

RADIOLOGICAL HEALTH MANUAL
FOR THE EXPERIMENTAL GAS-COOLED
REACTOR

RADIATION PROTECTION
STANDARDS AND REGULATIONS

Contract TV-21280A
Interagency Agreement AT-(40-1)2742

Experimental Gas-Cooled Reactor Operated By
The Tennessee Valley Authority at Oak Ridge

This document is
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Date: *08/13/2007*



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REGULATIONS (Continued)

- b. A known history of nonoccupational radiation exposure (diagnostic, therapeutic, etc.) significantly exceeding the maximum permissible limits for occupational exposure.
 - c. Other physical limitations specified by the Director of Health, TVA. (See Divisional Instruction VIII, "Health Services - Radiation Workers," Division of Health and Safety, TVA.)
2. Exposures at EGCR are kept as far below the maximum permissible dose limits as is feasible. The average limit of 100 mrem per week (total body exposure) is used as an operational limit, and any planned exposures in excess of this limit must be in accordance with the provisions of Table III-7.2, Section III-7.
 3. A Radiation Work Permit (see Section III-7), properly approved, is obtained prior to any assignment involving a single planned individual exposure greater than 20 mrem.
 4. Before subjecting employees to a planned exposure, the supervisor obtains adequate Radiological Health consultation to evaluate dose rates and establish work limitations, time controls, and radiation protection procedures.
 5. All potential exposure areas are zoned in accordance with the procedures described in Section III-2.



STANDARDS (Continued)

b. Plant Surfaces

TABLE II-2.2

Maximum Contamination Limits

On Nonzoned Surfaces

<u>Type of Radiation</u>	<u>Direct Reading Surface Contamination</u>	<u>Transferable Surface Contamination</u>
Alpha	300 dpm/100 sq cm	30 dpm/100 sq cm
Beta-Gamma	0.25 mrad/hr	1000 dpm/100 sq cm

NOTE: When the contamination involves an extensive area (larger than a single room or a major portion of a building) and consists of extremely hazardous nuclides, such as Pu²³⁹ or other long-lived alpha emitters of comparable toxicity, it may become necessary to reduce the listed maximum values for alpha contamination given in the above table. When decontamination efforts involved in cleaning a large area or room are considered to be economically unfeasible, the values given above for fixed and transferable alpha contamination may be increased by a factor of 10, provided the contaminated surface is sealed by an approved bonding material such as Amercoat. Surveillance of the area must be maintained as long as the contamination remains in excess of the levels given in Table II-2.2. Any subsequent work which might result in damage to the coating must have Radiological Health surveillance.

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c. Clothing and Shoes

TABLE II-2.3

Maximum Contamination Limits

On Clothing And Shoes

<u>Item</u>	<u>Direct Survey</u>		<u>Transferable (Smear)</u>	
	<u>Alpha</u> <u>(dpm/100 sq cm)</u>	<u>Beta-Gamma</u> <u>(mrad/hr)</u>	<u>Alpha</u> <u>(dpm/100 sq cm)</u>	<u>Beta-Gamma</u> <u>(dpm/100 sq cm)</u>
<u>Contamination Zone</u>				
<u>Shoes</u>				
Inside	150	1.0	30	1000
Outside	300	2.5	30	1000
Clothing	150	0.75*	Not applicable	
<u>Personal</u>				
<u>Shoes</u>				
Inside	150	0.3	30	200
Outside	300	0.6	30	200
Clothing	150	0.25	Not applicable	

*The average reading shall not exceed 0.75 mrad/hr in any 644-sq cm (100-sq in.) area.

NOTE: Whenever personal clothing or shoes become contaminated to levels in excess of values in this table and decontamination is not feasible or possible, the contaminated item is confiscated. (See EGCR Standard Practices Manual.)

AUTHORIZATION (Continued)

TABLE III-2.1

Requirements For Entry Into A Radiation Zone^a

1	2	3	4	5	6
Dose Rate Range (rem/hr)	Direct Reading Monitoring Instruments Required	Radiological Health Surveillance Required	<u>Administrative Authority</u>		
			Employee's Supervisor ^b	Supervisor Radiological Health Section	Project Manager
0.003 - 5 ^c	X	X			
5 - 20	X	X	X		
20 - 50	X	X	X	X	
Over 50	X	X	X	X	X

- a. For limitations on work in radiation zones, see Section III-7.
- b. Trainees, personnel on loan to the plant, and visitors must have approval of the appropriate technical or operating staff supervisor sponsoring their EGCR activities.
- c. In the exposure range 0.003 - 5 rems/hr, the requirements specified in columns 2 and 3 may be modified if the anticipated exposure time is such as to result in an accumulated daily whole body dose of less than 20 mrems. (See Section III-7.)

REGULATIONS

1. Radiation zones are established by the Radiological Health Section wherever an employee may encounter significant external dose rates. Dose rates given in Table III-2.2 are used as criteria for establishing radiation zones.

