ATTACHMENT # 6.C

OPERATIONS MANUAL

FOR

GAMMA INDUSTRIES'

POST OFFICE BOX 2543

BATON ROUGE, LOUISIANA 70821

CALIBRATION UNIT

MODEL 1

By

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TABLE 1

FIGURES

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General . . . .

The Gamma calibration unit, model 1, was specifically designed to be used as a calibration source for radiographic survey meters.

The device provides six distinct exposure rate levels (mr/hr), in such a combination that two of the exposure rates will fall on the mid and upper portion of each decade of the meter.

The main advantage is that the source to the center line of detector distance is fixed and that the exposure rate is varied by changing the amount of attenuating material in the beam.

The fixed geometery configeration reduces the overall space required for a calibration unit.

One important feature from the point of radiation safety is that the scattered radiation falling on the operator is about 1% of the [illegible] beam.

Physical description . . . .

The calibration unit consist of a 9.5 inch, lead filled, solid right circular cylinder in which is housed the source and the beam attenuator wheel containing the various filters.

The attenuator wheel rotates about an axil on sealed ball bearings. As the attenuator wheel is rotated each 60 degrees the exposure rate level is changed and the wheel is held in the desired position by a spring loaded plunger. The source capsule is a modified Gamma "Pipeliner" type. (PTL-#1

The outer shield is so oriented on the stand that the naturally unbalanced attenuator wheel will always return to the safe position. The device has been calibrated in each of it's six exposure positions and the exposure rate (mr/hr) is displayed on the top of the attenuator wheel on aluminum tags. When this tag faces the operator the device is timed to deliver the exposure rate level shown on the tag.

Operating and Safety Procedures . . . .

1. Position calibration unit so that the exposure port (front) is at least 55.5 inches from any scattering objects (walls, beams) and so that the side of the unit (non-operating side) is at least 24 inches from scatters. (See Fig. 1)

2. Construct stand for survey meter. The stand should be made of 1/4 inch wood or 1/16 inch aluminum or steel plate. This type of stand will minimize scatter and will result in more accurate calibrations. (See Fig. 2 for requirements for stand)

3. The stand containing the radiographic survey meter should then be located 18.5 inches from the front surface of the calibration unit so that the center line of the detector will coinside with 18.5 inches distance normal to center line of primary beam.

4. Radiographic survey meters with CM tubes used as radiation detectors should be calibrated from the front face (See Fig. 2). Often the center line of the GM tube is located within the case and parallel to the front of the case. The instrument calibration should then be checked from the side or short center

line of the tube for directional response of the instrument.

5. Meters, such as the Victoreen, model 592B, should be calibrated on the long center line of its ionization chamber (See Fig. 2) and then checked from the front (See Fig. 2) for directional response.

6. Care should be taken to calibrate the instrument with the detector in its case. Naturally most instruments must be removed from the outer case so that the calibration potentiometers may be adjusted. If the instrument is calibrated without the outer case, without applying proper correction, this may produce inaccurate readings when the case is replaced.

7. After the proper physical set up is achieved (See Fig. 1) the locking mechanism can be unlocked and the attenuating wheel rotated (toward the operator) to achieve the proper set of intensity rates for calibration of the particular meter of interest. (See Table 1)

8. The calibration intensity available at each position on the attenuating wheel can be read from the aluminum tags attached to the wheel.

CAUTION: The primary beam is 11 inches in diameter at the survey meter calibration position and diverges thereafter. The operator should take care not to enter the primary beam. If adjustment to the survey meter requires more than a few seconds the attenuator should be returned to the safe position (#1) to avoid long high intensity exposures.

9. The unit is so positioned on its stand that the attenuator wheel will return to the safe position should the locking pin be removed.

10. Correction for decay of the cobalt-60 (0.525 ci) source should be made monthly. A graph is provided showing the decrease in intensity verses time for each of the exposure rate positions.

11. Care should be taken to see that the attenuator wheel is in the safe position and the locking plunger is in the wheel when the calibration procedure is completed.

12. If the unit is to be moved the plunger must be locked and surveyed to insure the source is safely within the shield.

Parameters for Calibration Design Techniques for X and Gamma Ray Survey meters . . . .

The following is a collection of "rules of thumb" as found in references sited in the manual:

To accurately calibrate a survey meter, a source, whose activity (in Curies) or whose intensity at some distance (r/hr at 1 meter) has been carefully determined should be used. Some sources currently used are Co-60 and Cs-137. These isotopes have relatively long half lives thus giving a constant intensity output over long periods of time and do not require intensity corrections, but at monthly intervals. The isotopes have well known intensity outputs (r/hr per Curie at some distance) and also known energies, Cs-137 (0.66 mev) and Co-60 (1.25 mev average).

