Scratch-resistant laminated control panel and Bicron Kleen-Krome® trim on case top; durable black polyurethane paint on handle and case bottom.

Overall Dimensions: 4.25 x 8 x 6" including handle (10.8 x 20.4 x 15.2 cm).

Net Weight: 2.2 lbs. (1 kg.).

Options

Option A — Audible alarm which meter is full scale on any range. Includes internal sounder.

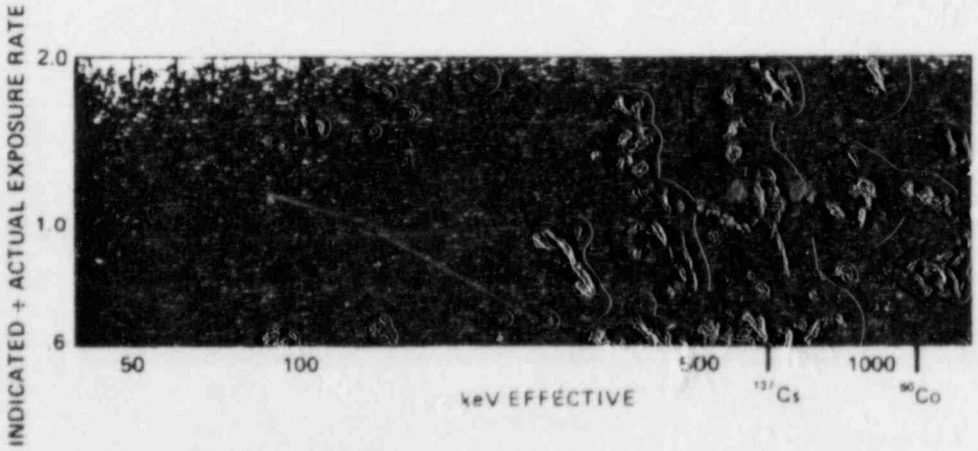
Option B — Additional internal battery holder which may be used as either storage for a spare battery or to increase battery life up to 200 hours.

Option H — HV Test Mode. Provides a means of monitoring the detector high voltage while performing surveys. Includes extra position on range switch and check band on meter.

Option S — Internal speaker to produce an audible 'click' for each detector pulse, with panel mounted ON-OFF switch.

Option V — Visual alarm. Meter dial flashes brightly when meter is full scale on any range. Includes internal xenon flash tube and circuitry with separate 9-volt battery supply. Not available with Option B.

Typical Energy Response



Bicron Corporation
12345 Kinsman Road
Newbury, Ohio 44065
Telephone (216) 564-2251

Bicron Corporation
European Office, P.O. Box 271
2410 AG Bodegraven, The Netherlands
Telephone (01720) 14733

Operations Manual
Bicron Corporation

radiographer™
Portable Survey Meter

BICRON
Electronic Products Group

Bicron Corporation
12345 Kinsman Road
Newbury, Ohio 44065
Telephone: (216) 564-2251
Telex: 980474

Bicron Corporation
European Office, P.O. Box 271
2410 AG Bodegraven The Netherlands
Telephone: 017 26/14243
Telex: 39772

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1.0 General Description

The Bicron radiographer™ is a portable, self-contained survey meter housed in a two-piece splashproof metal case. The unit is ergonomically designed and balanced for easy portability. The recessed meter movement is large and easy to read. The operational control is designed for one hand operation. All components are ruggedized to withstand weather, shock and impact for maximum field reliability. The energy compensated GM detector is board mounted for convenience. Various options are available (see data sheet).

1.1 Specifications

(See data sheet)

2.0 Battery Installation

With the instrument turned off, open the pull catches at each end of the case and remove the case bottom. This will expose the circuit board assembly and battery board. Install a 9-volt alkaline battery, Mallory MN1604 Duracell or equal, in the battery retainer clip using caution to observe proper polarity. The second battery retainer clip is typically designed to store a spare battery. Orient the case bottom with the sponge rubber pad under the battery, and replace the case bottom.

2.1 Battery Test

Turn the selector switch to the 'bat.' position. The meter should read within the 'bat.OK' check band.

2.2 High Voltage Test (Option H)

If the unit is equipped with Option H, turn the selector switch to the 'HV' position. The meter should read within the 'HV OK' check band. This provides a means of monitoring the detector high voltage.

2.3 Radiation Measurements

To make a radiation measurement turn the selector switch to one of the three linear ranges (X1, X10, X100). These ranges correspond to 10, 100, and 1000 milliroentgens per hour (mR/h) full scale.

The meter scale is calibrated directly in mR/h for ^{137}Cs gamma radiation. See the energy response curve (on data sheet) for typical response to other energies.

Caution:
An external source of ionizing radiation of the type the instrument was designed to measure must be used to determine proper operation of this instrument.

2.4 Audio

When Option A is included, an audible alarm will sound when the meter is approximately 30% or more above full scale on any range. This over-range alarm can be defeated by turning off an internal on-off switch located on the main circuit board.

When Option S is included, an internal speaker will produce an audible click for each detector pulse. This speaker is controlled by a panel mounted on-off switch labelled "audio".

When Option A and S are both included, the over-range alarm (Option A) will function only when the panel mounted "audio" control is in the off position, and the internal switch is on. When the "audio" control is in the on position, the over-range alarm (Option A) is defeated.

3.0 Circuit Description

The electronic circuitry in the Bicron radiographer™ is contained on three interconnected printed circuit boards.

Modern solid-state integrated circuitry is used throughout. The major components are:

1. High-voltage power supply. A feedback-regulated, electronically stabilized supply for the GM tube potential. Optional circuitry provides HV readout on the meter scale.
2. Count-rate meter. A linear charge pump ratemeter converts the GM tube pulses to an exposure rate reading on the calibrated meter scale. The circuitry includes a unique dead-time compensation technique to provide linear response over the full range, automatic time constant selection, anti-saturation, and temperature compensation.
3. Optional audio circuitry for individual pulse counting and overrange alarm.

3.1 GM Tube

The GM tube consists of a thin cylindrical shell which is the cathode, a fine wire anode suspended along the longitudinal axis of the shell, and an inert gas into which a small amount of a halogen gas is inserted to act as a quenching agent.

A potential of approximately 600 volts is maintained between the two electrodes with the anode always positive. This voltage is slightly less than that required to produce a discharge in the gas. When a nuclear particle or ray of sufficient energy enters the GM tube, it ionizes a molecule of the inert gas. Because of the high voltage maintained between the electrodes, the positive ions are attracted to the cathode and the electrons are attracted to the anode. In their movement toward the electrodes, these charged particles trigger the ionization of additional gas molecules, resulting in an avalanche of ions flowing between the electrodes. The gas discharge thus created is similar to the glow of a neon lamp. The tube conducts as long as the gas is in the ionized state.

The small amount of halogen gas in the gas mixture quenches the flow of ions, suppressing further electron avalanches until another nuclear particle or ray enters the tube. This flowing and quenching results in a rapid pulse or surge of current in the external circuit. The number of pulses per minute is approximately proportional to the radiation exposure rate. The meter, suitably connected to the tube, indicates the exposure rate on a calibrated scale.

4.0 Calibration

The instrument is factory calibrated with ^{137}Cs gamma rays. Recalibration is required after servicing, and at regular intervals specified by the appropriate regulatory agencies.

Place the instrument in a known radiation field with the incident radiation perpendicular to the front of the case. The GM tube is mounted internally near the front of the case, centered vertically and slightly to the right of center horizontally.

Individual calibration controls areprovided for each range, and should be used to adjust the meter reading to correspond to the known exposure rate. The locations of these controls are shown on a label in the case bottom.

> Note:
> Do not disturb the settings of any controls except those marked X1, X10, and X100.

Calibration procedures should follow those specified by the appropriate regulatory agencies.

OPERATING INSTRUCTIONS

MODEL 400/410

SURVEY METER

VICTOREEN

VICTOREEN
NUCLEAR ASSOCIATES

Victoreen, Inc.
Instrument Division

A Shaller Glober Corporation Subsidiary

CONTENTS

1. INTRODUCTION

The Victoreen Models 490 and 410 are radiation survey meters which use a single internal Geiger Mueller tube to detect x-ray and gamma radiation.

The meters contain a circuit (U.S. Patent #4,311,909) which corrects for lost radiation pulses occurring coincidentally within the dead time of the GM tube.

The Model 490 is designed especially for NDT industrial radiography and meets requirements of USNRC 10 C.F.R. 34 regulations. The meter operates over a range of 1mR/h to 1000mR/h.

The Model 410 operates over a range of 1mR/h to 10,000mR/h. This extended range offers quantification of nearly the full rate response of the GM tube before continuous discharge.

Both meters are exceptionally rugged due to a hi-impact thermoplastic water resistant case. They both provide a belt clip for convenience and an audible alarm for safety.

2. SPECIFICATIONS

Radiation Detected:	Gamma and x-ray above 40keV.
Operating Range:	400: 0-10, 0-100, 0-1000mR/h 410: 0-10, 0-100, 0-1000, 0-10,000mR/h
Control:	Recessed rotary switch, Off, Battery Check and range selections.
Readout:	Taut band meter - 55mm scale length. Semilog with true zero.
Alarm:	90db peak at 30cm, 3000Hz. Audible internal speaker will alarm when meter is full scale on any range.
Energy Response:	Within 20% from 70-1200keV.
Accuracy:	Within 15% of reading between 10% and 100% of full scale indication on any range. Calibration source is Cs-137.
Detector:	Energy compensated, halogen quenched GM tube.
Response Time: (90% final reading)	Less than 8 sec on 10mR/h range, less than 1 sec on higher ranges.
Overrange Response:	Full scale deflection up to 1000R/h from 40 to 1200keV.
Environmental Effects:	Less than 5% change due to temperature (-20 to +55°C) and humidity (0 to 90%rh).
Construction:	Molded hi-impact thermoplastic case. Circuit board mounted on molded in supports. Meter and GM tube shock mounted.
Ruggedness:	Survive 3 foot drop onto concrete floor. Failure rate: 1 out of 20 trials. 100g shock in any plane.
Water Resistance:	Electronic housing sealed against entry of water. The battery compartment is splashproof and sealed from the main electronics.
Dimensions:	80mm x 211mm x 47mm (3.2" x 8.3" x 1.9")

Belt Clip:	Metal belt clip mounted opposite the panel meter so that it can be read by looking down at it.
Power Requirements:	9V alkaline battery, Mallory MN1604 or equivalent. Approximately 100 hour life at ambient radiation and environmental levels.
Weight:	430gm (1 lb).

3. DESCRIPTION

Illustration 3.1 is a pictoral description of the Model 400 with numbered callouts. The Model 410 is identical in form and function except for the additional x1000 range position above x100.

1. The GM detector is internally mounted above the meter scale at the seam line.

2. Number 2 on the meter scale is accented to aid in a survey for the regulatory 2mR/h limit.

3. Taut band meter is shock mounted to withstand a 3 foot drop onto concrete. The 55mm scale length is graduated into semi-log divisions with a true zero.

4. A removable watertight plug allows access to the mechanical zero adjust of the meter.

5. The control is a 5 position (6 for Model 410) switch for selection of OFF, Battery Check or Operating Range. The knob is recessed flush to the surface and can be operated by the user's thumb.

6. The position identification of the control switch is part of the plastic overlay which has a very rugged and durable finish.

7. The speaker for full scale alarm is mounted directly below the grill. It is sealed against the entry of water.

8. Two screws retain the battery compartment cover.

9. The battery compartment cover is splashproof but not sealed. The compartment itself is sealed from the rest of the meter.

10. On the opposite side is a metal belt clip. It is mounted so that when worn, the meter readout is visible as the user looks down to the meter.

MODEL 400 SURVEY METER

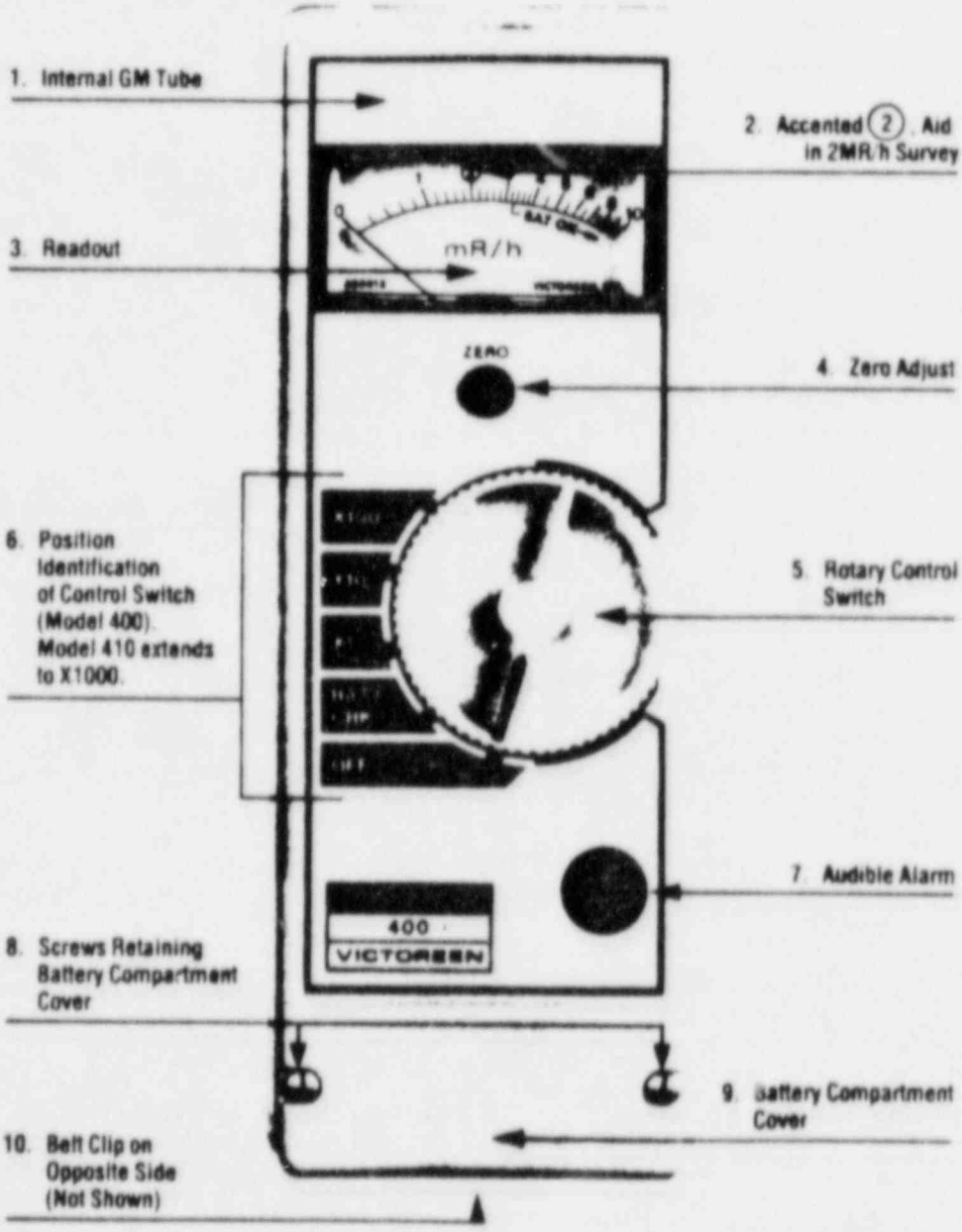


ILLUSTRATION 3.1 – FRONT PANEL, MODEL 400

4. OPERATION

4.1 Zero Check

With the control switch in the OFF position and the meter readout facing up, check if the meter pointer is within a half minor division of "0". If not, see Section 5.4.5 of this manual for adjustment.

4.2 Battery Check

Move the control switch to the BAT CHK position. The meter pointer should be within the scale region indicated by BAT OK; if not, move the control switch to OFF and replace the battery with a 9 volt alkaline, Mallory MN1604 or equivalent. Refer to illustration 3.1, remove two screws (8) and battery compartment cover (9). Battery can now be lifted out and replaced. Do not pull on connecting wires. Replace cover and screws and repeat battery check.

4.3 Functional Check

Move the control switch to the x1 range and place the meter on a stationary surface away from any radioactive sources. Natural radioactive background (10 micro R/h) and internal radioactive background of the GM tube itself will occasionally produce a single discharge which is observable on the meter readout. When this occurs, the meter pointer will deflect 1/4 to 1/2 of the first minor scale division. Observe the meter readout for 100 seconds; at least 4 such deflections should be observed. If not, switch the instrument OFF and on x1 again and repeat the test. If the instrument fails repeatedly, it may not be functioning properly and must be tested by a qualified service person.

If a high energy gamma button check source is available (such as 10 micro-Curie Cs-137 source, Nuclear Associates #62-103 or equivalent), position it over the GM tube (#1, Illustration 3.1). A response on the meter readout should be observed if the instrument is functioning properly. The NA #62-103 source should cause a 1/2 to full scale deflection on the x1 range.

4.4 Survey Measurement

Estimate the exposure rate which can be expected in the survey. Move the control switch to the range position whose full scale value is greater than the estimated rate. The numerical mR/h values on the meter scale are multiplied by the range value selected. The x1 range is 10mR/h full scale, the x100 range is 1000mR/h (1R/h) full scale.

For best results, direct the long axis of the instrument toward the radiation source to be surveyed. The meter readout should face the user for easy visual monitoring. The instrument does have some angular dependence when the width axis (meter scale) is not perpendicular to line toward the source; therefore, this axis should be kept perpendicular. This dependence is more severe for x-ray or gamma energies below 100keV. If no pointer deflection is observed, move the function switch to the next lower range until a deflection is observed.

Optimum time constants have been designed into each range to average the pointer fluctuations. However, due to the statistical nature of radiation, some pointer fluctuation will be noticed. Readings on the x1 range in a radiation field of 2mR/h will be within 15% of the true average 90% of the time. A better quantification of the radiation field can be obtained from the average of the maximum and minimum deflections observed over a 30 second period while the instrument is stationary.

Normally a survey measurement involves moving the survey meter and continuous monitoring of the readout. If a deflection is observed and the range used is x1, the time constant will keep the pointer deflected for several seconds even if the survey meter is moved to a lower field. To avoid waiting the normal time, the user can move the control switch to the x10 range and back to x1 to discharge the deflection caused by the past rate.

4.5 Alarm/Belt Clip

When the meter pointer is deflected full scale on any range, a speaker mounted under the front panel grill (#7, Illustration 3.1) will sound an intermittent alarm. This alerts the user immediately of a radiation rate higher than anticipated. The alarm is nonlatching and turns off when the meter moves off full scale.

A metal belt clip is located on the rear side of the case. When attached to the user's belt, the meter readout faces out and can be read directly by the user by looking down.

The belt clip and alarm are convenience and safety features not normally found in a survey meter. Because of the light weight and small size of Models 400 and 410, they can be comfortably worn on the belt by the user when he is performing work activity around radiation.

When worn on the belt, the control switch should be on the x1 range to maximize the alarm sensitivity; 10mR/h will then activate the alarm. The alarm should be tested every time the survey meter is used.

4.6 Cautions

a) This radiation survey meter responds only to x-ray and gamma radiation in the energy range specified in Section 2 of this manual. Regardless of the intensity, this survey meter responds to neither x-ray and gamma radiation below 10keV nor to alpha or beta radiation.

b) The response to pulsed radiation (typical for some x-ray machines) may be false and may indicate the pulse repetition rate instead of radiation intensity.

c) Alkaline batteries stop functioning below -20°C (-4°F). If the survey meter is worn under a coat, occasional use from under the coat may be possible.

d) RF electromagnetic radiation may cause a meter deflection. This survey meter should not be used in the presence of rf fields.

e) Use this alarming survey meter as a supplement to a personal pocket dosimeter.

5. SERVICE INFORMATION

5.1 Theory of Operation (Refer to the Schematic, Section 5.2)

5.1.1 Battery Power Supply

This instrument is powered by a single 9 volt alkaline battery. When the control switch (S1A) is turned to the battery check position, the 9V battery is connected to the meter. R25 has been selected to allow the meter pointer to move into the "BAT OK" region if the battery voltage exceeds 6.25 volts. When switch S1A is turned to the next position, the battery's power is applied to the high voltage power supply and to the 5 volt regulator, U5. The battery's direct connection to the meter is opened.

5.1.2 High Voltage Generation

The GM tube requires 550V to operate properly. The high voltage is generated by the oscillator comprised of the following components: T1, C13, R26, C14 and Q4. The current, through one side of the primary of T1 and into the collector of Q4, starts the oscillator. Feedback from the other side of the primary of T1, through C13, C14 and R26, sustains the oscillations. The oscillations are prevented from appearing on the low voltage D.C. power tracks on the PC board by C18.

The voltage at the transformer secondary winding, T1:1, should be approximately 180V peak. This voltage is doubled to 360V at the junction of D4 and C15 by the action of these two components. The transformer secondary voltage is tripled to 550V at the junction of C12 and D5 by the action of these two components. C16 filters the high voltage and D6 isolates C16 from the oscillating action of the voltage tripler.

R28 and R29 function as a voltage divider to feed back the output voltage to U6:2. R30, R31 and R32 provide a reference voltage of approximately 1.8V at U6:3. If the 550V output drops due to increased current flow in the GM tube caused by increased radiation, then U6:6 will drive more current through R27 into the base of Q4. This will cause the primary of T1 to oscillate at a higher frequency, increasing the voltage back to 550V and supplying more current to the GM tube. The maximum current flow through the GM tube is limited by R10.

5.1.3 Radiation Detection and Measurement

When the gas in the GM tube (U101) is ionized by a particle passing through it, current flows through R11 and R12. If the radiation is sufficiently high enough to cause the GM tube to enter into a continuous discharge condition then C3 will charge to a level high enough to cause the control input (U3:11) to disconnect U3:14 from U3:12 and connect U3:14 to U3:13. When this happens the meter is pegged at full scale and the full scale alarm is turned on.

R13 and C4 forms a differentiator of the current flow through the GM tube. R14 protects the input of the comparator (U2:2). R15 and R16 set the threshold of the comparator to 50mV. C5 prevents the comparator from oscillating due to an input having a slow fall time. A high going pulse at U2:2 will cause the output (U2:1) to pulse low and discharge C6. U2 is an open collector comparator, therefore, C6 can only be charged by R17. The time constant of R17 and C6 is approximately 50u sec. This is slightly greater than the recovery time of the GM tube.

The input of the second comparator (U2:5) is biased at 2 volts by R18 and R19. C7 prevents this comparator from oscillating due to an input with slow rise time. U2:7 outputs a positive 50 microsecond pulse for every single particle that is detected by the GM tube. R20 is the pull-up resistor for the open collector output of U2:7.

C8 and R22 provide a 4.7 microsecond pulse to the control input (U3:9) of a SPDT analog switch. This analog switch normally connects C9 and C10 to the voltage reference established by R2, R3 and R21. When U3:9 pulses high, the analog switch connects C9 and C10 to C11. The amount of charge transferred diminishes as the voltage builds up on C11 with increasing radiation. This characteristic of the circuit gives the instrument its semi-logarithmic meter scale.

Charge flows from C11, through the range selection resistor network (U7) and then through U3:2 to ground. The voltage on C11 is an equilibrium condition between the charge transferred to C11 by C9 and C10 and the charge removed from C11 by U7.

Normally a survey meter will read erroneously low when it is placed in radiation of enough intensity that a significant percentage of the particles passing through the GM tube occur during the

recovery time of the tube due to a previous particle. This is referred to as "coincidence loss". This instrument contains a patented coincidence loss recovery circuit. As particles strike the GM tube faster than it can recover, U2:1 will keep C6 discharged for longer periods of time. This causes U2:7 to remain high longer. This high level is connected to the control input of an analog switch (U3:10). The analog switch will be held open as long as U2:7 is high. Since charge cannot flow from C11, through U7, when the analog switch is open, C11 is maintained at a higher voltage.

At lower levels of radiation, charge flows through U7 a greater percentage of the time. The range select switch (S1B) connects progressively more of the resistors in the network (U7) together as higher ranges are selected.

The voltage from C11 is present at the input of another SPDT analog switch (U3:12). U3:14 is connected to U3:12 when U3:11 is low. U4 buffers the voltage at U3:14 and drives the meter through R24.

5.1.4 Full-Scale Audible Alarm

The audible alarm is a 3KHz tone, pulsed at a 4Hz rate. U1:10 in conjunction with R1 and C1 generates the 250ms square wave. U1:4 in conjunction with R4 and C2 generates the 333us square wave. The square wave at U1:4 is gated off and on by the square wave at U1:10. U1:3 is the inverse of the waveform at U1:4. When U4:6 reaches 2 volts the meter will be at its full-scale position. R23 is adjusted to turn on Q1 when the meter reads full-scale.

R9 prevents improper adjustment of R23 from damaging U4 or Q1. When Q1 turns on it pulls the base of Q2 and R5 to ground. This turns Q2 off and allows R6 to enable U1:13. U1:11 drives Q3 through R7. R7 limits the base current of Q3. R8 limits the current through the audio transducer (SP1). D7 clamps the negative voltages generated by the inductance of SP1.

5.4.5 Zero Adjust (back of case need not be removed)

The meter readout for Models 400 and 410 are factory adjusted to zero with the control switch in the OFF position. Normally this will not require further adjustments if the instrument is not abused. The meter zero will change occasionally with a severe shock.

To adjust the meter pointer back to zero:

a) Turn the function switch to OFF.

b) Position the instrument with the meter readout facing up.

c) Remove the black rubber stopper labeled Zero Adjust in Illustration 3.1.

d) Using a small screwdriver, turn the exposed slot until the meter pointer is on "0".

e) Replace the rubber stopper. It will be necessary to twist it into the hole because it is slightly oversized. It is very important to replace the rubber stopper to protect the electronics from water entry.

INSTRUCTION MANUAL

FOR

MODEL 492

RADIOGRAPHIC SURVEY METER

VICTOREEN

TABLE OF CONTENTS

ILLUSTRATIONS

LIST OF TABLES

APPENDICES

1 General Description

1.1 Purpose of Equipment - The VICTOREEN Model 492 Radiographic Survey Meter provides a fast, accurate determination of X and gamma radiation leaks at X-ray installations, hospitals, and industrial facilities. The instrument satisfies all NRC requirements for industrial radiography.

Reliability and accuracy under rough field usage are assured by the solid-state design and rugged construction.

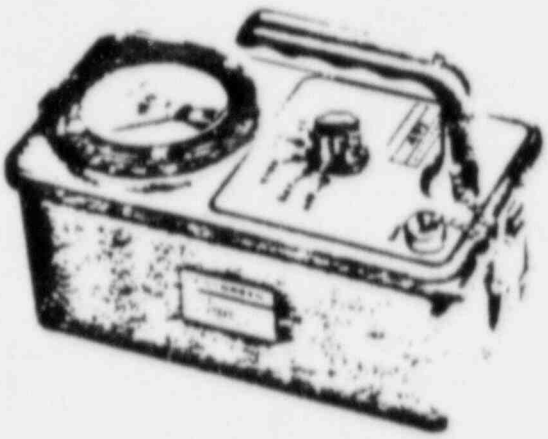


Figure 1. Model 492
Radiographic Survey Meter

1.2 Physical Description - The Model 492 is a portable, self-contained instrument housed in a two-piece splashproof metal case. The single operating control, conveniently located on the case top, provides on-off switching, range selection, and battery testing.

The batteries are retained in a high-impact plastic battery compartment which cannot be corroded by battery leakage fluids. The battery contacts are readily replaceable without tools to facilitate cleaning or replacement.

The CM tube detecting element is mounted inside the case for maximum operating convenience. No external probes are required. A phone jack is provided for the connection of a Model 490-50 Loudspeaker or 490-4 Headphone to allow aural monitoring. This is especially useful for detecting rapid changes in dose rate without constantly watching the indicating meter.

1.3 Specifications - The electrical and mechanical specifications for the instrument are listed in Tables I and II.

TABLE I: ELECTRICAL SPECIFICATIONS

Feature	Specification
Ranges	0-10, 0-100, 0-1000 mR/h in three linear ranges
Detector	Halogen-quenched GM tube
Accuracy	± 20% of full scale on all ranges when calibrated with Cesium-137
Response Time (10%-90%)	10 seconds nominal
Temperature Range	-20° F to 120° F (-29° C to 49° C), excluding batteries. Alkaline batteries are recommended at temperatures below 32° F (0° C).
Battery Complement	Two D size cells, NEDA Type 13 or 813
Battery Life	150 hours at 4 hours/day with standard carbon-zinc batteries
Energy Dependence	See energy response curve, Figure 3 Instrument normally calibrated with Cesium-137

TABLE II: MECHANICAL SPECIFICATIONS

Feature	Specification
Dimensions	4-1/2" (11.4 cm) wide x 8-3/4' (22.2 cm) long x 6" (15.2 cm) high (including handle)
Net Weight	3.5 lb (1.6 kg)
Construction	Splash-proof, shockproof, two-piece all metal case
Controls	5-position range selector and battery test switch
Optional Accessories	Vinyl carrying strap Loudspeaker, 490-50. Headphone 490-4

The sensing portion of the instrument, the Geiger tube, is mounted near the front of the case, centered vertically and slightly to the right of center horizontally. The incident radiation should be normal to the front of the case in line with the Geiger tube.

The meter scale is calibrated directly in mR/h for Cesium-137 gamma radiation. Refer to the Energy Response Curve, Figure 3, for the response to other energies.

An audible indication of relative dose rate is available by connecting a 490-50 loudspeaker or 490-4 headphone to the phone jack.

2.4 Use of Carrying Strap - A vinyl carrying strap with its attaching strap buckles is optional. The strap anchors are arranged in such a way that the meter is unobstructed when the instrument is carried from the shoulder. Refer to Figure 2.

3 Circuit Description

3.1 General - The overall operation of the Model 492 can best be understood by referring to the schematic circuit diagram, Figure 4. The GM tube detector is supplied with a regulated high voltage from the power supply, via R1. When the detector is energized by a photon of radiation, the current through R1 increases briefly, causing a negative pulse to appear at C1. This pulse is coupled via C1 to the pulse shaping circuit which amplifies and shapes the pulse. The shaped pulse supplies current for readout to the meter and its associated response time circuit.

3.2 Geiger Tube - The Geiger tube consists of a thin cylindrical shell which is the cathode, a fine wire anode suspended along the longitudinal axis of the shell, and an inert gas into which a small amount of a halogen gas is inserted to act as a quenching agent.

A potential of approximately 600 volts is maintained between the two electrodes with the anode always positive. This voltage is slightly less than that required to produce a discharge in the gas. When a nuclear particle or ray of sufficient energy enters the Geiger tube, it ionizes a molecule of the inert gas. Because of the high voltage maintained between the electrodes, the positive ions are attracted to the cathode and the electrons are attracted to the anode. In their

2 Operation

2.1 Battery Installation - Snap open the pull catches at each end of the case and remove the case bottom. This will expose the circuit board assembly and the battery compartment.

Squeeze the battery retainer clamp to remove it from the compartment. Install standard D size flashlight cells in the openings provided, observing the proper polarity. Replace the retainer clamp and the case bottom.

If operation below 32^0 F is contemplated, use alkaline batteries. Remove all batteries if the instrument is to be stored for any extended period of time.

2.2 Battery Test - Turn the selector switch to the BATT position. If the meter does not read within the check band, the batteries must be replaced. The battery test may be performed at any time, whether the instrument is in a radiation field or not.

W A R N I N G !

An external source of ionizing radiation of the type the instrument was designed to measure must be used to determine proper operation of this instrument. This is the only practical method of determining if the instrument is responding to radiation. Failure to conduct periodic performance tests in accordance with ANSI N323-1978, Paragraphs 4.6 and 5.4, and to keep records thereof in accordance with paragraph 4.5 of the same standard, could result in erroneous reading of potential danger. ANSI N323-1978 becomes, by this reference, a part of this operating procedure.

2.3 Radiation Measurements - Three operating ranges (X1, X10, and X100) are provided. These correspond respectively to 10, 100, and 1000 milliroentgens per hour (mR/h) full scale. For best reading accuracy, switch to the range which provides a reading in the upper 80% of the meter scale.