TABLE III-2.2

Criteria For Establishing
Radiation Zones

<u>Dose Rate Range</u>	<u>Immediate Action</u>	<u>Followup Action</u>
3 mrems/hr to 6 mrems/hr	Post warning tags.	Periodic review.
6 mrems/hr to 1 rem/hr	Post warning signs or tags. Rope off if weekly accumulation may equal or exceed 1 rem.	Periodic review.
1 rem/hr to 3 rems/hr	Post warning signs or tags. Rope off.	Erect a barricade which provides absolute exclusion of unauthorized personnel if the weekly accumulated dose in the area may equal or exceed 12 rems.
Over 3 rems/hr	Post warning signs or tags. Erect temporary barricade. Lock or block all entrances.	

REGULATIONS (Continued)

2. Contamination zones are established by the Radiological Health Section wherever personnel, equipment, or the environs may become significantly contaminated with radioactive materials. Table III-2.3 is used as a guide in the establishment of contamination zones.

TABLE III-2.3

Criteria For Establishing
Contamination Zones

<u>Type of Radiation</u>	<u>Airborne Contamination</u> <u>($\mu\text{c}/\text{cc}$ air)</u>	<u>Surface Contamination</u>	
		<u>Direct Reading</u>	<u>Transferable</u> <u>(dpm/100 sq cm)</u>
Alpha	7×10^{-11}	300 dpm/100 sq cm	30
Beta-Gamma	3×10^{-10}	0.25 mrad/hr	1000

NOTE: Nonzoned areas conform to these limits, are decontaminated to these limits, or--in the case of alpha surface contamination where decontamination to these limits is not economically feasible--may have the contamination permanently fixed to the surface by an approved bonding material, provided the contamination before bonding does not exceed 10 times the values listed for alpha in Table III-2.3.

3. Regulated zones may be established in work areas surrounding, adjacent to, within, passing through, or connecting contamination zones. Regulated zones are accessible to all authorized plant personnel with restrictions only on contamination zone personnel and equipment as defined in No. 4.

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4. Entrance into and exit from contamination zones are made only through specified portals. Personnel and equipment are permitted to pass from a contamination zone into a regulated zone only when approved monitoring techniques indicate no transferable contamination.
5. Signs at contamination zone portals provide up-to-date information on requirements and conditions relative to entry, work limitations, and exit.
6. If, in the absence of Radiological Health surveillance, operating supervisors find it necessary to enter a radiation zone where Radiological Health surveillance is required, the Office of the Supervisor, Radiological Health Section, is notified of the action taken.
7. Contamination zone clothing and equipment are not used outside a contamination zone or a regulated zone except when in a contamination zone vehicle.
8. Regulated zone vehicles in transit between contamination zones shall follow prescribed routes.
9. No lunchroom is permitted within a contamination zone or regulated zone. Eating, smoking, and drinking are prohibited in contamination zones.
10. Open cuts, puncture wounds, skin rashes, and infections must be adequately protected prior to entering a contamination zone. (See Section VI-2.)
11. The method of cleanup or decontamination prior to leaving a contamination zone or regulated zone is prescribed by the Radiological Health Section.
12. Trainees, personnel on loan to EGCR, and visitors are subject to these regulations.

WARNING SIGNS, TAGS, AND LABELS

POLICY

The presence of radiation or radioactive materials is denoted by standard warning signs, tags, and labels.

DISCUSSION

The standard radiation symbol (Figure III-3.1) adopted March 1, 1960, by the American Standards Association signifies the presence of radiation or radioactive materials.

R = Radius of central disc

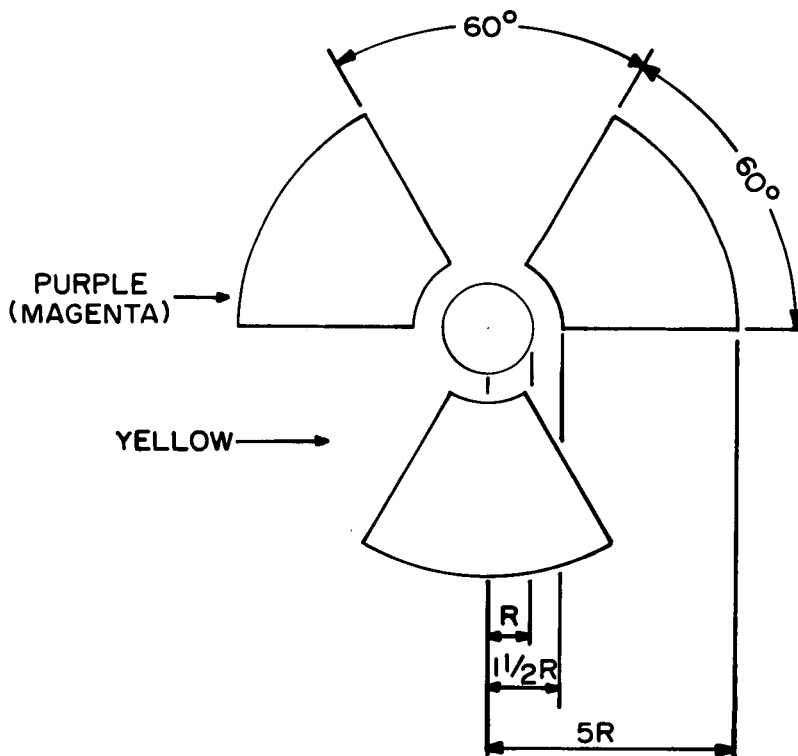


Figure III-3.1
Standard Radiation Symbol

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RESPONSIBILITIES

1. Radiological Health Section

- a. Establishes the need for and the application of radiation and contamination signs, tags, and other identification.
- b. Ensures that all hazardous areas are zoned, that such areas are conspicuously identified by standard signs, tags, or labels, and that these are up to date and are removed when no longer applicable.
- c. Designs new signs and tags as required for specific cases not covered by existent forms.

