CANBERRA's

Ultra Radiac

Personal Radiation Monitor

Resource Manual

PURPOSE

1. To familiarize Operations-level personnel with the CANBERRA UltraRadiac Personal Radiation Detector (PRD).

2. To provide directives for daily operational checks to be performed by Operations-level personnel.

3. To provide action guidelines for use of the UltraRadiac PRD in the field.

REFERENCES

1. UltraRadiac Personal Radiation Detector™ – Users Manual, CANBERRA Industries, Inc., 2006

2. Protective Action Recommendations For A Radiological Dispersal Event Including Improvised Nuclear Devices, WDOH, 2007

3. Planning Guidance For Response To A Nuclear Detonation, Homeland Security Council And Office Of Science And Technology Policy, Executive Office Of The President, 2009

4. Competencies For Operations-Level Responders Assigned Mission-Specific Responsibilities, Standard For Competence Of Responders To Hazardous Materials/Weapons Of Mass Destruction Incidents, NFPA 472 Chapter 6

5. Competencies For Responders Assigned Radiological Agent-Specific Tasks, Standard For Competence Of Responders To Hazardous Materials/Weapons Of Mass Destruction Incidents, NFPA 472 Annex D

DEFINITIONS

Dose The total amount of radiation received. Also called Accumulated Dose.

Dose Rate The average rate (in time) of radiation exposure; e.g., Roentgen per hour (R/hr). Also called Rate

Gamma One of the three types of natural radioactivity; unlike alpha and beta radiation, which are particles, gamma radiation is electromagnetic radiation (like X-rays or microwaves). Gamma rays are a most energetic and far-reaching form of electromagnetic radiation, with a very short wavelength

PRD Personal Radiation Detector

Rate The amount of radiation measured by the UltraRadiac every 2 seconds, then extrapolated to and displayed as units per hour

Roentgen Unit of radiation exposure (R); directly proportional to **rem** (Roentgen equivalent man) which measures the biological danger of absorbed radiation

Stay Time How much time remains, at the current Dose Rate, before the High Dose Alarm is triggered. (If the Dose Rate goes up, remaining Stay Time will go down.)

GENERAL INFORMATION

The potential threat of a radiological terrorism incident requires that first responders be equipped with a radiation monitor designed to address the radiation hazards they may face. CANBERRA's UltraRadiac Personal Radiation Detector (PRD) is being assigned to all Operations-level apparatus as a small, rugged, simple-to-operate radiation monitor that measures and displays both the instantaneous radiation dose rate, and the total dose that is received. Alarms are annunciated by a flashing display and loud audible signal when set dose rate or total dose alarm levels are exceeded. These thresholds are pre-set by Eastside Hazardous Materials Technicians prior to distribution and are determined by the Hazardous Materials Response Guidelines. They are not programmable by Operations-level users.

There are two separate alarm levels for both dose rate and total absorbed dose. The first alarm (Low Level Alarm) is set at a level somewhat above natural background to alert personnel that abnormal radiation is present. The second alarm (High Level Alarm) is set at a higher level, indicating a significant hazard that requires immediate action. The PRD also has a "stay time" feature that shows personnel how much time (at the current dose rate) he/she can remain in place before the high dose alarm is reached.

All companies in Operations will be issued an UltraRadiac. The Eastside Hazardous Materials Team (ESHMT) will maintain spare units to back-up frontline units not passing the Daily Operations Check discussed below. Action guidelines for when and where to power on the PRD are discussed below.

Other specifications:

- Gamma detector only – will not detect alpha or beta radiation
- Detection range of 1 µR/hr – 500 R/hr (dose rate) and 0.1 µR to 999 R (total dose)
- Low Rate Alarm set at 100 µR/hr
- High Rate Alarm set at 1 R/hr
- Low Dose Alarm set at 1 R
- High Dose Alarm set at 5 R
- Unit has an initialization time of less than 5 seconds
- Four AAA 1.5V alkaline batteries will provide 150 hours of continuous monitoring
- Low battery indication is triggered when remaining battery life is approximately 10 hours
- Unit is immersible to 3 ft and can be technically decontaminated
- Unit is NOT intrinsically safe

