UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322 (OL)
	)	
(Shoreham Nuclear Power Station, Unit 1)	)	
	)	

PARTIAL RESOLUTION OF SC CONTENTION 27/SOC CONTENTION 3 -- REGULATORY GUIDE 1.97

Suffolk County Contention 27/SOC Contention 3 alleges that Shoreham does not comply in 11 specified areas with the instrumentation requirements for monitoring and assessing plant and environs variables and systems during and following an accident, as set forth in Regulatory Guide 1.97, Revision 2. By prior agreement dated June 11, 1982, SC Contention 27(c)/SOC Contention 3(c) relating to iodine monitoring equipment was resolved and withdrawn by the County and SOC. Such resolution was without prejudice to the right of the County and/or SOC to submit a contention in the emergency planning proceeding to contest the adequacy of the accuracy of iodine monitoring at the Shoreham plant. Suffolk County has submitted such an emergency planning contention.

The parties have further discussed the 10 areas of concern remaining in SC Contention 27/SOC Contention 3 and have agreed to the following resolution of five of the concerns expressed in the contention:

(1) Part (b) of SC Contention 27/SOC Contention 3 involves the Regulatory Guide 1.97, Revision 2, requirement for instrumentation to monitor radioactivity concentration in the circulating primary coolant for the purpose of detecting breach of the fuel cladding.

Part (e) of SC Contention 27/SOC Contention 3 involves the Regulatory Guide 1.97, Revision 2, requirement for instrumentation to monitor, by sampling, reactor coolant system soluble boron concentration for the purpose of verifying that plant safety functions are being accomplished.

Part (f) of SC Contention 27/SOC Contention 3 involves the Regulatory Guide 1.97, Revision 2, requirement for instrumentation capable of analyzing the primary coolant gamma spectrum for the purposes of mitigating a breach of the fuel cladding and to verify and monitor the presence of fission products in the primary coolant.

Part (j) of SC Contention 27/SOC Contention 3 involves the Regulatory Guide 1.97, Revision 2, requirement for accident sampling and analysis capability onsite for the purposes of assessing, verifying and analyzing releases during and following an accident.

LILCO has provided Suffolk County and SOC with information, in addition to that contained in FSAR Section II.B.3, describing certain additional equipment which will be installed in the Shoreham post accident sampling facility (See Attachment 1), 1/ including systems for monitoring boron, chloride and dissolved oxygen concentrations in the coolant. Based upon a review of this information and additional discussions between LILCO and Stone & Webster representatives and County technical consultants concerning the capabilities of such equipment to meet the range, timing, and qualification requirements of Regulatory Guide 1.97, Revision 2, the County and SOC have determined that LILCO's installation of such equipment will resolve the concerns expressed in parts (b), (e), (f), and (j) of SC Contention 27/SOC Contention 3.

(2) Part (i) of SC Contention 27/SOC Contention 3 involves the Regulatory Guide 1.97, Revision 2, requirement for portable instrumentation to measure and analyze plant and environs radiation for the purpose of assessing and analyzing releases during and following an accident. FSAR Section 12.5.2.2.2 includes a general description of portable radiation

---

1/ In addition to the information included in Attachment 1, LILCO provided copies of all or portions of the following: Orion Model 1610 Boron/PH Detector Preliminary Instruction Manual, Model 2001 Preamp Specifications, Orion Model 1617 Chloride Detector Preliminary Instruction Manual, Model 2713 Dissolved Oxygen Measurement System and a system description of the ion chromatograph.

monitoring equipment to be used at Shoreham. LILCO has provided Suffolk County and SOC with additional information which includes a more detailed description of the portable radiation monitoring equipment which has been ordered by LILCO (See Attachment 2). Based on a review of this information and additional discussions between LILCO and Stone & Webster representatives and County technical consultants concerning the environmental qualification of the portable radiation monitoring equipment and details of the equipment's compliance with Regulatory Guide 1.97, Revision 2, requirements, Suffolk County and SOC have determined that LILCO's acquisition and deployment of such equipment will resolve the concerns expressed in part (i) of SC Contention 27/SOC Contention 3.

LILCO agrees that the equipment described above and in Attachments 1 and 2, which equipment relates to parts (b), (e), (f), (i) and (j) of SC Contention 27/SOC Contention 3, will be fully installed and operable, and personnel trained in its use by June 1, 1983.

Based upon the foregoing, Suffolk County and SOC withdraw parts (b), (e), (f), (i), and (j) of SC Contention 27/SOC Contention 3, subject to the following conditions:

(a) LILCO will provide Suffolk County and SOC with reasonable notice of any and all meetings to be held with the NRC Staff for the purpose of discussing scheduling or

implementation of compliance with Regulatory Guide 1.97, Revision 2 for those items covered by SC 27/SOC 3, and will provide Suffolk County and SOC with copies of all correspondence between LILCO and the NRC Staff concerning such matters;

(b) Suffolk County and SOC will be entitled to have representatives attend as observers any and all meetings attended by LILCO and the NRC Staff concerning the scheduling or implementation of compliance with those items of Regulatory Guide 1.97, Revision 2 covered by SC 27/SOC 3; and

(c) LILCO's obligation to provide Suffolk County and SOC notice of meetings discussing scheduling or implementation of compliance with Regulatory Guide 1.97, Revision 2 and copies of all correspondence concerning such matters shall end two years from the date of this agreement.

It is understood that the remaining parts of SC Contention 27/SOC Contention 3 (parts a, d, g, h, and k) are not resolved by this Partial Resolution.

Respectfully submitted,

LILCO (date) Aug. 26, 1982

Suffolk County (date) Aug 26, 82

NRC Staff (date) 8/27/82

SOC (date) 8/27/82

Item No.		(e) Reactor Coolant System Soluble Boron	(f) Analysis of Primary Coolant Gamma Spectrum	(j) Post Accident Sampling Capability
1	TYPE Gas Grab Sample Liquid		X	X
2	Gross Activity			X
3	Gamma Spectrum		X	X
4	Boron Content	X		X
5	Chloride Content			X
6	Total Gas			X
7	Dissolved Oxygen			X
8	PH			X

ATTACHMENT 1

Post Accident Sample System (PASS)

Instrumentation Description

Post Accident Sampling System has been implemented to comply with Reg. Guide 1.97 and NUREG-0737. A description of instrumentation is as follows:

1. Grab sample capability -- any liquid or gas that is analyzed on line by the PASS can additionally have a grab sample taken. The grab sample flask and sampling system capability is designed such that the flasks removal from the system will not cause any release of sample to the environment. The grab sample container is designed for any form of radioactive service as well as being a direct sample for Gamma spectrum analysis.

The sample flasks are manufactured by the LILCO site and can be produced in any quantity.

2. Gross Activity -- the gross activity of all samples in the PASS system is measured by a Victoreen 847A-1 monitor. There are three monitors; (a) liquid sample, (b) atmospheric sample and (c) gas evolved from liquid monitor. These monitors are 8 decade monitors (.1 mr to 10^7 mr) and reside side by side in a 4 π shield configuration.