The two most widely used calibration methods are the "open air" and the "collimated beam" method.

The first or "open air" method probably yields the greatest accuracy, but suffers strongly from two difficulties. One, the source and detector must be far removed from any scatterers to avoid allowing scattered radiation to the detector and thus producing high readings.

If this method is to be used the source to detector distance can be no greater then the distance between a scattering point and either the source or detector.

An example would be if the source to ground distance is 5 feet then the source to detector distance can be no greater than 5 foot without realizing results that are erroneous.

If this condition as sited in the above example were used then about 10% scatter contribution would result in the detection readings.

The second difficiently is more serious from a radiation safety view point in that sources of sufficient activity to be used for such a purpose have far too large an activity to be used in the open air condition without elaborate and costly automatic equipment necessary to protect the person calibrating the instrument.

The second type of physical calibration arrangement is composed of a source enclosed in a shield of sufficient thickness to reduce intensity to levels in which personnel can safely operate.

This device then has a collimator or "beam" port built into the shield housing when the port is cleared or opened the source is exposed and allows a well defined or collimated beam of radiation to fall on the instrument to be calibrated. The calibration shield assembly should meet the following cretia:

1. Length of the collimator tube or cone section should equal 4.75 to 6.75 inches.
2. The end of the collimator diameter should equal 1.25 inches.
3. The distance from the center of the source to the end of the collimator should equal at least 6 inches.
4. Construction of the tube should be of 1/32"- 3/64" brass tube or cone section surrounded by lead (if a dye is necessary).
5. The thickness of lead or other high density shielding material must be sufficient to reduce the intensity by a factor of at least 100 in all directions outside the collimated beam. This factor maybe much larger depending on source strength.
6. The system for changing or holding the source must not have any parts inside the cylinder or cornical channel of the collimator (or its

projection to a distance of 6.75 inches).
The latter physical arrangement will most likely be chosen for all practical calibration systems.

If the latter is chosen the method for vary beam intensity must be decided upon.

The two methods available for vary of intensity are variation of the distance by use of the inverse square law and placing filtration in the collimated beam. If the variable distance method is chosen then three distinct problems arrise:

1. As the distance is increased, the beam diverges and will be so large as to allow the operator to be in the primary radiation beam.
2. The source to detector distance must be accurately known and reproduced in likewise manner.
3. A source to detector distance increases then the scattering from walls, ceilings, and structures members becomes a large percentage of the primary beam.

If the varible filter technique is used then two considerations must be given careful attention:

1. The thickness of the individual filters must

must be calculated or determined accurately.

2. The source to detector distance must be reproduced accurately.

To illustrate the necessity of accurate reproduction of source to detector distance consider the following: If a 1 Curie source of Co-60 is used, then the intensity at 12 inches equals 14.4 r/hr. If the instrument is mistakenly placed at 11 inches instead of 12 inches the intensity then becomes 17.1 r/hr. This results in an error of 18.75% high. If the distance is 13 inches the intensity is 12.3 r/hr an error of 14.6% low. This example also illustrates the need for an optimum distance where the proper intensity for calibration can be obtained and where error in source to detector distance reproduction will not produce a large error in beam intensity.

Other important factors which should be considered in calibration systems are the physical sizes and shape of the source and detector. The shape and size of commercially available sources considered here are such (so small) that self absorption is negligible and need not be considered.

The reflection from the source shield to the primary beam should be considered, however, and for Co-60 on lead at small distances (less than severl yards) is about 4 to 5% of the primary beam intensity. The percentage quoted or for a relatively small beam port used here.