2. Operations Group

- a. Installs permanent signs and tags when requested by the Radiological Health Section.
- b. Notifies the Radiological Health Section when it becomes necessary to alter or to remove a permanent sign, tag, or label.

REGULATIONS

1. Signs, tags, and labels bearing the standard radiation symbol in magenta on a yellow background are used to denote the actual or potential presence of radiation or radioactive materials. They shall not be used for any other purposes.
2. All hazards from ionizing radiation (including confined contamination) which are zoned for the purpose of radiation and contamination control are clearly identified by approved signs, tags, and labels.
3. Warning tags and labels installed or prescribed by the Radiological Health Section are clearly recognizable from a safe distance and have the following information thereon.
 - a. Description of radiation or contamination hazards.
 - b. Dose rates at specific locations and distances.

REGULATIONS (Continued)

- c. Type and degree of contamination--surface, air, direct reading, etc.
- d. Date of survey.
- e. Special instructions and precautions.
- f. Signature of the Radiological Health Section representative.
4. Information on warning tags and labels may be changed only by authorized persons.
5. Warning signs, tags, labels, etc., are removed by Radiological Health Section when no longer applicable.
6. Other identification systems approved by the Operating Superintendent and the Radiological Health Section may be employed to supplement standard warning signs, tags, and labels.
7. Approved warning signs, tags, and labels in use at EGCR include:
 - a. Radiation Hazard Tag (Figure III-3.2)
 - b. Radioactive Contamination Tag (or Material Transfer Tag) (Figure III-3.3)
 - c. Low-Level Radiation Tag (Figure III-3.4)
 - d. Radiation Zone Sign (Figure III-3.5)
 - e. Radiation Zone Tape (Figure III-3.6)
 - f. Contamination Zone Sign (Figure III-3.7)
 - g. Contamination Zone Tape (Figure III-3.8)
 - h. Regulated Zone Sign (Figure III-3.9)
 - i. Radiation Hazard - Keep Out Sign (Figure III-3.10)
 - j. Bull's Eye Radiation Hazard Sign (Figure III-3.11)
 - k. Contamination and Radiation Clearance Tag (Figure III-3.12)

DESCRIPTION



Figure III-3.2

Radiation Hazard Tag

This tag identifies a radiation hazard where external dose rates to personnel may be > 3 mrem/hr.

DESCRIPTION (Continued)



Figure III-3.3

Radioactive Contamination Tag

(or Material Transfer Tag)

The Radioactive Contamination Tag identifies an area or object which may involve contamination of personnel or large areas, and in which one or all of the following conditions may apply.

Surface Contamination

- α (direct reading) > 300 dpm/100 sq cm
- α (transferable) > 30 dpm/100 sq cm
- β , γ (direct reading) > 0.25 mrad/hr
- β , γ (transferable) > 1000 dpm/100 sq cm

Airborne Contamination

> (MPC)_a for 40-hour week

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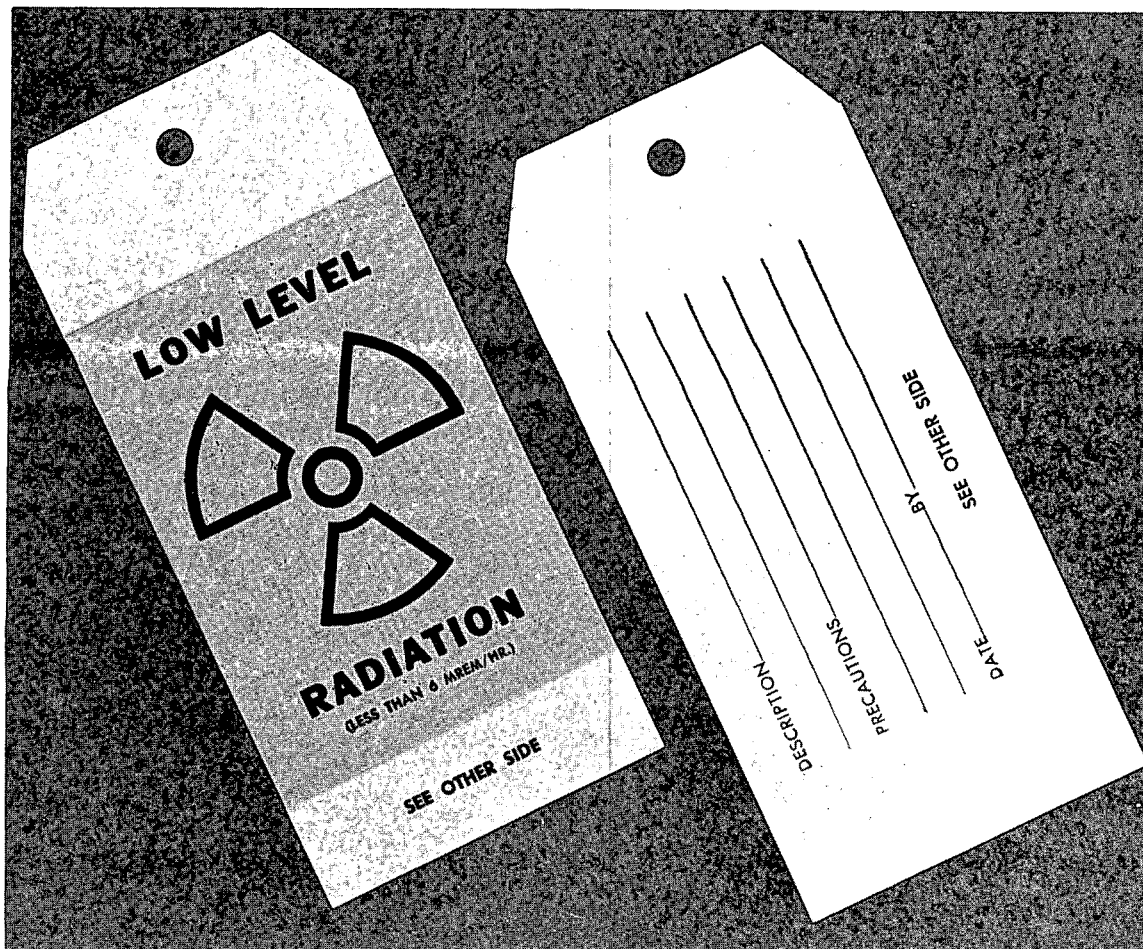