They can be used to:

(a) determine if a representative sample is in the PASS system (reading plateaued and stabilized after recirculation time is complete);

(b) determine gross activity of the sample (direct reading);

(c) used in performing dilution operation (i.e. feed and bleed by plateauing and stabilization to a desired level and determination of fixed volume dilution effectiveness);

(d) determination of full system flush for system clean-up. Should the "observed" portion of tube become contaminated to the point where spectrum analysis is compramized a full system flush is performed and that segment of tube can be easily replaced, thus restoring full capability.

The detector and shield are presently installed in the post accident sample building.

3. Gamma Spectrum -- The device used to count the iodine samples for the station vent monitor (1D11*PNL-126) is a gamma-ray spectrometer. A gamma-ray spectrometer is a device which detects and counts gamma-rays as a function of energy. The signal chain consists of a Ge (Li) detector, a preamplifier, an amplifier, an analog to digital converter (ADC), and a memory device.

Each gamma emitting isotope emits gamma-rays with a unique set of energies (a "fingerprint"). The isotopes present in a radioactive sample may be determined by associating the energies of the observed emissions with a table of radioisotopes and their known gamma emission energies.

The number of counts in a given channel is the number of detected photons of the energy which corresponds to this particular channel. As in any other nuclear counting application, the number of counts is proportional to the quantity of activity present in the sample.

A thorough treatise on gamma spectroscopy can be found in Radiation Detection and Measurement by Glenn F. Knoll.

a) Brief Description -- The PASS gamma spectrometer is a Canberra Industries, Jupiter System consisting of the following individual components:

1 Canberra Hyperpure Germanium (HpGe)

1 Canberra Model 2001 preamplifier

1 Canberra Model 8623 PHA/LTC (Amplifier/ADC) unit

1 Canberra Series 80 MCA

1 DEC PDP-11/34 computer

1 DEC RL01 Hard Disk Drive unit

The detectors, preamplifiers, and model 8623 units comprise two parallel signal chains which feed the single Series 80 multi-user microprocessor based (Intel 8080A) multichannel analyzer. The DEC PDP-11/34 provides greater versatility of control, more sophisticated spectral analyses, and more convenient data storage and retrieval than the stand alone Series 80. The disk drives provide greater storage capacity. Detector specifications are efficiency $\geq$ 10% at 1.33 MeV, and resolution $\leq$ 1.9 KeV FWHM. Appendices 1 and 2 contain the specifications on the model 2001 Preamplifier and model 8623 PHA/LTC, respectively.

In addition to the above hardware, a software package has been purchased from Canberra Industries. This software, when run on the PDP-11/34, may be used to perform system calibrations, spectral analyses, and quality assurance measurements. The calibration and analysis programs are contained in a package called SPECTRAN-F. Correction for decay during the counting period is accounted for in the Canberra software.

ANSI N42.14-1978 established methods for calibration and usage of germanium detectors for the measurement of gamma-ray emission rates of radionuclides. It covers the energy and full-energy peak efficiency calibrations as well as the determination of gamma-ray energies in the 0.06 to 2 MeV energy region. ANSI N42.14-1978 is to be used as a general guide in procedure preparation and performance assessment. Calibrations are to be performed with NBS traceable standards.

In addition to this, the normal counting room gamma spectrometer system is available. It consists of the following equipment:

2 Canberra Ge(Li) detectors with liquid N_2 dewars

2 Canberra Model 2001 preamplifiers

2 Canberra Model 8623 PHA/LTC (amplifier/ADC) units

1 Canberra Series 80 MCA

1 DEC PDP-11/34 computer

2 DEC RL01 Hard Disk Drive Units

1 DEC RX02 Floppy Disk Dual Drive Unit

b) Ranges -- Gamma spectral analysis equipment of the type we own is very sensitive for detecting radioactivity. Due to this, samples with high activity concentrations must be diluted before being introduced to the instrument. The post-accident sample panel is used to provide a diluted sample with the dilution factor known. Using this scheme, the range in Reg. Guide 1.97, 1 μCi/gm to 10 Ci/gm, can be measured by the purchased equipment. The sample flask is introduced directly into the detector shield and counted directly.

c) Accuracy -- The documentation for the radioactivity standard used to prepare the calibration sources gives the overall uncertainty in the emission rate as typically less than 3%; however, for certain gamma-rays it is as high as 3.8%.

This standard is then diluted further and small aliquots taken to make new standards. Even considering the error inherent in preparing new standards, the estimated error in the calibration source will not exceed 4%.

The variance in NBS traceable sources is $\pm$ 5%.

The error in the reproducibility in the determination of the net full-energy peak counts is $\pm$ 3%.

The error in the reproducibility of the positioning of the source relative to the detector and source geometry is estimated at $\pm$ 3%.

In testing the installed SNPS gamma-spectrometer in the normal counting room it has been found that in the low energy

region (below 279 KeV) the efficiency changes rapidly with energy and that the accuracy of the efficiency calibration should be taken to be approximately ± 9%, while above 279 KeV the uncertainty is approximately ± 6%. The PASS equipment is expected to behave similarly.

The accuracy of the live=time determinations and pile-up corrections is ± 2%.

Calibration error	4%
	5%
Poisson distribution error (high count rates)	0.5%
Reproducibility of Peak Area	3%
Positioning of Sample	3%
Determination of Efficiency	6%
Live-Time Pile-Up uncertainty	2%

The total expected error is given by:

Expected Error = $4^2+5^2+0.5^2+3^2+3^2+6^2+2^2 = 10\%$

(d) Status -- The equipment described was ordered in the fall of 1981. It was shipped from Canberra Industries to a warehouse early this year. We released the equipment for shipment to the plant recently where it will be stored until installation is possible in the construction schedule.

4. Boron Content:

(a) Boron instrument is a Model 1610 analyzer by Orion Research,

(b) Instrument description is covered in the attached preliminary operation manual,

(c) Range 100 to 1000 ppm boron,

(d) Accuracy± 10%,

(e) Status of implementation installed at site awaiting final hookup in system.

5. Chloride Content:

(a) The chloride instrument is a 2110i Ion Chromatograph by Dionex,

(b) Instrument description is covered in the attached catalog cut,

(c) Range 0 to 20 ppm chloride,

(d) Accuracy ± 5%,

(e) Status of implementation -- chromatograph on order, scheduled to arrive on site in under 4 weeks.

6. Total Gas:

(a) Total gas analyzer was designed by Stone and Webster Engineering Corporation and constructed on site,

(b) The analyzer uses gas expansion as a means of determining total gas content. A liquid sample, under pressure, is trapped in a flask. The samples' pressure and temperature is recorded. The sample is allowed to expand into a previously evacuated flask where again the temperature and pressure is recorded. By utilizing the pressure of gas (final) the amount of total gas in the system can be correlated to the final pressure,

(c) Range 2000 cc/kg,

(d) Accuracy ± 10%,

(e) Status - installed.