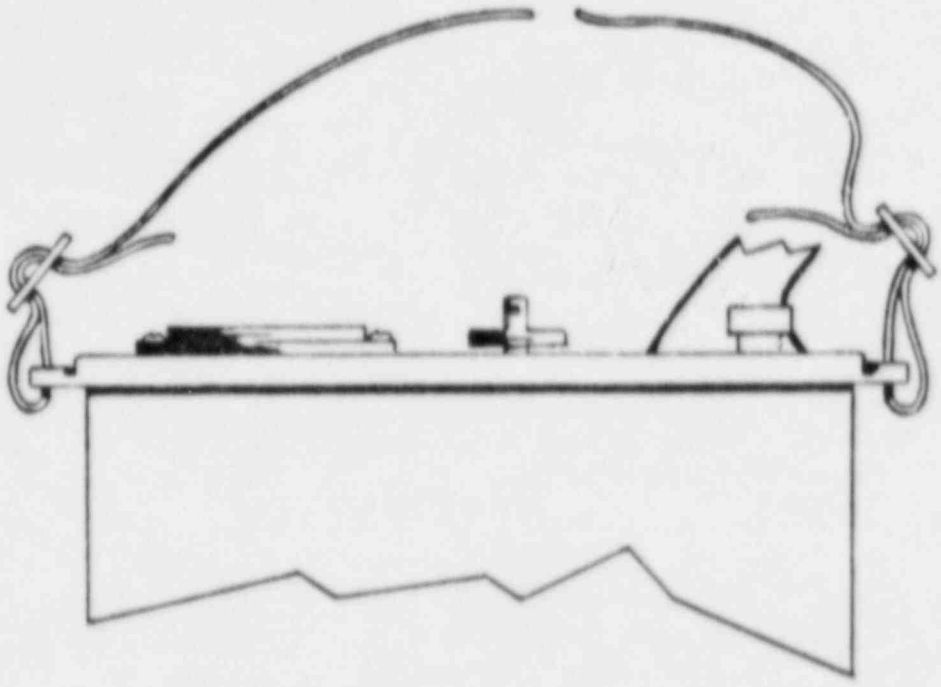


Figure 2. Attachment of Carrying Strap

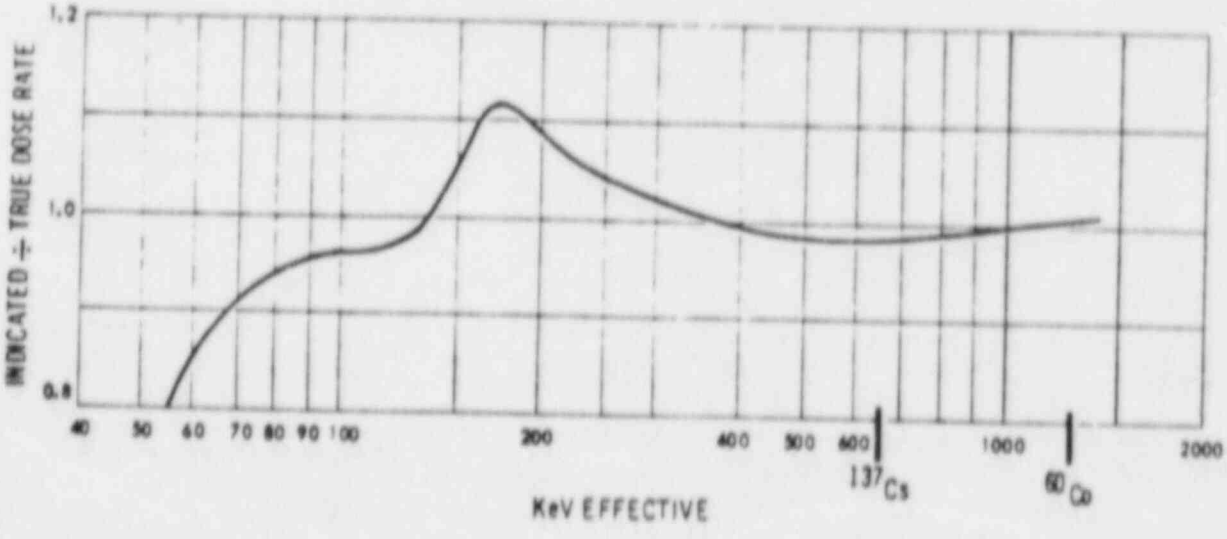


Figure 3. Energy Response

movement toward the electrodes, these charged particles trigger the ionization or additional gas molecules, resulting in an avalanche of ions flowing between the electrodes. The gas discharge thus created is similar to the glow of a neon lamp. The tube conducts as long as the gas is in the ionized state.

The small amount of halogen gas in the gas mixture quenches the flow of ions, suppressing further electron avalanches until another nuclear particle or ray enters the tube. This glowing and quenching results in a rapid pulse or surge of current in the external circuit. The number of pulses per minute is proportional to the amount of radiation present. The meter, suitably connected to the tube, indicates the dose rate on a calibrated scale.

3.3 Power Supply - The power supply provides two regulated outputs: 600 volts for the Geiger tube, and -7 volts for the pulse shaping circuit. The circuit operates as a blocking oscillator in the flyback mode.

The blocking oscillator portion of the circuit consists of transistor Q3, windings 3-4 and 5-6 of transformer T1, resistor R3, and the batteries. C4 serves only to suppress high frequency parasitic oscillations caused by the transistor parameters.

The high voltage power supply portion of the circuit consists of winding 1-2 of T1, diode CR1, the associated resistors and capacitors, and the corona discharge tube V1. The low voltage section is comprised of winding 5-6 of T1, diode CR3 and capacitor C9.

The operation of the power supply is as follows: When the instrument is turned on, Q3 conducts and an increasing current flows through winding 3-4 and the collector of Q3. This current induces a voltage in winding 5-6 or such polarity as to sustain and increase the conduction of Q3. The collector current continues to increase until Q3 becomes saturated, at which time the current through Q3 and winding 3-4 reaches a constant value. Because the current in winding 3-4 is constant, the induced voltage in winding 5-6 falls to zero, causing the base current to drop. This decreasing current induces a voltage in winding 5-6 of such polarity as to turn off the transistor. After the induced voltage at the base reaches zero, the transistor conducts again and the cycle repeats. Potentiometer R3 controls the rate of repetition.

As a result of the flyback action of the circuit, large voltage pulses appear on all the transformer windings. The voltage present is proportional to the number of turns on the winding.

The voltage at winding 1-2 is rectified by CR1, filtered by C3, R2, and C2, and regulated by the corona regulator tube V1. This provides 600 volts for the GM tube. At winding 5-6, the pulses are rectified and filtered by CR3 and C9. The regulating action of V1, reflected back through the transformer, maintains the output of the low voltage supply at a constant level.

3.4 Pulse Shaping Circuit - The pulse shaping circuit, consisting of transistors Q1 and Q2 and their associated components, is a monostable, or one-shot multivibrator. Its function is to provide a uniform current pulse output for each pulse input, regardless of the shape or magnitude of the input pulse.

With no pulse input, Q2 is saturated due to the large base current supplied through R13. Because the transistor is saturated, the voltage across its collector to emitter is about 0.2 volts. This voltage is dropped to about 0.1 volt through R9 and R4, and applied to the base of Q1. This effectively maintains Q1 cut off, placing its collector at the supply voltage. Because there is no current through Q1, and thus through R5 and R6, the supply voltage also appears at the junction of R5 and R6. Whichever timing capacitor (C5 through C7) is connected in the circuit thus has a voltage drop across it equal to the difference between the supply voltage and the base voltage on Q2.

4 Maintenance

4.1 Battery Replacement - The best preventive maintenance that can be recommended is to keep the instrument turned off when it is not in use, to remove the batteries during extended periods of storage, and to be sure that fresh batteries are used.

Battery life is about 150 hours with carbon-zinc cells when operated at an average rate of four hours per day. Battery replacement is required if the Battery Test, paragraph 2.2, is below the check band.

4.2 Power Supply Adjustment - The operating point of the power supply oscillator is adjusted by means of potentiometer R3, located inside the case on the right when the instrument is viewed from a normal operating angle. The adjustment provides for optimum battery life and voltage regulation. Check the setting before calibration, and after any components have been replaced.

To check the operating point, insert a 0-100 mA meter in series with a fresh set of batteries. With the instrument turned on, the current should be 33 mA with carbon-zinc batteries and 30 mA with alkaline batteries.

If the current is within ± 2 mA of the correct value, no adjustment is required. If not, turn the POWER control, R3, counterclockwise, then clockwise until the correct value is obtained.

4.3 Calibration - The instrument is designed for long-term stability so that calibration should not be frequently required. However, field calibration, preferably with Cesium-137 gammas, may be performed at any time in the following manner:

1. Install a new set of batteries and check the Power Supply Adjustment according to section 4.2 before proceeding with calibration.
2. Place the instrument in a 70 to 90 mR/h radiation field. Distance should be measured from the center of the GM tube, V2.
3. Switch the instrument to the X10 range and adjust the calibration control for a correct meter reading. The calibration control, R8, is located inside the case, on the left side of the instrument as viewed from the normal operating position.

4.4 Checking Pulse Shaping and Metering Circuit - After it has been determined that the power supply is operating properly, and after voltage and resistance checks have been made as indicated on the schematic, the monostable multivibrator may be checked with an oscilloscope.

With the instrument measuring background, or with a small gamma source placed next to the GM tube, check for waveforms as follows:

- Q1 collector: Positive 7 volt square wave
- Q2 base: Positive 3.5 volt pulse, rising sharply and decaying exponentially
- Q2 collector: Negative 7 volt square wave

The pulses will occur with each input pulse. The nominal pulse width is 7 milliseconds on the X1 range, 799 microseconds on the X10 range and 70 microseconds on the X100 range.

INDUSTRIAL RADIOGRAPHY EQUIPMENT

Gamma Industries

A DIVISION OF NUCLEAR SYSTEMS, INC

Gamma Industries

A DIVISION OF NUCLEAR SYSTEMS, INC

Gamma Century Radiography Exposure Device

Lightweight, rugged, safe and simple to operate, the Gamma Century is the choice of radiographers throughout the world with years of outstanding field use to support its reliable yet simple design.

Isotope Radiography Devices & Accessories

Gamma Industries
Century "S" & "SA" Radiography Exposure Device

Catalog Numbers: 821-1001-005 ("S"); 821-1001-006 ("SA")

Purpose

The Gamma Industries' Century is a rugged radiography exposure device for making radiographic exposures with Iridium-192. The Century is versatile and is suitable for meeting those radiography needs in the laboratory as well as those under the most extreme environmental conditions. It meets DOT standards as a transport container, and with depleted uranium shielding, is lightweight and portable. These two features and the general design and construction of the Century allow for transportation via rapid delivery (small package air carriers) so you may move from job to job quickly no matter what the distance.

Description

The Gamma Century is compact and entirely self-contained with a nominal capacity of 100 curies of Iridium-192. Depleted uranium is employed as the shielding medium for the source. Positive mechanical control of the source is provided by Control Assembly and Source Guide Tube attachments. A safety plug in the outlet nipple and a safety cap in the lock box assure the security of the source when not in use. The source cannot be withdrawn from the shield through the lock box. Key-operated locks prevent use by unauthorized persons.

Attachments

- Source Guide Tubes
- Control Assemblies

See corresponding catalog sheets for these items.

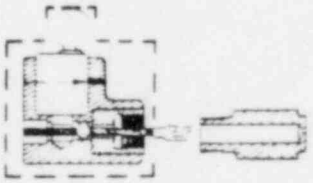
Accessories

- Panoramic Collimators
- Side Collimators

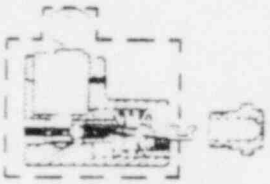
See corresponding catalog sheets for these items.

"SA" Safety Features

1. The source cannot be exposed unless a secure connection between the source assembly and the control assembly is made.
2. The source assembly cannot be disconnected after use unless the source is in the safe position in the shield.



"S" Lockbox



"SA" Lockbox

Specifications

• Isotope:	Iridium-192
• Nominal Capacity:	100 curies
• Source Model:	"S" A-2-A or A-1-A "SA" A-2-A
• Shielding Material:	Depleted Uranium
• Shielding Weight:	26 lb. (12 kg.)
• Device Weight:	42 lb. (19 kg.)
• Shipping Weight:	65 lb. (30 kg.)
• Dimensions:	Height – 10 in. (25 cm.) Width – 12 in. (30 cm.)

Due to Gamma Industries' continuing program of research and engineering development, all specifications subject to change without notice and may be varied at manufacturer's discretion.

Sales and Service

Call Toll Free 1-800-535-8132 (except in Louisiana)

Home Office-Manufacturing

P.O. Box 2543
2255 Ted Dunham Avenue
Baton Rouge, LA 70821
(504) 388-0800

P.O. Box 125
201 Grefer Avenue
Harvey, LA 70058
(504) 366-6462

P.O. Box 34526
9320 Tavenor Lane
Houston, TX 77034
(713) 944-7676

Gamma Industries
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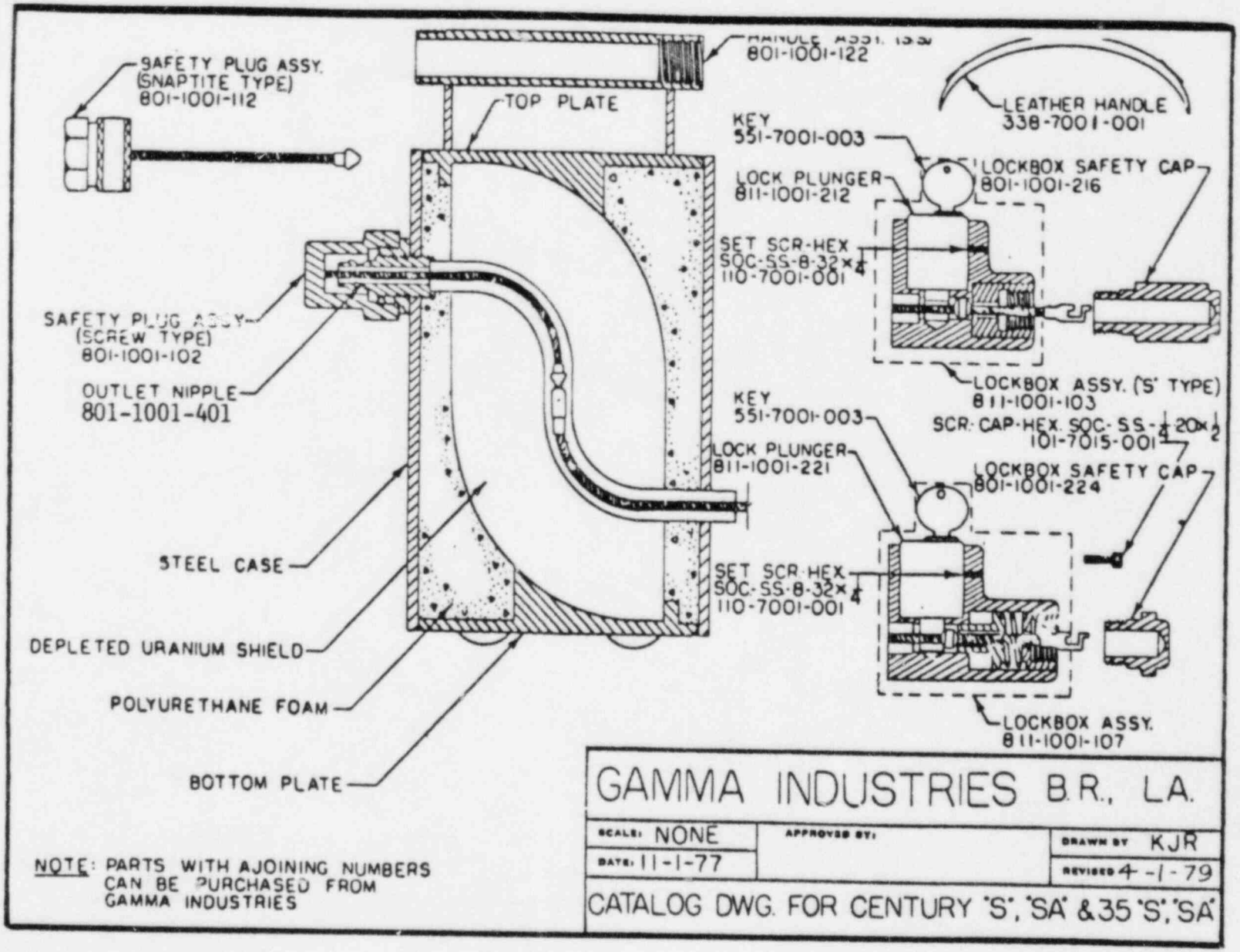

SAFETY PLUG ASSY.
(SNAPTITE TYPE)
801-1001-112
HANDLE ASSY. (SS)
801-1001-122
TOP PLATE
LEATHER HANDLE
338-7001-001
KEY
551-7001-003
LOCK PLUNGER
811-1001-212
LOCKBOX SAFETY CAP
801-1001-216
SET SCR-HEX
SOC-SS-8-32×4
110-7001-001
SAFETY PLUG ASSY.
(SCREW TYPE)
801-1001-102
OUTLET NIPPLE
801-1001-401
LOCKBOX ASSY. ('S' TYPE)
811-1001-103
KEY
551-7001-003
SCR-CAP-HEX-SOC-SS-¼-20×½
101-7015-001
LOCK PLUNGER
811-1001-221
LOCKBOX SAFETY CAP
801-1001-224
STEEL CASE
SET SCR-HEX
SOC-SS-8-32×4
110-7001-001
DEPLETED URANIUM SHIELD
POLYURETHANE FOAM
BOTTOM PLATE
LOCKBOX ASSY.
811-1001-107
GAMMA INDUSTRIES B.R., LA.
SCALE: NONE
APPROVED BY:
DRAWN BY KJR
DATE: 11-1-77
REVISED 4-1-79
CATALOG DWG. FOR CENTURY 'S', 'SA' & 35 'S', 'SA'
NOTE: PARTS WITH AJOINING NUMBERS CAN BE PURCHASED FROM GAMMA INDUSTRIES

GAMMA INDUSTRIES'

MODEL GAMMA CENTURY S & SA

Your GAMMA CENTURY SA exposure device is the result of our best efforts in engineering, materials and workmanship. Nothing has been spared in our endeavor to make this unit the finest radiography device on the market.

Drawing #142 at the back of this pamphlet is a cross-sectional view of the unit with source pigtail in position. You will note that the component parts are essentially the depleted uranium shield, the steel case, top and bottom saddle plates and lock box. In addition to the top and bottom saddle plates used to support the shield, polyurethane is employed as support for the shield casting. With only a minimum of maintenance, your unit should give trouble free, safe operation for an indefinite period.

DESCRIPTION

The GAMMA CENTURY SA is a uranium-shielded industrial radiography device for the making of panoramic and similar exposures with iridium 192. The unit is distinguished by the following features.

CAPACITY

Maximum capacity is 100 curies of iridium 192.

REMOTE CONTROL

Positive mechanical control of the source is provided

by a 25 foot control assembly and a 14 foot source guide tube. No external power supply is required.

MOBILITY

The GAMMA CENTURY SA is compact, entirely self-contained and weighs only approximately 38 pounds.

SAFETY FEATURES

A safety plug in the outlet nipple and a safety cap in the lock box assure the security of the source when not in use.

The source cannot be exposed unless a secure connection between the source pigtail assembly and the control cable is made. This feature is provided only on the SA model.

The control cable cannot be disconnected after use unless the source is in the safe position in the shield. This feature is also provided only on the SA model.

The source cannot be withdrawn from the shield through the lock box even when the lock is open.

The GAMMA CENTURY S & SA meets all DOT regulations for shipping and all USAEC regulations for isotope radiography devices.

OPERATION

1. Have an operating survey meter on hand always and use it.
2. Remove the protector cap from the lock box thereby exposing the pigtail connector.

3. Crank the control cable to a length of approximately six inches.
4. Connect control cable to pigtail.
5. Crank control cable in so that male connecting thread can be screwed into lock box.
6. Screw connecting thread into lock box.
7. Remove safety plug from protruding nipple located approximately 1" from top of unit.
8. Connect source tube.
9. Place free end of source tube in desired position trying to keep it in a straight line without kinks.
10. Stretch control cable away from exposure device in as straight a line as possible.
11. Unlock the unit by turning the handle back (counter clockwise) which will permit the key to be turned. This is required only on the SA model.
12. Crank source out as smoothly as possible. When you feel that source is approaching end of source tube, slow the turning speed so that pigtail does not strike the end of the source tube with undue force.
13. Survey to see that radiation levels are within limits.
14. At the end of exposure, retract source into unit.
15. Now for the most important step of all: <u>Survey carefully to be sure that source has returned to safe position</u>.

16. Turn crank back (counter clockwise) and depress lock plunger. The SA models only require that handle be pulled back.
17. Disconnect cable.
18. Screw safety cap into place.
19. Disconnect source tube.
20. Insert safety plug.

PERIODIC INSPECTION AND MAINTENANCE FOR

GAMMA CENTURY, GAMMA "35", SA MODELS, GAMMATRONS AND UTILITY TWINS

Periodic inspection of exposure devices should be performed at intervals not to exceed 90 days or whenever operation of the device appears to be impaired through abuse or wear. However, it should be emphasized that this applies only to the device. DO NOTHING TO THE SOURCE. If the source appears worn or faulty in any way, contact Gamma Industries. In order to perform device inspection and maintenance proceed as follows:

1.1 Remove safety cap in lock box and inspect source connector. The holding pin should still have a true 90 degree elbow; it should be straight and parallel with axis of source connector and the key on apex of elbow should not be worn excessively. Check flexibile cable at connector for straightness.

Maintenance: If the elbow is not bent out of line, the mating connector should then be connected to the source and tested by pulling straight back on cable applying about 30 to 40 pounds of pressure.

1.2 The lock plunger should be inspected and checked for ease of operation. Foreign matter may at times foul the plunger

and make it inoperative. The lock plunger may not retract to its fullest extent which is 1/2 inch. This would prevent free travel of the source in and out of the lock box.

Maintenance: The lock plunger may be removed by removing the two 8-32 set screws in the lock box. Wash lock in solvent to remove dirt or other foreign matter. Lock may also be cleaned and lubricated by spraying a lubricant (such as WD-40) into the lock.

1.3 Inspect the source outlet nipple by first removing safety plug. The outlet nipple should be round and smooth so that it will match with the I. D. of the source tube.

Maintenance: If the outlet nipple should be out-of-round it can sometimes be straightened by using a punch or round bar on the inside of the outlet. If it cannot be straightened or if the nipple has been broken by dropping the unit, it must be replaced. This replacement can be done in the field shop, or returned to Gamma Industries.

1.4 Inspect labeling on exposure device. The warning signs and source identification tags should be distinct and legible.

1.5 Inspect source tubes for damage such as crimps, foreign matter, ease of connecting, and disconnecting from exposure

device.

Maintenance: Crimps, kinks, and other damaged places may be cut out, and connectors placed on ends so that tube is not shortened excessively. The quick disconnect coupling that connects to outlet nipple of exposure device may be removed with heat and replaced. Foreign matter may be washed from tube with solvent and blown with compressed air.

1.6 Inspect source connector on drive cable. The hole should be 7/64 inch in diameter when new. This hole should show some wear after much use, but should not be out-of-round to the extent that it will disconnect from the mating piece other than in the correct position. It should not be loose on the drive cable. The portion of the connector with the connector hole should not be bent, but should be straight and parallel with body of connector.

Maintenance: This worn connector may be replaced by one of two methods.

1. Send back to Gamma Industries to have new connector replaced by swedging on new replacement.
2. Order new core with connector attached.

1.7 Inspect remainder of drive cable for wear, rusty sections, causing cable to become stiff and non-flexing, kinks, or other

damaging conditions that would prevent cable from running on gear in the gear box housing.

Maintenance: The drive cable should be cleaned with a solvent such as varsol, diesel fuel or some other solvent that will not dry out. This is done to remove sand, dust and other foreign matter that will cause abrasions in the exposure device and gear box drive mechanism. Drive cable that has become rusty and non-flexible should be replaced. Failure to replace cable may cause controls to become stiff, hard to operate, wear excessively, and possibly break. The cable would usually break when the source is exposed. Lubrication of the drive cable is important. In areas where there is a problem with sand or other abrasive material, dry powered graphite is excellent. Graphite should not be packed continually since it will tend to pack in the gear box and cause excessive wear to the gear housing and to the gear. Where the control cables can be kept reasonably clean, a light oil will be adequate.

1.8 Inspect the control assembly. This assembly consists of the gear box assembly and the crank handle. The bronze bushings in the gear housing and the plate are the most likely places to find wear. When these bushings are worn

*Refers to old type control assembly
For new type substitute "Ball bearing" for "bronze bushing"

they tend to permit the gear to wobble and eventually wear out. Usually (due to some build-up on the drive cable or the gear teeth) there will be some wear around the inner circumference of the housing. This will permit the drive cable to slip on the gear and prevent source form moving properly through the exposure device.

Maintenance: It is suggested that if powdered graphite is used as a lubricant the gear box be cleaned with compressed air occasionally so as to remove any packed graphite in the gear mechanism. The application of some type light oil on bronze bushings will help prevent excessive wear.

1.9 Inspect drive cable housing or conduit. This conduit can be damaged by dropping it across a hot weld, severe kinking, or by dropping some object on the conduit. Any of these can prevent the drive cable from moving freely. The conduit at the end connections may become damaged from excessive flexing while being assembled or disassembled.

Maintenance: In any case where the inner liner has been damaged, the conduit must be replaced. When the outer covering has been damaged, waterproof tape should be wrapped around the break to prevent the entrance of water or other corrosive substances. If the extreme ends of the conduit

are damaged, they tend to permit the gear to wobble and eventually wear out.

IMPORTANT - READ CAREFULLY BEFORE CHANGING SOURCE

SOURCE CHANGING INSTRUCTIONS

FOR C-10 SHIPPING CONTAINER
Revised 4/22/74

Attached is a cross-sectional view (Dwg. 323-Revision 1) of the shipping container used for transporting your pigtail source. The container has two lock boxes--one on each side. The upper lock box is labeled "NEW SOURCE" and the upper tube contains the new source. The lower lock box and tube contain a safety plug when shipped to you. The lower tube will be used to return the decayed source to Gamma Industries.

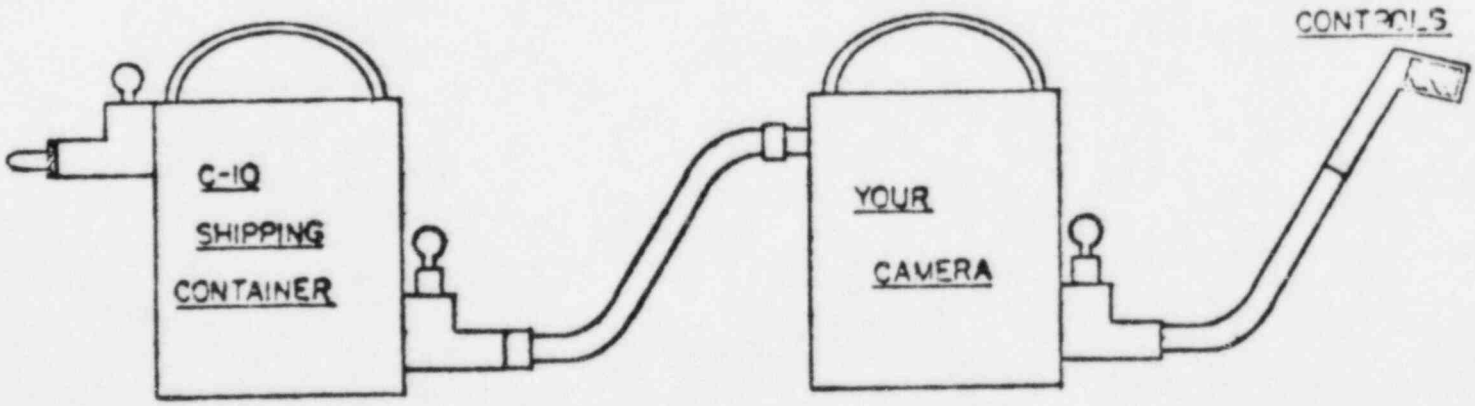
The following procedure should always be followed in the source changing operation:

ALWAYS HAVE A PROPERLY OPERATING SURVEY METER AT HAND WHEN CHANGING SOURCES!

1. Survey the C-10 shipping container with meter. The radiation intensity should not exceed 10 mr/hr at 1 meter from any surface of the C-10.

2. Open the lower lock of the C-10 shipping container. Remove the safety plug.

3. Connect one end of short exchange tube (provided in the shipping barrel) to the lower lock box of the C-10 shipping container. Attach the other end of the short exchange tube to your camera.



4. Crank your old source into the C-10 shipping container until it reaches a definite stop.

5. Survey to assure that the old source has reached a safe position.

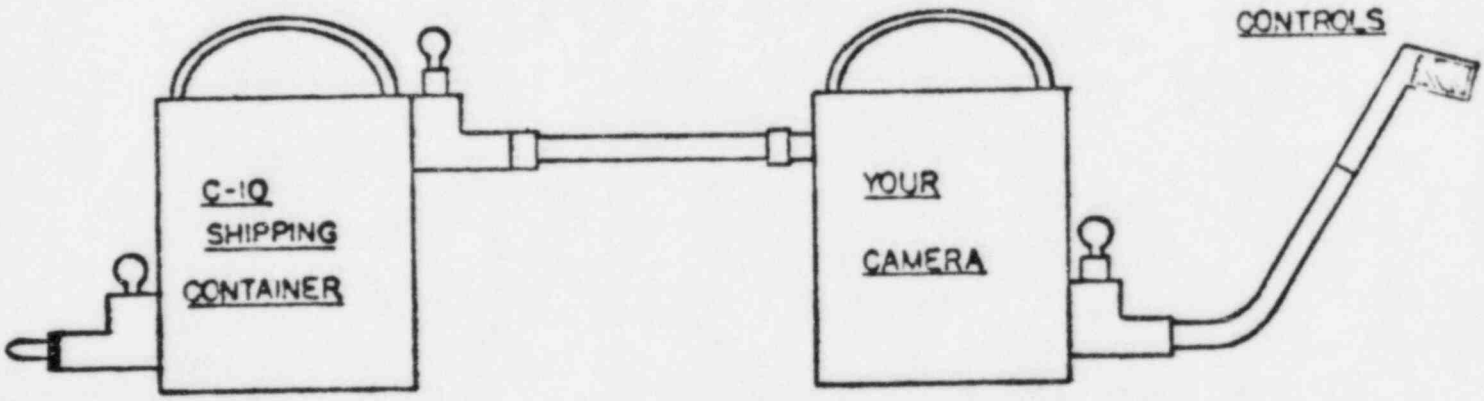
6. Lock the lower lock of the C-10 shipping container onto the old pigtail locking ball. You must be aware that the source could be removed from the open end of the lock box if the lower lock is not locked.

7. Remove the short exchange tube from the C-10 shipping container. Disconnect the control cable from the old pigtail. (Attempt to move the pigtail into and out of the C-10 shipping container to assure the lock is depressed upon the pigtail locking ball. If the pigtail can be moved, then open the lower lock, carefully move the pigtail, and lock the lock upon the pigtail locking ball. This will assure that the old source will remain properly locked and shielded during the return shipment.)

8. Remove the source protector cap from the upper lock box and attach the source protector cap over the old source pigtail in the lower lock box.

9. Attach the control cable to the new pigtail which is in the upper lock box.

10. Attach short exchange tube to the C-10 shipping container upper lock box.



11. Unlock the upper lock from the new source.

12. Standing as far away as possible, crank the new source from the C-10 shipping container into your camera.

13. Survey.

14. Lock your camera lock.

15. Remove the short exchange tube from your camera. Remove the short exchange tube from the C-10 shipping container.

16. Insert the safety plug into the upper tube of the C-10 shipping container. Lock the upper lock of the C-10 shipping container.

17. Survey.

18. Place the C-10 into the barrel in the same orientation which it was received. Place the short exchange tube into the barrel. Place the top on the barrel and secure with the locking ring.

19. Insert a safety seal into the barrel locking ring.

20. Survey. (The radiation intensity should not exceed 200 mr/hr at any barrel surface or 10 mr/hr at one meter from any barrel surface.)