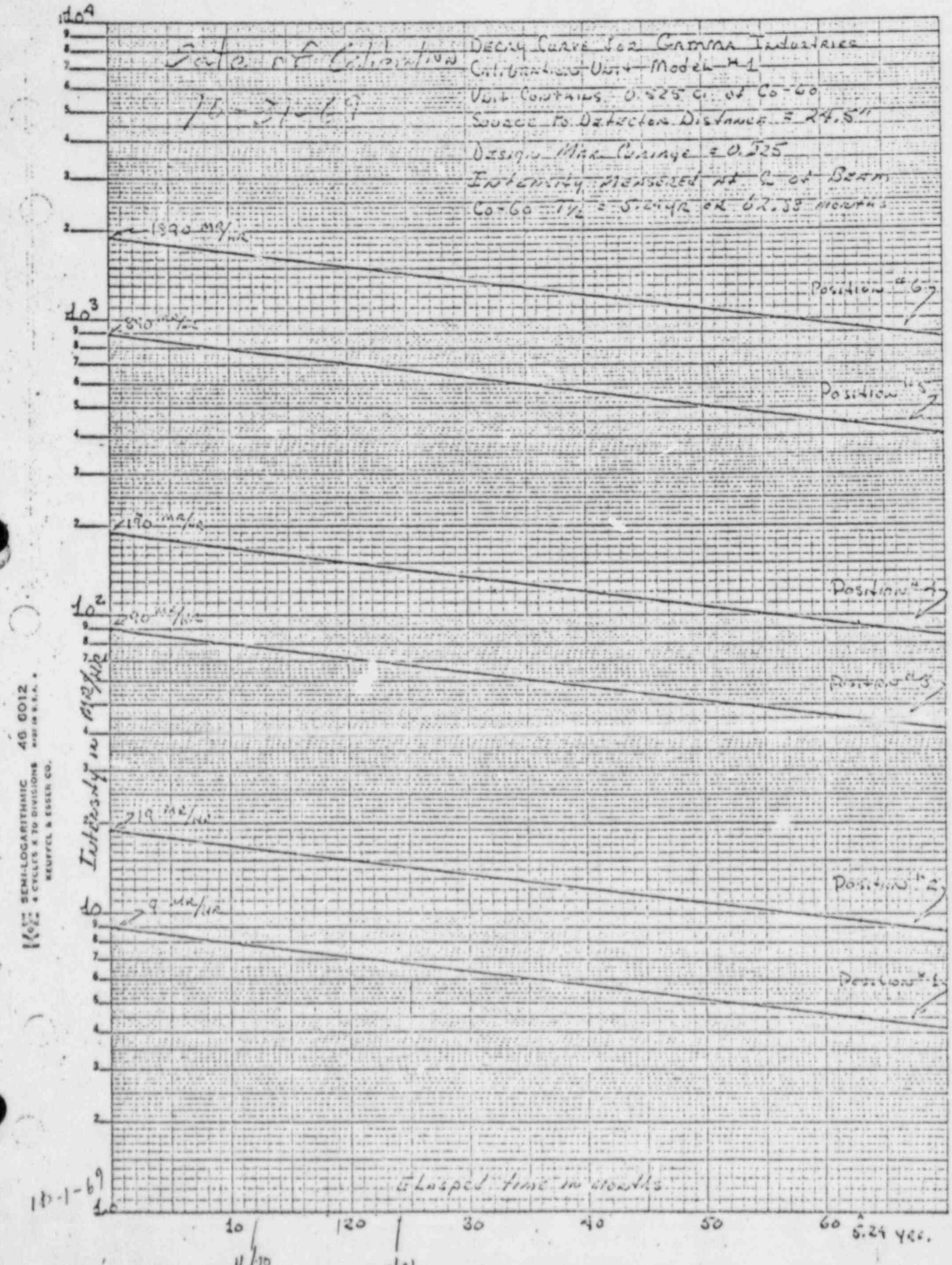
Rules governing source detector distance as a function of source or detector size are as follows: The source to detector distance should be at least 2 times the largest dimensions of either the source or the detector for an error of not greater than 10%. An example for a point source and a thimble chamber, the closest they may be placed is 3 cm (about 1 inch) where a large volume "cutie pie" must be at least 30 cm or about 1 foot. If the inverse suqare law is expected to hold, then the source to detector distance should be at least 6 to 8 times the largest dimension of either the source or the detector.

<u>NOTE</u>: The diameter of the beam at the point of calibration should be at least as large as the sensitive volume of the detector and up to 4 times as large as the sensitive volume to achieve proper effective intensity readings.

Finally, because of the definition of the Roegnten unit the source to detector distance(s) should be measured from the center line of the source to the center line of the sensitive volume of the detector used. When this most important condition is fulfilled then the instrument is calibrated to read mr/hr at the point which coinsides with the center line of the detector.

TABLE 1

Position	Exposure rate in mr/hr	Beta 200 full scale reading	Victoreen 592B full scale reading
1	9	20	10
2	19	20	100
3	90	200	100
4	190	200 & 2000	1000
5	900	2000	1000
6	1890	2000	


Date of Calibration
10-31-69
Decay Curve for Gamma Industries
Calibration Unit Model #1
Unit Contains 0.525 Ci. of Co-60
Source to Detector Distance = 24.5"
Design Max Curiage = 0.525
Intensity Measured at ℄ of Beam
Co-60 T½ = 5.24 yr or 62.88 months
1890 mR/hr
Position "6"
890 mR/hr
Position "5"
190 mR/hr
Position "4"
89 mR/hr
Position "3"
19 mR/hr
Position "2"
9 mR/hr
Position "1"
Intensity in mR/hr
Elapsed time in months
10-1-69
10
20
30
40
50
60
5.24 yrs.
11/70
11/71
K&E SEMI-LOGARITHMIC 46 6012
4 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