7. Dissolved Oxygen:

(a) Dissolved O_2 instrument is a Model 2713 analyzer by Orbisphere labs,

(b) Description is covered in the attached catalog cut,

(c) Range 1ppb to 19.99 ppm oxygen,

(d) Accuracy 4% or ± 1 ppb thorughout the range,

(e) Status -- onsite awaiting final hookup to system.

8. PH

(a) PH instrument is an integral part of Orion 1610 Boron/PH analyzer,

(b) Instrument description is covered in preliminary operations manual,

(c) Range 1 to 13 PH,

(d) Accuracy ± 10%,

(e) Status installed at site awaiting final backup into system.

ATTACHMENT 2

Plant and Environs Radiation (Portable Instruments)

(a) Types of Instrument

FSAR Section 12.5.2.2.2., paragraphs 3 and 4 describe briefly the types of portable dose rate instruments planned for Shoreham, and the numbers of these instruments to be on site by fuel load. The combination of ion chamber and Geiger-Mueller (GM) dose rate instruments used to satisfy the FSAR will meet the Reg. Guide 1.97 requirement with the addition of a high range ion chamber style instrument.

(b) Brief Description

The ion chamber instruments to be used are the Eberline RO-2, RO-2A, RO-4A, RO-4B and RO-7. The first four instruments are of the Juno style, while the RO-7 is a Cutie-Pie type instrument with interchangeable probes which can be used at the end of a cable up to 500 feet remote from the readout unit. Brief descriptions of the instruments are contained in Appendices 1 through 3.

The GM instruments to be used are the Eberline Teletector. This consists of an instrument body with a meter or LCD readout (we have both) and a GM tube at the end of a 13 feet long telescoping pole. A description of this instrument is Appendix 4.

(c) Ranges

The ranges are as shows on the description sheets. These are:

RO-2 meter reads 0 mR/hr to 5 R/hr

RO-2A meter reads 0 mR/hr to 50 R/hr

RO-4A LCD reads 0.1 mR/hr to 200 R/hr

RO-4B LCD reads 0.1 mR/hr to 2 R/hr

RO-7 LCD reads 0.1 mR/hr to 20,000 R/hr

Teletector [LCD reads 0.1 mR/hr to 1,000 R/hr
[Meter reads 0 mR/hr to 1,000 R/hr

(d) Accuracy

These are high quality instruments which will be calibrated in accordance with station procedures on a well designed calibration device by well qualified individuals. The accuracy of the readings taken with these instruments is $\pm$ 10% of the actual value.

(e) Status

The FSAR (Section 12.5.2.2.2.) requires 24 ion chamber and 8 GM type dose rate instruments be available on-site at fuel load. We are working toward that requirement. The current status of instrument availability is as follows:

	In Service	In Stores On-Site	On Order
RO-2	4	12	6
RO-2A	1	2	4
RO-4A	6	0	0
RO-4B	1	0	0
RO-7	0	0	1
Teletector	2	1	0

Sufficient numbers of instruments will be kept available to support the need for plant and environs release assessment and analysis under accident conditions. Five RO-2 instruments are contained in offsite survey emergency kits. The exact location of this equipment is in the process of being determined as part of LILCO's emergency planning effort. All these will be changed out and calibrated with a frequency which will ensure operable instruments remain available to support accident use. This complement of instruments can be supplemented with the other in-service instru-

ments that will be stored in the Health Physics Office and the Storeroom in the Machine Shop.

Appendix 1

Description of Eberline RO-2 and RO-2A

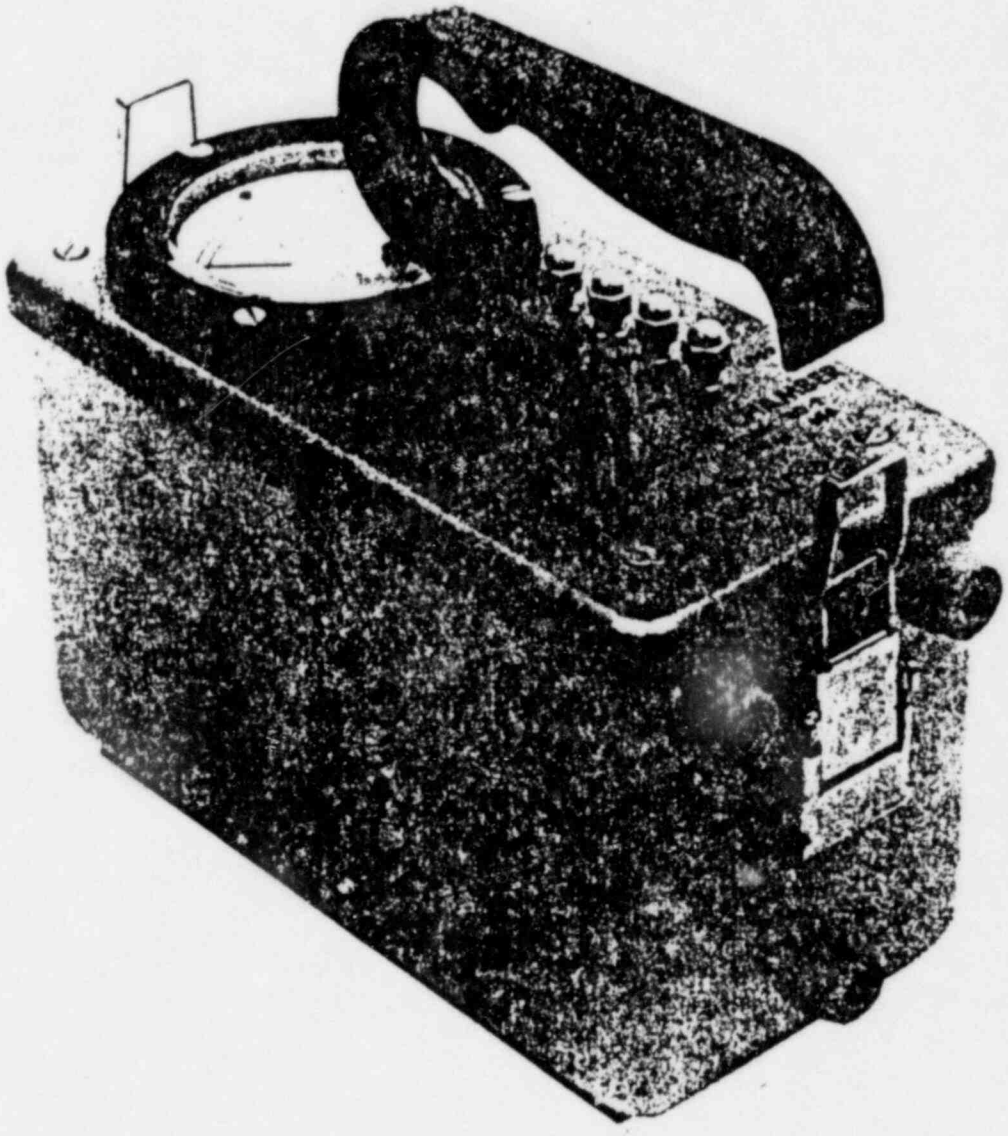


Figure 1-1. Ion Chamber, Model RO-2

SECTION I
GENERAL

A. PURPOSE AND DESCRIPTION

The Ion Chamber, Model RO-2, is a portable air ion chamber instrument used to detect beta (β), gamma (γ) and x-ray radiation. The RO-2 has four linear ranges of operation to measure dose rate for x-ray and γ radiation. The ion chamber is vented to atmospheric pressure and is specifically designed to have flat energy response into the x-ray region. The Model RO-2 is sensitive to β, γ and x-ray and is calibrated to γ radiation (^{137}Cs). A single rotary switch turns the instrument off, provides a battery check, checks the zero setting and selects the range of operation.