END OF SOURCE INTERCHANGE INSTRUCTIONS

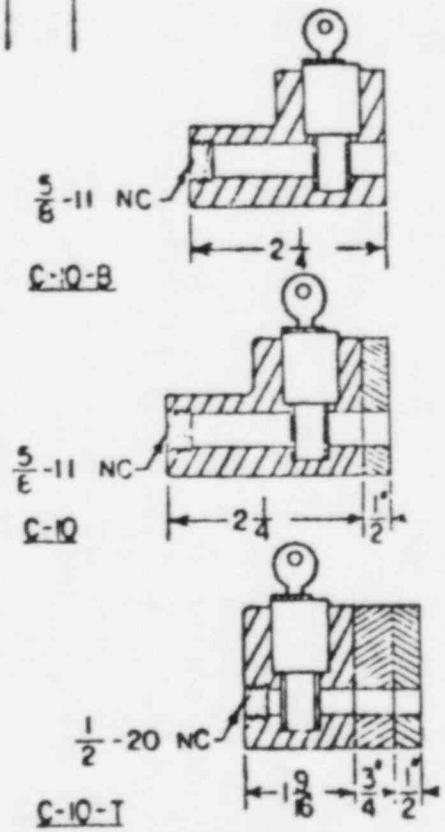
Be sure that you:

1. Attach two "Radioactive Yellow-III" labels to the barrel.

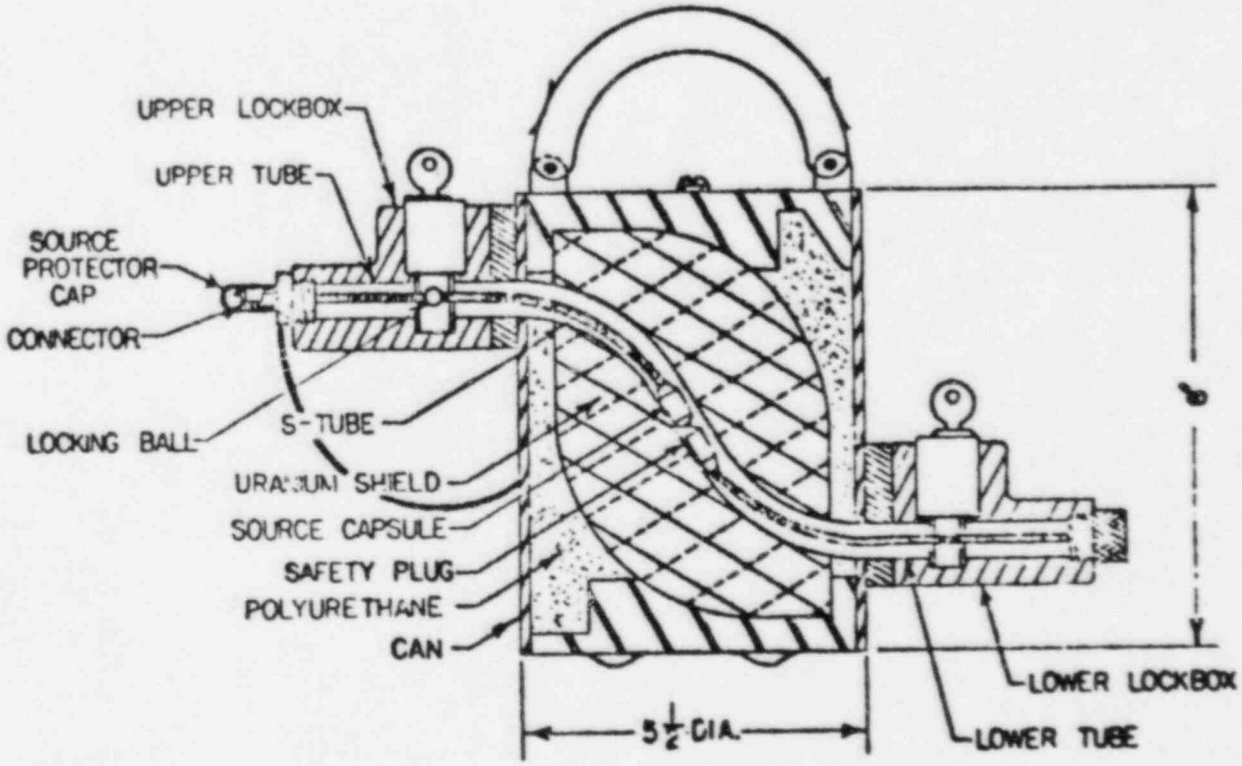
2. Measure and write the transport index upon the affixed labels.

3. Properly fill out all shipping documents.

	DATE	BY
SCALE	4-22-74	NCL



NOTE: BY REMOVING C-10 LOCK ASSEMBLY AND REPLACING WITH EITHER C-10-B OR C-10-T LOCK ASSEMBLIES THE SHIPPING CONTAINER CAN BE MADE UP TO CONTAIN SOURCES AS LISTED.



C-10 ASSEMBLY

NOTE- THIS IS NOT A WORKING DRAWING. TO BE USED ONLY FOR SCHEMATIC ARRANGEMENTS.

C-10-B	B-4-B	D-1-G
	B-4-G	D-1-R
	B-5-B	B-1-B IR[192]
	B-5-G	B-1-G
C-10	A-1-A	T-1-T
	A-1-G	T-1-A
	A-2-A	T-1-G
	A-2-G	
C-10-T	T-3-T	

GAMMA INDUSTRIES B.R., L.A.

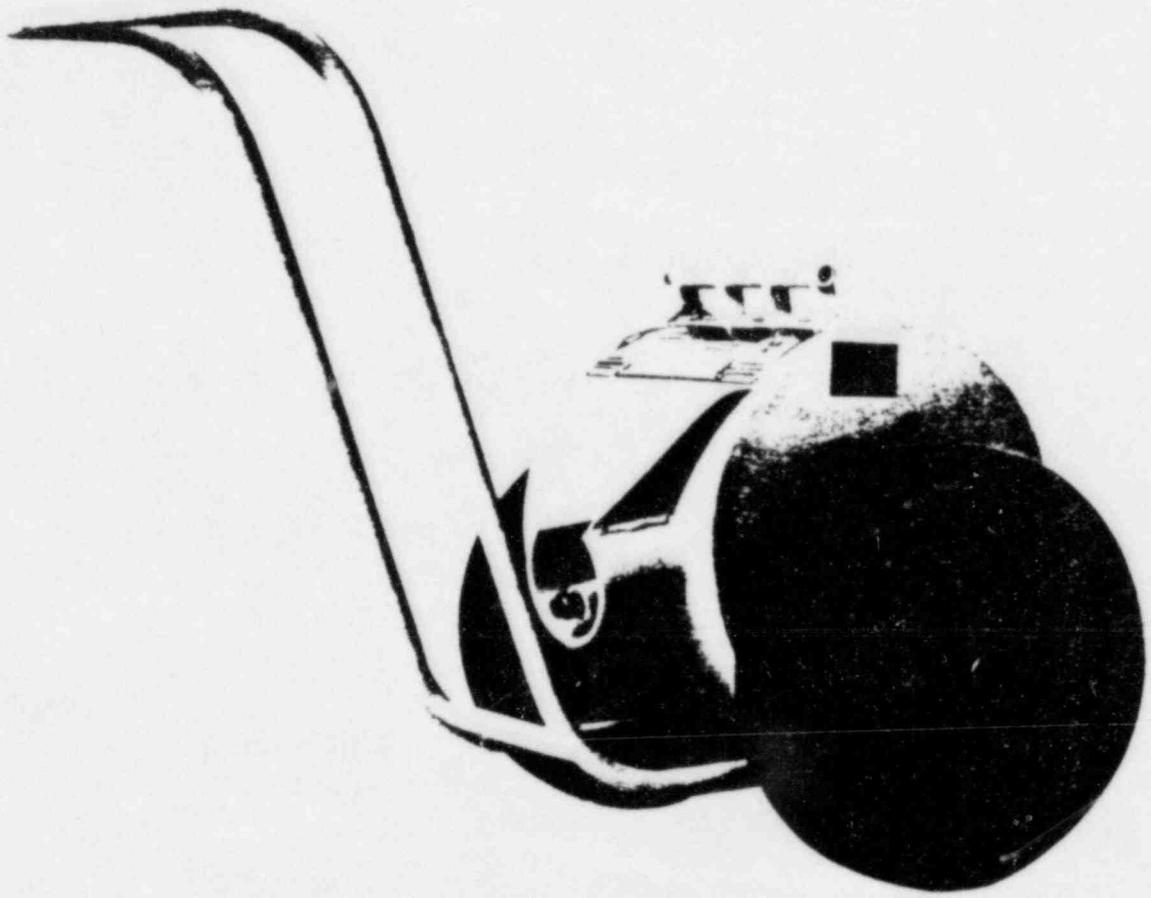
SCALE: NONE	APPROVED BY:	DRAWN BY: CL
DATE: 6-18-73		REVISED

SHIPPING CONTAINER
MODEL NOS. C-10, C-10-B, C-10-T

DRAWING NUMBER 323-REV-1

Gamma Industries

A DIVISION OF NUCLEAR SYSTEMS, INC.



Gammatron Cobalt Radiography Exposure Devices

For applications requiring high energy radiography examination, the Gammatron Cobalt-60 radiography exposure devices are field-proven radiography systems. Heavy section radiography in the field and fabrication shop is a reasonable task using the Gammatrons.

Isotope Radiography Devices & Accessories

Gamma Industries
Gammatron 20A, 50A, 100A, 200A

Catalog Numbers: 821-1001-014 (20A); 821-1001-015 (50A); 821-1001-016 (100A); 821-1001-017 (200A)

Purpose

The Gamma Industries' Gammatrons are designed to provide versatility, minimum weight, low maintenance and mobility for heavy industrial radiography applications. By utilizing depleted uranium shielding, welded construction and mounting with pneumatic tires, these units offer a high degree of mobility. Gammatrons are certified type B transport containers which are approved for shipment worldwide. All four models are identical except for capacity and weight and conveniently use the same interchangeable controls, source tubes and accessories.

Description

The Gammatrons are portable Cobalt-60 radiography systems with nominal capacities of 20, 50, 100 and 200 curies of Cobalt-60. Positive mechanical control of the source is provided by Control Assembly and Source Guide Tube attachments. A safety plug in the outlet nipple and a safety cap in the lock box assure the security of the source when not in use. The source cannot be withdrawn from the shield through the lock box. Key-operated locks prevent use by unauthorized persons.

Attachments

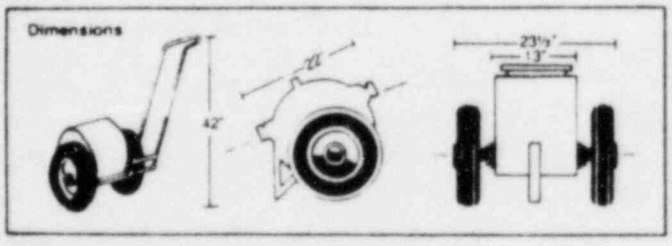
- Source Guide Tubes
- Control Assemblies

See corresponding catalog sheet for these items.

Accessories

- Panoramic Collimators
- Side Collimators

See corresponding catalog sheet for these items.



Specifications

	20A
• Isotope:	Cobalt-60
• Nominal Capacity:	20 curies
• Source Model:	A-7-A
• Shielding Material:	Depleted Uranium
• Shielding Weight:	230 lb. (104 kg.)
• Device Weight:	310 lb. (141 kg.)
• Shipping Weight:	410 lb. (186 kg.)
• Dimensions:	See diagram
	50A
• Isotope:	Cobalt-60
• Nominal Capacity:	50 curies
• Source Model:	A-7-A
• Shielding Material:	Depleted Uranium
• Shielding Weight:	230 lb. (104 kg.)
• Device Weight:	340 lb. (141 kg.)
• Shipping Weight:	410 lb. (186 kg.)
• Dimensions:	See diagram
	100A
• Isotope:	Cobalt-60
• Nominal Capacity:	100 curies
• Source Model:	A-8-A
• Shielding Material:	Depleted Uranium
• Shielding Weight:	360 lb. (163 kg.)
• Device Weight:	515 lb. (233 kg.)
• Shipping Weight:	615 lb. (279 kg.)
• Dimensions:	See diagram
	200A
• Isotope:	Cobalt-60
• Nominal Capacity:	200 curies
• Source Model:	A-8-A
• Shielding Material:	Depleted Uranium
• Shielding Weight:	360 lb. (163 kg.)
• Device Weight:	515 lb. (233 kg.)
• Shipping Weight:	615 lb. (279 kg.)
• Dimensions:	See diagram

Due to Gamma Industries' continuing program of research and engineering development, all specifications subject to change without notice and may be varied at manufacturer's discretion.

Sales and Service

Call Toll Free 1-800-535-8132 (except in Louisiana)

Home Office-Manufacturing
P.O. Box 2543
2255 Ted Dunham Avenue
Baton Rouge, LA 70821
(504) 388-0800

P.O. Box 125
201 Grefer Avenue
Harvey, LA 70058
(504) 366-6462

P.O. Box 34526
9320 Tavenor Lane
Houston, TX 77034
(713) 944-7676

Gamma Industries
A DIVISION OF NUCLEAR SYSTEMS INC

INSTRUCTION MANUAL

GAMMATRON MODEL 100 and 100A
GAMMATRON MODEL 50 and 50A
GAMMATRON MODEL 20 and 20A

GAMMA INDUSTRIES
A DIVISION OF NUCLEAR SYSTEMS, INCORPORATED
2255 TED DUNHAM AVENUE
BATON ROUGE, LOUISIANA 70821

INSTRUCTION MANUAL

GAMMATRON MODELS

1.0 DESCRIPTION

The GAMMATRON is a uranium-shielded industrial radiography device for the making of panoramic and similar exposures with cobalt-60. The unit is distinguished by the following features.

1.1 Capacity

Maximum capacity of the GAMMATRON 100 and 100A is 200 Curies of cobalt-60 for in-plant applications. Ordinarily, field radiography is limited to 100 Curies of cobalt-60 by regulatory agencies. The GAMMATRON 100 and 100A can be provided with a cobalt-60 source specified by license up to 200 Curies. The maximum capacity of the GAMMATRON 50 and 50A is 50 Curies of cobalt-60; the maximum capacity of the CAMMATRON 20 and 20A is 20 Curies of cobalt-60.

1.2 Remote Control

Positive mechanical control of the source is provided by a 30-foot control assembly and matching source guide tube. No external power supply is required.

1.3 Mobility

The GAMMATRON 100 and 100A is compact, entirely self-contained and weighs only 475 pounds. Roller-bearing wheels and pneumatic tires, together with the "easy-press" handle permit easy handling of the unit by one man.

Large eyes on the shield permit crane handling and the handle is easily removed for handling, crating or storage. The GAMMATRON Models 50 and 20 are identical, except that their weight is 335 pounds and 300 pounds respectively.

1.4 Construction

Drawing Number 190-1 is a cross-sectional view with the source in the shielded position, showing the depleted uranium metal shield, the steel case and end plates with provisions for crane handling, the outlet nipple and the lock box. Polyurathene envelops the shield and fills the cavity within the steel shell. The carefully engineered simplicity of construction and skilled workmanship minimize maintenance.

1.5 Safety Features

A safety plug in the outlet nipple and a safety cap in the lock box assure the security of the source when not in use. The source cannot be withdrawn from the shield through the lock box even when the lock is open.
The GAMMATRON meets all DOT regulations for shipping and all USAEC regulations for isotope radiography devices.

2.0 OPERATION

2.1 Uncrating

Approach crate only with an operating survey meter.

Remove rate. Assemble handle. Except for attachment of controls, the unit is now ready for use.

NOTE: AT NO TIME SHOULD ANY ISOTOPE RADIOGRAPHY DEVICE BE APPROACHED OR USED WITHOUT AN OPERATING GAMMA SURVEY METER OF APPROPRIATE TYPE AS WELL AS OTHER PERSONNEL MONITORING INSTRUMENTS.

2.2 Use

2.2.1 Place exposure device in the desired location and lay out the control cable and guide tube as straight as possible. Too many or too tight bends may restrict movement of the drive cable.

2.2.2 Remove safety plug from the lock box.

2.2.3 Turn control crank forward (clockwise) and expose about eight inches of drive cable.

2.2.4 Connect control cable to source pigtail, matching keyway to key on the male and female Saf-T-Key connector.

2.2.5 Crank the control cable back in (counterclockwise) so that the male thread on the swivel connector can be screwed into the lock box. Attach control cable.

2.2.6 Remove safety plug from the outlet nipple on the front of the shield.

2.2.7 Connect source guide tube by pulling back the sleeve on the quick disconnect and slide the fitting over the outlet nipple. Slide the sleeve toward the shield and turn it to lock in place.

2.2.8 Unlock the unit by pulling back on the crank handle (counterclockwise) which will permit the unit to be unlocked--only "A" models require that the handle be pulled back.

2.2.9 Crank source out smoothly, slowing the speed of cranking near the end of travel so as not to cause the source to strike the end piece with undue force.

2.2.10 Survey to determine that radiation levels are within prescribed limits.

2.2.11 At the end of the exposure, retract the source by cranking counterclockwise.

2.2.12 <u>SURVEY CAREFULLY</u> TO INSURE THAT THE SOURCE HAS RETURNED TO THE SAFE POSITION. If the survey

meter indicates that the source is not in the safe position, INSTITUTE EMERGENCY PROCEDURES AT ONCE.

2.2.13 Turn crank back (counterclockwise) and depress lock plunger--only "A" models require that the handle be pulled back.

2.2.14 Disconnect control cable and screw safety plug in place.

2.2.15 Disconnect source tube and attach safety cap.

2.2.16 Return unit to storage area.

3.0 MAINTENANCE AND INSPECTION

Periodic inspection of exposure devices should be performed at intervals not to exceed 90 days or whenever operation of the device appears to be impaired through abuse or wear. However, it should be emphasized that this applies only to the device. DO NOTHING TO THE SOURCE. If the source appears worn or faulty in any way, contact Gamma Industries. In order to perform device inspection and maintenance as follows.

3.1 Remove safety cap in lock box and inspect source connector. The holding pin should still have true 90 degree elbow, it should be straight and parallel with axis of source connector and the key on apex of elbow should not be worn excessively. Check flexible cable at connector for straightness.

Maintenance: If the elbow is not bent out of line, the mating connector should then be connected to the source and tested by pulling straight back on cable applying about 30 to 40 pounds pressure.

3.2 The lock plunger should be inspected and checked for ease of operation. Foreign matter may at times foul the plunger and make it inoperative. The lock plunger may not retract to its fullest extent which is 1/2 inch. This would prevent free travel of the source in and out of the lock box.

Maintenance: The lock plunger may be removed by removing the two 8-32 set screws in the lock box. Wash lock in solvent to remove dirt or other foreign matter. Lock may also be cleaned and lubricated by spraying a lubricant (such as WD-40) into the lock.

3.3 Inspect the source outlet nipple by first removing safety plug. The outlet nipple should be round and smooth so that it will match with the I.D. of the source tube.

Maintenance: If the outlet nipple should be out-of-round it can sometimes be straightened by using a punch or round bar on the inside of the outlet. If it cannot be straightened or if the nipple has been broken by dropping the unit, it must be replaced. This replacement can be done in the field shop, or returned to Gamma Industries.

3.4 Inspect labeling on exposure device. The warning signs and source identification tags should be distinct and legible.

3.5 Inspect source tubes for damage such as crimps, foreign matter, ease of connecting, and disconnecting from exposure device.

Maintenance: Crimps, kinks, and other damaged places may be cut out and connectors placed on ends so that tube is not shortened excessively. The quick disconnect coupling that connects to outlet nipple of exposure device may be removed with heat and replaced. Foreign matter may be washed from tube with solvent and blown

with compressed air.

3.6 Inspect source connector on drive cable. The hole should be 7/64" in diameter when new. This hole should show some wear after much use but should not be out-of-round to the extent that it will disconnect from the mating piece other than in the correct position. It should not be loose on the drive cable. The portion of the connector with the connector hole should not be bent, but should be straight and parallel with body of connector.

Maintenance: This worn connector may be replaced by one of two methods.

1. Send back to Gamma Industries to have new connector replaced by swedging on new replacement.
2. Order new core with connector attached.

3.7 Inspect remainder of drive cable for wear, rusty sections, causing cable to become stiff and non-flexing, kinks, or other damaging conditions that would prevent cable from running on gear in the gear box housing.

Maintenance: The drive cable should be cleaned with a solvent such as varsol, diesel fuel or some other solvent that will not dry out. This is done to remove sand, dust and other foreign matter that will cause abrasions

in the exposure device and gear box drive mechanism. Drive cable that has become rusty and non-flexible should be replaced. Failure to replace cable may cause controls to become stiff, hard to operate, wear excessively, and possibly break. The cable would usually break when the source is exposed. Lubrication of the drive cable is important. In areas where there is a problem with sand or other abrasive material, dry powered graphite is excellent. Graphite should not be used continually; however, since the graphite will tend to pack in the gear box and cause excessive wear to the gear housing and to the gear. Where the control cables can be kept reasonably clean, a light oil will be adequate.

3.8 Inspection of control assembly. This assembly consists of the gear box assembly and the crank handle. The bronze bushings in the gear housing and the plate are the most likely places to find wear. When these bushings are worn they tend to permit the gear to wobble and eventually wear out. Usually (due to some build-up either on the drive cable or the gear teeth) there will be some wear around the inner circumference of the housing. This

will permit the drive cable to slip on the gear and prevent source from moving properly through the exposure device.

Maintenance: It is suggested that if powdered graphite is used as a lubricant the gear box be cleaned with compressed air occasionally so as to remove any packed graphite in the gear mechanism. The application of some type light oil on bronze bushings will help prevent excessive wear.

3.9 Inspect drive cable housings or conduit. This conduit can be damaged by dropping it across a hot weld, severe kinking, or by dropping some object on the conduit, Any of these can prevent the drive cable from moving freely. The conduit at the end connections may become damaged from excessive flexing while being assembled or disassembled.

Maintenance: In any case where the inner liner has been damaged, the conduit must be replaced. When the outer covering has been damaged, waterproof tape should be wrapped around the break to prevent the entrance of water or other corrosive substances. If the extreme ends of the conduit are damaged, these can be replaced with new pieces by returning the conduit to Gamma Industrie

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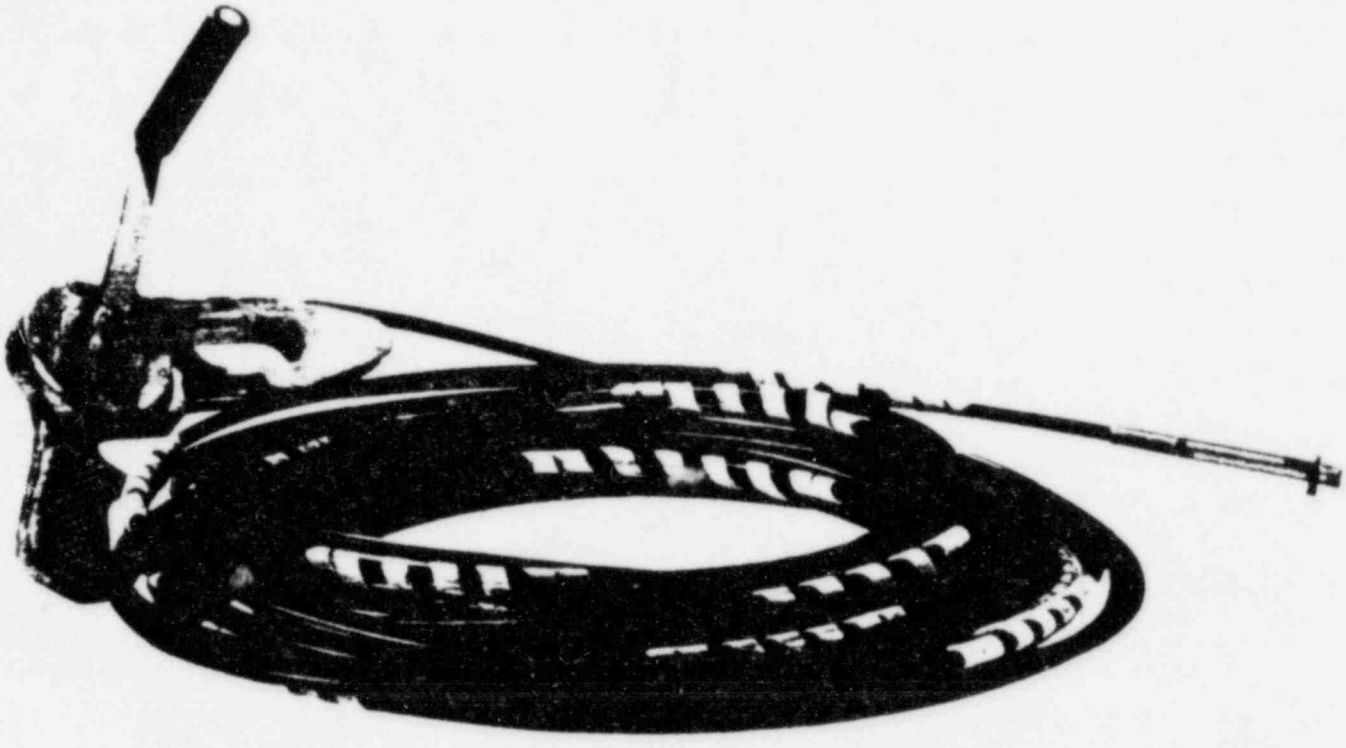


Gamma Industries' Source Control Assemblies

Gamma Industries' Source Control Assemblies have been designed with many years of manufacturing experience backing each feature. These controls allow the radiographer a method of rapid source movement which provides ease and reliability of operation.

Source Control Assemblies

Source Control Assemblies consist of the following parts which are described in detail on the reverse side of this sheet.

- Pistol Grip Assembly
- Source Drive Cable
- Conduit Assembly
- Swivel Adaptor

The Source Control Assemblies are available in five standard lengths and can be manufactured to your specific requirements.

Standard Sizes	Catalog Numbers
15 ft. (4.6 m.)	811-1002-016
25 ft. (7.6 m.)	811-1002-013
30 ft. (9.1 m.)	811-1002-017
40 ft. (12.2 m.)	811-1002-018
50 ft. (15.3 m.)	811-1002-035

Gamma Industries
Source Control Assemblies

Pistol Grip Assembly

Catalog Number: 811-1002-119

The Gamma Industries' Pistol Grip Assembly is a cast hardened aluminum grip with a hobbed gear supported with ball bearings. These features result in a smooth operating, lightweight assembly that is rugged enough to give top performance in the field.

Conduit Assemblies

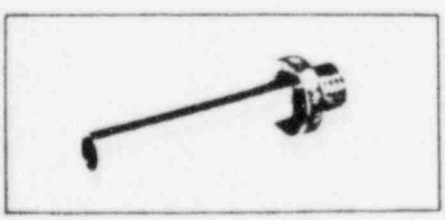
These flexible casings are designed to protect the Source Drive Cable in the environs of radiography. Casings are constructed with a tough polyethylene outer cover and liner with a phosper-bronze, wire-wound core. Brass machined fittings are swaged on either end of the casing to facilitate connecting to equipment. Conduit Assemblies are available in four standard lengths and can also be manufactured to meet specific requirements.

Standard Sizes	Catalog Numbers
15 ft. (4.6 m.)	801-1002-105
25 ft. (7.6 m.)	801-1002-101
30 ft. (9.1 m.)	801-1002-108
40 ft. (12.2 m.)	801-1002-104

Source Drive Cable

This cable is manufactured to the exact specifications of the aircraft industry. It is of phosper-bronze material with a 19-strand inner core around which is wrapped a helix cable which fits the hobbed gear of the Pistol Grip Assembly. Various source connectors may be crimped onto the cable to facilitate the control of many source types. Standard assemblies have the Gamma Industries' SAF-T-KEY A connector; connectors for other devices are available upon request.

Standard Lengths	Catalog Numbers
30 ft. (9.1 m.)	801-1002-106
50 ft. (15.3 m.)	801-1002-103
60 ft. (18.3 m.)	801-1002-109
80 ft. (24.4 m.)	801-1002-107



Swivel Adaptor

Catalog Number: 801-1002-102

Swivel Adaptors are used to connect the control assembly to the radiography exposure device. They are constructed with a stainless steel sleeve and a brass male thread to give strength and prevent thread gauling. Adaptors for other devices are available upon request.

Due to Gamma Industries' continuing program of research and engineering development, all specifications subject to change without notice and may be varied at manufacturer's discretion.

Sales and Service
Call Toll Free 1-800-535-8132 (except in Louisiana)

Home Office-Manufacturing
P.O. Box 2543
2255 Ted Dunham Avenue
Baton Rouge, LA 70821
(504) 388-0800

P.O. Box 125
201 Grefer Avenue
Harvey, LA 70058
(504) 366-6462

P.O. Box 34526
9320 Tavenor Lane
Houston, TX 77034
(713) 944-7676

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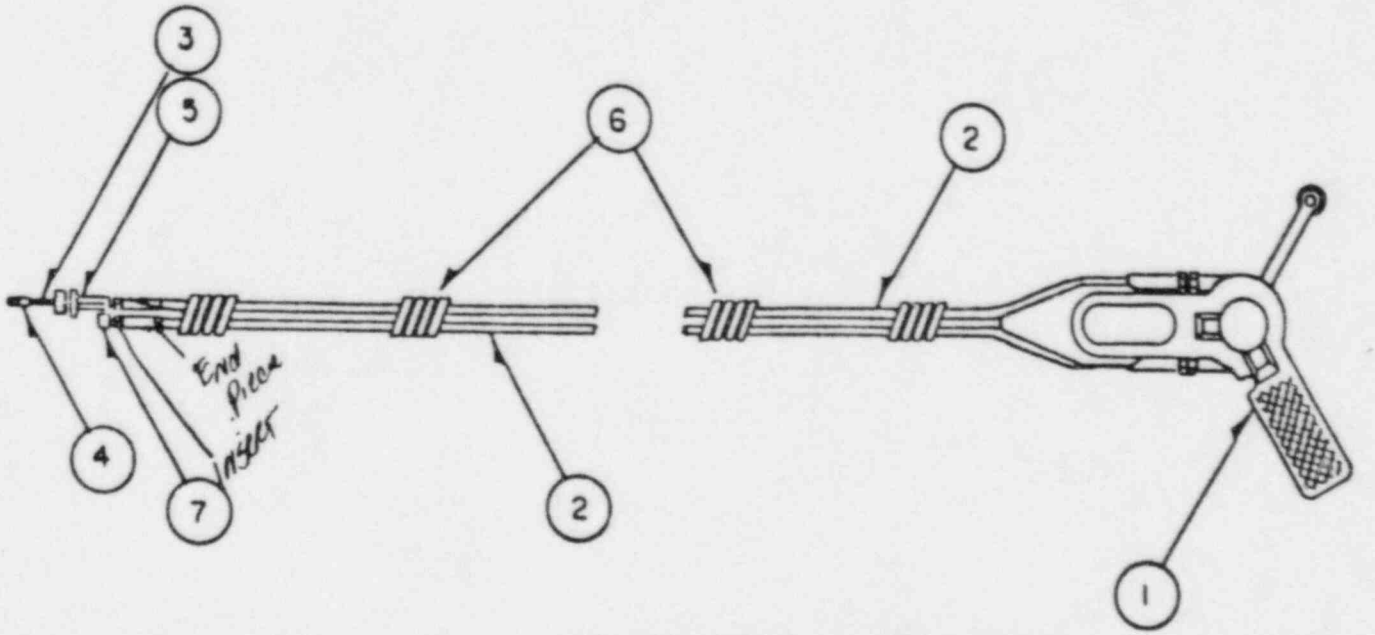


5. Swivel Adaptor - 801-1002-102
6. Rally Wrap - 455-7001-001
7. Thread Protector

1. Pistol Grip Assy.- 811-1002-119
2. Control Conduits - 2 Per Assy
   - 15ft. 801-1002-105
   - 25ft. 801-1002-101
   - 30ft. 801-1002-108
   - 40ft. 801-1002-104
3. Drive Cable
   - 30ft. 801-1002-106
   - 50ft. 801-1002-103
   - 60ft. 801-1002-109
   - 80ft. 801-1002-107
4. Connector
   - Gamma "A" 801-1002-208

GAMMA INDUSTRIES, BATON ROUGE, LA.

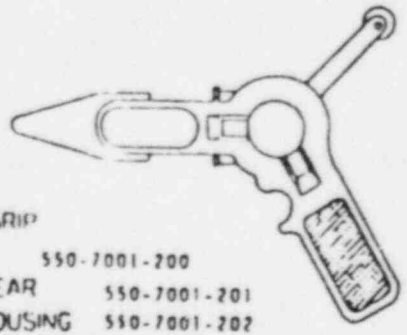
CRANKOUT CONTROL ASSEMBLY

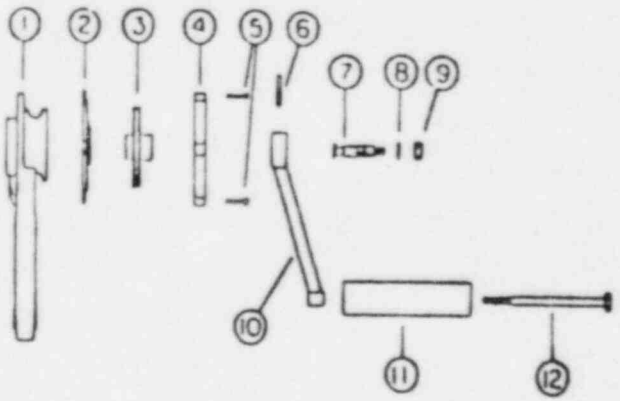
SCALE: None	APPROVED BY:	DRAWN BY JRG
DATE: 9-29-70		REVISED

CATALOG DWG.