BASIC FUNCTIONS

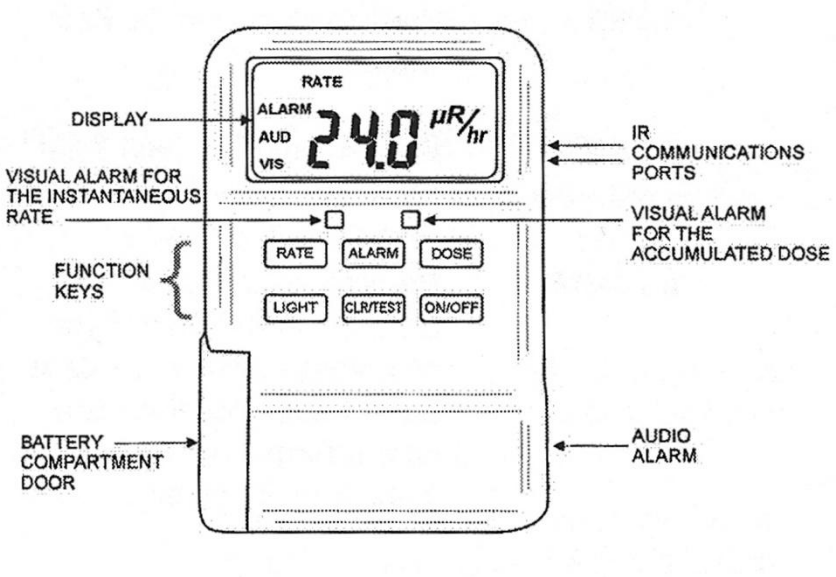


Figure 1 – The UltraRadiac Front Panel

The Function Keys

ON/OFF Press and hold to turn the unit on or off.

DOSE Press to change to the Dose Mode (default ON mode is RATE). Current accumulated dose is displayed in R.

RATE Press to change to Rate Mode from Dose Mode. Current Rate is displayed in R/hr.

ALARM Press to see the Stay Time, the number of minutes you can safely stay in the area at the current Dose Rate.

LIGHT Press to illuminate the display for about 5 seconds.

CLR/TEST In the Rate Mode, press and hold to enable the Display Test Sequence (see Daily Operational Check).

Battery Life Indicators

- If a blinking *b* is displayed, the unit has stopped functioning. Replace the batteries before the unit's next use.
- If a blinking *BAT* is seen in the top-left corner of the display, the unit's batteries have 10 hours or less of useful life. Replace the batteries as soon as possible.
- If the display is blank, the batteries are dead. Replace the batteries before the next use.

- In the Rate mode with the *BAT* indicator blinking, press the CLR/TEST key. A three-digit number indicating the approximate remaining battery life, in minutes, will be displayed.
- **NOTE: When replacing batteries at any time, be sure to turn the unit off first!**

DAILY OPERATIONAL CHECK

While periodic maintenance and calibration of the UltraRadiac PRD will be handled by the ESHMT, all Operations companies will perform Weekly Operational Checks on the units assigned to them.

1. Check the calibration due date. If calibration is within 30 days of expiration, coordinate with the ESHMT for transfer of unit for re-calibration.
2. Perform a visual inspection. Remove dust, moisture, loose dirt from outside surfaces of the unit with a clean, soft cloth. If necessary, the unit may be cleaned with a mild solution of ordinary detergent and water, rinsed, and thoroughly dried.
3. Press and hold the ON/OFF key until the display appears, and release the key.
    - The Rate Mode should appear, with the word *RATE* shown at the top left of the screen (Figure 2).

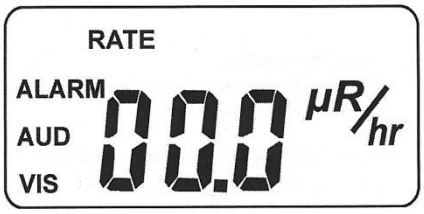


Figure 2 – The Rate Display

- *AUD* and *VIS* indicate that the Audio and Visual alarms are both enabled.
- The unit will start counting and displaying the instantaneous Rate. Naturally occurring background radiation will cause the unit to display a low reading.
- Press the DOSE key to switch to Dose Mode. The Dose Mode should appear, with the word *DOSE* shown at the top left of the screen (Figure 3)

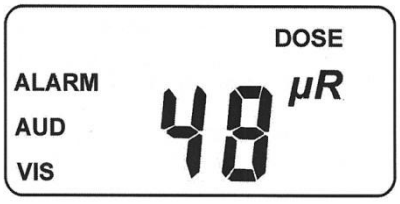


Figure 3 – The Dose Display

- Press the RATE key to switch to Rate Mode.