Figure III-3.4

Low-Level Radiation Tag

The Low-Level Radiation Tag identifies a radiation zone where the dose rate is less than 6 mrems/hr. (See Section III-2.)

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EGCR RADIATION DETECTION INSTRUMENTS

PORTABLE

<u>Instrument</u>	<u>Type</u>	<u>Model Number</u>
<u>Alpha</u>		
Alpha Survey Meter (PSA)	Scintillation	ORNL, Q-1975A
<u>Beta-Gamma</u>		
G-M Survey Meter	Geiger-Mueller	ORNL, Q-2092A
Cutie Pie	Air Ionization	ORNL, Q-2299
Survey Meter (High Range)	Air Ionization	ORNL, Q-2299 (Modified)
<u>Neutron</u>		
Thermal Neutron Survey Meter	BF ₃ Proportional	ORNL, Q-2004
Fast Neutron Survey Meter	Proportional Counter	ORNL, Q-2047A

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STATIONARY

<u>Instrument</u>	<u>Type</u>	<u>Model Number</u>
<u>Alpha</u>		
Alpha Scintillation Poppy	Scintillation	ORNL, Q-2091 (w/alpha probe)
<u>Beta-Gamma</u>		
Continuous Air Monitor	Moving Filter G-M Tube	ORNL, Q-2240
Local Ratemeter	Geiger-Mueller	Tracerlab, Type SU-3D
Hand and Foot Monitor	Geiger-Mueller	ORNL, Q-1939B
Building Area Monitor	Geiger-Mueller	Tracerlab, Type TA-6-10R
Liquid Waste Monitor	Scintillation	Tracerlab, Type MW-2P
Coolant Loop Monitor	Geiger-Mueller	Tracerlab, Type TA-6-100R
Spent Fuel Storage Basin Monitor		Tracerlab, Type MW-1A
Stack Gas Monitor	Particulate, Total Gas, Iodine	Tracerlab, Model MAP-1A/MGP-1A

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SURVEY METER (HIGH RANGE)

PORTABLE

DESIGN

Type of radiation detected	Beta, gamma
Range	1.0 (\pm .1) R/hr to 100 (\pm 10) R/hr
Response time	Not applicable
Warmup time	Not applicable
Detector face area	Not applicable
Detector geometry	Not applicable
Calibration standard	Ra gamma

APPLICATION

The high-range survey meter (100 R/hr type) is particularly suited for obtaining beta-gamma dose rates in inaccessible locations without undue exposure to the person performing the survey. The extended probe allows approximately 4 feet of distance between the person and the sensitive portion of the detector.

SENSITIVITY TO OTHER TYPES OF RADIATION

Slightly sensitive to neutron radiation.

LIMITATIONS

May be influenced by the presence of high frequency and magnetic fields and is affected by moisture and temperature fluctuations.