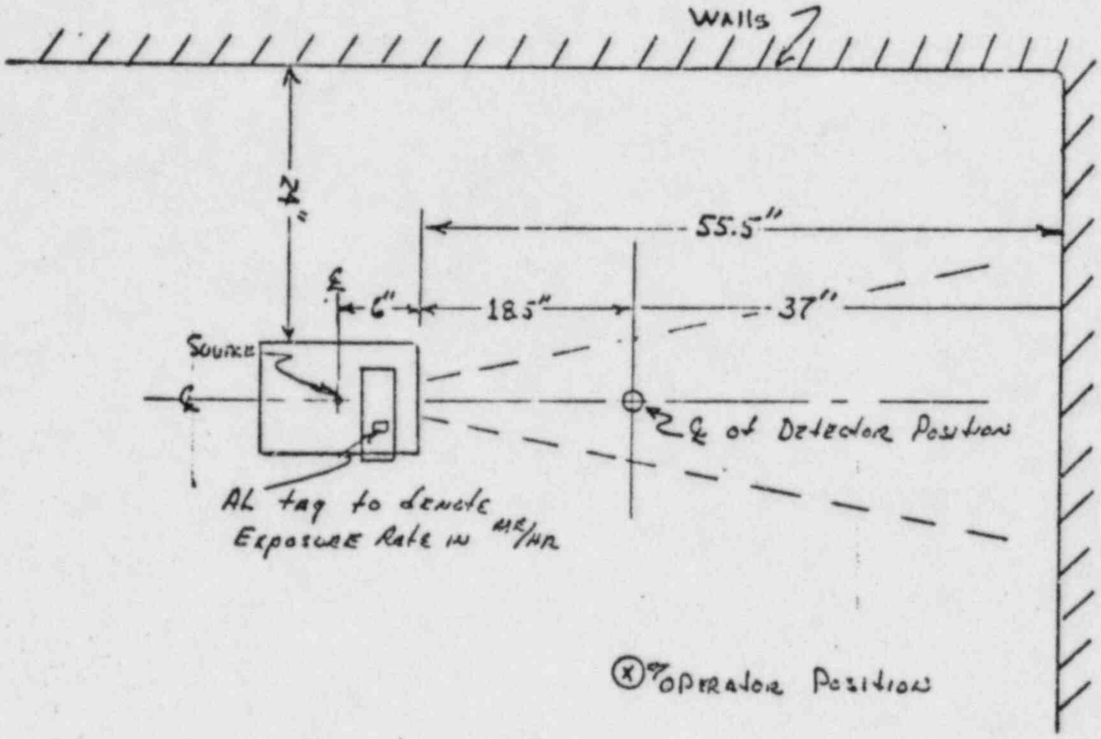


Figure #1

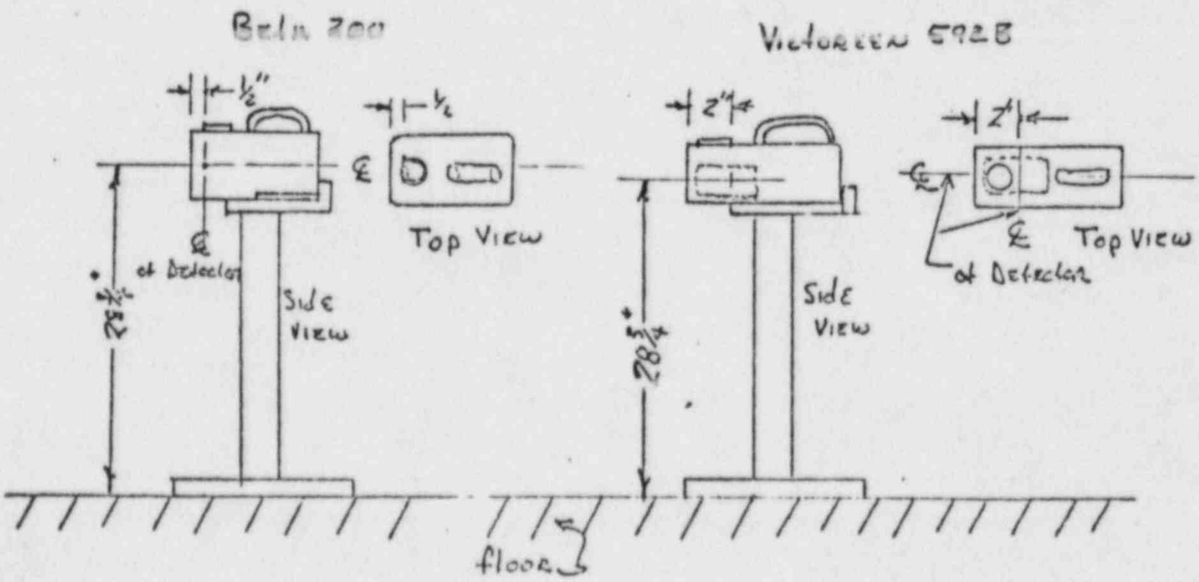


Figure 2

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Applied Doseninty, Atomizdat, 1962, Translated Seripta Technica, English, Ed. 1965, Iliffe Books Itd. Doset House, Stanford St.

Radiation Doseniectry, Hine, G.J. and Brownell, G.L., Academic Press, Inc., 1956, New York.

"Health Physics Instrument Manual" ORNL-332 (3rd ed.) TID-4500, 19th ed. Rev. Davis D.M. and Gupton, E.D., 1963.

INSTRUCTION MANUAL

VICTOREEN MODEL 492

RADIOGRAPHIC SURVEY METER

Part No. 492-1 Form: 1280C-3-76 Litho. in U.S.A.

3

INSPECTION AND MATERIAL RETURN INSTRUCTIONS

Instruments should be examined and tested as soon as received by the purchaser. Claims for damage, if any, should be filed at once with the carrier. Instruments returned to the plant for warranty service, repair, calibration, replacement or credit must be accompanied by VICTOREEN's Return Material Authorization, Form Number 9080D-12-74. Two copies of this form is located at the end of this manual.

Material valued at $200.00 or more and/or weighing more than twenty pounds should be shipped prepaid and fully insured by Express or other similar means.

We suggest that any instrument weighing over twenty pounds be wrapped in heavy kraft paper and packed in a double corrugated carton or wooden box. Protect the instrument on all sides with at least three inches of excelsior or similar padding. Mark the case plainly with suitable caution warnings to insure careful handling.

INSTRUMENT WARRANTY

VICTOREEN warrants that in the event any defects in material or workmanship should develop within one (1) year from date of shipment, the company assumes full responsibility for servicing equipment of its manufacture without charge.