B. SPECIFICATIONS

1. DETECTOR

a. Size: 3-inch diameter, volume 12.7 cubic inches (7.62 cm diameter, 208 cc).

b. Fill: Air, vented to atmospheric pressure.

c. Wall: One-sixteenth inch phenolic, approximately 200 mg/cm^2 inside 0.050 inch wall aluminum case.

d. Window: Two layers 0.001 inch mylar, approximately 7 mg/cm^2 total.

e. Beta Shield: Sliding shield on bottom of case with positive friction lock. Approximately 400 mg/cm^2 (1/8 inch phenolic).

f. Radiation Detected: Beta, gamma, x-ray.

g. Photon Energy Response: Nominal ±15% from 12 keV to more than 1.3 MeV. (See Figure 1-2.)

h. Example of Beta Response

(1) Uranium Slab: 33% of true mrad/hr field behind 7 mg/cm^2 window with RO-2 resting on slab, slide open.

(2) ^{90}Sr-^{90}Y: 75% of true mrad/hr field at 40 cm with slide open, 8% with slide closed.

i. Fast Neutron Response: Reads approximately 10% in mR/hr of true neutron field in mrem/hr.

2. GENERAL

a. Ranges: Four linear ranges: 0-5, 5-50, 0-500 and 0-5000 mR/hr.

b. Meter: Ruggedized, sealed, 2.38 inch (6.04 cm) scale length, 2% accuracy. Linear markings from 0 to 5 in 25 minor increments.

c. Response Time: 5 seconds, 0 to 90% of reading.

d. Linearity: Within ±5% of full scale.

e. Battery Dependence: No calibration shift with battery voltage change (down to BATTery check mark on meter).

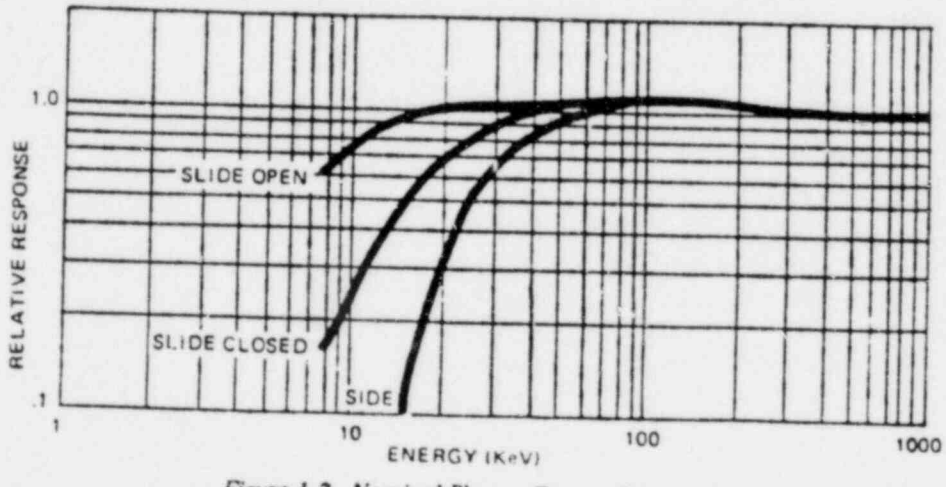


Figure 1-2. Nominal Photon Energy Response

f. Controls

(1) Range switch with OFF, ZERO and BATTery checking positions.

(2) ZERO knob used to set meter to zero when ZERO position of range switch is selected or when in no significant radiation field.

(3) Calibration controls, one for each range.

g. Batteries

(1) Type: Three NEDA 1604, 9 V type, 10 to 5.4 V per battery.

(2) Life: Two batteries approximately 200 hours CZn, 330 hours alkaline, 330 hours mercury. Third battery life indefinitely long.

h. Environment

(1) Temperature: Operable from -40°F to 140°F (-40°C to 60°C). (Operation at low temperatures may be limited by battery performance.)

(2) Moisture: Seals used at openings for dust and water resistance. Detector is protected by a silica-gel drying box.

(3) RF Sensitivity: Reading unaffected by radar fields up to 20 mW/cm^2.

i. Weight: Approximately 3.8 pounds (1.7 kg), including CZn batteries.

j. Size: 3-15/16 inches wide x 8-5/16 inches long x 7-7/16 inches high (10 x 21.1 x 18.9 cm), including handle.

Manual Insert:

RO-2A

This insert sheet and the RO-2 Technical Manual comprise the Technical Manual for the RO-2A.

The RO-2A is identical to the RO-2 except that the range of operation has been shifted higher by a factor of ten. The ranges of the RO-2A are 0-50 mR/hr, 0-5 R/hr and 0-50 R/hr.

To effect the change, R1 and R2 have been decreased to 3×10^{11} and 3×10^{9} ohms, respectively. Another battery (BT4) has been added in series with BT3 to double the RO-2 chamber voltage, and the front panel markings have been changed to correspond to the new ranges.

In the MAINTENANCE section of the RO-2 manual (page 9, paragraph A, 1), it is noted that when either BT1 or BT2 require replacement they should be replaced with BT3. The new battery should then replace BT3. In the RO-2A this same procedure should be followed, except that either BT3 or BT4 should be used to replace BT1 or BT2, and the new battery should replace the battery removed. BT4 is the battery next to BT2. Viewed from the top the battery lineup is as follows (left to right): BT2, BT4, BT3, BT1.