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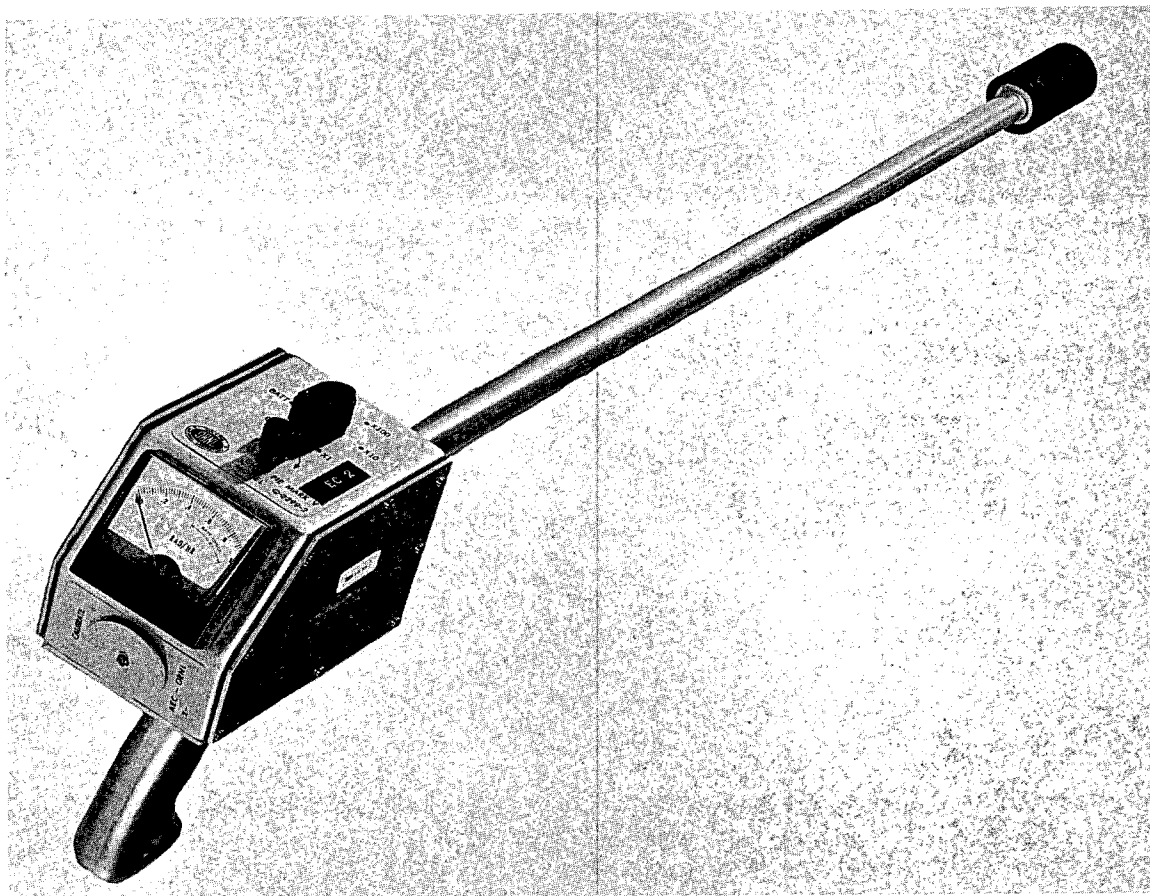


Figure A-III-1.2

Survey Meter (High Range)

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G-M SURVEY METER

PORTABLE

DESIGN

Type of radiation detected	Beta, gamma
Range	0-500,000 counts per minute
Response time	< 3 seconds
Warmup time	None
Detector face area	G-M tube--Normal sensitive area is 3 inches in length and 3/4 inch in width.
Detector geometry	Not applicable
Calibration standard	Ra gamma

APPLICATION

This instrument is intended primarily as a detection device and not as a dose-rate or dose-measuring instrument. With the shield open, it will detect beta radiation with energies above 0.2 Mev.

SENSITIVITY TO OTHER TYPES OF RADIATION

Slightly sensitive to fast and slow neutrons.

LIMITATIONS

G-M type instruments have an inherent disadvantage of "blocking" or indicating zero in high-radiation fields. Consequently, such instruments must never be used as dose-rate devices where there is the possibility of intense radiation beams or "leaks" in biological shields. Earphones should be used when monitoring low-contamination levels.