DRAWING NUMBER 507-7001-016

Gamma Industries
A DIVISION OF NUCLEAR SYSTEMS



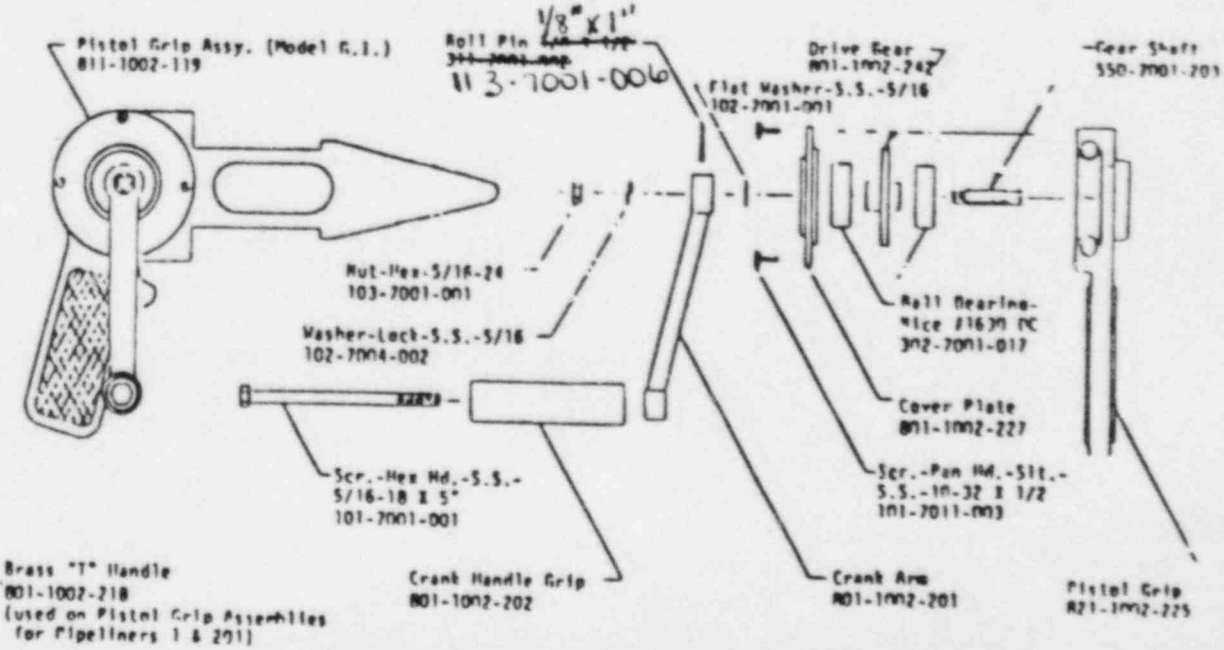


1	[illegible] GRIP	
2	[illegible]	550-7001-200
3	[illegible] GEAR	550-7001-201
4	GEAR HOUSING	550-7001-202
5	HOUSING SCREWS	101-7011-001
6	ROLL PIN	~~311-7001-007~~ 113-7001-002
7	CRANK SHAFT	550-7001-203
8	LOCK WASHER	102-7001-001
9	NUT	103-7001-001
10	CRANK ARM	801-1002-201
11	CRANK HANDLE GRIP	801-1002-202
12	CRANK HANDLE BOLT	101-7001-001

Gear Box Assy. - #2,3,4,& 7 - 550-7001-001

Crank Handle Assy. - #10,11,& 12 - 801-1002-201

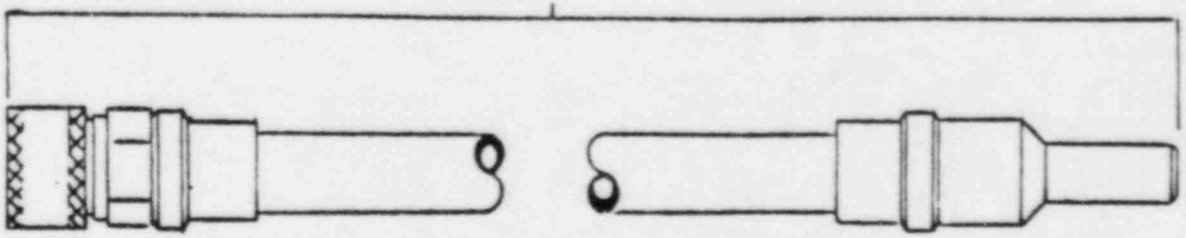
GAMMA INDUSTRIES, B.R.,LA.		
SCALE: 1/4" = 1"	APPROVED BY:	MADE BY: WRL
DATE: 10-1-73		REVISED
PISTOL GRIP ASSEMBLY		
OLD STYLE		DRAWING NUMBER 607-7001-002

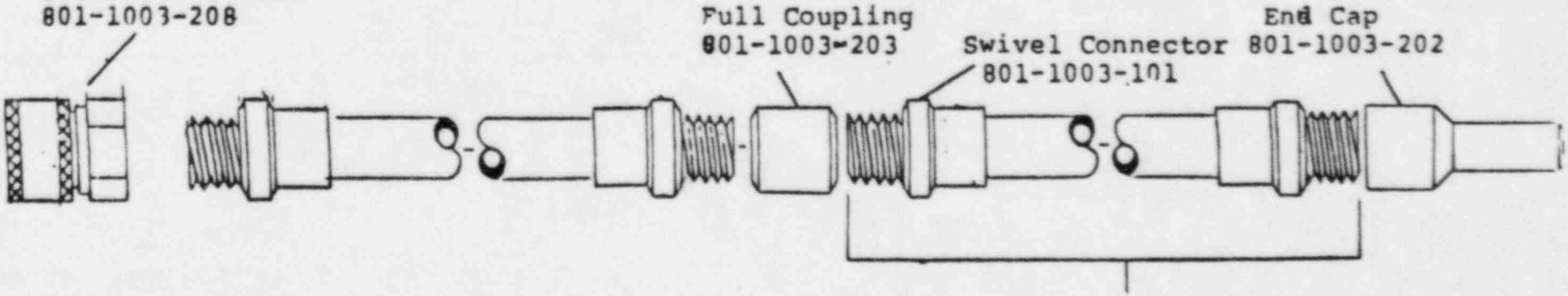


GAMMA INDUSTRIES, B.R., LA.		
SCALE: NONE	APPROVED BY:	DRAWN BY: KJR
DATE: 11-9-77		REVISED
CATALOG DWG FOR PISTOL GRIP ASSEMBLY		
MODEL G1		DRAWING NUMBER G07-7001-004

Gamma Industries
A DIVISION OF NUCLEAR SYSTEMS INC

One Piece-Metal Source Tube





Metal Source Tube Extension Assy.

GAMMA INDUSTRIES B.R., LA.		
SCALE: NONE	APPROVED BY:	DRAWN BY KRH
DATE: 5-1-78		REVISED REV-1
CATALOG DWG.- METAL SOURCE TUBE		
$\frac{3}{8}$" I.D.		DRAWING NUMBER 607-7001-01(

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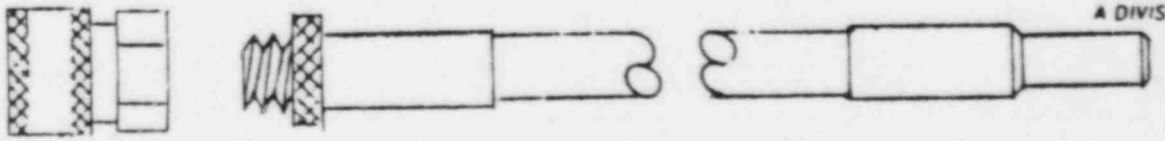
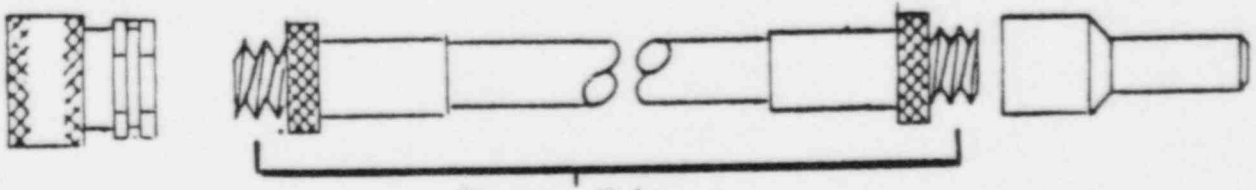
A DIVISION OF NUCLEAR SYSTEMS

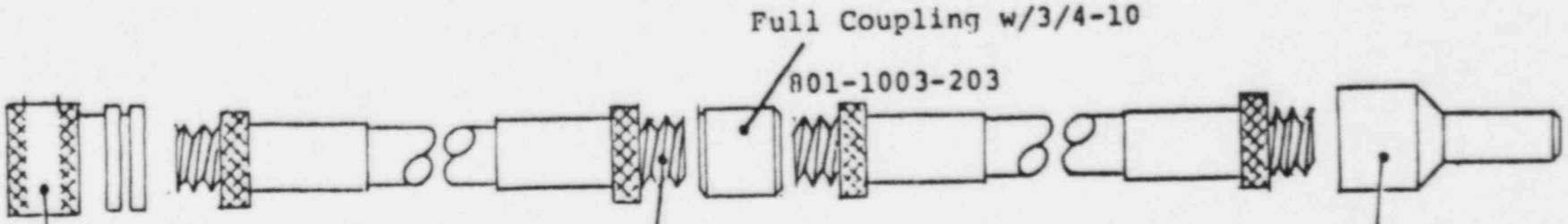


Quick Disconnect
with 3/4-10
801-1003-208

Source Tube w/Crimp Cap



Source Tube



Quick Disconnect
w/3/4-10
801-1003-208

Swivel Connector
w/3/4-10
801-1003-233

Extension

End Cap
w/3/4-10
801-1003-202

GAMMA INDUSTRIES, ER, LA		
SCALE: NONE	APPROVED BY: D. Riddle	DRAWN BY [illegible]
DATE: 4-5-79		REVISED REV 1
CATALOG DRAWING		
VYL SOURCE TUBES		DRAWING NUMBER 607-705-017

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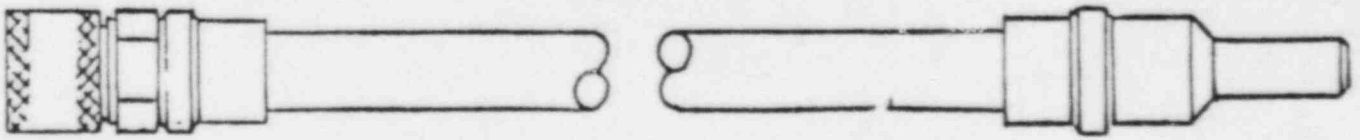
A DIVISION OF NUCLEAR SYSTEMS

One Piece-Metal Source Tube

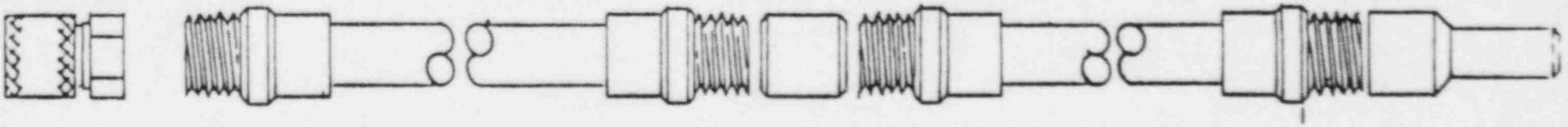


Quick Disconnect
801-1003-209

Full Coupling
801-1003-207

Swivel Connector
801-1003-107

End Cap
801-1003-206



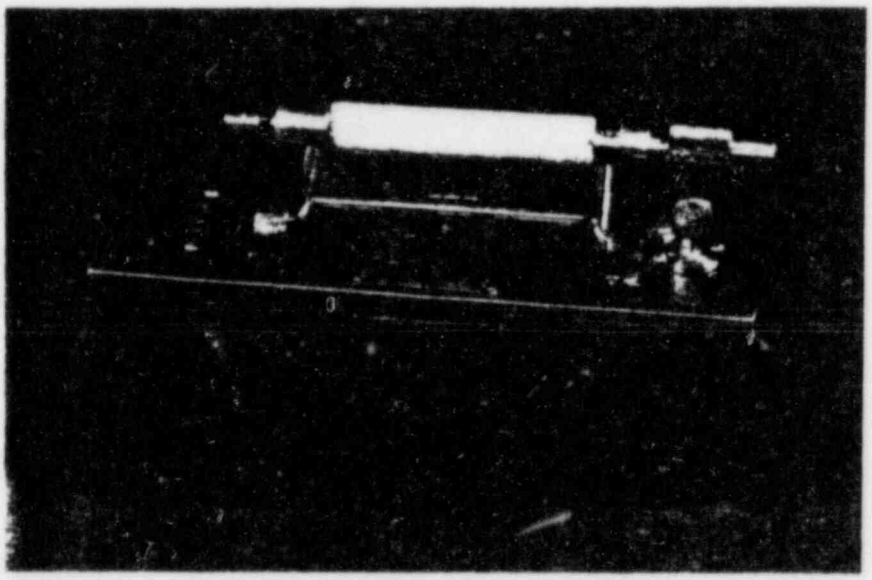
Metal Source Tube Extension Assy.

Quick Disconnect Adaptor (not shown)
801-1003-221 To adapt a 1/2" source tube to a 3/4-10 threaded quick disconnect.

GAMMA INDUSTRIES, BR. LA.		
SCALE: NONE	APPROVED BY: D. Riedel	DRAWN BY Hank
DATE: 4-2-79		REVISED
CATALOG DRAWING		
1/2" I.D. METAL SOURCE TUBE		DRAWING NUMBER 607-7001-011

spec

Source of Quality the SPEC 2-T



200 CURIES IRIDIUM-192

The first portable crank-out type radiography device designed specifically for use with up to 200 Curies Iridium-192 has been introduced by SOURCE PRODUCTION AND EQUIPMENT CO., INC.

Even with its increased capacity, the SPEC 2-T weighs no more than comparable 100 Curie units now in use. The SPEC 2-T has many unique features not found in existing units. The durable aluminum handle provides storage for the safety plug and lock cap. The shape and low-profile of the unit renders it "topple-proof" and allows it to be used in many positions. The outlet nipple and control assembly connectors are protected from breakage by steel flanges, thus eliminating one of the most common problems in field radiography. The entire unit is fabricated of heavy gauge stainless steel!

A totally new innovation is the improved and ultra flexible control assembly. This assembly features a cast aluminum pistol grip-gear box combination with ball bearing mounted shaft. This light weight pistol grip assembly is extremely durable under field conditions.

Sources for the SPEC 2-T may be changed in the field and are shipped from SPEC in the SPEC Model C-1 Source Changer. You will find that the SPEC Model C-1 is one of the safest and most convenient changers introduced in years.

Source Production & Equipment Co., Inc.
625 Oxley Street Kenner, LA 70062 Phone 504/464/9471

spec

TECHNICAL DATA on the SPEC 2-T

CAPACITY: Any strength up to 200 Curies Iridium-192

WEIGHT: 40 lbs.

DIMENSIONS: Length 12½" Width 4½" Height (exc. Handle) 4"

RADIATION LEVELS: Meets applicable requirements of State and Federal Regulatory Agencies.

CONSTRUCTION: Welded stainless steel jacket. Depleted uranium shield secured with welded steel straps. Both outlet nipple and control connections protected by steel flanges. Source cannot be removed from rear of unit, even when unlocked.

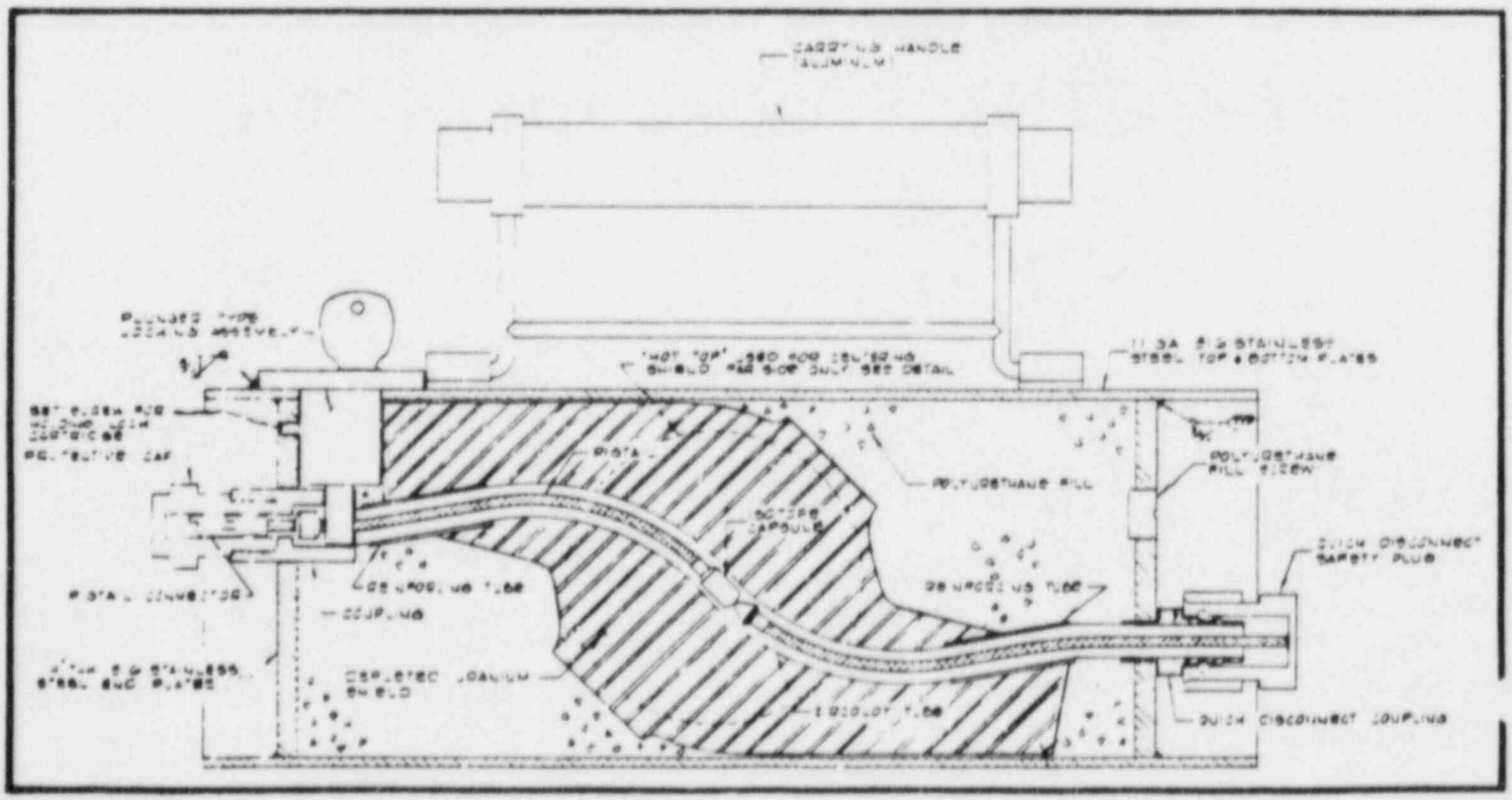
HANDLE: Metal construction. Provides storage for both lock cap and safety plug.

CONTROLS: The SPEC control assembly is one of the most advanced and break resistant systems available. It consists of a two piece cast aluminum pistol grip featuring a roller bearing mounted gear shaft. 25 ft. flexible nylon conduit is standard. Source tubes are of flexible construction and utilize quick disconnect couplings. Source tubes are supplied 14 ft. in length standard or can be made to order.

SOURCE CAPSULE: Model G-1 stainless steel encapsulation. Meets all applicable regulatory requirements.

SHIELD: Approximately 32 lbs. of depleted uranium with a zircoloy tube.

All Specifications Are Subject To Change Without Notice.



Source Production & Equipment Co., Inc.
625 Oxley Street Kenner La. 70062 Phone 504/464-9471

SOURCE PRODUCTION AND EQUIPMENT CO., INC.

MODEL SPEC 2-T

SAFETY INSPECTION AND MAINTENANCE PROCEDURES

Although the SPEC 2-T radiography exposure device is designed for virtually maintenance-free operation, regulatory agencies usually require that a thorough inspection be performed at least every 90 days, or more frequent if the device appears to warrant it. Maintenance procedures for the exposure device are simple and can be performed in the field. Should a source require repair, however, return it to the manufacturer. Do Not attempt source repair. A daily check list is affixed to the device for operator convenience. A complete inspection procedure follows:

1. Remove safety cap and inspect source connector. The holding pin should still have a true 90 degree elbow; it should be straight and parallel with axis of source connector and the key on apex of elbow should not be worn excessively. Check flexible cable at connector for straightness.

   Maintenance: If the elbow is not bent out of line, the mating connector should then be connected to the source and tested by pulling straight back on cable applying about 30 to 40 pounds of pressure. If source connector is damaged, do not use. Return unit to Source Production and Equipment Co., Inc.

2. The lock plunger should be inspected and checked for ease of operation. Foreign matter may at times foul the plunger and

make it inoperative. The lock plunger may not retract to its fullest extent which is ½ inch. This would prevent free travel of the source in and out of the device.

Maintenance: The lock plunger may be removed by removing a set screw in the back of the unit. Wash lock in solvent to remove dirt or other foreign matter. Lock may also be cleaned and lubricated by spraying a lubricant (such as WD-40) into the lock.

3. Inspect the source outlet nipple by first removing safety plug. The outlet nipple should be round and smooth so that it will match with the I.D. of the source tube.

   Maintenance: If the outlet nipple should be out-of-round it can sometimes be straightened by using a punch or round bar on the inside of the outlet. If it cannot be straightened or if the nipple has been broken by dropping the unit, it must be replaced. This replacement can be done in the field shop or returned to Source Production & Equipment Co., Inc.

4. Inspect labeling on exposure device. The warning signs and source identification tags should be distinct and legible.

5. Inspect source tubes for damage such as crimps, foreign matter, ease of connecting, and disconnecting from exposure device.

   Maintenance: Crimps, kinks, and other damaged places may be cut out, and connectors placed on ends so that tube is not shortened excessively. The quick disconnect coupling that

connects to outlet nipple of exposure device may be removed and replaced. Foreign matter may be washed from tube with solvent and blown with compressed air.

6. Inspect source connector on drive cable. The hole should be 7/64 inch in diameter when new. This hole should show some wear after much use, but should not be out-of-round to the extent that it will disconnect from the mating piece other than in the correct position. It should not be loose on the drive cable. The portion of the connector with the connector hole should not be bent, but should be straight and parallel with body of connector.

   Maintenance: This worn connector may be replaced by one of two methods.

   1. Send back to Source Production & Equipment to have new connector replaced by swaging on new replacement.
   2. Order new core with connector attached.

7. Inspect remainder of drive cable for wear, rusty sections, causing cable to become stiff and non-flexing, kinks, or other damaging conditions that would prevent cable from running on gear in the gear box housing.

   Maintenance: The drive cable should be cleaned with a solvent such as varsol, diesel fuel or some other solvent that will not dry out. This is done to remove sand, dust and other foreign matter that will cause abrasions in the exposure device and gear box drive mechanism. Drive cable that has become rusty and non-flexible should be replaced. Failure to replace cable

may cause controls to become stiff, hard to operate, wear excessively, and possibly break. The cable would usually break when the source is exposed. Lubrication of the drive cable is important. In areas where there is a problem with sand or other abrasive material, dry powdered graphite is excellent. Graphite should not be packed continually since it will tend to pack in the gear box and cause excessive wear to the gear housing and to the gear. Where the control cables can be kept reasonably clean, a light oil will be adequate.

8. Inspect the control assembly. The bronze bushings (if used) in the gear housing and the plate are the most likely places to find wear. When these bushings are worn they tend to permit the gear to wobble and eventually wear out. This normally will not occur in control assemblies equipped with roller bearings. Usually (due to some build-up on the drive cable or the gear teeth) there will be some wear around the inner circumference of the housing. This may permit the drive cable to slip on the gear and prevent the source from moving properly through the exposure device.

   Maintenance: It is suggested that if powdered graphite is used as a lubricant the gear box be cleaned with compressed air occasionally so as to remove any packed graphite in the gear mechanism. The application of some type light oil on bronze bushings or bearings will help prevent excessive wear.

If the inner circumference of the housing is severly worn, it should be replaced.

9. Inspect drive cable housing or conduit. This conduit can be damaged by dropping it across a hot weld, severe kinking, or by dropping some object on the conduit. Any of these can prevent the drive cable from moving freely. The conduit at the end connections may become damaged from excessive flexing while being assembled or disassembled.

   Maintenance: In any case where the inner liner has been damaged, the conduit must be replaced. When the outer covering has been damaged, waterproof tape should be wrapped around the break to prevent the entrance of water or other corrosive substances. If the extreme ends of the conduit are damaged, they should be returned to the manufacturer for repair.

SOURCE PRODUCTION & EQUIPMENT CO., INC.

MODEL SPEC 2-T

OPERATING MANUAL

GENERAL DESCRIPTION

The SPEC 2-T exposure device is a remotely controlled uranium shielded radiography unit designed for use in the field as well as the laboratory. The basic composition of the unit is the light weight depleted uranium shield with its zircoloy "S" tube and a steel housing. The SPEC 2-T is built for use under the most adverse conditions with virtually no maintainence.

The SPEC 2-T requires no external power source and its complete portability and light weight make field use by only one operator simple and efficient.

SPECIFICATIONS

Total weight of the SPEC 2-T is approximately 40 pounds and contains approximately 35 pounds of depleted uranium. The case is heavy gauge steel built to DOT specifications. The unit has been approved by all applicable regulatory agencies for use with an iridium-192 source up to 200 curies.

The source is controlled with a 25 foot mechanical control assembly. The assembly is extremely light weight and the flexible source guide tube used in this control assembly may be up to 23 feet long.

The handle of the unit is designed to store the protector cap and safety plug when these items are not being used. This should eliminate losing these parts.

SAFETY

The source is secured in the shielded position with a plunger-type keyed lock. Further security is provided by a lock cap and safety plug when the unit is not in use. The source can not be withdrawn from the back of the unit even in the unlocked position.

The rectangular shape of the unit makes it virtually impossible to "topple" over and enables the operator to place it in an extremely small or constricted areas.

OPERATING PROCEDURES

1. Before handling the SPEC 2-T make sure you have an operable, calibrated survey meter and monitor every operation.

2. Remove the safety cap from the back of the unit (end nearest lock) exposing the pigtail connector.

3. Turn the crank on the control assembly in a clockwise direction to expose approximately eight inches of drive cable.

4. Connect the drive cable to the source pigtail.

5. Crank the control assembly in a counter clockwise direction so that the swivel connector can be threaded into the back of the unit. Screw the male connecting thread all the way into the back of the unit.

6. Remove safety plug from the outlet on the front of the unit by retracting the quick disconnect coupling

7. Connect the source tube by snapping the quick disconnect coupling over the outlet nipple.

8. Check to see that the end piece is securely in place on the end of the source tube. Place the end of the source tube in the desired position while avoiding small radius bends and kinks.

9. Fully extend the controls from the unit avoiding as many turns and kinks as possible.

10. Unlock the unit using key provided.

11. To expose the source, turn crank handle clockwise. As source nears the end of the source tube, diminish turning speed to prevent the source from hitting the end piece with undue force. Count the number of crank turns so you will know when you are approching the end of the tube.

12. Survey to determine if radiation levels are appropriate.

13. To retract the source after the exposure, turn the crank handle counter clockwise.

14. Survey to ascertain that the source is in the stored or safe position.

15. Lock the device by depressing the lock plunger. Jiggle the connector to be certain that the pigtail is firmly locked in position.

16. Unscrew the swivel connector and crank out approximately 8 inches of the drive cable.

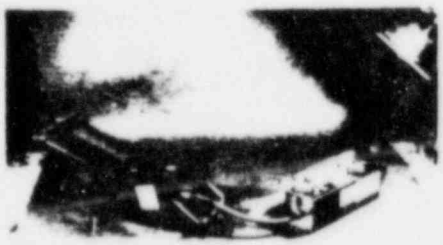
17. Disconnect the drive cable from the source pigtail.

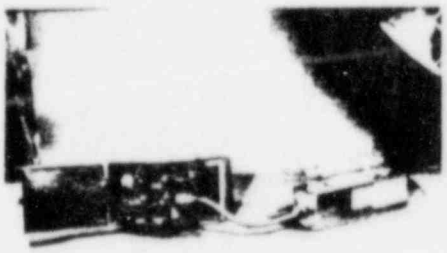
18. Replace safety cap over the source pigtail.

spec

SOURCE OF QUALITY

C-1 SOURCE CHANGER





The SPEC Model C-1 Source Exchanger is a lightweight shipping container/source exchanger device designed and built for safety.

After years of service, the SPEC Model C-1 has been accepted as one of the safest source changers available. The device is designed to accommodate almost any length of pigtail-type source with an activity up to 200 curies Iridium-192. The unit has been approved as both a source exchanger and a Type B shipping package by all applicable domestic and international agencies.

The SPEC Model C-1 was designed to withstand the most rugged treatment it could normally receive. The basic composition is a welded, heavy gauge steel box containing a depleted uranium shield weighing approximately 45 pounds. Sources are secured in the shielded position with steel, spring loaded plungers which secure the pigtails immediately behind the source capsule. The steel box, which is fitted with a padlock, cannot be closed unless the plungers are in the locked position for added safety.

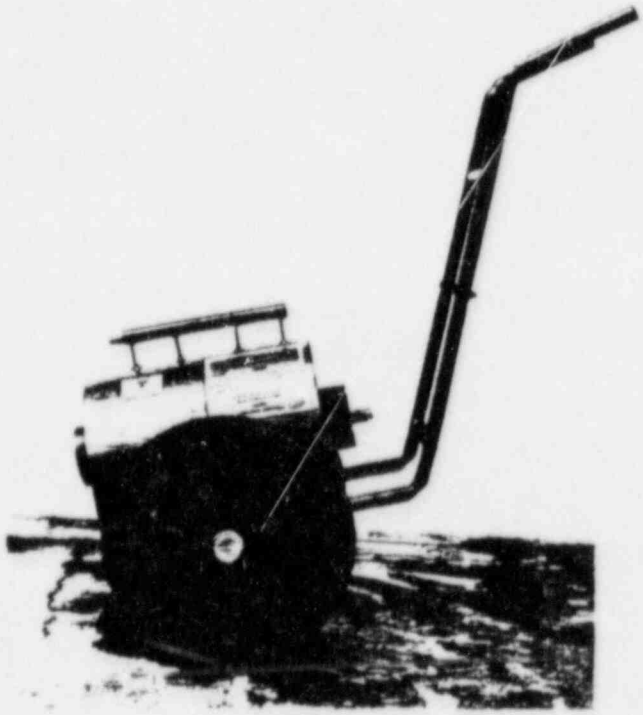
The C-1, which is approved as a shipping container, is normally shipped inside a steel drum designated as a "convenience overpack." This drum provides an excellent receptacle for source tags, return shipping labels, source exchange tubes, and the like. The entire shipping package weighs only 65 pounds.

Source Production & Equipment Co., Inc.
625 Oxley Street Kenner, La. 70062 Phone 504/464-9471

spec

SPECIFY SOURCE MODEL
G-37

Source of Quality the SPEC Co-60 MODEL I



100 CURIES COBALT 60

The SPEC Co-60 MODEL I exposure device is another rugged and dependable radiography unit introduced by SOURCE PRODUCTION AND EQUIPMENT CO., INC.

This remotely controlled unit has been designed for the most adverse field conditions with virtually no maintenance required. No external power source is required and its complete portability and light weight make both field and laboratory use simple and efficient.

Total weight of the SPEC Co-60 Model I is approximately 475 pounds and it contains approximately 350 pounds of depleted uranium. The basic composition of the unit is the depleted uranium shield with its zircoloy "S" tube and welded steel housing. The unit has been approved by all applicable regulatory agencies for use with a cobalt-60 source of any activity up to 100 curies.

A totally new innovation is the improved and flexible 30 ft. control assembly. This assembly features a cast aluminum pistol grip-gear box combination with ball bearing mounted shaft. This lightweight pistol grip assembly is extremely durable under field conditions.

Source Production & Equipment Co., Inc.
625 Oxley Street, Kenner, LA 70062 Phone 504/464-9471

SOURCE PRODUCTION & EQUIPMENT CO., INC.

MODEL SPEC Co-60
Model I

OPERATING MANUAL

GENERAL DESCRIPTION

The SPEC Co-60 Model I exposure device is a remotely controlled uranium radiography unit designed for use in the field as well as the laboratory. The basic composition of the unit is the depleted uranium shield with its zircoloy "S" tube and a steel housing. The SPEC Co-60 Model I is built for use under the most adverse conditions with virtually no maintainence.

The SPEC Co-60 Model I requires no external power source and its complete portability and light weight make field use simple and efficient.

SPECIFICATIONS

Total weight of the SPEC Co-60 Model I is approximately 400 pounds and contains approximately 350 pounds of depleted uranium. The case is heavy gauge steel built to DOT specifications. The unit has been approved by all applicable regulatory agencies for use with a cobalt-60 source of 100 curies strength.

The source is controlled with a 25ft. mechanical contol assembly. The assembly is extremely light weight and the flexible source guide tube used in this control assembly may be up to 23 feet long.

SAFETY

The source is secured in the shielded position with a plunger-type keyed lock. Further security is provided by a lock cap and

safety plug when the unit is not in use. The source can not be withdrawn from the back of the unit even in the unlocked position.