eberline

P. O. Box 2108, Santa Fe, New Mexico 87501 (505) 471-3232 TWX: 910-985-0678

REF NO. 1263

Appendix 2

Description of Eberline RO-4A and RO-4B

Figure 1-1. Ion Chamber, Model RO-4A

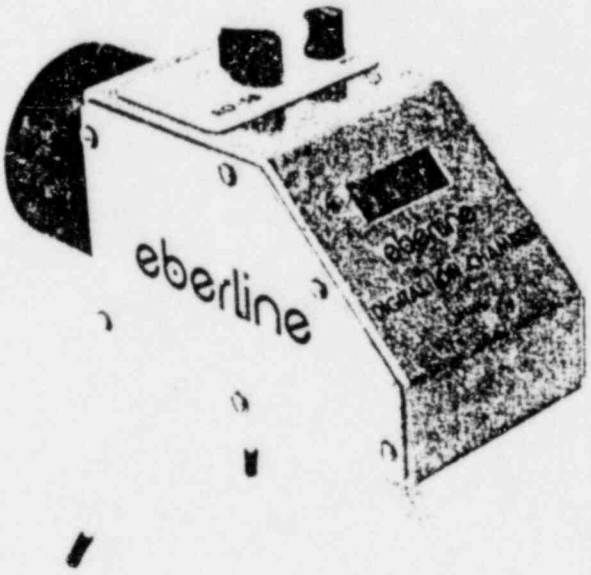


Figure 1-2. Ion Chamber, Model RO-5B

SECTION I
GENERAL

A. PURPOSE AND DESCRIPTION

Ion Chambers, Model RO-4_ and Model RO-5_, are portable ion chamber instruments used to detect beta, gamma and x-ray radiation. Both instruments feature 3-1/2 digit, liquid crystal display with switch selected back lighting for low ambient light conditions. The two instruments are very similar in operation and in electronic design, but differ in case design. The RO-4_ is a juno style case, see Figure 1-1, and the RO-5_ is a cutie pie case, see Figure 1-2. Both instruments are available in three configurations: "A" with two dose ranges; "B" and "C" with one dose rate range and one integrate range; thus an RO-4A would be a juno type instrument with two dose rate ranges. The ion chamber in the instruments is vented to atmospheric pressure and is specifically designed to have flat energy response into the x-ray region. Both instruments are sensitive to beta, gamma and x-ray and are calibrated to gamma radiation. A single rotary switch on either instrument turns the instrument off, checks the zero setting and selects the range of operation.

B. SPECIFICATIONS

1. Detector

a. Size: 3 inch diameter, volume 208cc (12.7 cubic inches)

b. Fill: Air vented to atmospheric pressure

c. Wall: One-sixteenth inch phenolic, approximately 200 mgm/cm^2. For the RO-4_ the detector is enclosed in a .050 inch wall aluminum case. For the RO-5_ the detector has a removable beta shield of approximately one-sixteenth phenolic.

d. Window: RO-4_, two layers of .001 inch mylar, approximately 7 mgm/cm^2 total; RO-5_, single layer of .001 inch mylar, approximately 3.5 mgm/cm^2 total.

e. Beta Shield: RO-4_, sliding shield on bottom of case with positive friction lock, approximately 400 mgm/cm^2 (1/8 inch phenolic); RO-5_, removable shield on front of chamber, approximately 400 mgm/cm^2 (1/8 inch phenolic).

f. Radiation Detected: Beta, gamma, x-ray

g. Fast Neutron Response: Reads approximately 10% in mR/hr of true neutron field in mRem/hr.

2. General

a. Ranges

1) Configuration "A": High dose rate range; 199.9 R/hr full scale, .01 R/hr least increment. Low dose rate range; 1999 mR/hr full scale, 0.1 mR/hr least increment.

2) Configuration "B": Dose rate range; 1999 mR/hr full scale, 0.1 mR/hr least increment. Integrate range; 1999 mR full scale, 0.1 mR least increment.

3) Configuration "C": Dose rate range; 199.9 R/hr full scale, .01 R/hr least increment. Integrate range; 1999 mR full scale, 0.1 mR least increment.

4) Each range has one decade of automatic range switching. This effectively doubles the number of switch selectable ranges.

b. Display: Liquid crystal, 3-1/2 digit display with low battery indication. Back light switch for low ambient lighting conditions.

c. Response Time: Approximately 5 seconds, 0 to 90% of reading.

d. Linearity: See Figure 1-3

e. Battery Dependence: No calibration shift with battery voltage change from full battery voltage to low battery indication on display. Batteries monitored automatically when instrument is in operation.

f. Controls - External

1) Range switch with "OFF", "ZERO" and two range postions.

2) "ZERO" knob used to set display to zero when "ZERO" position of range switch is selected or when in no significant field.

3) "LIGHT" switch to turn on display back light when instrument is used in low ambient light conditions.

g. Controls - Internal: Calibration potentiometer for each range.

h. Batteries:

1) Type: Three Neda type 1604, 9 volt batteries and two Neda type 210, 30 volt batteries.

2) Life: Depending on instrument use rate, one 9 volt battery life dependent on use of internal light for illumination of display. The other 9 volt batteries; approximately 200 hours for carbon zinc, 330 hours for alkaline and 330 hours for mercury. Indefinite life for the two 30 volt batteries. Automatic indication on display when batteries are weak.

i. Environment

1) Temperature: Operable from 32°F to 122°F (0°C to 50°C)

2) Moisture: Seals used at openings for dust and water resistance. Detector is protected by a silica-gel drying box.

j. Weight

1) RO-4_: Approximately 3.5 pounds (1.6 kg)

2) RO-5_: Approximately 3 pounds (1.4 kg)

k. Size

1) RO-4_: 3-15/16 inches wide x 8-5/16 inches long x 7-7/16 inches high (10 cm x 21.1 cm x 18.9 cm)

2) RO-5_: 4-1/4 inches wide x 9 inches long x 9-1/2 inches high (10.8 cm x 22.9 cm x 24.1 cm)