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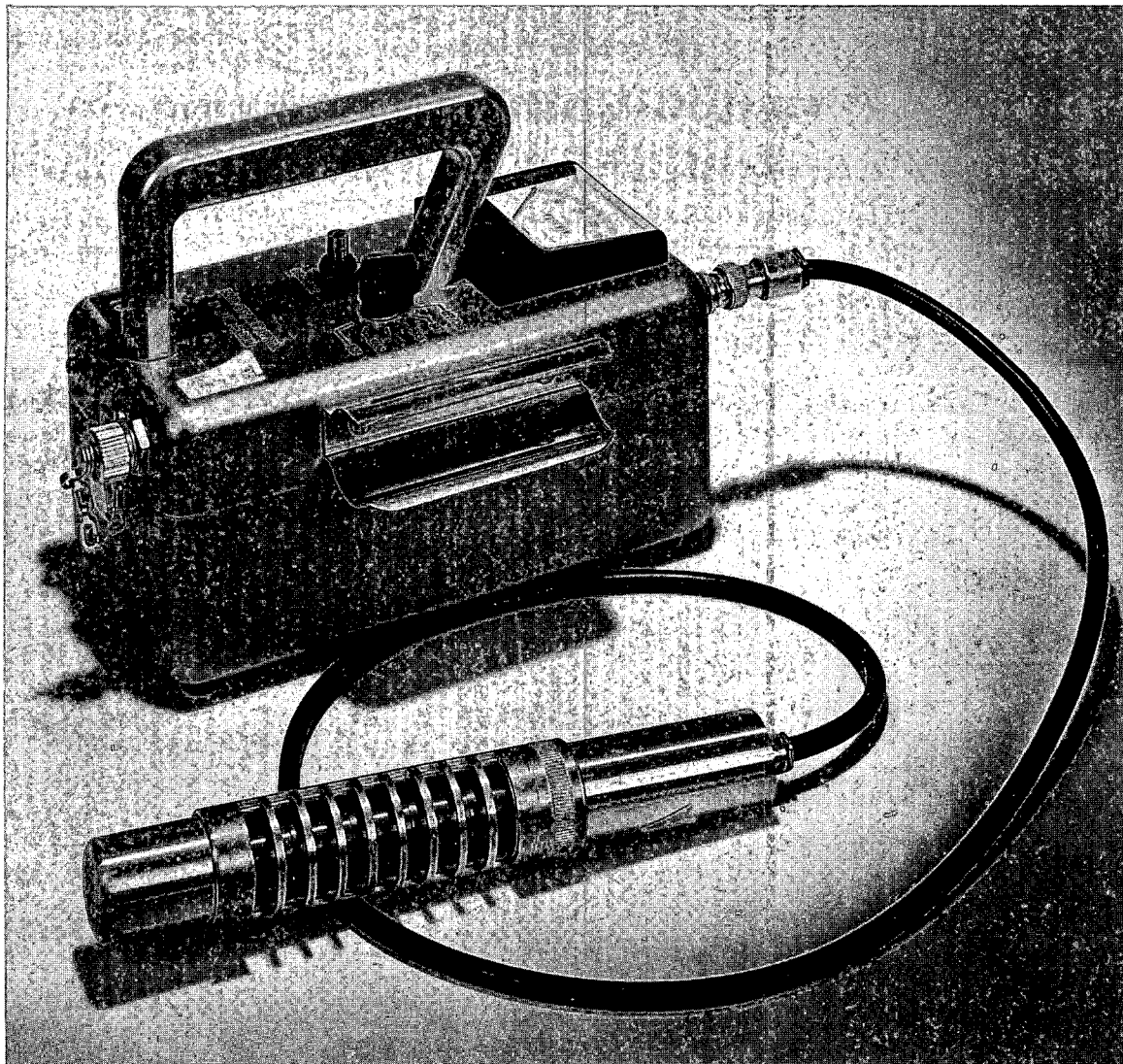


Figure A-III-1.3

G-M Survey Meter

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FAST NEUTRON SURVEY METER

PORTABLE

DESIGN

Type of radiation detected	Fast neutrons
Range	0 to 2500 mrems/hr
Response time	30 seconds
Warmup time	30 seconds
Detector area	Not applicable
Detector geometry	Not applicable
Calibration standard	Po-Be neutron source

APPLICATION

The fast neutron survey meter is used to measure fast neutron dose rates in the presence of other radiation.

SENSITIVITY TO OTHER TYPES OF RADIATION

When properly adjusted, is sensitive only to fast neutrons.

LIMITATIONS

This instrument is a highly specialized survey meter which requires considerable knowledge in operating techniques for correct usage.

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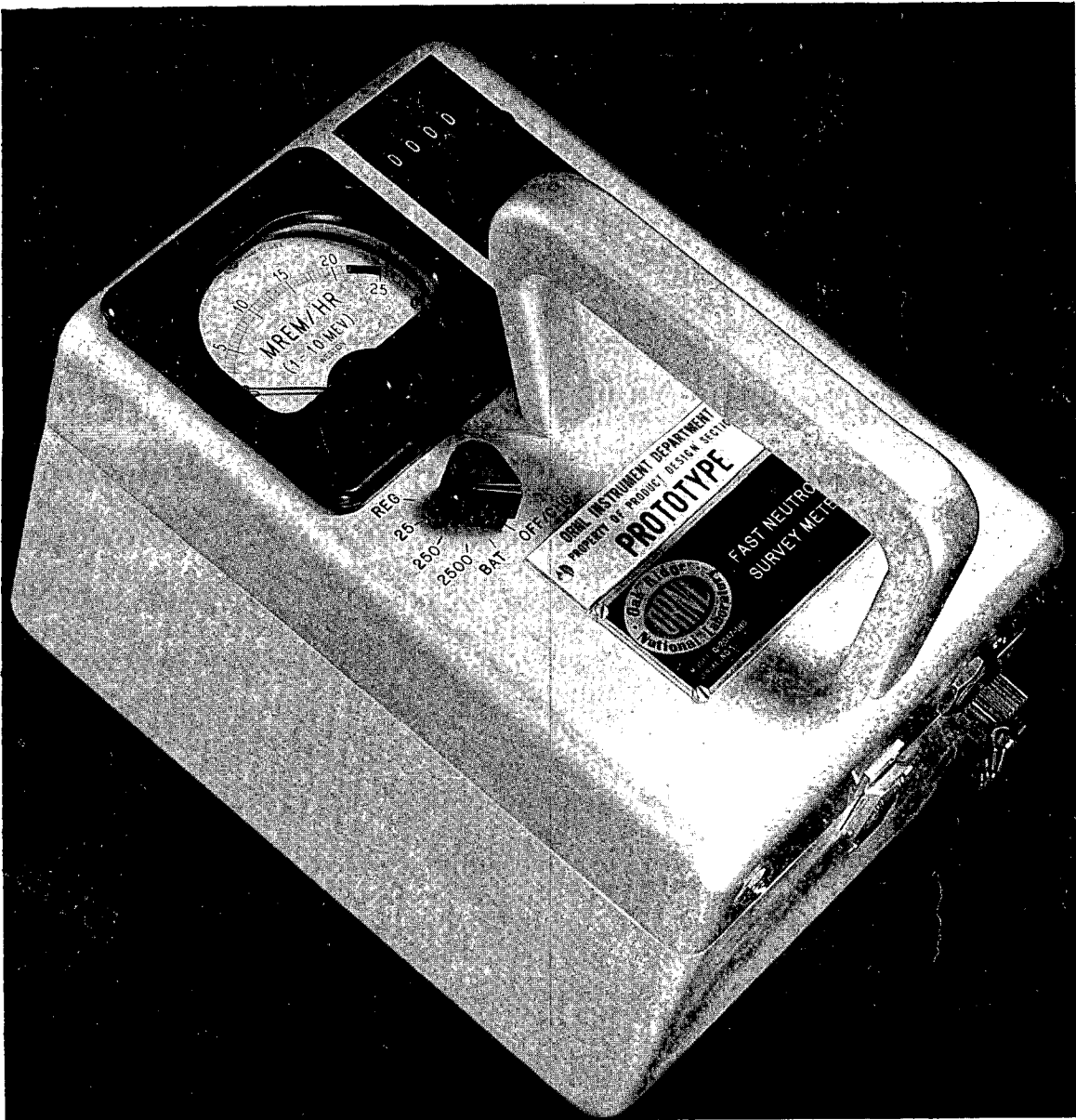