The calibration of an instrument, as it leaves the VICTOREEN factory, is warranted to be within its specified accuracy limits. In the event of calibration error, VICTOREEN's liability is limited to a standard recalibration at no cost to the customer. VICTOREEN cannot be responsible for injury or damage resulting from improper use as well as faults or calibration errors which develop subsequent to our shipment of the instrument. VICTOREEN will not be liable for damages or delays caused by defects beyond making repairs or furnishing replacement parts, nor shall VICTOREEN be liable for any defective material replaced without its consent during the period of this warranty.

If VICTOREEN determines that a fault has been caused by misuse, abnormal operating conditions or repairs by unauthorized personnel during the warranty period, repairs will be billed at normal rates. VICTOREEN reserves the right to perform warranty service in its own factory or authorized repair station, or at the customer's installation.

This warranty specifically excludes the following items which are covered instead by their original manufacturer's warranty; photomultiplier, geiger and proportional tubes, crystal and other solid-state detectors, batteries, display devices, and major ancillary items of instrument systems such as, but not limited to, recorders and pumps.

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1.0 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 AEC requirements for industrial radiography.

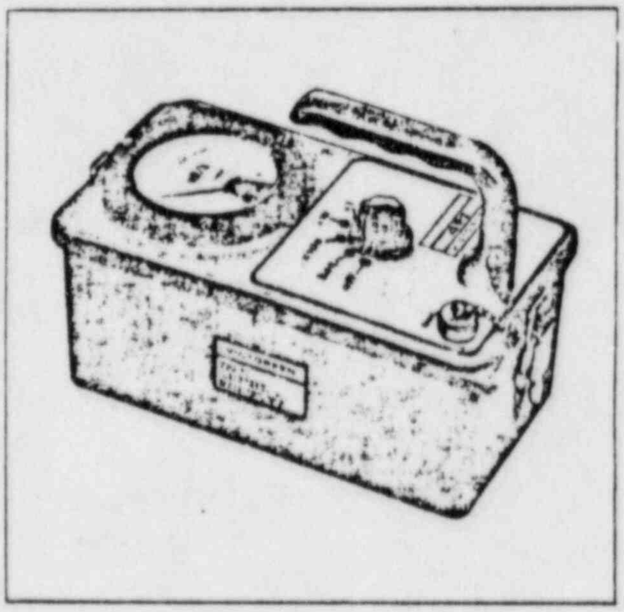


Figure 1. Model 492 Radiographic Survey Meter

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

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 GM 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 1 and 2.