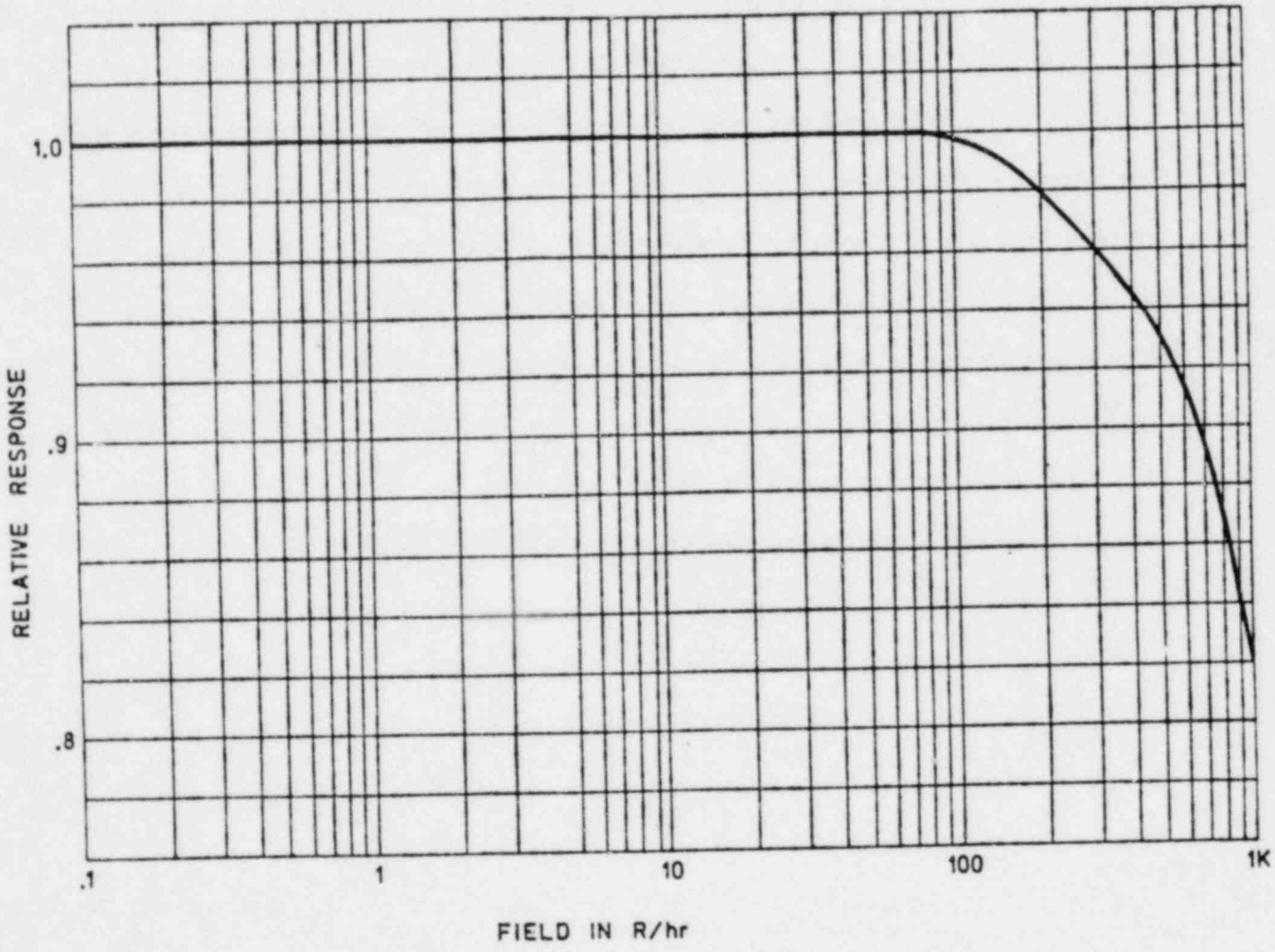


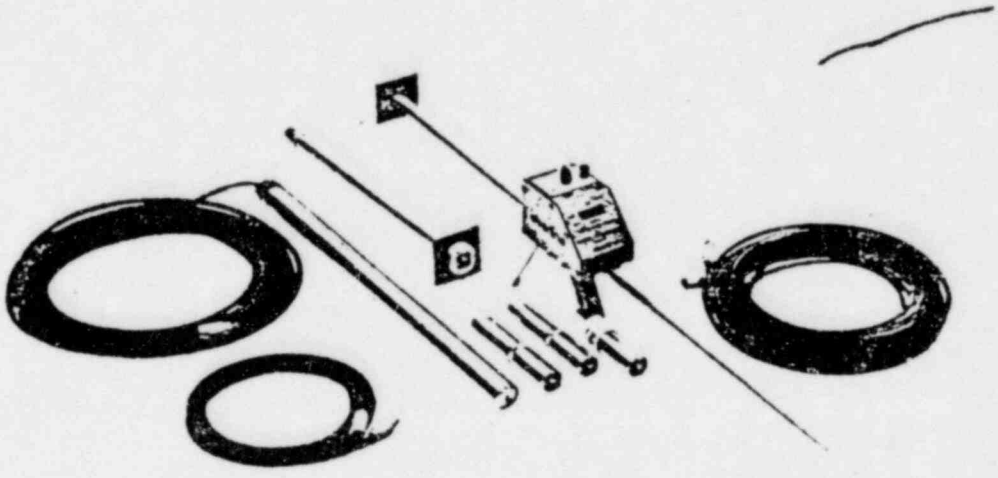
Figure 1-3. Dose Rate Response Curve

Appendix 3

Description of Eberline RO-7

Model RO-7

High Range Survey System



- HIGH RANGE
  Up to 20,000 R/h Gamma
  Up to 20,000 rad/h Beta
- DIGITAL READOUT
- AUTOMATIC DECIMAL POINT PLACEMENT
- WATERPROOF PROBE HOUSING FOR UNDERWATER SURVEYS

Eberline

A DIVISION OF Thermo Electron CORPORATION

RO-7

Model RO-7

GENERAL DESCRIPTION

The RO-7 Survey System has been designed as a multipurpose unit. Detectors are attached to the Digital Readout/Logic Unit for hand held survey applications. The detectors may also be attached via rigid extensions or flexible cables for remote surveys.

Three detectors are available to provide a wide detection range. All three detectors will operate in the RO-7-UWH (Underwater Housing) for pool or other underwater surveys to depths of up to 60 feet.

Standard remote cables are available which permit the detectors to be remoted from the Readout/Logic unit. Special cables can extend this remote capability up to 500 feet.

The Intelligent Digital Readout/Logic Unit senses the range of the detector which has been connected and indicates the proper units (R/h, kR/h) and sets the proper decimal point placement on the Liquid Crystal Display (LCD). A blinking arrow on the LCD indicates the connection of the high range detector (RO-7-BH).

The nomenclature assigned to the system components is as follows:

→ Model RO-7	Digital Readout/Logic Unit
Model RO-7-LD	Low Range Detector, 0 to 1.999 R/h, gamma
→ Model RO-7-BM	Mid Range Detector, 0 to 199.9 R/h, gamma 0 to 199.9 rad/h, beta
→ Model RO-7-BH	High Range Detector, 0 to 19.99 kR/h, gamma 0 to 19.99 krad/h, beta
Model RO-7-C15	Flexible Cable, 15 feet (4.6 meters)
Model RO-7-C60	Flexible Cable, 60 feet (18.3 meters)
Model RO-7-RX2	Rigid Extension, 2 feet (0.61 meters)
→ Model RO-7-RX5	Rigid Extension, 5 feet (1.5 meters)
→ Model RO-7-UWH	Underwater Housing with 60 foot cable (18.3 meters)

Indicated items requisitioned.

SPECIFICATIONS

RO-7 READOUT/LOGIC UNIT

Display: Liquid Crystal (LCD), 3½ digits, ½ inch (1.3 cm) high. Includes units, decimal point, minus sign, high range indication, low battery indication. Illumination provided.

LCD Up-Date Time: The reading is up-dated about three times per second.

Response Time: Approximately 2.5 seconds to 90% of final reading on all ranges.

Controls: External: On-Off Switch, Zero Control, Light Control. Internal: Calibration Control, Battery Check.

Battery Complement: Three 9V NEDA 1604, two 30V NEDA 210.

Battery Life: 30v batteries: shelf life. 9V batteries (carbon zinc): 160 hours. Use of display light will shorten battery life. Low battery indication is a colon on the LCD.