Figure A-III-1.7

Fast Neutron Survey Meter

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AREA RATEMETER

DESIGN

Type of radiation detected	Beta, gamma
Range	0-20,000 counts per minute
Response time	1 second
Warmup time	Not applicable
Detector area	Varies with type of tube
Detector geometry	Approximately 10 percent
Calibration standard	Co^{60}

APPLICATION

Area ratemeters are located at the exits from potentially contaminated areas and are used by personnel in monitoring for contamination on clothing and hand-carried equipment.

SENSITIVITY TO OTHER TYPES OF RADIATION

None

LIMITATIONS

May be affected by fluctuations in line voltage and by excessive temperature and moisture conditions.

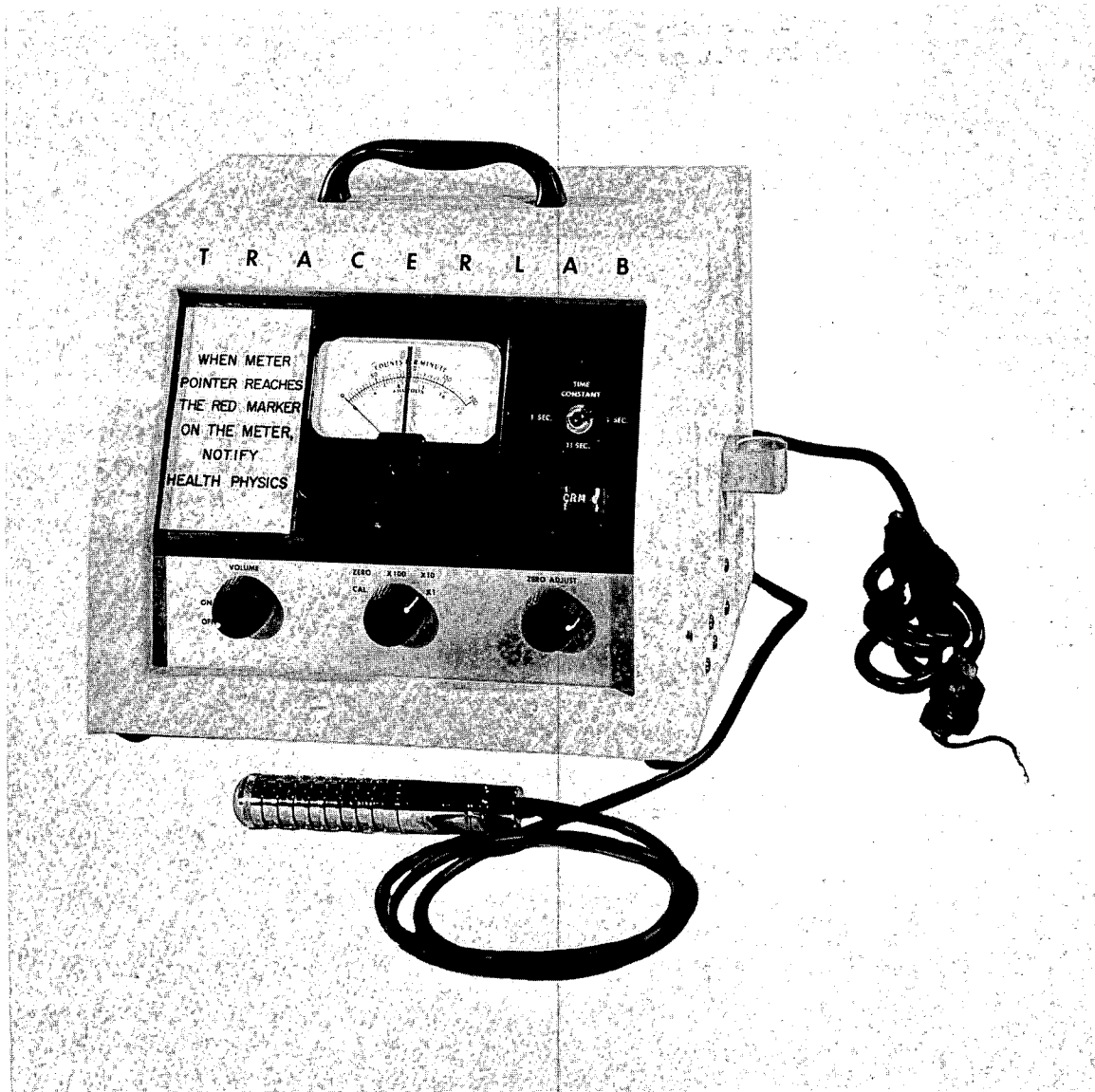


Figure A-III-1.8

Area Ratemeter

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ALPHA SCINTILLATION POPPY

STATIONARY

DESIGN

Type of radiation detected	Alpha
Range	0-25,000 counts per minute
Response time	1 minute
Warmup time	30 seconds
Detector area	61 sq cm
Detector geometry	10-15 percent
Calibration standard	Pu ²³⁹ plated on stainless steel

APPLICATION

The AC-powered alpha poppy is intended as a contamination monitoring instrument at contamination zone portals and at other designated locations. When detecting low levels of contamination, the probe face must be very near the object being monitored and moved slowly.