TABLE 1

ELECTRICAL SPECIFICATIONS

Item	Description
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 2

MECHANICAL SPECIFICATIONS

Item	Description
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 pounds (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.

2.0 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 $32^{\circ}F$ 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 "bat." 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.

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.

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. For greatest accuracy, the radiation should be incident from 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.

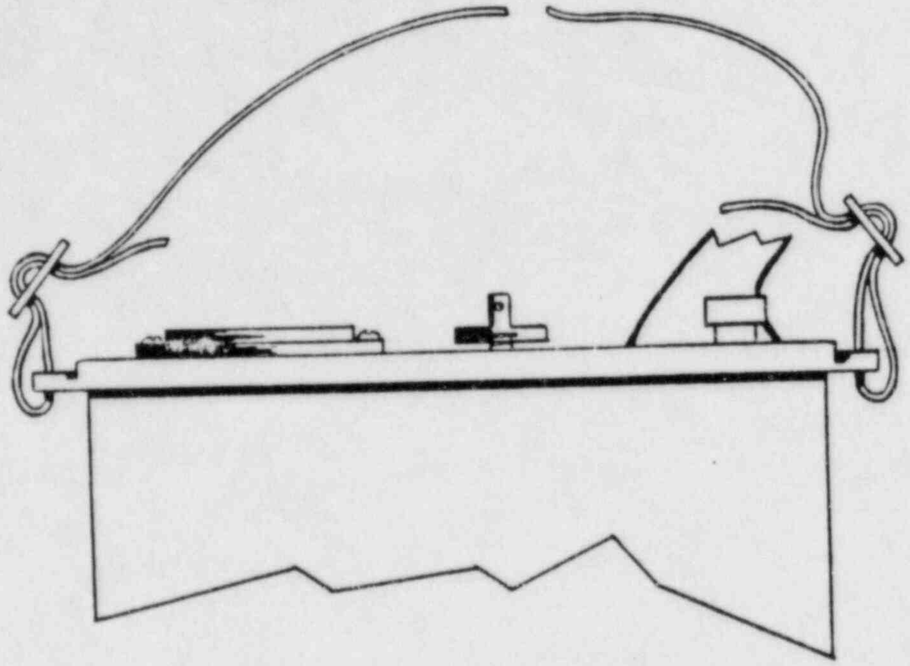


Figure 2. Attachment of Carrying Strap

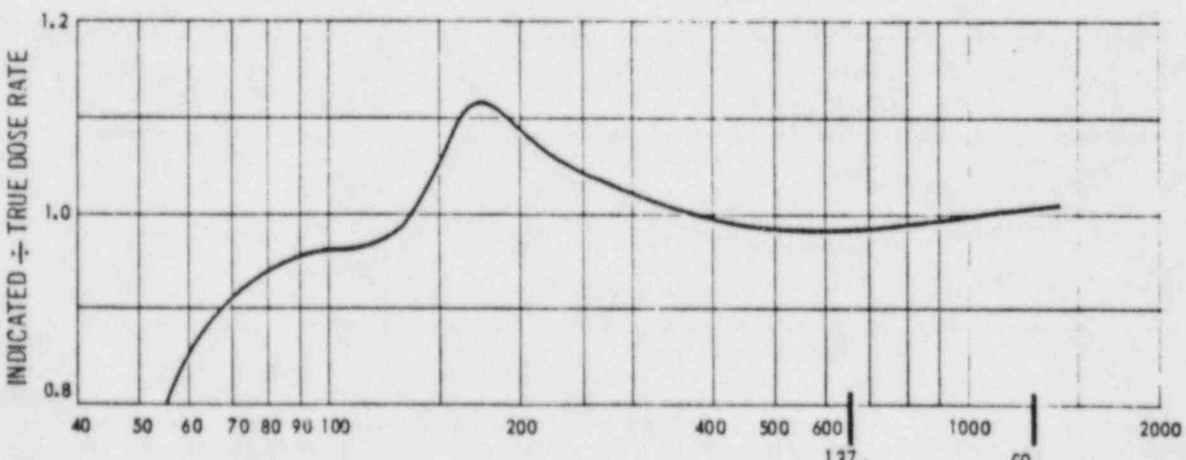


Figure 3. Energy Response

3.0 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 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 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 of 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, in turn, causes the current in 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. 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