Construction: Painted aluminum case.

Size: 9.5 in. (24 cm) high, 4.25 in. (10.8 cm) wide, 9.5 in. (24 cm) long.

Weight: 2.7 pounds (1.2 kg).

Temperature: Operational from +15°F to +130°F (−10°C to +55°C). The LCD will change readings at a slower rate below +25°F.

ALL DETECTORS

Power Input: Chamber and amplifier voltages provided by the RO-7.

Temperature Range: −20°F to +160°F (−30°C to 70°C).

Temperature Compensation: Detector fully compensated over the temperature range for output accuracy within ±10%.

RO-7-LD LOW RANGE DETECTOR (GAMMA)

Range: 1.999 R/h at full scale. Resolution is 0.001 R/h (1 mR/h).

Ion Chamber: Aluminum housing, plastic lined, vented to atmosphere. Aluminum housing thickness, nominally 0.060 inch (1.5 mm). Phenolic liner thickness nominally ⅛ inch (3.2 mm). Chamber dimensions, 1 inch diameter x 4 inches long (2.5 cm x 10 cm). Chamber sensitive volume: 50 cm^3.

Detector Dimensions: 1½ inch diameter (3.8 cm). 7.8 inch body length, (19.8 cm). Overall length, 8.2 inches (20.8 cm).

Weight: 0.58 pounds (0.26 kg).

RO-7-BM MID RANGE DETECTOR (BETA/GAMMA)

Range: 199.9 R/h at full scale. Resolution is 0.1 R/h (100 mR/h).

Ion Chamber: Aluminum housing, plastic lined, thin entry window, vented to atmosphere. Aluminum housing thickness nominally 0.060 inch (1.5 mm). Phenolic liner thickness nominally ⅛ inch (3.2 mm). Chamber dimensions, 1 inch diameter x 0.6 inches long (2.5 cm x 1.5 cm). Entry window, one inch (2.5 cm) diameter x 0.002 inch (0.05 mm) thick mylar. (Approximately 7 mg/cm^2). Chamber sensitive volume: 7 cm^3.

Beta Response: When the detector is calibrated with ^{137}Cs, the difference in the readings with the beta shield off and on is multiplied by 1.1 to convert the observed readings to rad/h beta. This beta factor is based upon calibration to a ^{90}Sr-^{90}Y source. The beta factor ranged from 1.0 at 11cm from the source, to 1.2 at 50cm from the source. The beta factor ranges from 1.0 to 2.0 for most beta emitters.

Beta Shield: Friction held plastic cap, approximately 1000 mg/cm^2 over beta window.

Dimensions: Basic detector, 1½ inches (3.8 cm) diameter x 4.2 inches (10.7 cm) body length, 4.6 inches (11.7 cm) overall length. The beta shield is 1.6 inches (4.1 cm) long, 1⅞ inches (4.8 cm) maximum diameter and adds 0.4 inch (1 cm) to the overall length.

Weight: 0.48 pounds (0.22 kg) with shield. Without shield, 0.39 pounds (0.18 kg).

RO-7-BH HIGH RANGE DETECTOR (BETA/GAMMA)

Range: 19.99 kR/h at full scale. Resolution is 10 R/h.

Other specifications same as for RO-7-BM.

RO-7-UWH UNDER WATER HOUSING

Maximum Depth: Sixty feet (18.3 meters).

Materials: Stainless steel. Joint sealed with two O-rings and cable sealed with two rubber glands.

Wall Thickness: 1/16 inch (1.6 mm) in ion chamber region.

Dimensions: 1¾ inches diameter x 30 inches (4.5 cm x 76 cm).

Weight (excluding cable): 6.13 pounds (2.8 kg).

Cable: Length, 60 feet (18.3 m). Weight, 6 pounds (2.7 kg).

CABLES

RO-7-C15: 15 feet (4.6 m), 1½ pounds (0.7 kg).

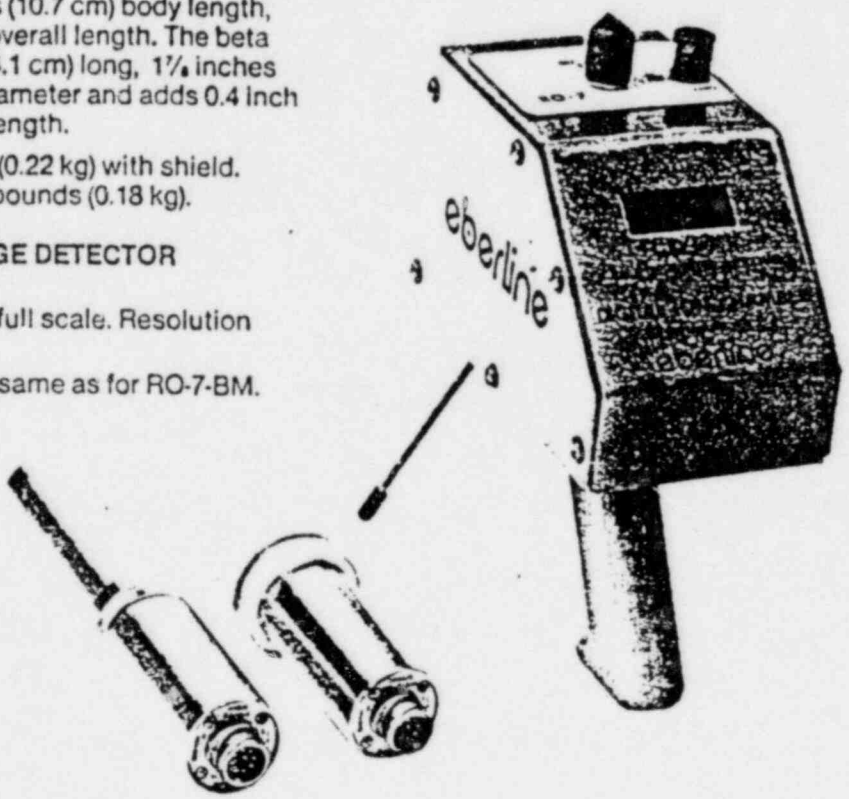
RO-7-C60: 60 feet (18.3 m), 6 pounds (2.7 kg).

RIGID EXTENSIONS (ALUMINUM)

Tube O.D., 1 inch (2.5 cm). Mounting flange, 3.5 inches (8.9 cm) square.

RO-7-RX2: 2 feet (61 cm), 0.82 pounds (0.37 kg).

RO-7-RX5: 5 feet (1.5 m), 1.4 pounds (0.64 kg).