The rectangular shape of the unit makes it virtually impossible to "topple" over and enables the operator to place it in an extremely small or constricted areas.

OPERATING PROCEDURES

1. Before handling the SPEC Co-60 Model I make sure you have an operable, calibrated survey meter and monitor every operation.

2. Remove the safety cap from the back of the unit (end nearest lock) exposing the pigtail connector.

3. Turn the crank on the control assembly in a clockwise direction to expose approximately eight inches of drive cable.

4. Connect the drive cable to the source pigtail.

5. Crank the control assembly in a counter clockwise direction so that the swivel connector can be threaded into the back of the unit. Screw the male connecting thread all the way into the back of the unit.

6. Remove safety plug from the outlet on the front of the unit by retracting the quick disconnect coupling.

7. Connect the source tube by snapping the quick disconnect coupling over the outlet nipple.

8. Check to see that the end piece is securely in place on the end of the source tube. Place the end of the source tube in the desired position while avoiding small radius bends and kinks.

9. Fully extend the controls from the unit avoiding as many turns and kinks as possible.

10. Unlock the unit using key provided.

11. To expose the source, turn crank handle clockwise. As source nears the end of the source tube, diminish turning speed to prevent the source from hitting the end piece with undue force. Count the number of crank turns so you will know when you are approching the end of the tube.

12. Survey to determine if radiation levels are appropriate.

13. To retract the source after the exposure, turn the crank handle counter clockwise.

14. Survey to ascertain that the source is in the stored or safe position.

15. Lock the device by depressing the lock plunger. Jiggle the connector to be certain that the pigtail is firmly locked in position.

16. Unscrew the swivel connector and crank out approximately 8 inches of the drive cable.

17. Disconnect the drive cable from the source pigtail.

18. Replace safety cap over the source pigtail.

SOURCE PRODUCTION AND EQUIPMENT CO., INC.

SPEC Co-60 MODEL I

SAFETY INSPECTION AND MAINTENANCE PROCEDURES

Although the SPEC Co-60 Model I radiography exposure device is designed for virtually maintenance-free operation, regulatory agencies usually require that a thorough inspection be performed at least every 90 days, or more frequent if the device appears to warrant it. Maintenance procedures for the exposure device are simple and can be performed in the field. Should a source require repair, however, return it to the manufacturer. Especially do not attempt a source repair. A daily check list is affixed to the device for operator convenience. A complete inspection procedure follows:

1. Remove safety cap and inspect source connector. The holding pin should still have a true 90 degree elbow; it should be straight and parallel with axis of source connector and the key on apex of elbow should not be worn excessively. Check flexible cable at connector for straightness.

   Maintenance: If the elbow is not bent out of line, the mating connector should then be connected to the source and tested by pulling straight back on cable applying about 30 to 40 pounds of pressure. If source connector is damaged, do not use. Return unit to Source Production and Equipment Co., Inc.

2. The lock plunger should be inspected and checked for ease of operation. Foreign matter may at times foul the plunger and

make it inoperative. The lock plunger may not retract to its fullest extent which is ¼ inch. This would prevent free travel of the source in and out of the device.

Maintenance: The lock plunger may be removed by removing set screws from the lock plunger housing. Wash lock in solvent to remove dirt or other foreign matter. Lock may also be cleaned and lubricated by spraying a lubricant (such as WD-40) into the lock.

3. Inspect the source outlet nipple by first removing the safety plug. The outlet nipple should be round and smooth so that it will match with the I.D. of the source tube.

Maintenance: If the outlet nipple should be out-of-round it can sometimes be straightened by using a punch or round bar on the inside of the outlet. If it cannot be straightened or if the nipple has been broken by dropping the unit, it must be replaced. This replacement can be done in the field shop or returned to Source Production & Equipment Co., Inc.

4. Inspect labeling on exposure device. The warning signs and source identification tags should be distinct and legible.

5. Inspect source tubes for damage such as crimps, foreigh matter, ease of connecting, and disconnecting from exposure device.

Maintenance: Crimps, kinks, and other damaged places may be cut out, and connectors placed on ends so that tube is not shortened excessively. The quick disconnect coupling that

connects to outlet nipple of exposure device may be removed and replaced. Foreign matter may be washed from tube with solvent and blown with compressed air.

6. Inspect source connector on drive cable. The hole should be 7/64 inch in diameter when new. This hole should show some wear after much use, but should not be out-of-round to the extent that it will disconnect from the mating piece other than in the correct position. It should not be loose on the drive cable. The portion of the connector with the connector hole should not be bent, but should be straight and parallel with body of connector.

   Maintenance: This worn connector may be replaced by one of two methods.

   1. Send back to Source Production & Equipment to have new connector replaced by swaging on new replacement.
   2. Order new core with connector attached.

7. Inspect remainder of drive cable for wear, rusty sections, causing cable to become stiff and non-flexing, kinks, or other damaging conditions that would prevent cable from running on gear in the gear box housing.

   Maintenance: The drive cable should be cleaned with a solvent such as varsol, diesel fuel or some other solvent that will not dry out. This is done to remove sand, dust and other foreign matter that will cause abrasions in the exposure device and gear box drive mechanism. Drive cable that has become rusty and non-flexible should be replaced. Failure to replace cable

may cause controls to become stiff, hard to operate, wear excessively and possibly break. The cable could actually break when the source is exposed. Lubrication of the drive cable is important. In areas where there is a problem with sand or other abrasive material, dry powdered graphite is excellent. Graphite should not be packed continually since it will tend to pack in the gear box and cause excessive wear to the gear housing and to the gear. Where the control cables can be kept reasonably clean, a light oil will be adequate.

Inspect the control assembly. Sometimes (due to some build-up on the drive cable or the gear teeth) there will be come wear around the inner circumference of the housing. This may permit the drive cable to slip on the gear and prevent the source from moving properly through the exposure device.

Maintenance: It is suggested that if powdered graphite is used as a lubricant the gear box be cleaned with compressed air occasionally so as to remove any packed graphite in the gear mechanism. The application of some type light oil on bronze bushings or bearings will help prevent excessive wear. If the inner circumference of the housing is severly worn, it should be replaced.

Inspect drive cable housing or conduit. This conduit can be damaged by dropping it across a hot weld, severe kinking, or by dropping some object on the conduit. Any of these can prevent

connections may become damaged from excessive flexing while being assembled or disassembled.

Maintenance: In any case where the inner liner has been damaged, the conduit must be replaced. When the outer covering has been damaged, waterproof tape should be wrapped around the break to prevent the entrance of water or other corrosive substances. If the extreme ends of the conduit are damaged, they should be returned to the manufacturer for repair.

OPERATION and MAINTENANCE MANUAL Model 660 SERIES GAMMA RAY PROJECTION SYSTEMS

TECHNICAL OPERATIONS, INC.
Radiation Products Division
Burlington, Mass. 01803
Phone (800) 225-1383 (toll free)
[in Mass. call (617) 272-2000]

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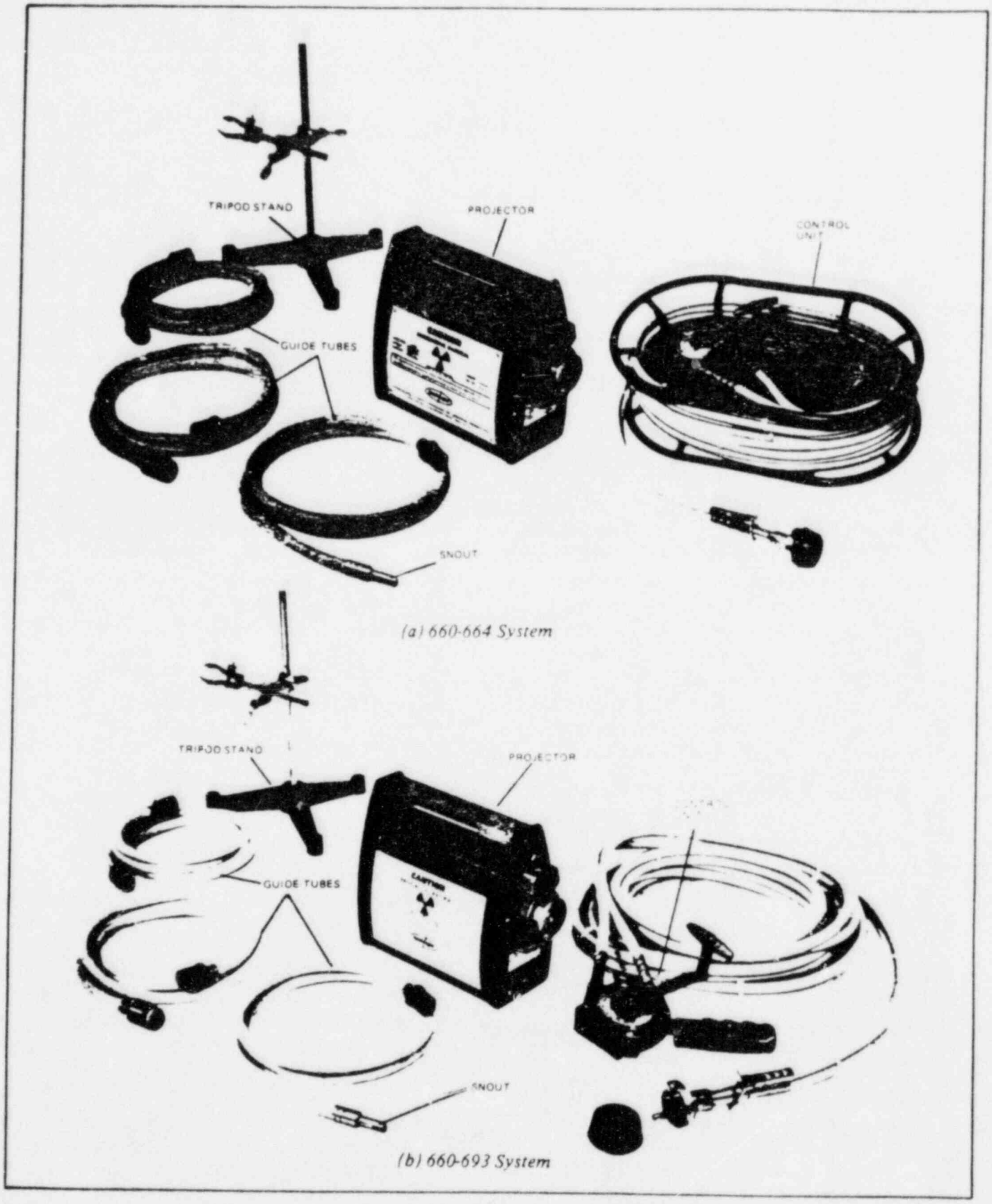


Figure 1-1. 660 Series Portable Gamma Ray Projector Systems.

Refer to Section II, Recommended Safety Precautions, before operating or servicing these systems.

SECTION I
GENERAL INFORMATION

1-1. GENERAL

The 660 Series Portable Gamma Ray Projector Systems, shown in Figure 1-1, are used primarily for industrial radiography. The systems operate in similar manner and differ only in the type of control unit supplied.

The portability feature of the system provides both a safe means of transporting the radioactive source and operating flexibility, particularly needed in limited access areas. In use, either system safely positions an Iridium^{192} radioactive source at a predetermined location. The 360° (panoramic) radiation pattern may be used to full advantage, either for multiple specimen work or for circumferential exposure techniques. Optional collimators are available which limit the panoramic pattern to a directional beam. The systems may be used with Iridium^{192} isotope sources up to a maximum of 100 curies. Iridium^{192} sources of other capacities are available, upon request. Basic source information is contained on the nameplate of the source shield (projector).

1-2. SYSTEM SAFETY

The systems provide maximum operator safety. A positive mechanical control of the source and an accurate visual indication of its position are given at all times. In addition, the systems have a fail-safe connection; where:

a. the system cannot be operated (source exposed) unless a secure connection to the control cable is made, and

b. the controls cannot be disconnected unless the source is properly stored in the shield.

1-3. SYSTEM COMPONENTS

All components of the 660-664 and 660-693 Systems are identified in Figure 1-1. Components common to both systems are discussed first. The separate control units are discussed last.

a. Gamma Ray Projector Model 660.

The Gamma Ray Projector, shown in Figure 1-2, can be used in either system. The projector serves as the storage and transport device of the radioactive source assembly. The projector consists of a steel housing which contains approximately 29 pounds of "depleted uranium" shielding material. When the source is properly stored in the projector, the effective shielding properties of the depleted uranium reduce radiation at the projector exterior to a level well below the regulatory mr/hr limits prescribed in applicable NRC regulations.

Figure 1-2 shows both ends of the projector. A special fail-safe connector is located at one end. This connector is used to engage the cable from the control unit. The safety features of the connector were discussed in paragraph 1-2. The control connector contains a three-position selection device – OPERATE, LOCK, and CONNECT. For maximum safety when the projector is disconnected from the control cable and guide tubes, the connector should be in the LOCK position with the attached lock and storage cover engaged and the key removed. All of the connector positions are discussed in detail in Section III, Operation. The guide tube connector is located at the other end of the Projector. Figure 1-2 identifies the connector. Also shown in Figure 1-2 is the storage plug which must be removed before the guide tubes are connected. The storage plug should be used to prevent dirt and dust from entering the projector whenever the projector is not in use.

The total weight of the projector is 44 pounds. The projector is 9½" high, 4¾" wide, and 12¾" long (includes handle and connectors).

b. Guide Tube Assembly.

The guide tube assembly consists of one seven-foot master guide tube and two seven-foot extender guide tubes (see Figure 1-1). The master is

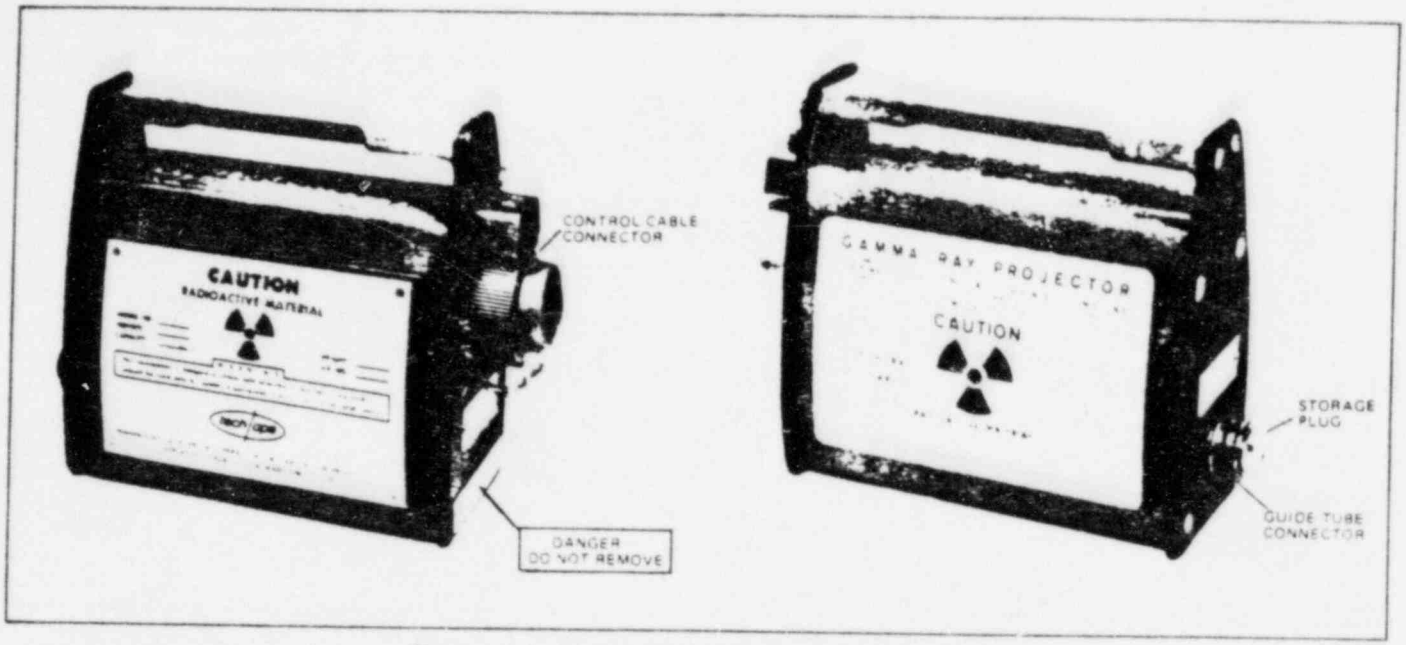


Figure 1-2. Model 660 Gamma Ray Projector

the guide tube section which contains the snout or source stop at one end. The system should never be operated without the master guide tube attached to the projector. The two extender sections can be used as necessary to lengthen the guide tube to 14 or 21 feet. Both master and extender guide tubes are made from flexible stainless steel tubing with a protective polyvinyl covering. The three guide tube sections weigh approximately five pounds.

CAUTION

NEVER OPERATE THE SYSTEM WITH MORE THAN THREE GUIDE TUBE SECTIONS (MASTER SECTION PLUS TWO EXTENDER SECTIONS– TOTAL GUIDE TUBE LENGTH OF TWENTY ONE FEET).

c. Tripod Stand.

The tripod stand provides a means of securing the snout end of the master guide tube section so that the source can be positioned at the desired focal position. The stand has adjustable clamps which will provide an unlimited degree of positioning flexibility. The weighted tripod base provides a solid foundation for the stand. The tripod stand, complete with clamps, weighs approximately ten pounds.

d. Model 664 Control Unit.

The 664 unit is used with the 660-664 Gamma Ray Projector System. The unit consists of a hand crank, odometer, and 25-foot control cable, and lightweight convenient storage cable reel. In operation, the hand crank controls the movement of the source from the storage position in the projector to the exposure position in the master guide tube. The odometer indicates the distance in feet and inches that the source has been moved from its storage position. The reel provides a convenient storage facility for both the control cable and the three guide tubes. The outer control tubing is similar to the construction of the guide tubes. The inner spiral-wound flexible steel drive cable (the actual controlling element) terminates with the male section of a swivel-type fastener used to securely engage the female section which is attached to the leader cable of the radioactive source assembly. The control tube is terminated at one end by the connecting plug assembly which mates with the fail-safe connector on the projector and at the other end by fittings which attach it to the main frame of the control unit. The 664 control unit with the control cable weighs approximately twenty-two pounds.

e. Model 693 Control Unit.

The 693 unit is used with the 660-693 Gamma Ray Projector System. The basic purpose of the 693 is similar to that of the 664 unit. However, the 693 unit does not have the storage reel and is provided with a pistol grip handle for convenient operation. The 693 control unit with the control cable weighs approximately nineteen pounds.

1-4. RADIOACTIVE SOURCE ASSEMBLY

The radioactive source assembly is the most vital component in the system. It is supplied and must be ordered separately from other system components. The system can operate with various capacity sources up to the maximum 100 curies (+20%). The source is contained in a stainless steel capsule firmly attached to one end of the short leader cable.

The source can easily be changed in the field using a TO-414 or TO-650 Source Changer which also serves as a shipping container.

1-5. SYSTEM OPTIONAL ACCESSORIES

Table 1-1 lists the options available for both projector systems.

Also available is a complete range of radiation survey and personnel monitoring dosimeters.

1-6. PRINCIPLES OF OPERATION

The hand crank on the control unit moves the drive cable through the control tube. The control cable is locked to the encapsulated radioactive source via a short leader. Figure 1-3(a) shows the source in the stored position in the projector (hand cranked fully clockwise – in the full RETRACT position). Figure 1-3(b) shows the source being moved out of the projector and into the guide tubes. This action occurs by rotating the hand crank in the EXPOSE counterclockwise direction. Figure 1-3(c) shows the source reaching the snout which serves as a mechanical stop at the radiographic focal spot. The hand crank will not turn any farther and the odometer in the control unit should indicate a reading which approximates the total length of the combined guide tubes. To return the source to the projector (stored position), the hand crank is turned to the full RETRACT (clockwise) position.

1-7. SPECIFICATIONS

a. Source Data
- Isotope: Iridium ^{192} (A424-9 only)
- Maximum strength: 100 curies (+20%)
- Shielding: Conforms to NRC requirement, title 10 CFR part 34.21

b. Size and Weight
- Projector Size: 4¾ x 9½ x 12¾ inches
- Projector Weight: 44 pounds
- Model 664 Control Unit Size: 6 5/8 x 12 x 21 inches
- Model 664 Control Unit Weight: 22 pounds (with control cable)
- Model 693 Control Unit Weight: 19 pounds (with control cable)
- Guide Tubes: 5 pounds
- Tripod Stand: 10 pounds

c. Operating Specifications
- Maximum distance, projector to control unit: 25 feet
- Distance, projector to exposure position: 7, 14, or 21 feet
- Source position reproducibility: ±1/16 inch

Table 1-1. System Options

MODEL NO.	DESCRIPTION
527	Collimator with stand for directional 60° beam or 360° panoramic 20° wide-band beam
653	Side collimator
654	Front collimator
534	Slide-rule type exposure calculator with leather case
492D	GAMMALARM radiation monitor
492E	GAMMAFLASHER used with 492D GAMMALARM

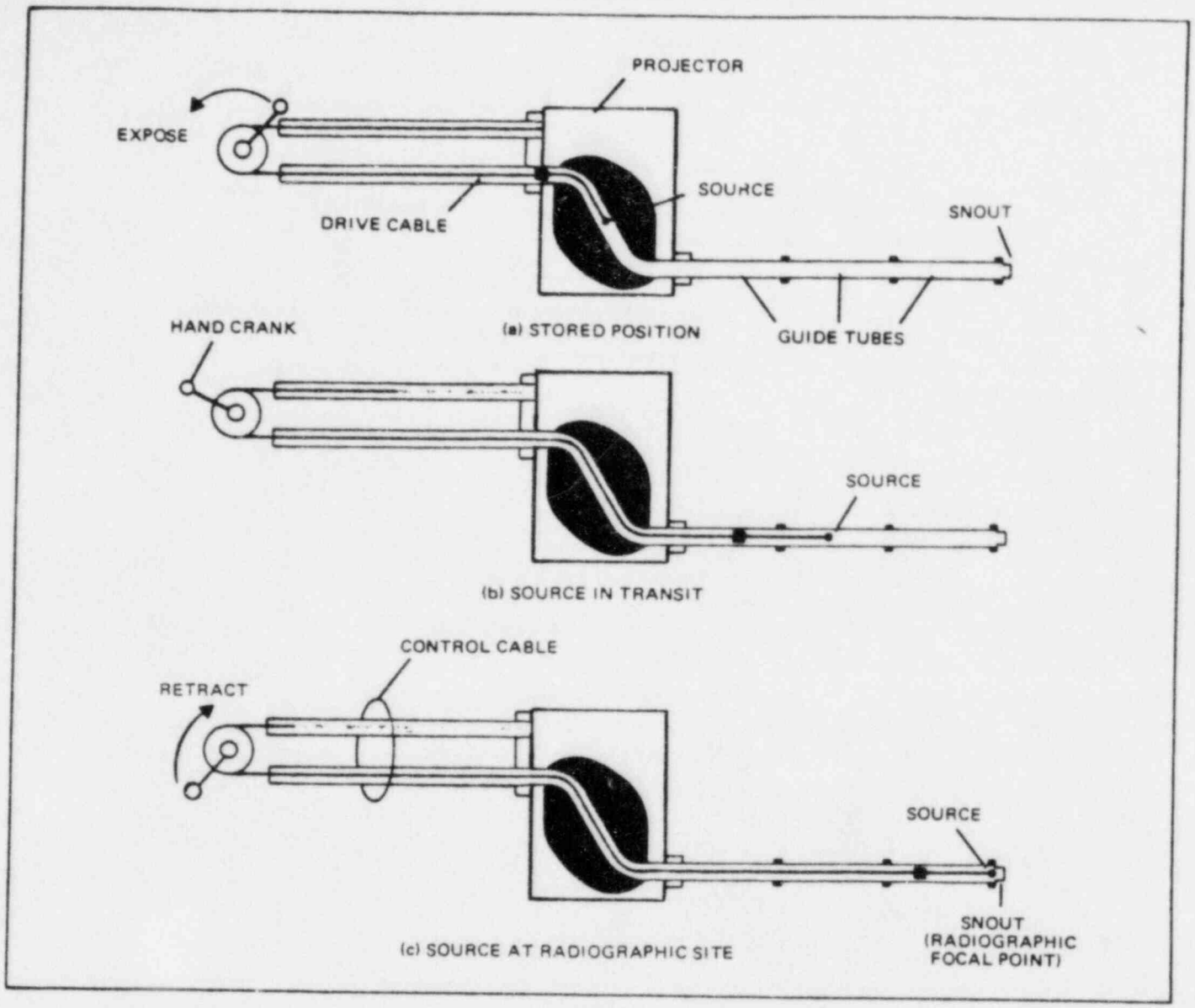


Figure 1-3. Mechanical Schematic.

SECTION II
RECOMMENDED SAFETY PRECAUTIONS

2-1. GENERAL

The Model 660 Ray Projector is designed to afford operators maximum protection from radiation. However, precautions consistent with accepted isotope handling practices must be observed at all times.

2-2. RADIATION MEASURING INSTRUMENTS

The use of radiation measuring equipment is mandatory: all handling of isotope units should be monitored by proper radiation detectors. The following are recommended:

a. Survey Meters.

Survey meters must be used as a matter of routine to determine the radiation rate per unit time. Technical Operations, Inc. recommends a gamma survey meter of the ionization chamber type, with a full scale range of at least 1000 mr/hr.

b. Film Badges.

Personnel using or working near isotope equipment should wear film badges to provide permanent running records of the radiation dosage received.

c. Pocket Dosimeters.

Technical Operations, Inc. also recommends the use of pocket dosimeters, to allow personnel to determine the exposure received in any given period.

2-3. WORKING DISTANCE

Every precaution should be taken to insure that adequate distance exists between the exposed source and areas accessible to personnel. Surrounding areas should be surveyed – any areas in which readings are excessive should be restricted and posted. (See Code of Federal Regulations, Title 10, Atomic Energy, Part 20.105.) Personnel operating equipment should always work at the maximum possible distance from the source. (The exposure rate varies inversely with the square of the distance from the source.) Always avoid unnecessary or excessive dosages.

2-4. EXPOSURE TIME

Maximum radiation doses to personnel are specified by State and Federal regulations. (See Code of Federal Regulations. Title 10, Atomic Energy, Part 20.101.) Always observe good radiographic techniques to keep doses to a minimum.

2-5. SHIELDING

Wherever possible, the control unit and operating personnel should be positioned behind a shield. Shielding materials commonly used to absorb or stop radiation are concrete, iron, steel, and lead.

2-6. HAND-CARRYING

Hand-carrying should be limited to operations where absolutely necessary. Unnecessary personnel exposures can result from hand-carrying the unit for extended periods. Personnel carrying the unit should always monitor the exposure using a dosimeter or film badge on the part of the body nearest to the source.

2-7. SHIPPING

The Model 660 meets the requirements for a Type B shipping container under the regulations of the U. S. Nuclear Regulatory Commission, the U. S. Department of Transportation and the International Atomic Energy Agency. The container has been assigned USNRC Certificate No. 9033 for domestic shipments and IAEA Certificate No. USA-DOT-RAM-6-70 for international shipments.

Under the terms of USNRC regulations in 10CFR71.12(b), prior to the first shipment of the container, the shipper must register as such with the Transportation Branch, Division of Materials and Fuel Cycle Facility Licensing, USNRC.

In shipment the device must be locked and the storage plug must be inserted and secured with a tamper proof seal.

When shipped with the contained Iridium^{192}, the RADIOACTIVE YELLOW III label must be identified with "Iridium^{192}", the number of curies

contained, and the maximum radiation level measured at a distance of three feet from the surface of the container (Transport Index).

When shipped without the Iridium^{192} source, a RADIOACTIVE WHITE I label must be identified with "Depleted Uranium" and " Curies."

These shipping labels are shown in Figure 2-1 and are available from Technical Operations.

(a) With Isotope *(b) Without Isotope*

Figure 2-1. Typical Shipping Labels

SECTION III
UNPACKING AND STORAGE

3-1. INITIAL INSPECTION

If external damage to the shipping containers is evident, ask the carrier's agent to be present when the system is unpacked. Technical Operations, Inc. should be notified immediately if any components were damaged in transit.

WARNING

UNPACK THE SYSTEM ONLY IN AREAS MONITORED WITH APPROPRIATE RADIATION MEASURING EQUIPMENT. SEE SECTION II.

3-2. UNPACKING

Portable Gamma Ray Projector System Components are normally shipped in two cardboard containers. Inspect cartons for external signs of possible damage. Open the cartons and remove the system components.

The components are as follows:

(a) Swivel Clamp
(b) Source Tube Clamp
(c) Tripod Base
(d) Tripod Rod
(e) Control Unit with attached Control Cable
(f) Projector
(g) Three 7-foot Guide Tube Sections

3-3. COMPONENT INSPECTION

Examine all components for damage. Check all items against packing list or Figure 1-1.

3-4. STORAGE

When storing the system between uses, keep the plastic caps, supplied with the system, in place on the three guide tubes. This eliminates dust accumulation within the tubes. During storage the storage plug must be inserted to meet the conditions of 10CFR34.21 and to prevent the entry of foreign material.

SECTION IV
OPERATION

4-1. PREPARATION FOR USE

WARNING

ASSEMBLE THE SYSTEM FOR USE ONLY IN AREAS MONITORED WITH APPROPRIATE RADIATION MEASURING EQUIPMENT. SEE SECTION III.

a. Guide Tube Assembly

1. At the radiographic focal point, position and secure the snout of the master guide tube using the tripod stand and swivel clamps.

2. Remove the plastic dust caps and attach additional extender guide tubes, as necessary, to the master guide tube.

3. Determine the position of the projector (source shield) allowing for maximum possible operating shielding. Assuming appropriate shielding is available, the operator will be approximately twenty-five feet from the projector during actual operation.

4. Lay out the guide tubes as straight as possible directing them toward the projector. Note that the bend radius of the guide tubes should not be under twenty inches. Smaller bend radii may restrict the movement of the control cable.

NOTE

The guide tubes should not be subjected to any undue stress or abuse which could cause restrictions in the tubes.

5. Remove the storage plug from the projector connector and attach the last guide tube to the projector (see Figure 1-2).

CAUTION

NEVER OPERATE THE SYSTEM WITH MORE THAN THREE GUIDE TUBE SECTIONS (INCLUDING THE MASTER).

b. Control Unit.

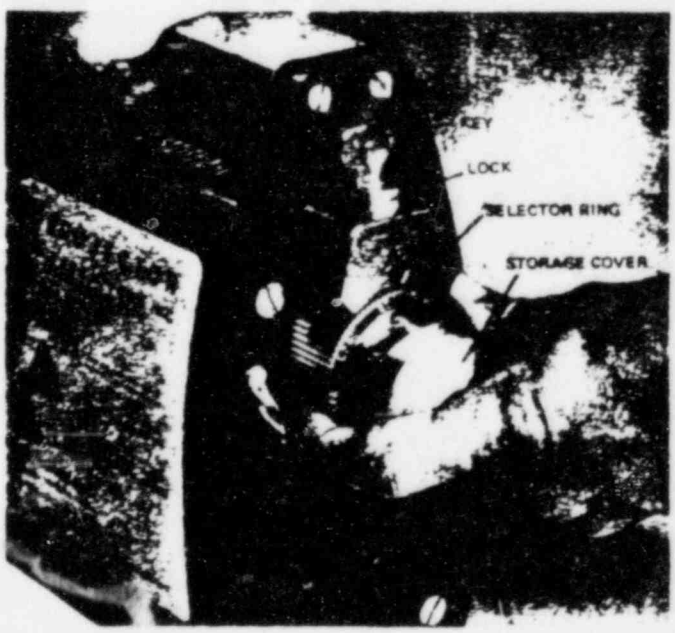
1. Determine the operating site of the control unit. For maximum safety, the operator should be located behind a protective shield.

2. Lay out the control cable as straight as possible directing it toward the projector. Note that the bend radius should not be less than three feet. Smaller bend radii may restrict the movement of the control cable.

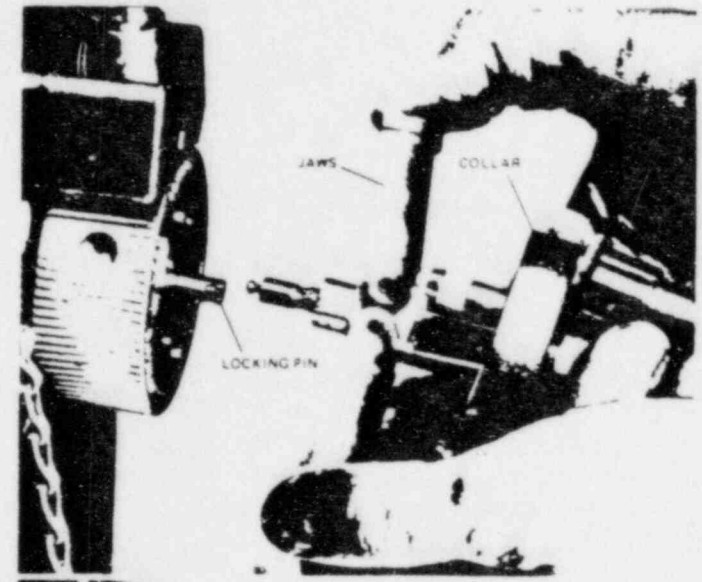
NOTE

The control cable should not be subjected to any undue stress or abuse which could cause restrictions in the cable.