4. While in Rate Mode, press and hold the CLR/TEST key until you see the test display in Figure 4 (approximately 4 seconds), and release the key.

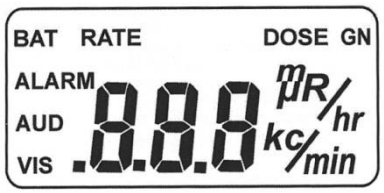


Figure 4 – The Test Display

- A set of numbers in the following order will appear. Check that all of the numbers are exactly as shown in Figure 5.

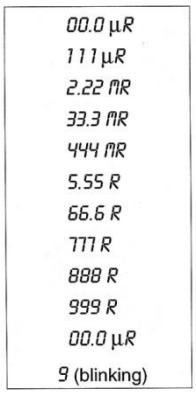


Figure 5 – Test Sequence

- At any time during the CLR/TEST sequence of numbers:
    - Press the RATE key – the audio alarm should sound and the Rate LED (left one below the display) should turn on.
    - Press the DOSE key – the audio alarm should sound and the Dose LED (right one below the display) should turn on.
    - Press the ALARM key – the audio alarm should sound and both LEDs should turn on.

- The blinking *9* indicates that the unit passed all self-tests. A blinking *0* indicates a failure; contact the ESHMT immediately to arrange replacement.

- Press the CLR/TEST key to return to Rate Mode (or wait about 10 seconds).

5. Press the LIGHT key; the display's backlight will turn on for about 5 seconds.
6. **IMPORTANT: Clear the accumulated dose prior to use!** Press and hold DOSE + CLEAR/TEST. The display will flash for a few seconds, then clear any accumulated dose. Return to the Rate Mode by pressing the RATE key.
7. Press and hold the ON/OFF key.
    - *OFF* will be displayed.
    - – – – will then be displayed. Release the ON/OFF key; the unit will power off.

ACTION GUIDELINES

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, was changed in 2008 to include new skill requirements for Operations-level personnel. While basic core competencies were not changed, a new mission-specific menu of objectives was added, including air monitoring and sampling, evidence preservation and sampling, and victim rescue and recovery. The new standard and its mission-specific competencies address what the fire service has already found to be true: Operations-level personnel will fill in where possible and do what must be done when Technicians are not available.

The UltraRadiac gives Operations-level personnel an additional tool to not only facilitate better recognition of radiological incidents, but to enhance Operations-level participation in monitoring radiological incidents, making the scene safer for both Operations- and Technician-level personnel. Operations-level first responders – the most likely to diagnose a radiological terrorist/WMD event – will need to provide initial information about the radiation characterization of the incident site, as well be able to determine for themselves safe routes of travel to victims or fires.

Any unexplained detonation shall be considered a potential terrorist event utilizing a radiological dispersal device. Place, time, occupancy, and other clues to the origin of an explosion will determine Operations-level approaches to the response. Obviously, a car fire on the freeway would be considered an explained event and not necessitate the use of the PRD; a car bomb in front of the Federal Building would be suspicious and require the use of the PRD when approaching the incident.

While on day-to-day business, leave the PRD stowed on the apparatus with power off.