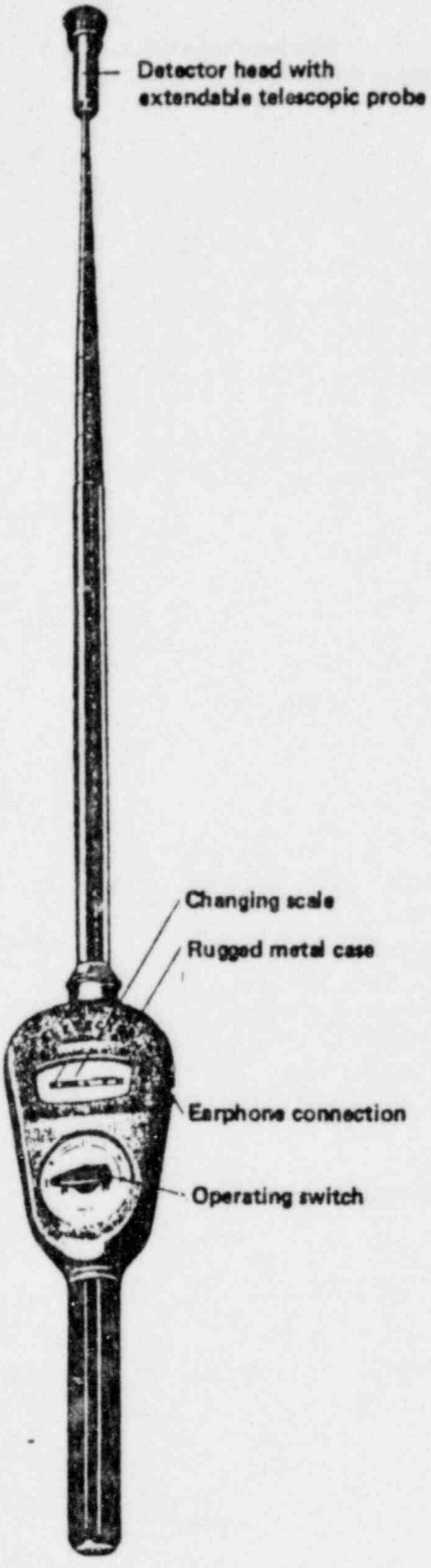


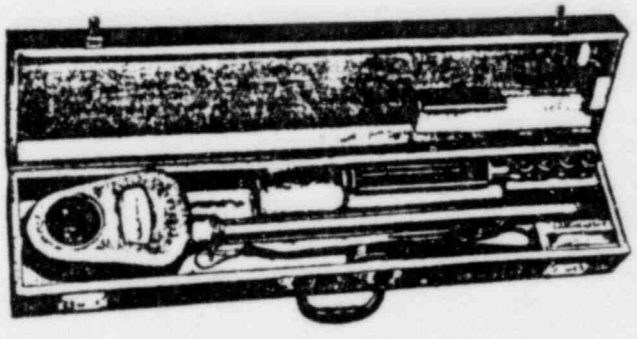
Appendix 4

Description of Eberline Teletector

Portable Gamma Dose Rate Meter with Telescoping Probe

The Teletector Model 6112





WIDE RANGE OF 0.1 mR/hr TO 1000 R/hr ON 5 SCALES
TELESCOPING PROBE EXTENDS OVER 13 FEET (4 m)
EXCELLENT ENERGY RESPONSE
NON-SATURATING TO AT LEAST 3 X 10^4 R/hr
ILLUMINATED, SCALE-CHANGING METER FACE
PROBE WILL OPERATE UNDER WATER
OPERATES OVER A WIDE TEMPERATURE RANGE
USES STANDARD C BATTERIES

eberline

Portable Gamma Dose Rate Meter with Telescoping Probe, The Teletector Model 6112

GENERAL DESCRIPTION

The TELETECTOR Model 6112 is a lightweight portable, battery-operated, gamma dose rate instrument with the additional capability of detecting beta radiation. Its wide range, telescoping probe, rugged and waterproof construction, and scale-changing characteristics make the 6112 an extremely versatile tool for radiation monitoring.

The TELETECTOR is complete with earphone, batteries, storage and carrying case, shoulder strap, manual, two probe sheaths and is calibrated with ^{137}Cs. One year warranty is included except for batteries and GM tubes.

SPECIFICATIONS

DETECTORS: Amperex 18529 and18504 GM tubes or equal.

RANGES, FULL SCALE: 2 mR/hr; 50 mR/hr; 2 R/hr; 50 R/hr; 1000 R/hr.

BETA DETECTION: Beta window (30 mg/cm^2) included on first three ranges.

TEMPERATURE RANGE: 0°F to 120°F (-18°C to 49°C).

AUDIO SIGNAL: Earphone Connection.

BATTERIES: Four 1.5 volt C cells (Eveready-935, Military BA-42, Mallory Mn-1400 or equivalent).

BATTERY LIFE: 20 -60 hours depending on batteries used.

SCALE-CHANGING: Coupled to operating switch. Proper scale appears as range is selected.

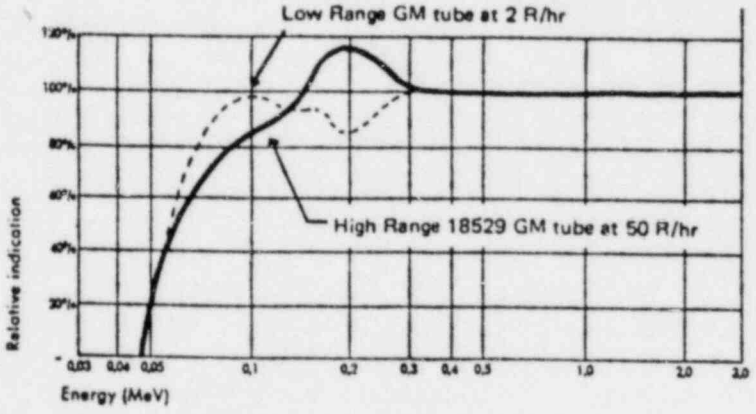
SCALE ILLUMINATION: Automatic when instrument is turned on.

TELESCOPING PROBE: Stainless steel; 20 in. (51 cm) long retracted; 160 in. (4 m) long fully extended; O. D. of detector head 7/8 in. (2.2 cm).

OVERALL DIMENSIONS: Length 36 in. (91 cm) (probe retracted) 15 ft. 1 in. (4.6 m) (probe extended), Width 5-1/4 in. (13.3 cm), Height 3-1/4 in. (8.3 cm), Weight 7 lbs. (3.18 Kg). Shipping weight 17 lbs. (7.7 Kg) including carrying case and accessories.

APPLICATIONS

Monitoring irradiated fuel storage and transport – even under water.
Monitoring the removal of irradiated samples from reactors.
Reducing the exposure to personnel when locating and evaluating radioactive sources of unknown strength.
Assessing fire or other physical damage to sources and source storage areas.
A generally useful and versatile tool to have on hand for routine and emergency radiation incidents.



TELETECTOR Energy Dependence

Teletector is a product of Automation uno Messtechnik GmbH, sold, serviced and warranted exclusively in the U. S. by Eberline Instrument Corporation.

eberline P.O. Box 2108, Santa Fe, New Mexico 87501 (505) 471-3232 TWX: 910-985-0678

June 1, 1977