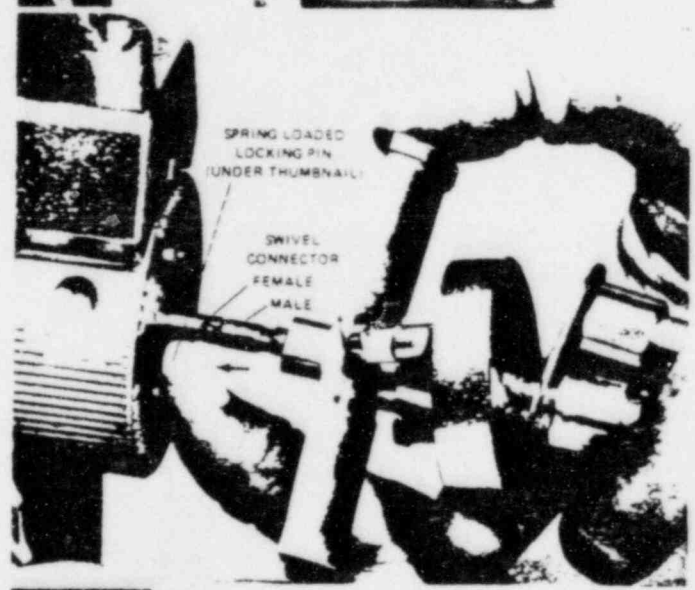
3. Attach the control cable to the projector in accordance with the following illustrated sequence:



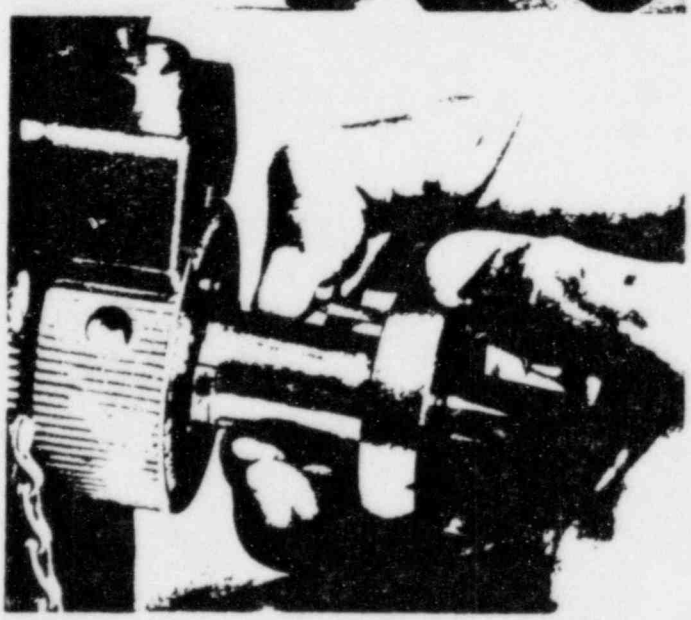
Unlock the projector with the key provided and turn the connector selector ring from the LOCK position to the CONNECT position. When the ring is in the CONNECT position, the storage cover will disengage from the projector as shown.



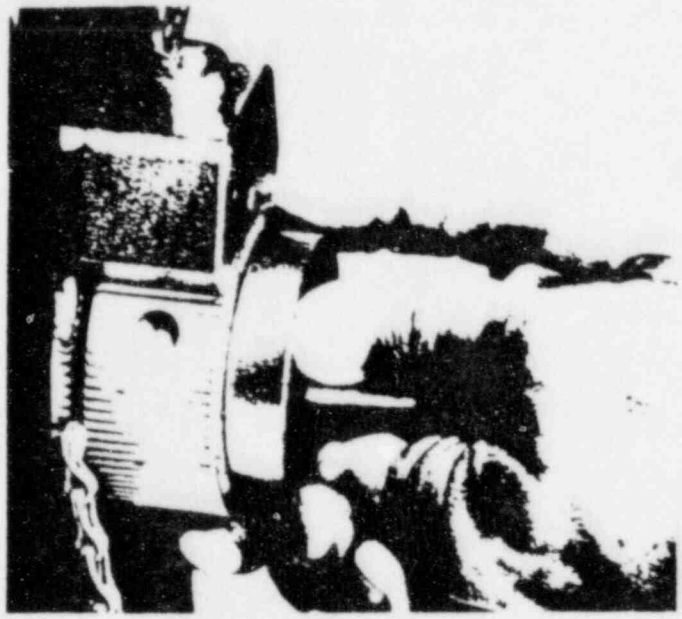
Slide the control cable collar back and open the jaws of the control cable connector. This exposes the male position of the swivel connector as shown.



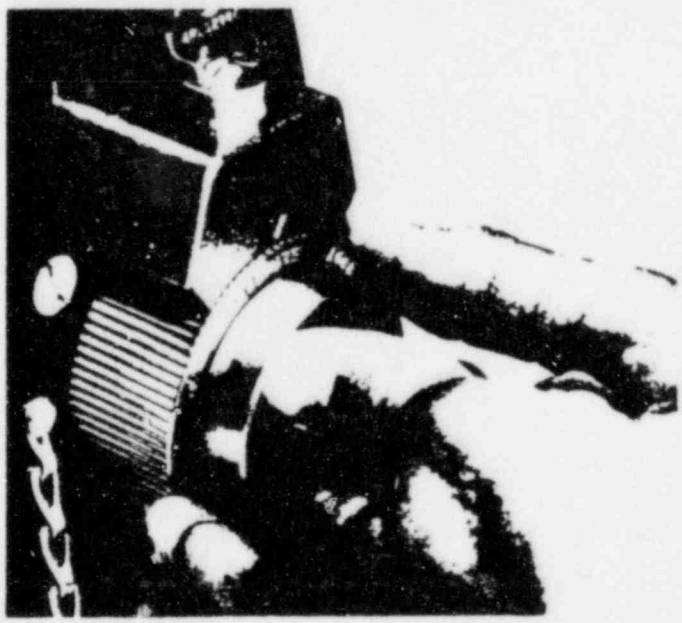
Engage the male and female portions of the swivel connector as shown by depressing the spring-loaded locking pin toward the projector with the thumbnail. Release the locking pin and test that the connection has been properly made.



Close the jaws of the control cable connector over the swivel-type connector.



Slide the control cable collar over the connector jaws.



Hold the control cable collar flush against the projector connector and rotate the selector ring from the CONNECT position to the LOCK position. Keep the projector in the LOCK position until actual operation is ready to start.

4-2. OPERATION

Thoroughly check all cable connections and bend radii and the position of the snout of the master guide tube. (This represents the radiographic focal point of the source.) To operate the system, perform the following:

WARNING

OPERATE THE SYSTEM ONLY IN AREAS MONITORED WITH APPROPRIATE RADIATION MEASURING EQUIPMENT. SEE SECTION II.

a. Unlock the projector connector and rotate the selector ring to the OPERATE position. The source is now free to move.

NOTE

If cranking becomes difficult at any time during the next step, reverse the direction of the cranking to return the source to the stored position in the projector. First monitor the area with a survey meter to insure that the source is properly stored. Then check the control and guide tubes for excessively small bend radii and repeat the step.

b. At the control unit (in a shielded area), rapidly rotate the hand crank in the EXPOSE (counterclockwise) direction to move the source out of the projector and into the guide tubes toward the radiographic focal point. Both the Model 664 and 604 Control Units, shown in Figure 4-1 operate in similar fashion. Continue to rotate the hand crank until the source reaches the snout which serves as a mechanical stop for the source. The odometer reading will indicate the total distance the source traveled (approximately seven feet for one guide tube section, fourteen feet for two sections, and twenty-one feet for three sections).

c. Specimen exposure should be figured from the time that the source reaches the snout or stop.

d. To return the source to the projector, after the desired exposure time has elapsed, rapidly turn the hand crank in the RETRACT (clockwise) direction. Continue to turn the crank until the odometer reading reaches the 000 position. (source properly stored).

CAUTION

AFTER AN EXPOSURE, THE PROJECTOR SHOULD BE THOROUGHLY MONITORED WITH A SURVEY METER BEFORE CONTINUING WITH STEP E.

e. At the projector, rotate the connector selector from the OPERATE position to the LOCK position and secure with the projector lock.

NOTE

If the projector selector ring cannot be rotated to the LOCK position, the source has not been fully retracted. Check the control unit odometer reading. It should be 000. Turn the hand crank to the full clockwise (RETRACT) direction.

4-3. DISASSEMBLY

If the system is to be moved for another exposure or to be stored, the components should be disassembled. Unscrew the guide tube sections from each other and remove the master guide tube from the tripod stand. Place the plastic caps on the tube ends and projector connector to eliminate dust and dirt from entering the tubes. Store the tubes in an area where they will not be subjected to any undue stress or abuse which could cause restrictions. Insert storage plug into position and tighten.

To disconnect the control unit from the projector, perform the following:

a. Unlock the projector using the supplied key.

b. Rotate the connector selector ring from the LOCK position to the CONNECT position. When the selector ring reaches the CONNECT position, the control cable connector will partially disengage from the projector.

c. Slide the control cable connector collar over the jaws away from the projector.

d. Open the connector jaws and disconnect the swivel-type connector by depressing the spring-loaded locking pin towards the projector with the thumbnail and separating the male and female connections.

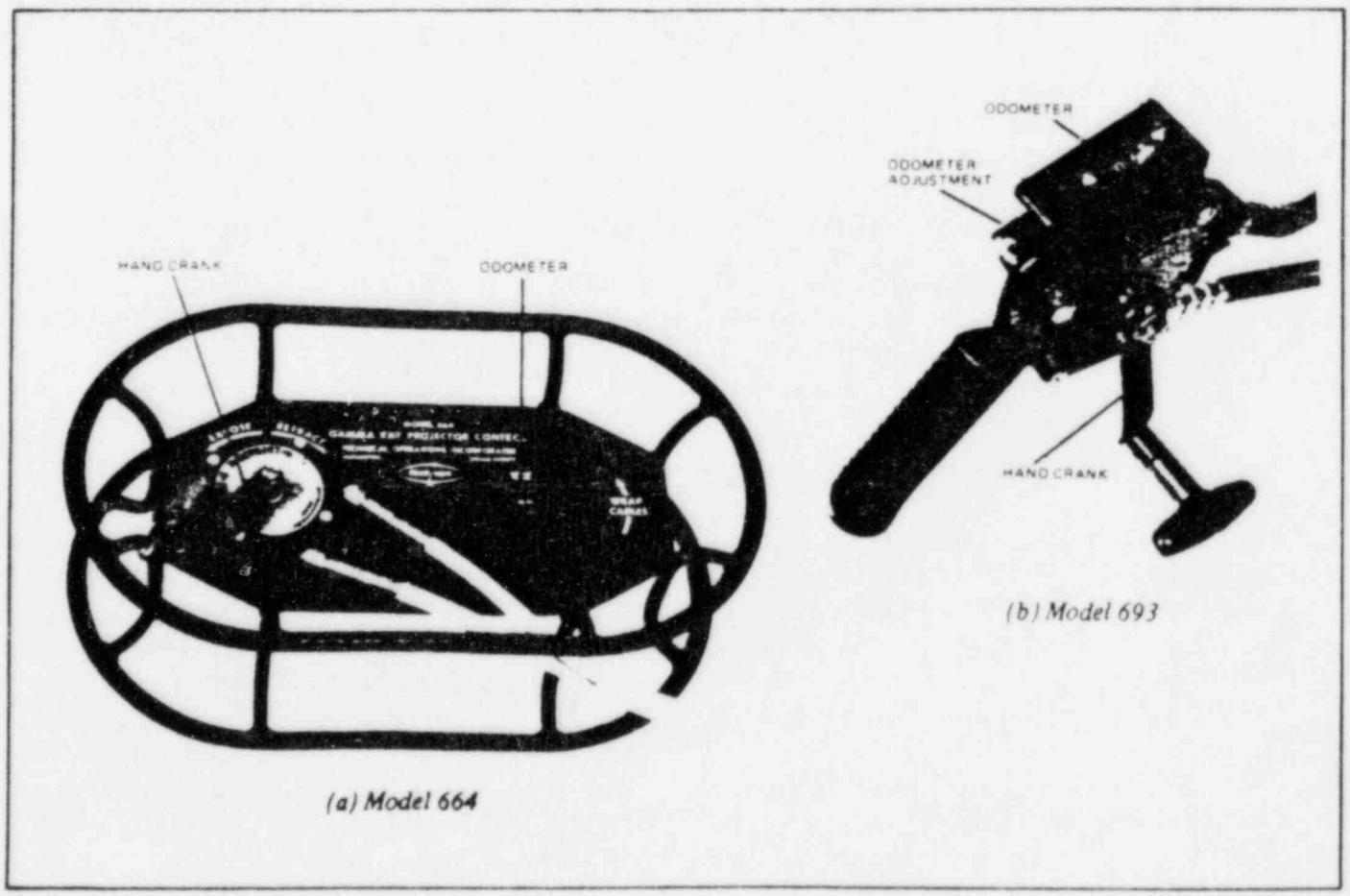
NOTE

If any difficulty is encountered, refer to the illustrated instructions given for making the connection for further assistance.

e. Replace the storage cover in the projector connector and rotate the selector ring to the LOCK position. Remove the key and engage the lock to secure the projector.

f. Coil the control cable in the 664 control unit or around the 693 control unit and store the unit in an area where the cable will not be subjected to undue stress or abuse.

g. Disassemble the tripod stand for storage.



(a) Model 664

(b) Model 693

Figure 4-1. Control Units.

SECTION V
MAINTENANCE

5-1. GENERAL

It is imperative that all system components be kept clean. No amount of dirt can be considered negligible. When the system must be operated in a dirty environment, particular care must be exercised to avoid dirt from entering the control or guide tubes. Dirt-clogged cables, tubes, and connectors impede the drive cable movement and could cause jamming.

5-2. CONTROL CABLE

Inspect the control cable regularly for signs of damage. Avoid twisting or bending the cable excessively. Recoil the control cable carefully for storage. Never drag the cable on the floor or ground. Use the protective cover (over the connector) when the control cable is not in use.

5-3. GUIDE TUBES

Inspect the guide tubes regularly for signs of damage. Avoid twisting or bending the tubes excessively. Recoil the guide tubes carefully for storage. Never drag the tubes on the floor or ground. Replace the plastic caps on the guide tubes connectors when not in use.

5-4. CLEANING AND LUBRICATING SYSTEM CABLES

The frequency of cleaning and lubrication depends on the amount and type of use. These procedures should be performed whenever the cranking of the control unit becomes difficult. Perform the following:

1. Disconnect the control cable from the projector.

2. Turn the hand crank in the EXPOSE (counterclockwise) direction until the cable disengages from the drive gear. This becomes apparent because further turning of the hand crank will have no effect on the control cable.

3. Pull the cable free from the control cable housing. Coil the cable (a radius of not less than four inches) and place the cable in a container of degreasing solvent. Do not use water-based cleaning agents. Allow the cable to soak as long as is necessary to remove all accumulated foreign matter.

4. Remove the control cable from the control unit by loosening the two fittings. (Before removing the fittings, label them to facilitate reassembly.)

5. Pour degreasing solvent into the control cable tubing to clean. Continue to flush the tubing until the solvent leaving the hose is free from impurities.

6. Use compressed dry clean air (do not exceed fifteen pounds) to thoroughly dry both the housing and cable. Any remaining solvent could cause permanent damage.

NOTE

Since the drive cable and control tubing has been thoroughly cleaned, care must be exercised to avoid any dust or dirt contamination during the remainder of this procedure.

7. Lightly grease the drive cable with MIL-G-23827A type grease. Other greases may form tars or corrosive compounds when exposed to radiation.

8. Carefully feed the cable into the tubing from the cable end which attaches to the projector.

9. When the cable reaches the control unit fitting, guide the cable into the hand crank housing. Slowly turn the hand crank in the RETRACT (clockwise) direction until the cable engages the crank gear.

10. Reconnect the two fittings which connect the control cable to the control unit.

11. Turn the hand crank in the RETRACT direction until the cable is completely contained in the housing. If the odometer reading is not 000 at

this time, refer to the odometer adjustment procedure given in this section.

To clean the guide tubes, flush them thoroughly with a cleaning solvent (chlorothene or carbon tetrachloride). Dry thoroughly with clean dry compressed air. Replace all plastic dust caps when storing the tubes.

5-5. REPLACING THE CONTROL CABLE

To replace the control cable, refer to the cleaning procedures given in paragraph 5-4.

5-6. ODOMETER ADJUSTMENT

The odometer in both the 664 and 693 control units, has a knob adjustment control. If the hand crank is in its full RETRACT position, the odometer should indicate 000. If not, slowly adjust the control to obtain a 000 reading. The odometer adjustments are located in Figure 6-4 for the 693 control unit and Figure 6-3 for the 664 control unit.

5-7. SOURCE REPLACEMENT

Renewal sources are available from Technical Operations, Inc. for replacement in the field. For instructions, see the procedure supplied with the replacement source.

A dummy source is normally supplied with the system. A clip inside the storage cover of the projector converter is provided for dummy source storage. The dummy source can be used when the radioactive source has been removed (using a source changer) so that the control cable can be disconnected from the projector. Note that the fail-safe feature of the connector requires either a source or a dummy source properly stored in the projector before the control cable can be disengaged.

5-8. CONTROL UNIT REPAIR

Exploded views of both the 664 and 693 control units are given in Section VI (Figures 6-3 and 6-4). If parts must be replaced, use the index numbers of the related illustration as a guide to disassembly and reassembly. The illustrations also include a parts list for ordering replacements.

5-9. GAMMA RAY PROJECTOR

WARNING

THE SOURCE SHIELD PORTION OF THE PROJECTOR IS NOT REPAIRABLE IN THE FIELD. A COVER PLATE HAS BEEN ATTACHED (SEE FIGURE 1-2) TO PREVENT OPENING THE SHIELD WHICH COULD RESULT IN A SERIOUS RADIATION OVEREXPOSURE.

SECTION VI
REPLACEABLE PARTS

6-1. GENERAL

All parts that are replaceable in the field are listed and identified in this section.

6-2. GAMMA RAY PROJECTOR

CAUTION

NEVER DISASSEMBLE THE PROJECTOR IN THE FIELD (SEE PARAGRAPH 5-9).

Refer to Figure 6-1 for component identification.

6-3. TRIPOD STAND

Refer to Figure 6-2 for component identification.

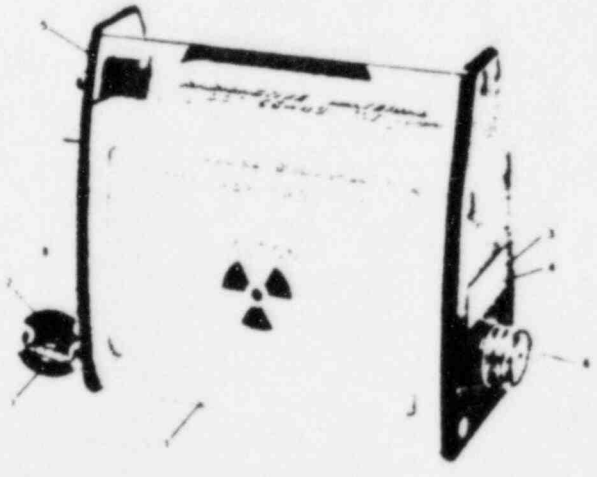
6-4. GUIDE TUBES

The guide tubes are replaced as a complete assembly. Order Part Number B48906 for replacing the master guide tube (with snout) or Part Number B48907 for replacing either of the extension guide tubes.

6-5. CONTROL UNITS

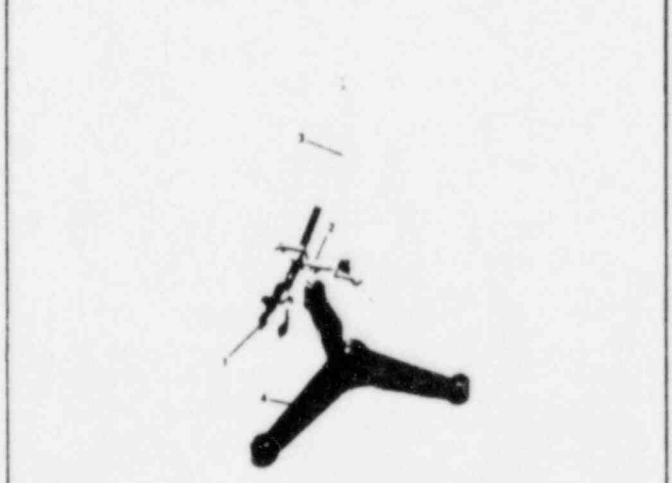
a. Model 664 Control Unit.
Refer to Figure 6-3.

b Model 693 Control Unit.
Refer to Figure 6-4.



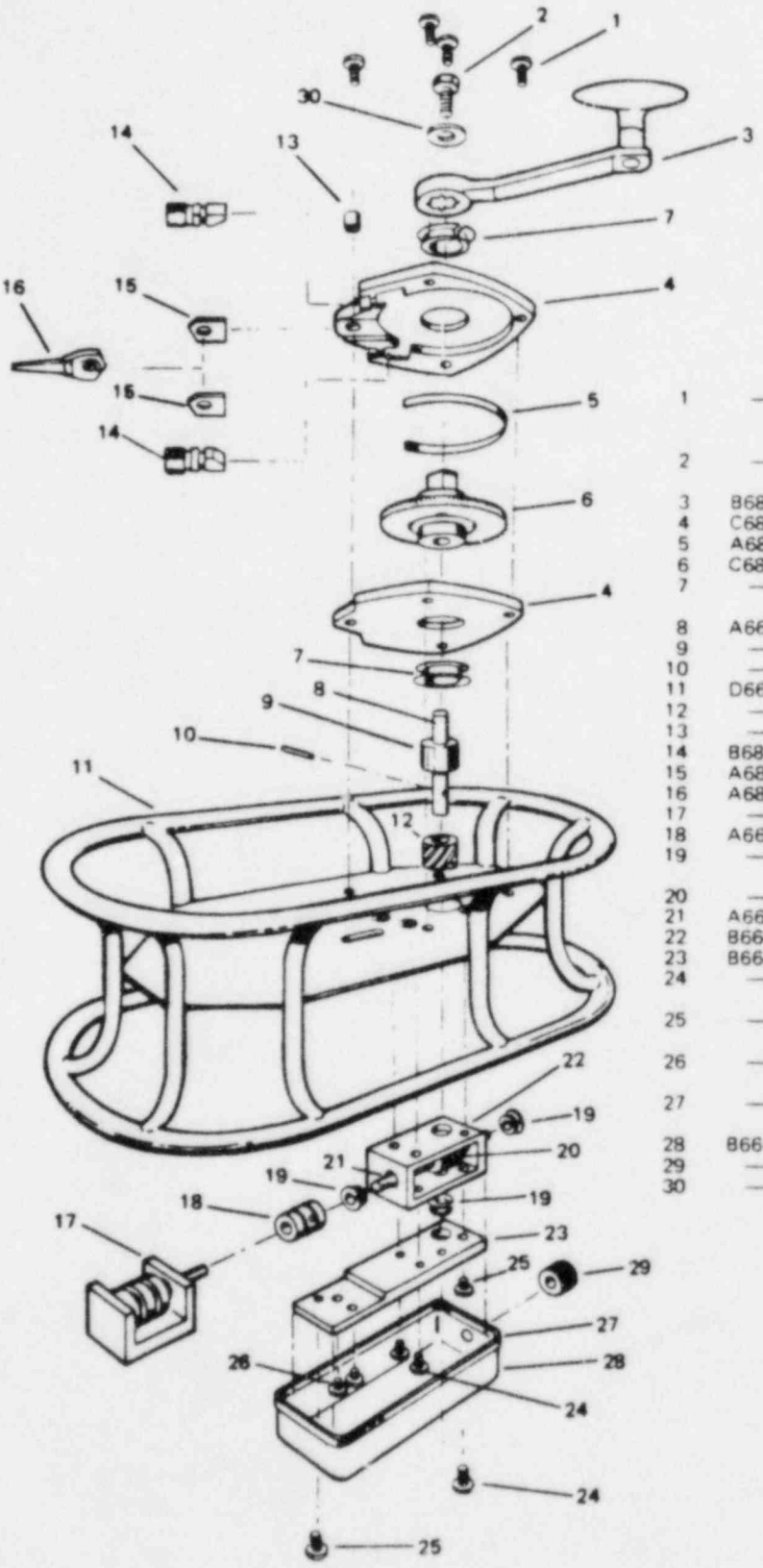
1	D66001	Gamma Ray Projector (complete)
2	B66001-7	Storage Cover
3	–	#6 – 32 x 3/8 LG Pan Head Screw
4	C66001-10	Nameplate
5	A66001-11	Key
6	A52401-1	Storage plug
7	B66001-20	Dummy Source
8	–	Sash chain, 2¾", steel/copper (NS)

Figure 6-1 Gamma Ray Projector.



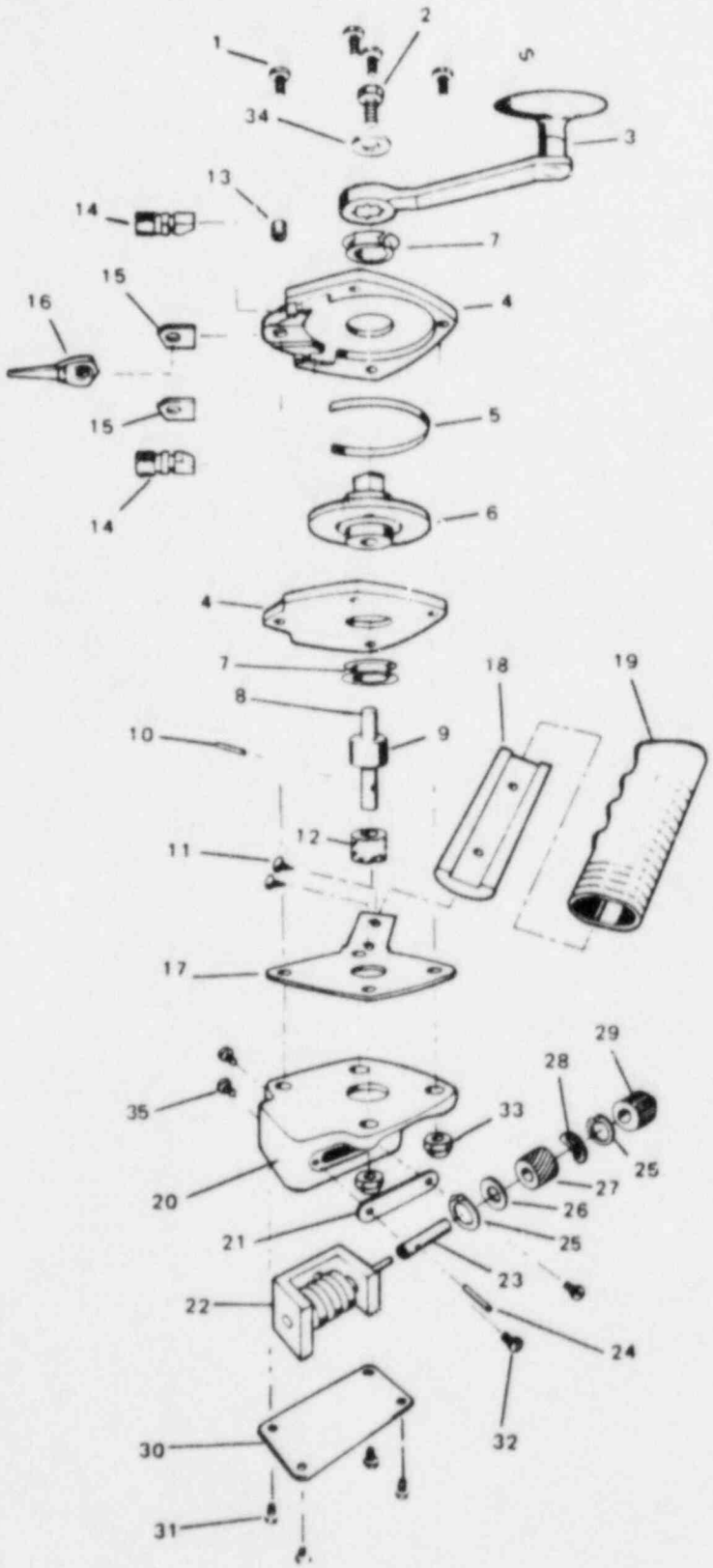
1	40201-7	Burrett clamp
2	40201-8	Clamp holder
3	P/O 40201-9	Aluminum rod, ½ diameter x 32", threaded 3/8 – 16 x 5/8"
4	P/O 40201-9	Tripod base

Figure 6-2. Tripod Stand.



1	——	#10–32 x 1-1/4 Lg. Bind. Hd. Screw and #10–32 Elastic Stop Nut (4 Each Required)
2	——	5/16–18 x 5/8 Lg. Hex Hd. Bolt (AN 10–5)
3	B68901	Crank Arm Assembly
4	C68900-1	Control Box Housing (2 Req.)
5	A68900-7	Wear Strip
6	C68900-9	Drive Wheel
7	——	Nylon Bearing – Thomson #12L2-FF (2 Req.)
8	A66404-1	Gear Shaft
9	——	Oilite Bearing – Bost. Gear #848-3
10	——	Dowel Pin – 3/32 Dia. 5/16 Lg.
11	D66402-1	Frame
12	——	Helical Gear – Bost. Gear #H2410L
13	——	Brake Bearing – Bost. Gear #835–4
14	B68900-2	Cable Adapter (2 Req.)
15	A68900-4	Brake Jaw (2 Req.)
16	A68900-3	Brake Arm
17	——	Odometer – Durant #3Y-8822–R–S–AC
18	A66403-4	Coupling
19	——	Nylon Bearing – Thomson #4L2-FF (3 Req.)
20	——	Helical Gear – Bost. Gear #H2412L
21	A66403-3	Odometer Connecting Shaft
22	B66403-2	Gear Box
23	B66403-1	Mounting Plate
24	——	#8–32 x 3/8 Lg. Bind. Hd. Screw (3 Req.)
25	——	#8–32 x 1/4 Lg. Bind. Hd. Screw (2 Req.)
26	——	#4–40 x 1/4 Lg. Bind. Hd. Screw (2 Req.)
27	——	Rubber Gasket – Green Rubber Co. #GR-121
28	B66403-5	Cover
29	——	Reset Knob – Raytheon #70–1–2
30	——	5/16 Bevel Washer

Figure 6-3 Model 664 Control Unit (Revised July 1974)



1	——	#10–32 x 1-1/4 Lg. Bind. Hd. Screw and #10–32 (4 Each Required)
2	——	5/16–18 x 5/8 Lg. Hex Hd. Bolt (AN 10–5)
3	B68901	Crank Arm Assembly
4	C68900-1	Control Box Housing (2 Req.)
5	A68900-7	Wear Strip
6	C68900-9	Drive Wheel
7	——	Nylon Bearing – Thomson #12L2-FF (2 Req.)
8	A69302-1	Gear Shaft
9	B-48-5	Oilite Bearing – Bost. Gear #B48-3
10	——	Dowel Pin – 3/32 Dia. 5/16 Lg.
11	——	#8 Sheet Metal Screw 5/8 Lg. Flat Head (2 Req.)
12	——	Helical Gear – Bost. Gear #H2410L
13	——	Brake Bearing – Bost. Gear #B35–4
14	B68900-2	Cable Adapter (2 Req.)
15	A68900-4	Brake Jaw (2 Req.)
16	A68900-3	Brake Arm
17	C69201-1	Control Handle
18	B69201-2	Handle Filler
19	——	Handle Grip Hunt-Wilde #FG–1-1/4 Stock #1856
20	C69301-1	Odometer Mount
21	A69301-3	Window
22	——	Counter Durant #3Y-8822–R–AC
23	A69303-1	Odometer Drive Shaft
24	——	Roll Pin, 1/16 Dia. x 1/4 Lg.
25	——	Grip Ring, Tru-Arc #5555-25 (1/4 Dia.) (2 Req.)
26	——	Spacer, Pic #88-11 (1/4 Dia. x 1/8 Lg.)
27	——	Helical Gear Boston Gear #H2412L
28	——	Spring Washer, Shakeproof #3502-14-48
29	——	Reset Knob Raytheon #70-1-2
30	A69301-2	Odometer Mount Cover
31	——	8–32 x 3/8 Lg. Bind Hd. Screw (4 Req.)
32	——	4–40 x 3/16 Lg. Bind Hd. Screw (2 Req.)
33	——	10–32 Locknut, Elastic Stop Nut #22 NTM-02 (4 Req.)
34	——	5/16 Bevel Washer
35	——	4–40 x 1/2 LG. RD. HD Screw (2 Req.)