Power on the PRD, clear any accumulated Dose, and deploy the units from the apparatus when:

- **Responding to unexplained detonations (assume RDD) or any other inexplicable circumstances: USE COMMON SENSE**
- **Responding to known HazMat incidents or to known hazard sites (hospitals, cancer-care units, industrial sites, universities, etc.)**
- **Elevated Threat Level (local/national)**
- **Directed by the Chief of the Department**

When the UltraRadiac is deployed, crews will employ a process known as the "Radiological Alarm Response Guide" to:

- **DETECT** elevated radiation levels
- **VERIFY** the radiation alarm
- **LOCALIZE** or narrow down the radioactive field or source material
- **MEASURE** the radiation level

Detect

Detection begins when any of the radiation alarms on the PRD are triggered. Average background radiation is 5 – 25 µR/hr. The Low Level Rate Alarm for all Operations-level units is

set at 100 µR/hr. Note that this is still an exceedingly small amount of radiation: 100 times less than the rate at which Operations-level personnel will be directed to turn back (10 mR/hr), and 500,000 times less than the rate at which a stay time of an hour would result in minor biological effects (50 R). See Appendix I for an explanation of metric prefixes, and Appendix II for time/dose equivalents. A Low Level Rate Alarm indicates the abnormal presence of some radiation. Units should observe their surroundings (location, occupancy, event, anything that is out of place). Acknowledge the alarm and note the Rate reading.

Verify

Move in a direction that allows the UltraRadiac to fall below the Low Level Rate Alarm (100 µR/hr). Return to the original area and observe if the instrument goes back into alarm. A repeat measurement with the same or other instrument is a positive indication that there is a real increase in radiation. Further investigation will be required. Again consider your surroundings:

- Could there be a legal process for using a radioactive source (e.g. hospitals, labs, medical treatment centers)?
- Is it a high value target (e.g. event with large group of people or dignitaries, government building)?
- Is there anything out of place (e.g. large, unplacarded vehicles, unattended packages)?

A verified Low Level Rate Alarm (100 µR/hr) indicates an abnormal presence of radiation. If no legal explanation exists, contact Dispatch via radio for a HAZMAT response and verbalize the Rate readings and suspected threat in the initial report. Also request police to your location.

If initial readings send the PRD into High Rate Alarm (1 R/hr) immediately, contact Dispatch via radio for a full HAZMAT response and provide the Rate readings and suspected threat in the initial report.

If you are unable to measure due to above conditions, report the following to the HazMat team and retreat to a safe location:

- Highest Rate reading
- Approximate location where the reading was taken
- Approximate distance from the suspected source where the reading was taken
- Description of the suspected source, including markings, labels, dimensions, color, etc.

Important Note: The "Turnback Rate" of 10 mR/hr applies to crews in survey operations. However, the new NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, allows for Operations-level personnel to work in the Hot Zone to achieve important tactical objectives. Crews now have the PRD to further guide them toward completion of those objectives. While crews are directed to not go beyond the 10 mR/hr threshold while surveying, life-safety operations and other high-value mission specific objectives can still be performed at higher rates with commonsense precautions. OSHA specifies the following exposure limits for emergency workers in radiation fields:

- 5 rem any work
- 10 rem to protect property
- 25 rem to protect life (exceeded voluntarily with knowledge of risks)

Crews are directed to use the Dose function of the PRD to monitor their accumulated dose while operating in fields beyond the High Rate Alarm and performing high-value tactical objectives. Members must remain physically proximal to each other for the PRD's readings to apply to the entire crew. Crews must at all times practice the ALARA Principle (As Low As Reasonably Achievable) and at no time should crews exceed the OSHA exposure limits for life safety actions (25 rem). By monitoring with the PRD for lower-rate pathways through a radiation field, crews can significantly and positively influence the outcomes of a significant event.

CONCLUSION

The CANBERRA UltraRadiac is just one more tool to aid Operations-level companies while safely performing their duties at emergency scenes. As with any other operation, no one tool can replace common sense and judiciousness. Understanding the abilities and the limitations of the PRD will help companies make wise decisions when dealing with a radiological event. Performing the daily operations check and regularly practicing with the UltraRadiac will foster familiarity with the instrument, familiarity that will be of great use should companies be called upon to assist the HazMat team when responding to an actual incident.

Localize

A verified alarm requires further investigation. Recall that the Low Alarm for the UltraRadiac is set at 100 μR/hr. Also recall that the Zone-1 Operations-level safe general work Rate limit is determined to be 10 mR/hr, 100 times higher. Operations-level crews will have plenty of time in range to attempt to localize the source of the material before being required to turn back – this will be a great asset to the HazMat team when it arrives to perform mitigation efforts. Note that your primary use of the PRD is to further your tactical objectives (victim rescue, fire suppression, etc.) by determining safe routes of travel through a possible radiation field; NOT to become Technician-level identifiers or mitigators.