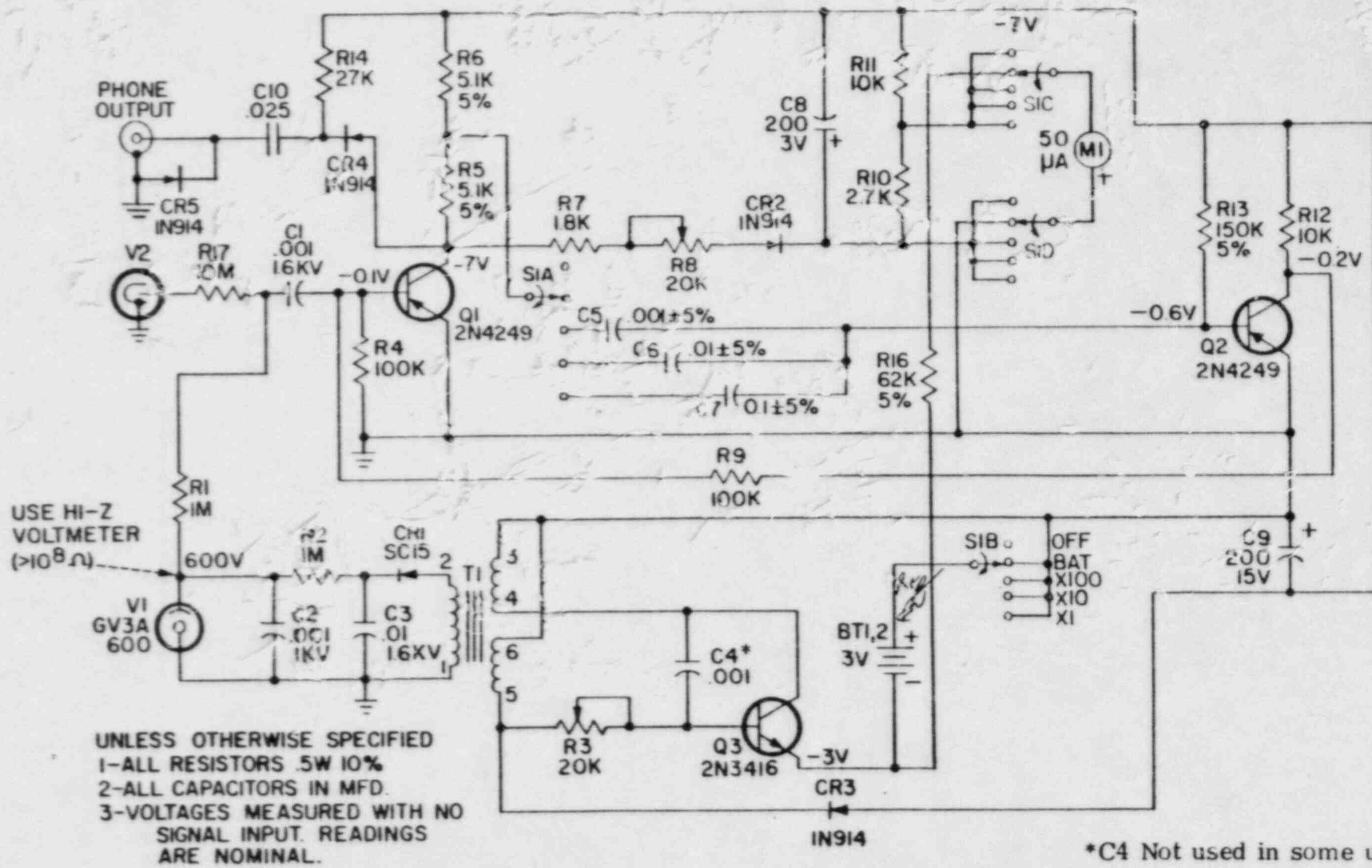
The pulse shaping circuit, consisting of transistors Q1 and Q2 and their associated components, is a monostable, or "one-shot" multivibrator. Its function is to provide a uniform current pulse output for each pulse input, regardless of the shape or magnitude of the input pulse.

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.

When a pulse appears at the base of Q1 of sufficient magnitude to forward bias it, collector current begins to flow. This drops the voltage at the junction of R5 and R6 to one-half the supply voltage. The change in voltage is coupled to the base of Q2 through the timing capacitor and appears as a positive voltage at the base. This reverse biases Q2, the collector current drops, and the collector voltage rises. The rise is coupled to the base of Q1 via R9 and causes Q1 to conduct even harder. This results in a regenerative action which causes a rapid change of state, with Q2 now turned off and Q1 in saturation.