Figure 6-4. Model 693 Control Unit.

GENERAL DESCRIPTION

The Source Changer Model 650 is a portable, shielded container for transferring encapsulated radioisotope sources into radiography projectors. The changer is designed to safely contain the radiographic sources during shipment and to permit field exchange of old for new sources without exposing the operator to unsafe radiation levels. The source changer has depleted uranium for shielding.

QUICK REFERENCE DATA

Source Types	Sealed sources (Tech/Ops sources only) Isotope: Iridium-192 Radiation: Gamma rays
Container capacity	Iridium-192: 200 Curies + 20%
Shielding	Depleted Uranium (U238), weight 35 lbs.
Housing	Steel
Design	Type B Radioactive Material Shipping Container (USNRC Certificate of Compliance No. 9032 and IAEA Certificate of Competent Authority No. USA-DOT-5-69).
Effective radiation shielding	Well below regulatory mR/hr limits prescribed in 10CFR34.21 and 49CFR393(i)
Dimensions	13¼ in. H X 10 in. L X 8¼ in. W
Shipping weight	66 lbs.

SHIPMENT DATA

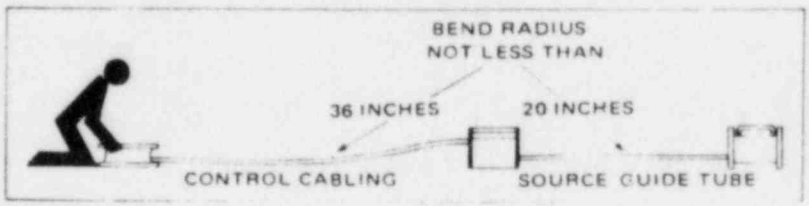
1. Source decay chart and leak test certification. Keep for user's records.
2. Source identification (ID) plate. Affix to user's projector.
3. Return shipping labels.
4. Tamperproof seals.
5. Instruction manual.

OPERATION

NOTE: All the precautions used when making readiographic exposures must be followed.

Wear personnel monitoring devices during all source changing operations. Monitor all operations with a calibrated, operable survey meter.

1. Upon receipt of the source changer, survey the source changer to ensure that the source is in the proper storage position.
2. Locate the source changer and projector in a restricted area. Locate the devices so as to avoid sharp bends in the guide tube or control housing.



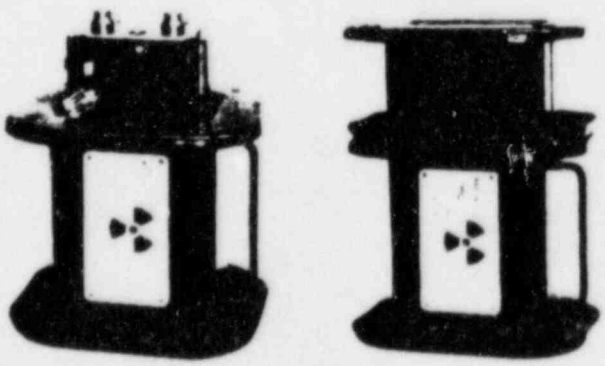
Typical Source-exchange Arrangement

3. Set the projector as for an exposure.
4. Remove the cover from the source changer by breaking the seal wire and removing the bolts.
5. Remove the source holddown cap by breaking the seal wire and unbolting.

   CAUTION: When the source holddown cap is removed, the source connector is exposed. Care must be taken to ensure the source is not dislodged when handling the changer.

6. Connect one end of a guide tube extension to the projector and the other end to the fitting above the empty chamber in the source changer.
7. Close and latch the source guides.
8. At the projector controls, crank the source from the projector to the source changer.
9. Approach the projector with the survey meter. Survey the projector on all sides, survey the guide tube and survey the source changer on all sides to ensure the source has been properly transferred. The maximum radiation level at the source changer should be less than 200 milliroentgens per hour at contact.
10. Open the source guides. Disconnect the drive cable from the source assembly by moving the lock pin down and sliding the drive cable connector out through the keyway.
11. Disconnect the guide tube from the source changer. Connect the guide tube to the fitting above the chamber containing the new source.

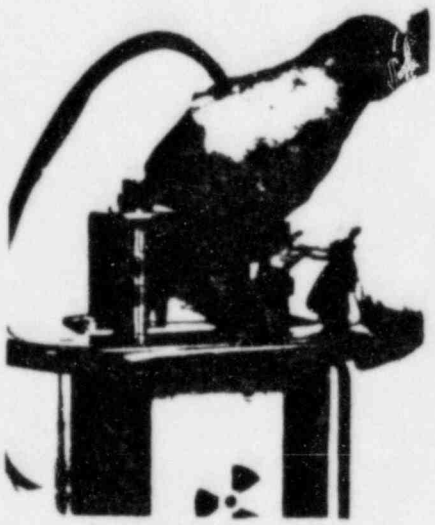
12. Couple the drive cable to the source by depressing the lock pin, sliding the drive cable connector into the keyway, and releasing the lock pin. Test for proper engagement.
13. Close and latch the source guides.
14. At the projector controls, crank the source from the source changer to its storage position in the projector.
15. Approach the projector with the survey meter. Survey the projector on all sides, survey the guide tube, and survey the source changer on all sides to ensure the source has been properly transferred.
16. Lock the projector.
17. Disconnect the source guide tube from the source changer.
18. Affix the identification plate of the new source to the projector and attach the identification plate of the old source to the source holddown cap.
19. Bolt the source holddown cap in place and seal wire.
20. Bolt the source changer cover in place and seal wire.
21. Survey all exterior surfaces of the source changer to ensure that the radiation level does not exceed 200 milliroentgens per hour at contact.
22. Measure the radiation level three feet from all exterior surfaces of the source changer and ensure that the radiation level is less than 10 milliroentgens per hour. The maximum radiation level measured three feet from any exterior surface is the Transport Index. (Example: With a maximum radiation level of 2.2 milliroentgens per hour, the Transport Index is 2.2.)
23. Complete the "RADIOACTIVE III" shipping labels. For contents, list the radioisotope contained (Iridium-192). Indicate the activity as the number of Curies. Record the Transport Index as determined above.
24. Apply the RADIOACTIVE III shipping labels, properly completed, to two opposite sides of the container.
25. Return the container to Technical Operations Inc.



Preparing Source Changer for Shipment

NOTE

Please return container promptly. Rental charges will be made for containers held beyond normal transportation time.



Connecting/Disconnecting

Testing Connection

WARNING

Do not move source assembly more than 1/2 inch from its stored position when connecting/disconnecting or when testing for proper connection.

TO ENGAGE CONNECTORS

1. With fingernail move lock pin back from keyway. (Pressure on pin is downward toward stored position of source.)
2. Slide drive-cable connector into keyed sleeve and release pin.
3. Test connection by pulling between source and drive cable. (Note WARNING.)

TO DISENGAGE CONNECTORS

1. With fingernail move lock pin back from keyway.
2. Slide drive-cable connector out through keyway and release pin.

CAUTION

Move connector sideways only. Do not bend or twist.

Figure A. Procedure for engaging and disengaging the Model 550 source assembly connector. Testing for proper connection must be performed.

Tech/Ops

Series 900 Gamma Ray Projectors

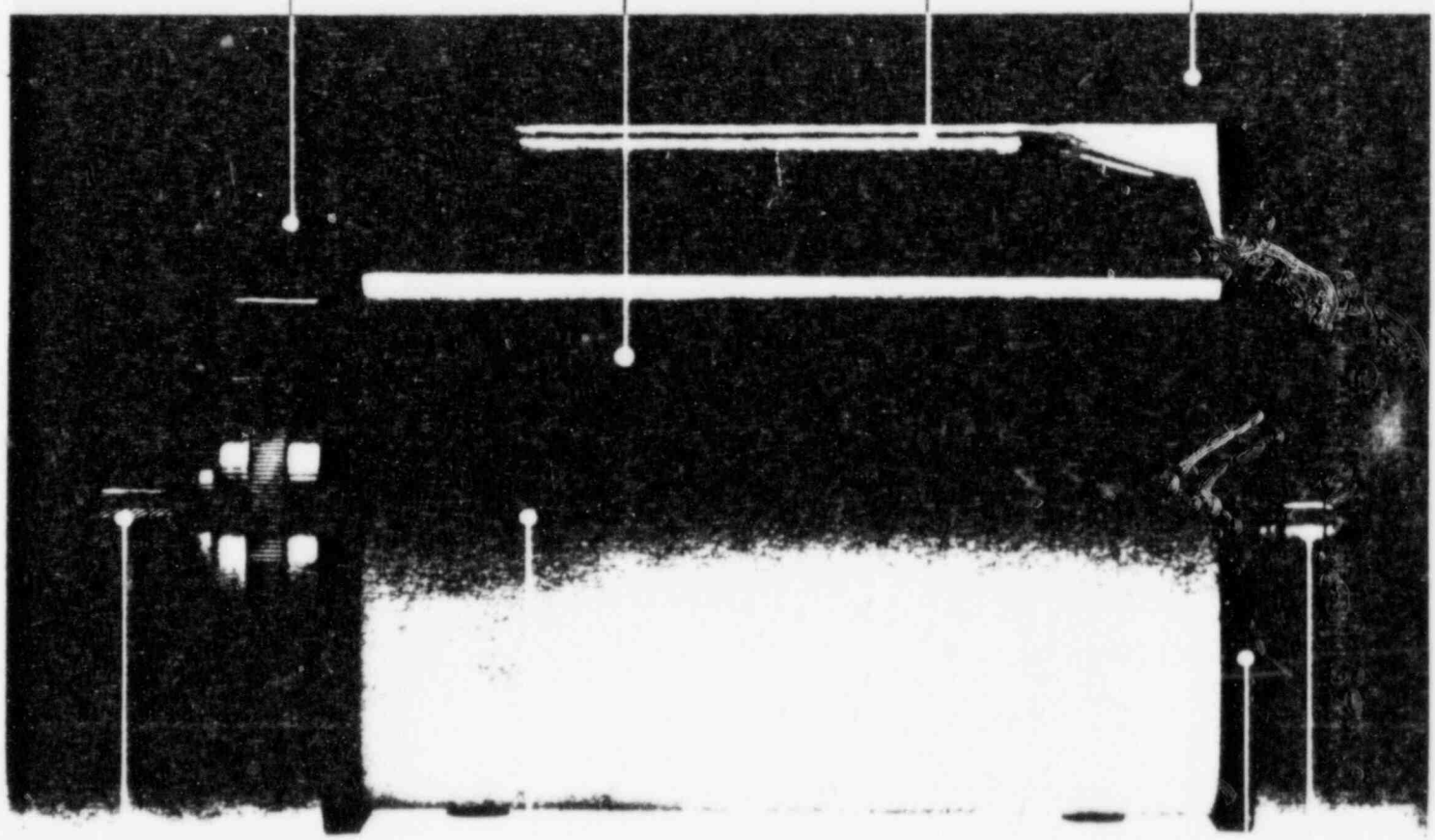
The Tech/Ops Series 900 Projectors offer new economic and safety benefits. This new design significantly extends the life of the gamma ray projector. The Model 900's are lighter in weight and smaller in size. Different size and weight models for different applications are available with new features for operator safety and regulatory compliance.

Safety Lock Control Connector Source remains in safe stored position until a positive proper connection is made. Can only be properly disconnected or connected when source is safely stored.

Depleted Uranium Shield-Dose Rates Well Below Allowed Levels The shield assembly is rigidly supported in the projector by end plates. A wear resistant tungsten source tube is in the center of the depleted uranium shielding. Void space between the shield and shell is filled with castable rigid polyurethane foam. The mass of the shield assures low surface dose rates - well below regulatory requirements.

Handle A comfortable, rugged, aluminum handle assures ease of portability and positioning.

Visual Positive Source Position Indicator Secures the source automatically in projector when fully returned to storage position. Must be reset by operator after every exposure. Visually indicates if source is stored or in open position.



Straight Source Channel Tube The tungsten source tube is cast into a depleted uranium shield. Shield shape reduces weight substantially. Straight thru design extends projector and tube life significantly.

Front/Rear Housing Plates Fabricated from durable steel with yield strengths to assure and maintain the projectors' structural integrity.

Storage Plug Protects the source assembly connector end when not in use, and keeps it and the projector dirt and dust free.

Shell The depleted uranium shield is encased in castable, rigid polyurethane and housed in a stainless steel shell providing durability and strength.

Quick Disconnect Source Tube Allows for quick connection/disconnection of source guide tubes to or from projector.

Radiation Products Division
Northwest Industrial Park
Burlington, MA 01803 USA
Telephone (617) 272-2000 or Toll Free 1-800-225-1383

The Complete System

A complete Series 900 system for field or laboratory use includes the Gamma Ray Projector, choice of pistol grip or hand reel controls, control housings, source guide tubes, tripod and clamps. As an added feature, the stainless steel outer shell of the Series 900 GRP's has tapped holes on the bottom for easy mounting on vessel walls, solid plates, saddles, pipelines or other surfaces that require a firm stationary position. The 900's low center of gravity provides additional stability.

SPECIFICATIONS:

Standard Isotope:
Ir^{192} max capacity for Model 900 = 100 (+20%) ci
Ir^{192} max capacity for Model 920 = 200 (+20%) ci
Ir^{192} max capacity for Model 910 = 25 (+20%) ci
Source assembly is T/O 90003 for Models 900 and 920; 91003 for Model 910.

Special Isotopes:
Gamma Ray Projectors may also be used for millicurie amounts of Co^{60}—please write for information on other radioisotopes

Application:
Radiography of steel from 0.5 to 2.5 in. (1.25 to 6.25 cm) thick. Also light alloys 1.5 to 7.5 inches (4 to 19 cm) thick.

Shielding:
Model 900 - 28 lbs. (12.7 kg) of depleted uranium
Model 920 - 31 lbs. (14.0 kg) of depleted uranium
Model 910 - 18 lbs. (8.2 kg) of depleted uranium

Approvals Certification:
Meets all IAEA, USNRC, US DOT and ISO 3999 requirements for Type B(U) packaging and class P containers. Certification and approvals provided upon request.

Control Cable and Source Travel Lengths:
Standard Control Cable length is 25 ft. (7.6m); longer/shorter lengths available upon request. Standard source travel up to 21 ft. (6.4m); longer/shorter lengths available upon request.

Dimensions/Weights:

Gamma Ray Projector	length	12.25 in.	(311 mm)
	height	7.75 in.	(197 mm)
	width	5.25 in.	(133 mm)
	weight	Model 900	44 lbs.(20 kg)
		Model 920	47 lbs.(21.4 kg)
		Model 910	34 lbs.(15.5 kg)
664G Control Reel	length	21 in.	(533 mm)
	width	12 in.	(305 mm)
	height	6.6 in.	(168 mm)
	weight	22 lbs.	(10 kg)
693G Control-Pistol Grip			
	weight	19 lbs.	(8.6 kg)
Source Guide Tubes - 3 seven foot lengths (2.1m)			
	weight	5 lbs.	(2.3 kg)
Tripod Stand	weight	10 lbs.	(4.6 kg)
	height	24 in.	(600 cm)

OPTIONAL ACCESSORIES:

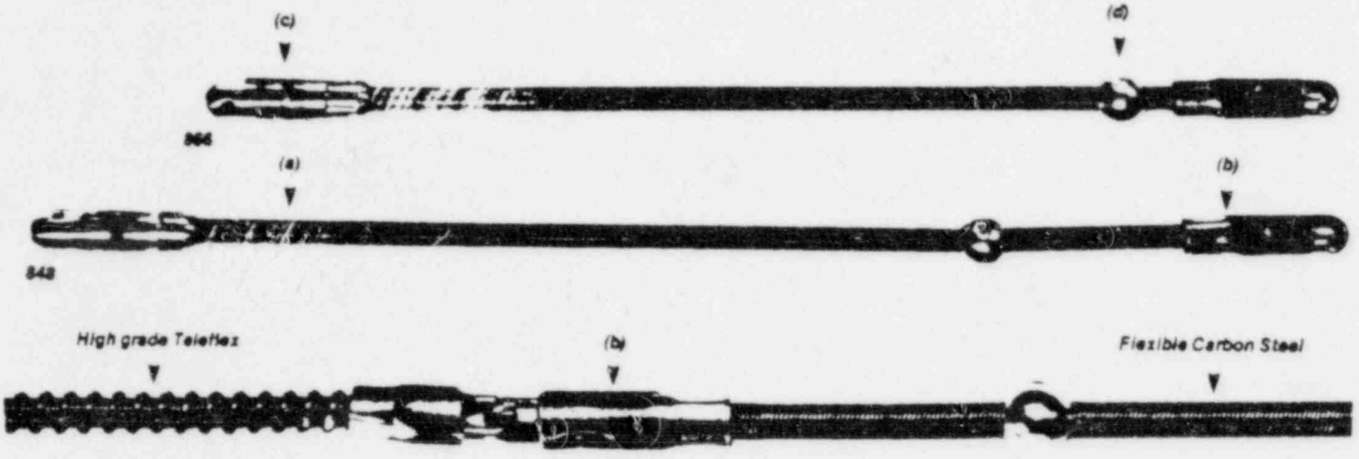
- Mini Collimators - Lead (Pb), Tungsten (W) or depleted uranium
- Combination Co^{60}/Ir^{192} slide rule exposure calculators
- Personnel/Laboratory and other Monitoring Systems - (visual, audible)
- Special Source Positioning and Centering Devices - Pipeline, Aircraft, etc.
- Special Purpose Accessories for different field and laboratory applications

U. K. Sales office
Tech/Ops Ltd. Radiation Products Division, Unit 1, Whitworth Road, Armstrong Industrial Estate, Washington, Tyne & Wear, NE 37 1PP, ENGLAND

Tech/Ops

Source Assembly Models 848, 866

New from Tech/Ops are the Models 848 and 866 source assemblies for Gamma Industries (Century S, SA, and Models 35S, SA) Gulf Nuclear (20 V) Automation Industries (520) and SPEC (2T) Exposure Devices.



Closeup of New Improved Connector

New Pigtail Concept (a)

Tech/Ops introduces a smoother, more resilient pigtail of superior quality. Made of highly flexible carbon steel, this pigtail is ***smoother*** to reduce unnecessary tube wear in tighter "S" design exposure devices. Though more flexible, pigtails of this material have proven to be ***stronger*** than the standard cables, having withstood pull tests of over 200 lbs. - well above the tension applied under operating conditions. Laboratory tests have included full cycling these pigtails in excess of 100,000 crank-outs.

New Design. . . Improved Connector (b)

Designed as an improvement over presently available connectors, this innovative advancement has met safety, dependability, ease of source changing, and projector life criteria. Manufactured to critical dimensional tolerances and made of heat treated 4130 steel casting, it is capable of withstanding the demands of rigorous use.

Capsule Assembly (c)

A stainless steel capsule, hermetically sealed by TIG Fusion Welding. The capsule joint is precision ground and at Tech/Ops every capsule is checked to confirm that the wall thickness is perfectly uniform.

Stop Ball (d)

Precision drilled, stainless steel for longer service life insures absolute positional accuracy for source storage. The ball is swaged at 4,000 psi in three places and must be within .005 inch of specified position on the pigtail. Imitations of this stop ball do not match Tech/Ops' critical tolerances that are essential to the safe operation of equipment.

Precision Source Assembly

The source assembly consists of a hermetically sealed capsule, containing the isotope, stainless steel stop ball, and connector which are attached to a specified length of pigtail at critical pressures to insure overall safety. Materials, tolerances, manufacturing processes and quality control in manufacturing are unparalleled in industry. Bargain imitations of the overall Tech/Ops design offer a poor compromise on durability and safety.

All Tech/Ops source capsules meet the I.A.E.A. and USNRC requirements of "Special Form" which means they have passed rigorous tests that prove encapsulation integrity. All source capsules meet or exceed ANSI N542 and ISO 2919 requirements.

Drive cable connector will be provided and swaged on to your cable at *no charge*.

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Burlington, MA 01803 USA
Telephone (617) 272-2000 or Toll Free 1-800-225-1383

Activity - "A curie is not a curie is not a curie"

The activity of a radiographic source is defined by measuring the radiation exposure rate at a specific distance from the source and using a conversion constant to express this value in curies. Some of the gamma rays which are emitted by the radioactive source are absorbed in the radioactive material itself and in the walls of the source capsule. The self-absorption of a typical 100 curie Iridium^{192} source is approximately 27%. Thus, in order to get a 100 "effective curie" source, we must load the capsule with approximately 138 actual or "disintegration" curies. Thirty-eight curies are lost in self-absorption! A common symptom of an inadequately loaded source is the inability to obtain the required film density when all of the radiographic parameters have been met. Tech/Ops uses a specific gamma ray constant of 0.55 RHM (Roentgen per hr per curie at one meter). Other suppliers have provided sources measuring as low as 0.39 RHM, which means that these sources are 40% lower in intensity. Thus, other suppliers' sources labeled at 100 curies may actually be as low as 70 curies in terms of Tech/Ops curies. The USNRC suggested gamma ray constant is 0.55 RHM/curies and is the Tech/Ops standard!

At Tech/Ops you get *OUTPUT* — not just curies.

Tech/Ops Iridium^{192} sources will meet all your radiographic and code needs. We make sources from less than one curie to several hundred curies and sources as small as 0.02 in. (0.5 mm) in diameter.

Focal Spot

The detail sensitivity of a radiograph is a function of the geometric unsharpness. Codes and standards place requirements on allowable geometric unsharpness for certain radiographic techniques. One parameter which is necessary for determining the geometric unsharpness is the actual focal size of the source. This is defined as the maximum dimension across the source in the plane of interest. The actual focal size of a gamma radiography souce is dependent upon:

- The activity of the source
- The specific activity of the radioactive material
- The method of construction

Specific activity — This is the ratio of intrinsic activity of a sample to its mass expressed in units of curies per gram. For Iridium^{192}, a desired specific activity is more than 600 curies per gram; for Cobalt^{60} it is 400 curies per gram. A typical 100 curie Iridium^{192} source may be .107" x .102" (or less) or .107" x .129". As the radioactive material decays, more of it must be used to provide the same amount of activity, leading to increased focal spot size.

Construction — All Tech/Ops Iridium^{192} sources are constructed from identical size material. Some suppliers have been known to mix different dimensional material and cause the source to lose its geometric dimensional integrity. Tech/Ops has developed a simple radiographic technique which can verify true size (and shape) to meet code and product liability standards. Besides uniform dimensions of the radioactive material, Tech/Ops insures the focal spot and shape via precision machined source cavities as well as springs to maintain proper dimensional form in the fabrication of the source capsule.

U. K. Sales office
Tech/Ops Ltd. Radiation Products Division Unit 1 Whitworth Road Armstrong Industrial Estate Washington Tyne & Wear NE 37 1PP ENGLAND

Tech/Ops

Source Assembly T/O Ir^{192}/Co^{60}

Iridium[192] and Cobalt[60] — Industrial Radiography Sources

A close look at a Tech/Ops source assembly

Focal Spot Tech/Ops will verify the focal spot dimensions that are required in code work via a simple radiographic technique that you can perform in your own laboratory. Dimensional stability is guaranteed.

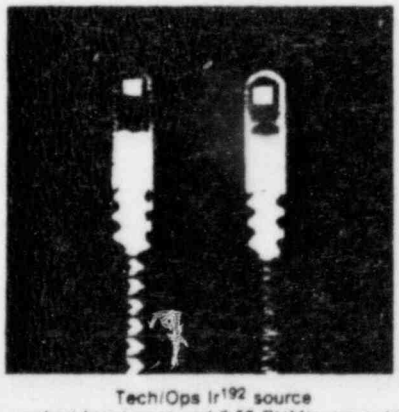
Assembly The capsule, stop ball and connector are attached to a specified length of Teleflex pigtail at critical pressures to insure overall safety. Materials, tolerances, manufacturing processes and quality control in manufacturing are unparalleled in industry. Bargain imitations of the overall Tech/Ops design offer a poor compromise on durability and safety.

Connector This patented unique connector, made of certified grade steel hardened to a specified Rockwell hardness, is manufactured to critical dimensional tolerances and has the best record for safety and wear resistance in the radiographic industry. The force of the stainless steel plunger spring is controlled to fractions of an ounce. The connector is attached to the pigtail under 4,000 psi swaging pressure, giving the assembly unmatched integrity.

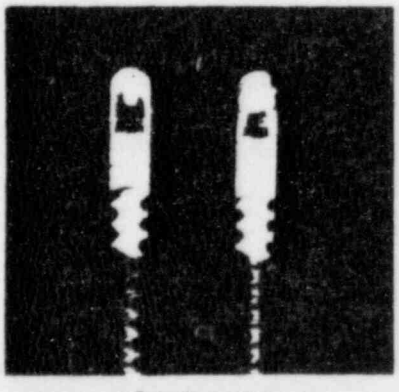
Capsule Assembly A stainless steel capsule, hermetically sealed by TIG Fusion Welding. The capsule joint is precision ground and at Tech/Ops every capsule is x-rayed to confirm that the wall thickness is perfectly uniform.

Pigtail Capsule assembly is attached to the Teleflex "pigtail" by precision die swaging at over 1,000 psi. The bond is pull tested at 75 lbs., a tension higher than what is applied under operating conditions. The high grade Teleflex cable has proven itself over the years to be most durable and not to compromise on safety. Competitive low cost multifilament airplane cable does not approach Teleflex on compressive strength and can easily fray and distort.

Stop Ball Precision drilled, naval bronze (stainless steel for cobalt - for longer service life) insures absolute positional accuracy for source storage. The ball is swaged at 4,000 psi in three places and must be within .005 inch of specified position on the pigtail. Imitations of this stop ball do not match Tech/Ops' critical tolerances that are essential to the safe operation of equipment.



Tech/Ops Ir^{192} source
verified focal spot and 0.55 RHM/curie output!



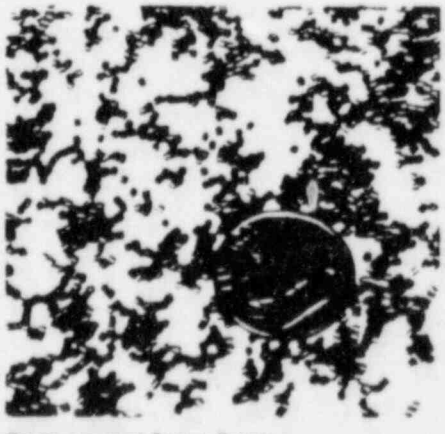
Bargain source
less output and more spot!

Our commitment to you! — Quality Assurance

- The source capsule welding system is an automatic Tungsten Inert Gas process with argon purge, flow rate, welding speed and post flow preprogrammed and automatically controlled from outside the loading cell.
- To assure proper weld penetration the capsule is subjected to a proprietary NDT technique to assure a properly sealed source. In addition, all Tech/Ops sources have been approved by the IAEA for special form and have met ANSI classification tests.
- A vacuum bubble leak test is performed by immersing the source capsule in isopropanol, reducing the pressure to 380mm of mercury and observing for bubbles. Acceptability is determined by the absence of bubbles emerging from a capsule.
- The source capsule is then placed in a swaging fixture and the source pigtail is inserted into the capsule. A test pull of 75 lbs. is applied between source capsule and connector.
- Each source Tech/Ops manufactures is subjected to a series of quality inspection tests that include several wipe tests with an acceptability limit of 0.0005 microcurie (USA legal limit is 0.005 microcurie) - a significantly more demanding standard is self-imposed for Tech/Ops manufactured sources!

Cobalt[60] high specific activity spherical sources

Not all Cobalt[60] sources are constructed the same way — Cobalt[60] sources are generally assembled from 1 mm diameter by 1 mm high cylindrical cobalt pellets. The activity per unit volume, which determines focal spot size, is proportional to the effective density of the metal in the capsule. Competitive jumble-packed sources have a much lower effective density than Tech/Ops high density Cobalt[60] spherical sources which are compression fired.



Relative size of Cobalt Pellets

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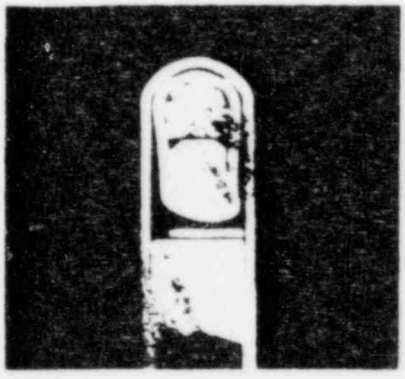
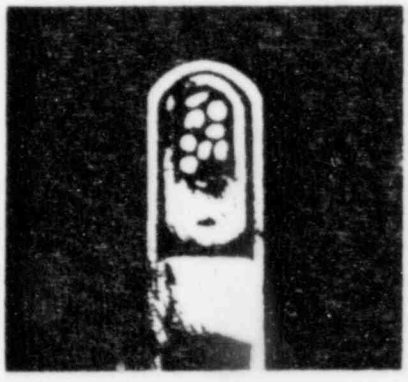
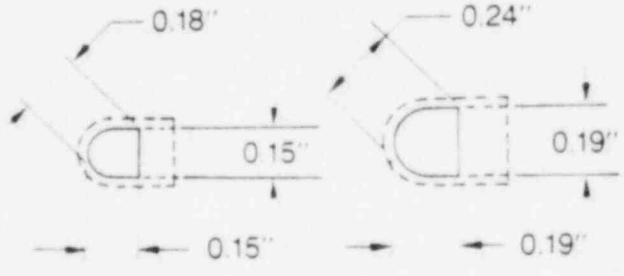


Tech/Ops high specific activity spherical Co^{60} source
- more activity and smaller spot



Jumble packed pellet Co^{60} source
- less activity and larger focal spot



	TECH/OPS COMPRESSED PELLET SOURCE	"JUMBLE PACKED" SOURCE
MINIMUM SOURCE TO SUBJECT DISTANCE $D_s = \frac{FT}{U_s}$	18 INCHES	24 INCHES
MINIMUM SOURCE TO FILM DISTANCE $D_f = D_s + T$	21 INCHES	27 INCHES
RELATIVE EXPOSURE TIME $\frac{T_1}{T_2} = \frac{(D_{f1})^2}{(D_{f2})^2}$	1.00	1.65

Comparison of Cobalt^{60} sources for radiography of 3 inch thick subject with geometric unsharpness equal to 0.03 inch.

Tech/Ops high specific activity spherical Cobalt^{60} sources

Tech/Ops Cobalt^{60} sources are fabricated using a proprietary "fusion-compressed pellet" technique where the cobalt pellets are deformed to conform to the shape of the sources' spherical capsule. This process has an effective density as high as 90% of the density of the cobalt metal. All TechOps doubly encapsulated Cobalt^{60} sources are made via this compression technique. This provides a considerably higher activity with smaller focal spot size, resulting in savings of hundreds and perhaps thousands of dollars in radiography exposure time alone.

Competitive sources are fabricated by "jumble packing" where cobalt pellets are randomly oriented in the source capsule. In this fabrication method the effective density of the active volume of the source is approximately 40% of the density of the cobalt metal.

A "jumble packed" 100 curie cobalt source using pellets with a specific activity of 400 curies per gram has a focal size approximately 30% larger than the focal size of the compressed spherical source. In radiographing a 3" thick subject at the minimum source to subject distance that will satisfy ASME code requirements for geometric unsharpness, the exposure time for the "jumble packed" source is 65% longer than for the compressed pellet source!

Tech/Ops high specific activity spherical Co^{60} sources from 1 to 1000 curies have more output and smaller focal spots!

U. K. Sales office
Tech Ops Ltd. Radiation Products Division, Unit 1, Whitworth Road, Armstrong Industrial Estate, Washington, Tyne & Wear, NE 37 1PP, ENGLAND

Tech/Ops

COU series Gamma Ray Projectors

The Tech/Ops COU series are field-proven gamma radiography systems using Cobalt[60]. All components of the systems have been developed to provide safe reliable service and long life under the harsh conditions of industrial use.

Description

The COU series of gamma ray projectors was developed to fulfill the need for radiographic systems that combined the highly penetrative radiation from Cobalt[60] with the mobility afforded by uranium shielding. Heavy section radiography in the shop and field is greatly facilitated by this series of projectors. The durable case was designed to ease rigging operations and to resist the hard knocks typical of industrial use.

All four models are identical except for capacity and size, and conveniently use the same interchangeable controls, source tubes and accessories.

The systems have maximum capacities of 10, 30, 100 and 300 curies of Cobalt[60] respectively.

The 360° panoramic radiation pattern may be used to full advantage either for multiple specimen work or for circumferential exposure techniques.

Features

Capacity
Maximum capacities of 10, 30, 100 or 300 curies, dependent upon projector model. All models may be shipped loaded under I.A.E.A. and USNRC transport regulations.

Self Contained
No external power supply is required.

Safety
The source cannot be exposed until a proper connection to the control cable is made. The unit cannot be locked nor can the control cable be disconnected until the source is completely retracted to the stored position. The key-operated lock prevents use by unauthorized persons.