SENSITIVITY TO OTHER TYPES OF RADIATION

Detects alpha radiation only.

LIMITATIONS

The detector is covered by a thin (0.1 mil), aluminized Mylar screen which is easily punctured.

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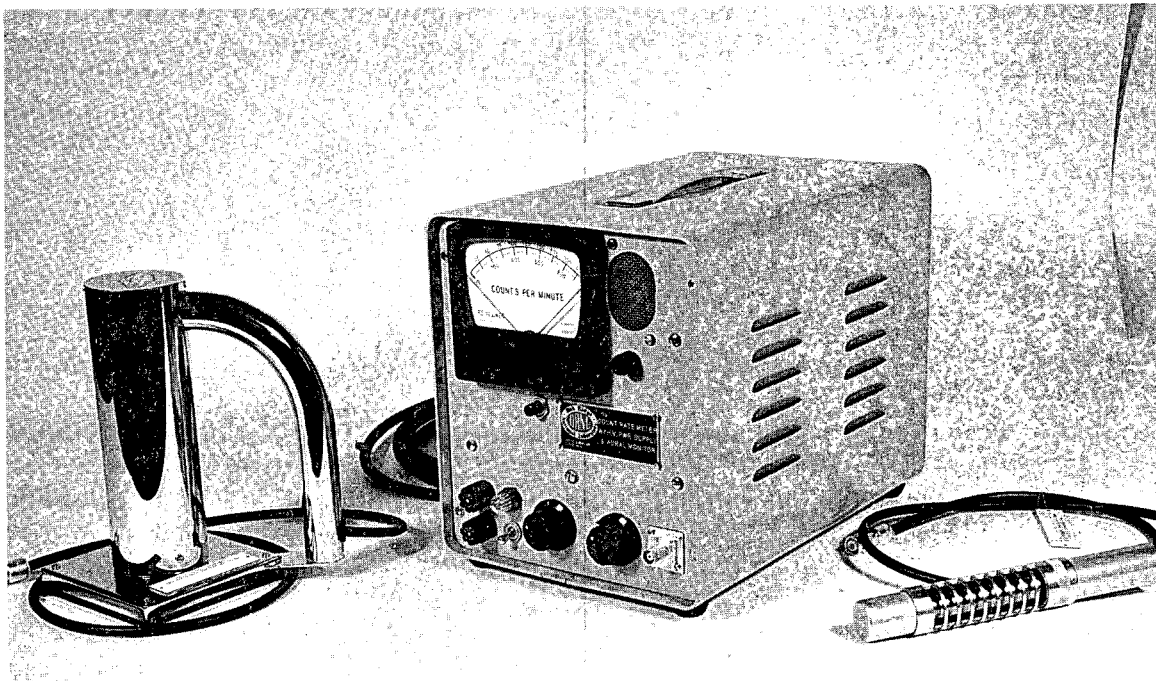


Figure A-III-1.9

Alpha Scintillation Poppy

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LOCAL RATEMETER

STATIONARY

DESIGN

Type of radiation detected	Beta, gamma
Range	200 cpm to 25,000 cpm
Response time	1 second for low scale
Warmup time	Not applicable
Detector area	Varies with type of G-M tube
Detector geometry	10 percent
Calibration standard	Ra gamma

APPLICATION

Local ratemeters are provided as beta-gamma contamination monitors at each contamination zone portal or change room.

SENSITIVITY TO OTHER TYPES OF RADIATION

Relatively insensitive to other types of radiation.

LIMITATIONS

The local ratemeter is a low-count-rate instrument intended only as a contamination monitoring device. High dose rates will "block" the detector tube and may result in damage to it and the instrument. It should not be used to survey highly contaminated objects.

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Figure A-III-1.11

Local Ratemeter