Because the voltage across a capacitor cannot change instantaneously, and the end of the timing capacitor which was at the supply voltage is instantaneously reduced to one-half the supply voltage (as Q1 becomes saturated), the end which connects to the base of Q2 must be at a positive voltage, equal in magnitude to one-half the supply voltage. This positive voltage keeps Q2 off, which, in turn, keeps Q1 in saturation. The base does not stay positive, however, as it is tied to the negative supply voltage via R13, and thus the capacitor charges toward the supply voltage at an exponential rate determined by the values of R13, R5, R6, and the timing capacitors. When this voltage reaches a slightly negative value, Q2 begins to conduct and, through the regenerative action, the circuit returns to its normal state with Q1 cut off and Q2 saturated.

Range switching is accomplished by switching timing capacitors in decade steps. This changes the charge per pulse available to the metering circuit by factors of ten.



*C4 Not used in some units

Figure 4. Schematic Circuit Diagram

4.0 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:

a. Install a new set of batteries and check the Power Supply Adjustment according to section 4.2 before proceeding with calibration.

b. Place the instrument in a 70 to 90 mR/h radiation field. Distance should be measured from the center of the GM tube, V2.

c. 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:

a. Q1 collector: Positive 7 volt square wave.

b. Q2 base: Positive 3.5 volt pulse, rising sharply and decaying exponentially.

c. 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, 700 microseconds on the X10 range and 70 microseconds on the X100 range.

5.0 REPLACEABLE PARTS LIST

5.1 Electrical Components

Symbol Desig.	Vico Part No.	Nomenclature	Qty.
BT1, BT2	16-4	Battery: Flashlight, 1.5V, NEDA 13	2
C1	21-209	Capacitor: .001 MFD 1.6 KV	1
C2, C4	21-32	Capacitor: .001 MFD 1 KV	2
C3	21-23	Capacitor: .01 MFD 1.6 KV	1
C5	21-97	Capacitor: .001 MFD 200V 5%	1
C6	21-94	Capacitor: .01 MFD 200V 5%	1
C7	21-92	Capacitor: .1 MFD 200V 5%	1
C8	21-151	Capacitor: 200 MFD 3V	1
C9	21-34	Capacitor: 200 MFD 15V	1
C10	21-192	Capacitor: .025 MFD 50V	1
CR1	52-38	Rectifier: SC-15	1
CR2,3,4,5	52-134	Diode: 1N914	4
M1	492-7	Meter Assembly	1
Q1, Q2	23-90	Transistor: 2N4249	2
Q3	23-76	Transistor: 2N3416	1
R1, R2	185-1	Resistor: 1 meg 1/2W 10%	2
R3, R8	22-226	Potentiometer: 20K	2
R4, R9	185-255	Resistor: 100K 1/2W 10%	2
R5, R6	185-224	Resistor: 5.1K 1/2W 5%	2
R7	185-347	Resistor: 1.8K 1/2W 10%	1
R10	185-252	Resistor: 2.7K 1/2W 10%	1
R11, R12	185-253	Resistor: 10K 1/2W 10%	2
R13	185-774	Resistor: 150K 1/2W 5%	1
R16	185-751	Resistor: 62K 1/2W 5%	1
R17	185-34	Resistor: 10 meg 1/2W 10%	1
R14	185-395	Resistor: 27K 1/2W 10%	1
S1	492-27	Switch; Rotary	1
T1	14-76	Transformer	1
V1	CPO-240	Tube, Voltage Regulator: GV3A-600V	1
V2	492-17	Tube Assembly, GM	1

5.2 Mechanical Components

Vico Part No.	Nomenclature	Qty.
700-66	Battery Box	1
720-121	Battery Box Cover	1
700-68	Battery Contact	4
488-45	Carrying Strap	1
492-11	Case Bottom Assembly	1
700-162	Case Top	1
492-23	Circuit Label	1
720-157	Gasket, Case	1
700-63	Gasket, Meter	1
51-7	Grommet	1
488-62	Handle	1
492-1	Instruction Manual	1
9-48	Knob	1
492-29	Label, Case Top	1
492-15	Lead Shield, Disc	1
200-60	Name Plate	1
46-25	"O" Ring, Handle	1
492-31	Printed Circuit Board	1
710-44	Strap Buckle	2
489-23	Cap and Chain	1
46-47	"O" Ring, Phone Jack	1
46-38	"O" Ring, Switch	1
700-21	Phone Jack	1

ATTACHMENT # 6.D

Film Badges:

Film badges shall be supplied and processed by: Radiation Detection Company, Sunnyvale, California on a monthly basis.

Dosimeters:

Victoreen Model 541-A

0 - 200 MR Direct Reading

Victcreen Dosimeter Charger Model 2000A