Low Surface Radiation
Well below the maximum allowed under I.A.E.A. & USNRC regulations.

Remote Control
Long cables allow the operator to control the source at a distance of 25 feet. When the source is at the focal point, the control can be at a distance of 46 feet. Extra length controls and source guide tubes are available on special order.

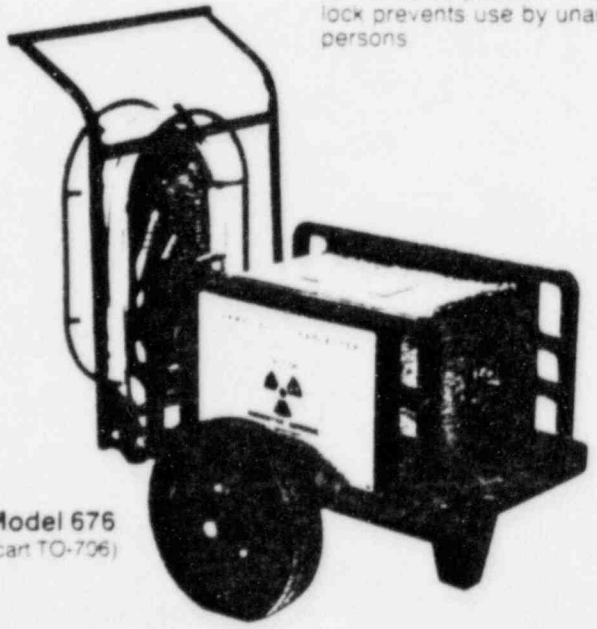
Ease of Positioning
The source can easily be positioned at the required focal point by means of guide tubes and a tripod stand. Exposure end of guide tube will pass through a 2 cm diameter hole.

Reliability
The system is designed to operate with a minimum of maintenance.

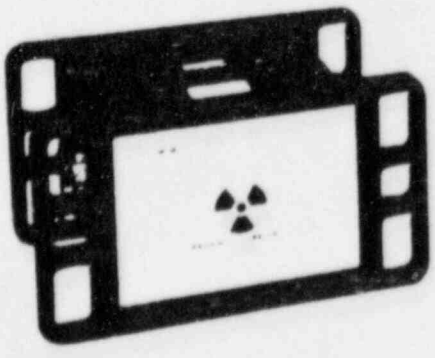
Panoramic or Directional Beam
Optional collimators quickly convert the 360° beam into a directional beam.

Ease of Rigging
Large openings on both ends of the frame provide maximum flexibility when hoisting.

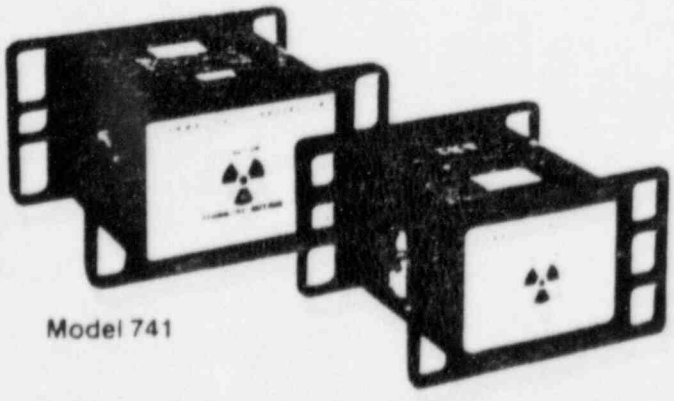
Projector
The projector, or storage container, consists of a steel housing which contains a radiation shield of depleted uranium. The control connector is located on one end plate of the projector with OPERATE LOCK and CONNECT positions for connection to the control device. The control connector also incorporates a key-operated lock which restricts the operation of the projector to authorized personnel. The other end plate houses the guide tube connector. When the projector is in shipment or storage, a metal shipping plug is fitted to the guide tube connector.



Model 676
(on cart TO-706)



Model 680



Model 741

Model 684

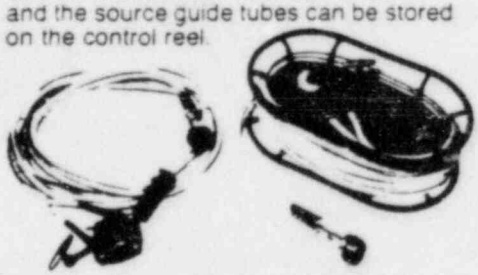
Radiation Products Division
Northwest Industrial Park
Burlington, MA 01803 USA
Telephone (617) 272-2000 or Toll Free 1-800-225-1383

Control Units

TO-664 Reel consists of a control panel built into a lightweight welded tubular cable reel and contains a handcrank to propel the source to the exposure position and back, and a source position indicating odometer calibrated in feet & inches.

TO-693 Pistol grip consists of a lightweight housing containing the handcrank and source position indicating odometer as incorporated in the TO-664 Reel.

The teflon-lined control cable consists of an outer sheath of flexible metal composite cable 25 feet long with a bright yellow polyvinyl cover and an inner spiral-wound flexible steel drive wire. Source guide tube consists of three sections of 7 foot flexible stainless steel cable with protective polyvinyl covering which can be used in 7, 14, 21 foot lengths. The end section is fitted with a stop for positive source location. Both the control cable and the source guide tubes can be stored on the control reel.



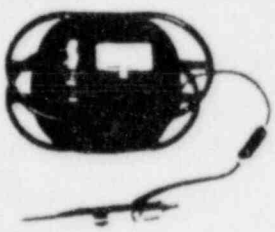
TO-693 PISTOL GRIP AND TO-664 REEL CONTROLS

Source Assembly

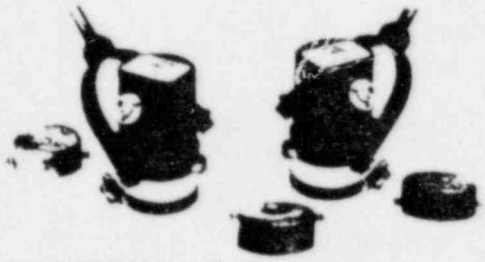
The source assembly consists of a hermetically sealed capsule containing the isotope attached to a leader cable. The opposite end of the leader cable has a connector for positive attachment to the source drive cable.

The source capsules meet the I.A.E.A. and USNRC requirements of "Special Form", which means they have passed rigorous tests that prove the integrity of the encapsulation.

Optional Accessories



SOURCE POSITION INDICATOR TO-681



COLLIMATORS TO-719 & TO-527

*TO-527	Collimator with stand for directional 60° (other angle optional) beam or 20° panoramic "band" beam.
TO-719	Depleted Uranium Collimator with inserts for directional or panoramic radiography (includes Labstand).
TO-613	Snout Switch used with the TO-681 Source Position Indicator. This switch will pass through a 3 cm hole.
TO-534	Combination Co^{60}/Ir^{192} slide rule type exposure calculator with leather case.
*TO-681	Source Position Indicator used in conjunction with TO-527 Collimator or the TO-613 Snout Switch. This unit provides a visual signal to indicate the source fully extended position.
TO-706	Cart for Models 684, 680, 676 and 741 projectors.

NOTE: To permit full 21 foot travel of the source, an additional section of guide tube B-48907 must be substituted for the source stop section.

Specifications

		Metric Equivalents
Isotope:	Cobalt^{60}	
Capacity:	Model 684 10 curies Model 741 30 curies Model 680 100 curies Model 676 300 curies	
Application:	Radiography of steel from 1" to 7" thick	25 to 175 mm
	Light alloys 3" to 15" thick	75 to 375 mm
Shielding Material:	Depleted Uranium metal Model 684 150 lb. uranium	68 kg
	Model 741 200 lb. uranium	91 kg
	Model 680 285 lb. uranium	130 kg
	Model 676 370 lb. uranium	168 kg
Package Specifications:	All models meet I.A.E.A. and U.S.N.R.C. requirements for Type B packaging.	

	I.A.E.A.	U.S.N.R.C.
Model 684	USA/9028/B(U)T	USA/9028/B(U)
Model 741	USA/9027/B(U)T	USA/9027/B(U)
Model 680	USA/9035/B(U)T	USA/9035/B(U)
Model 676	USA/9029/B(U)T	USA/9029/B(U)

Operating Specifications:	Standard control cable length 25 feet	7.6 M
	Standard source travel up to 21 feet	6.4 M
	Longer cables and source travel available on special order.	

Dimensions:		Metric Equivalents
Model 684 Shield Assembly		
	Length 17 inches	43 cm
	Width 13 inches	33 cm
	Height 9½ inches	24 cm
	Weight 225 pounds	102.3 kg
Model 741 Shield Assembly		
	Length 19 inches	48 cm
	Width 14 inches	36 cm
	Height 10½ inches	26.6 cm
	Weight 300 pounds	136 kg
Model 680 Shield Assembly		
	Length 21 inches	53 cm
	Width 14 3/4 inches	38 cm
	Height 11¾ inches	30 cm
	Weight 405 pounds	184 kg
Model 676 Shield Assembly		
	Length 29 inches	74 cm
	Width 15 inches	38 cm
	Height 14½ inches	36.8 cm
	Weight 545 pounds	250 kg
Control, 664 Reel		
	Length 21 inches	53.3 cm
	Width 12 inches	30.5 cm
	Height 6.625 inches	16.8 cm
	Weight 22 pounds	10 kg
Control, 693 Pistol Grip		
	Weight 19 pounds	8.6 kg
Guide Tubes, three 7-foot lengths		2.1 M
	Weight 5 pounds	2.3 kg
Tripod Stand		
	Weight 10 pounds	4.6 kg

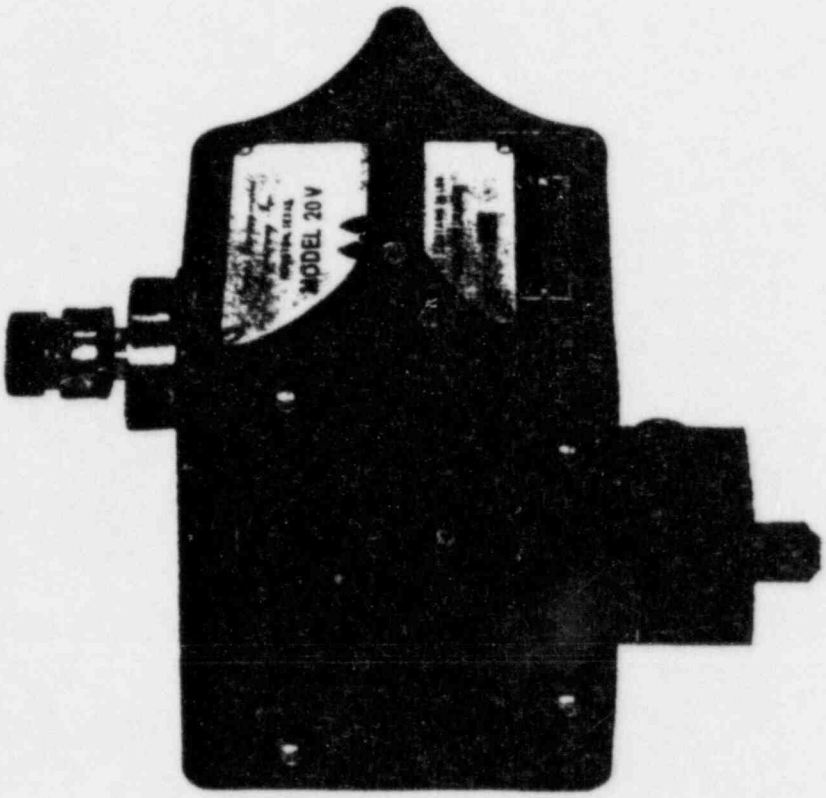
Ordering Information:

TO684-664	Portable radiographic unit for Cobalt^{60} sources up to 10 curies, complete with reel type control, source guide tubes, tripod and operating instructions.
TO684-693	Same as above except with pistol grip control.
A424-15	Source Assembly for Model 684 system.
TO741-664	Portable radiographic unit for Cobalt^{60} sources up to 30 curies, complete with reel type control, source guide tubes, tripod and operating instructions.
TO741-693	Same as above except with pistol grip control.
A424-18	Source assembly for Model 741 system.
TO680-664	Portable radiographic unit for Cobalt^{60} sources up to 100 curies, complete with reel type control, source guide tubes, tripod and operating instructions.
TO680-693	Same as above except with pistol grip control.
A424-14	Source assembly for Model 680 system.
TO676-664	Portable radiographic unit for Cobalt^{60} sources up to 250 curies, complete with reel type control, source guide tubes, tripod and operating instructions.
TO676-693	Same as above except with pistol grip control.
A424-13	Source assembly for Model 676 system.

U.K. Sales office
Tech/Ops Ltd., Radiation Products Division, Unit 1, Whitworth Road, Armstrong Industrial Estate, Washington, Tyne & Wear, NE 37 1PP, ENGLAND

THE 20 V CAMERA

(FOR GAMMA RADIOGRAPHY)



PROGRESS is a simple word to describe engineering advancement in the field of gamma radiography. The Model 20V represents major progress in the design and durability of cameras for gamma radiography.

This light weight uranium shielded camera features a rectangular shape permitting multiple operating positions, stainless steel sleeves to decrease the wear on the zircalloy S tube and a solid aluminum balanced handle bar. This unit has been designed to accept existing pigtail type sources and will adapt to some existing equipment.

The camera has endured an extensive field testing program to insure the advanced design of the 20V against standard defects and to make sure that it will stand up against the problems encountered in normal operations. The 20V operates smoother and with less wear than comparable competitive equipment.

Designed for 100 curies of Iridium-192 the camera has profiled showing less radiation than competitive cameras.

For more information on progress, safety and economy see the reverse side of this sheet.

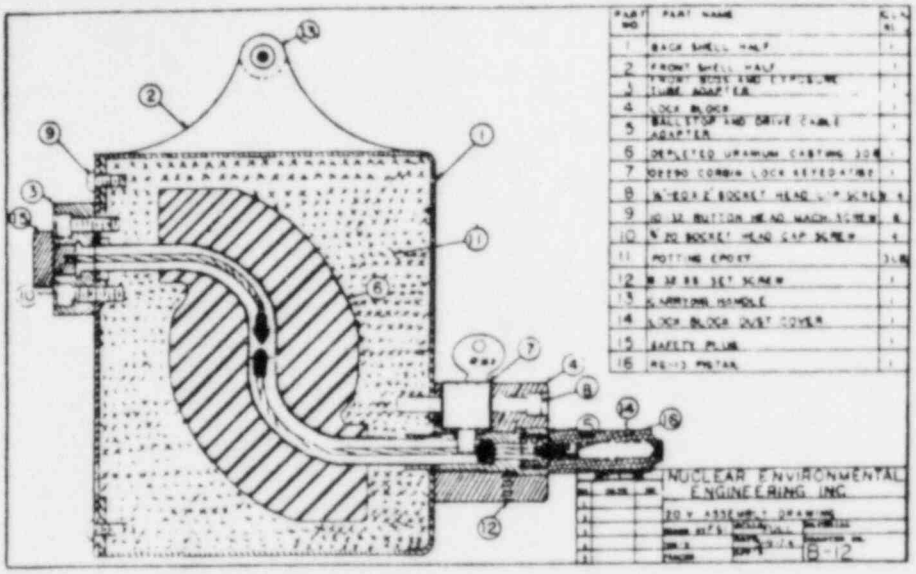
OPERATING PROCEDURES MANUAL

GULF NUCLEAR, INC.

P. O. BOX 58866 HOUSTON, TEXAS 77058

PHONE (713) 332-3581

SPECIFICATION SHEET
MODEL 20V CRANKOUT TYPE CAMERA



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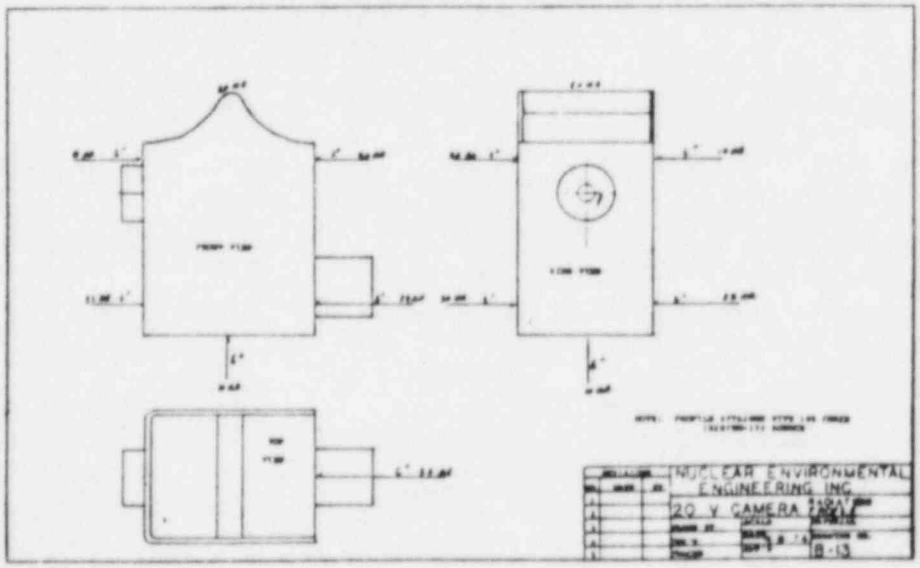
Weight: 37 lbs. **Size:** 9⅜" High x 6" Deep x 4¾" Wide **Color:** Black
Case: Machined Aluminum
Pigtail: NEEI MODEL RG-13
Normal Supply: With 25 ft. Crank Assembly and 15 ft. plastic source tube

RADIATION PROFILES



Sources are field changeable.

A license is required for possession of this camera.

Specify NEEI Model 20V Camera, Model RG-13 Source and a Model RC-6C or Model U-110 Source Changers for licensing purposes.

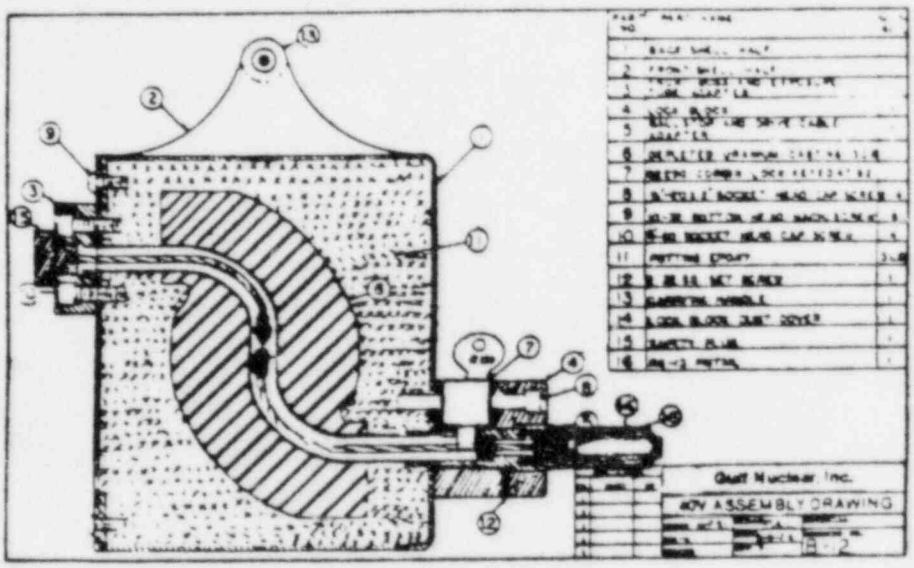
For more information phone or write:

GULF NUCLEAR, INC.

P. O. BOX 58866 HOUSTON, TEXAS 77058

PHONE (713) 332-3581

SPECIFICATION SHEET
MODEL 40V CRANKOUT TYPE CAMERA



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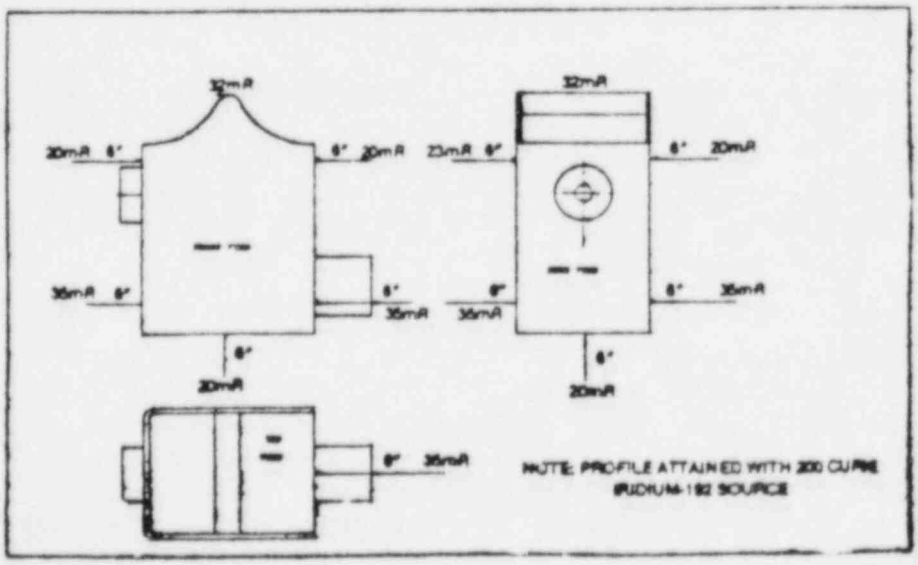
Weight: 39 lbs. **Size:** 9 3/8" High x 6" Deep x 4 3/4" Wide **Color:** Black
Case: Machined Aluminum
Pigtail: NEEI Model RG-13
Normal Supply: With 50 ft. Crank Assembly and 14 ft. brass source tube

RADIATION PROFILES



Sources are field changeable.

A license is required for possession of this camera.

Specify GNI Model 40V Camera, Model RG-13 Source and 1 Model U-110 Source Changer for licensing purposes.

For more information phone or write:

GULF NUCLEAR, INC.

P. O. Box 58868 HOUSTON, TEXAS 77058

PHONE (713) 222-1581

GULF NUCLEAR, INC.

MODEL 20V EXPOSURE DEVICE

GENERAL DESCRIPTION

The Gulf Nuclear, Inc. Model 20V camera is a crank out type exposure device used for making radiographs. The device is designed for Iridium-192 sources containing a maximum of 120 curies. The 20V is operated manually by turning a crank which drives the Iridium-192 source out of the shielded position into an exposure tube which has been positioned over the specimen to be radiographed. After a predetermined time the source is retracted to the shielded position with the crank and drive cable.

PHYSICAL DESCRIPTION

20V CAMERA (SHIELD)-The 20V camera is rectangular in shape with overall dimensions of 6" x 4-3/4" x 9-3/8". The shield is thirty (30) pounds of depleted uranium which is formed around a metal "S" tube. The outer housing is 1/8" aluminum and all void spaces between the shield and outer housing is filled with epoxy. Both the drive cable connector and the exposure tube connector are stainless steel.

CRANK ASSEMBLY-This assembly consists of a stainless steel gear box, an aluminum drive gear, an aluminum pistol grip and crank handle. The drive cable and conduits are manufactured by Teleflex. The conduits are twenty-five feet long.

EXPOSURE TUBE-The exposure tube is plastic with brass fittings and is twenty-two feet long.

RADIOACTIVE SOURCE ASSEMBLY-The radioactive source is the most vital component in the system. The 20V requires the Gulf Nuclear, Inc. Model RG-13 source. The source material is contained in a stainless steel capsule firmly attached to one end of a leader cable (pigtail). The source can easily be changed in the field with the Gulf Nuclear, Inc. Model U-110 exchangers.

SAFETY PRECAUTIONS

Operation and safety precautions must be in accordance with the regulations set forth by the regulatory agency under which the radioactive material is licensed.

PERSONNEL MONITORING-These requirements are set forth by the regulatory agency and must be strictly adhered to.

WORKING DISTANCE-Every precaution should be taken to insure that adequate distance exists between the exposed source and areas accessible to personnel. Surrounding areas should be surveyed and if readings are in excess of 2 mRem/hour, the areas should be restricted and posted. Personnel operating the 20V should always work at the maximum possible distance from the source. (The exposure rate varies inversely with the square of the distance from the source.) EXAMPLE-If the radiation survey meter indicates a dose rate of 200 mR/hr at a distance of 10 feet from the source, the reading at 20 feet will be approximately 50 mR/hr.

$$I = \frac{I_{\bullet} \times D_1^2}{D_2^2}$$

$$= \frac{200 \times (10)^2}{(20)^2}$$

$$= \frac{200 \times 100}{400}$$

$$= 50 \text{ mRem/hour}$$

SHIELDING-If possible, the exposed source should be positioned behind shielding materials such as concrete walls, steel beams, etc. This will greatly reduce the accumulated dose to operating personnel.

OPERATION

1. Remove safety plug from exposure tube side of camera and attach exposure tube. Position end of exposure tube at radiographic focal point.

2. Avoid sharp bends (bend radius of less than 20 inches) in the exposure tube. Sharp bends will restrict movement of control cable.

3. Remove dust cover from lock block and connect drive cable to source pigtail. Connect drive cable conduit to camera.

4. Unlock the 20V. Lock will snap up when unlocked.

5. The source is ready to be cranked out of the camera into the exposure tube.

   NOTE: Make sure that all personnel have cleared the exposure area and that the radiation survey instrument is ON and is operating.

6. Turn crank handle clockwise to drive the source from the camera into the exposure tube.

7. Specimen exposure should be calculated from the time that the source reaches the end of the exposure tube.

8. After the desired exposure time, turn handle counterclockwise rapidly to return source to the camera. Monitor area immediately with the radiation survey meter.

9. If meter shows that the source has been safely stored, depress lock to lock source in position.

10. Disconnect drive cable conduit and disconnect drive cable from source pigtail. Install dust cover.

11. Disconnect exposure tube and install safety plug.

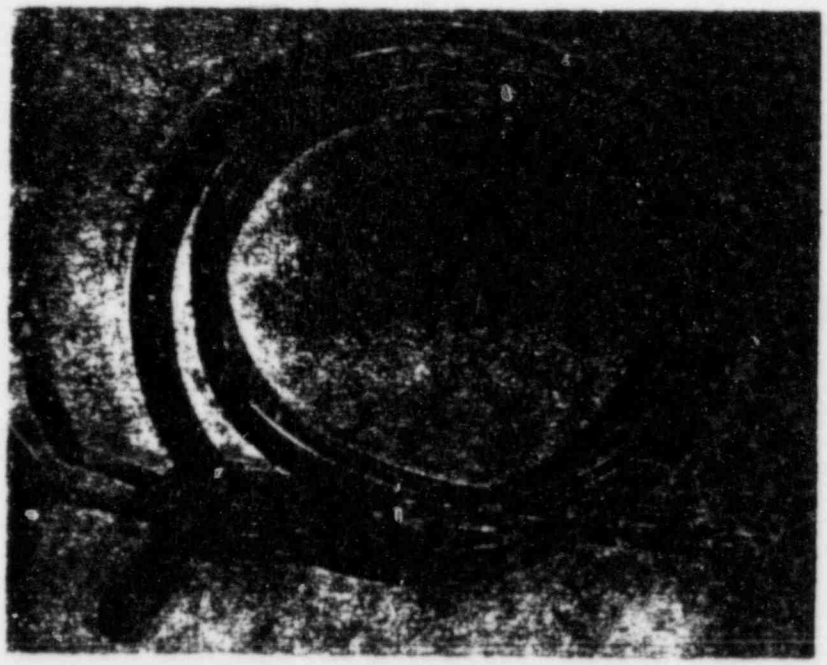
12. The camera is now ready to be moved to next location.

MAINTENANCE

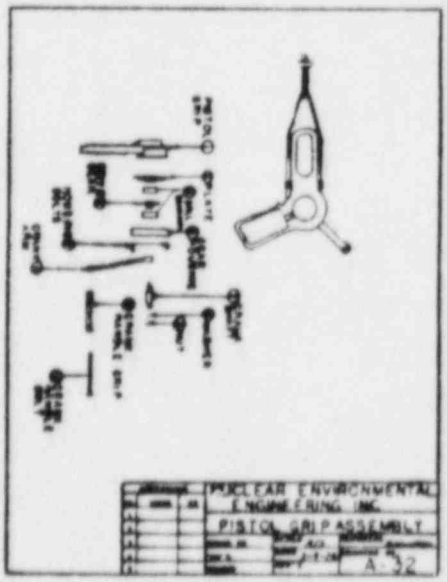
The 20V should be returned to Gulf Nuclear, Inc., 202 Medical Center Boulevard, Webster, Texas for all maintenance and repairs.

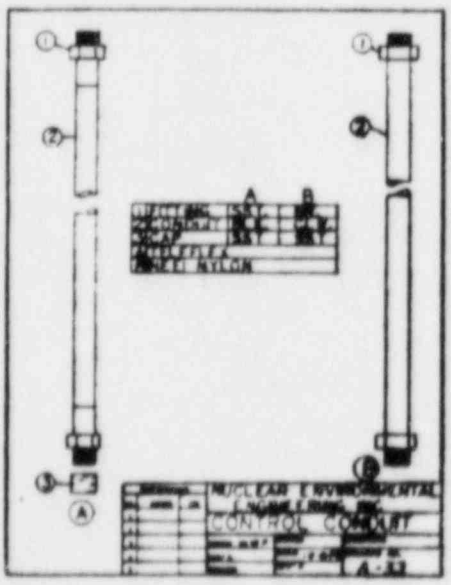
MODEL A-33-32

CONTROL CRANK ASSEMBLY



The Model A-33-32 Control Conduit Assembly features the Model A-32 pistol grip assembly with stainless steel gearbox and roller bearing crank. This assembly is the most modern long lasting assembly to be introduced into the industry. We also permit the option of nylon conduit versus stainless steel. The nylon does not have the steel support in the conduit.





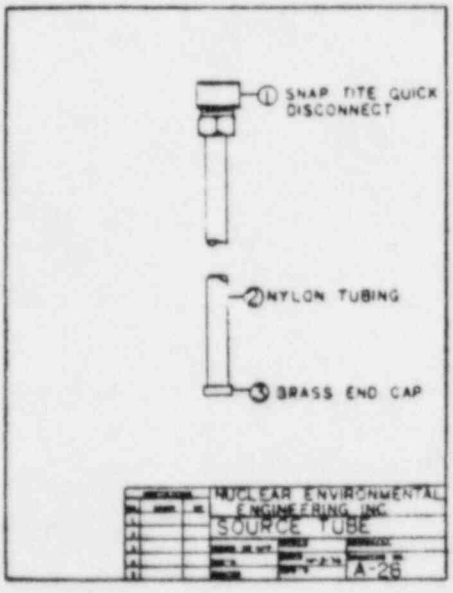
For more information phone or write

GULF NUCLEAR, INC.

P. O. BOX 58866 HOUSTON, TEXAS 77058

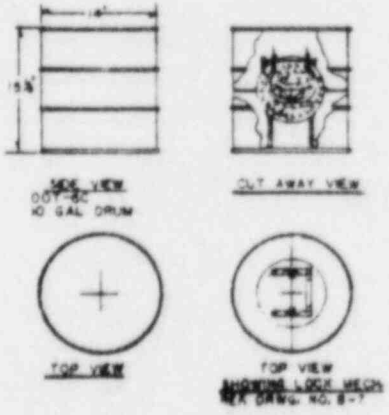
PHONE (713) 332-3581

MODEL A-28
SOURCE TUBE



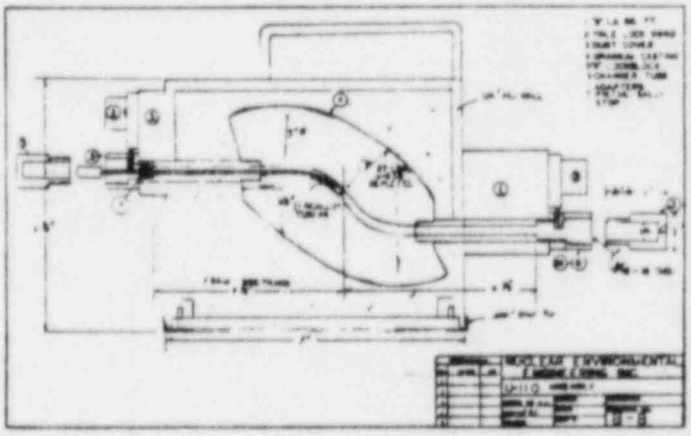
This nylon source tube is a replacement for the old brass laced type which is no longer available. The standard length is 23 feet. The fittings are brass.

RC-6C Shipping Container



A durable DOT Regulation container weighing up to 125 pounds. This unit is completely safe for radiography source shipments.

U-110 Shipping Container



This unit is lightweight, under 50 pounds, including the DOT Regulation drum required to ship the unit. Like the 6C this unit is completely safe.

All NEEI shipping containers have been approved by the licensing authority. The units are shipped with a source and connecting changer tube for adapting to your camera.

For more information phone or write

GULF NUCLEAR, INC.

P. O. BOX 58866 HOUSTON, TEXAS 77058

PHONE (713) 332-3581