The UltraRadiac has a response time of about 2 seconds. By slowly sweeping the unit left to right, up and down, and around, pausing every few feet or so for 2 seconds, crews will be able to "hone in" on the source. Caution must be taken to give the unit time to catch up to your forward motion. Crews should attempt to use command boards or paper and pencil to keep records of their progress. Use as much detail as possible to map your immediate environs.

The result of the localization process is the approximate direction towards the radioactive material. In this fashion, "safe corridors" to victims can be mapped out, as well as providing valuable information about the point origin of the radioactivity, dissemination of the radioactivity, and contamination of the surrounding area. Remember that you can move forward toward the source in this fashion until you begin achieving Rates at 10 mR/hr. If this happens, return to a safe area (a Rate under 10 mR/hr).

Measure

As measurements are taken, describe the location in enough detail to be able to relocate the suspected source or general area.

- Take readings with the PRD positioned as close as possible to the suspected source. Note your distance from the suspected source (person, package, vehicle, building, object).
- Always remember to record the units of the reading (μR/hr, mR/hr, R/hr). This is very important for later reckoning of absorbed doses.
- If possible, and allowed by Rate guidelines, take a reading at the distance of one meter from the suspected source and record the results. Try to attain readings from more than one direction near the source.

Do not attempt to measure under the following circumstances:

- You achieve Rate readings of greater than 10 mR/hr at 10 feet away from the suspected source; consider your tactical objectives – if only in survey mode, turn back
- Any High Alarm is activated
- The Gamma Detector Overload message (– – –) appears on the screen
- Undetonated explosives are suspected
- Loose, spilled, or leaking material is observed.

APPENDICES

Appendix I: Metric Prefixes

A metric prefix is a modifier on the root word to tell us the unit of measure. For example, milligram (mg) means we are counting in steps of one one-thousandth of a gram and microgram (μg) means millionths of a gram. Note that numbers we generally deal with in the macroscopic world reside in range 10^{-6} to 10^{6}. Units used in this training guide can be viewed as:

Prefix	Symbol	Numerical Multiplier	Exponential
kilo	**k**	**1,000**	**10^{3}**
No prefix		**1**	**10^{0}**
centi	**c**	**0.01**	**10^{-2}**
milli	**m**	**0.001**	**10^{-3}**
micro	**μ**	**0.000001**	**10^{-6}**

Appendix II: Dose Rates And Absorbed Dose As A Function Of Time

TIME/DOSE EQUIVALENTS

TIME UNTIL INDICATED DOSE LEVEL IS RECEIVED (in HOURS unless otherwise specified)

	MODERATE DOSE								*HIGH DOSE*	
	Limit To Protect Valuable Property			**Limit For Life-Safety Rescue**	**2% Increased Chance Of Cancer**		**Temporary Blood Changes**	**Radiation Sickness Likely**		**LD_{50} Dose Limit (EPA)**
DOSE RATE	**10 R**	**15 R**	**20 R**	**25 R**	**30 R**	**40 R**	**50 R**	**75 R**	**100 R**	**300 R**
100 μR/hr	100,000	150,000	200,000	250,000	300,000	400,000	500,000	750,000	1,000,000	3,000,000
10 mR/hr	1,000	1,500	2,000	2,500	3,000	4,000	5,000	7,500	10,000	30,000
50 mR/hr	200	300	400	500	600	800	1,000	1,500	2,000	6,000
100 mR/hr	100	150	200	250	300	400	500	750	1,000	3,000
500 mR/hr	20	30	40	50	60	80	100	150	200	600
1 R/hr	10	15	20	25	30	40	50	75	100	300
5 R/hr	2	3	4	5	6	8	10	15	20	60
10 R/hr	1	1.5	2	2.5	3	4	5	7	10	30
50 R/hr	12 min	18 min	24 min	30 min	36 min	48 min	1	1.5	2	6
100 R/hr	6 min	9 min	12 min	15 min	18 min	24 min	30 min	45 min	1	3
150 R/hr	4 min	6 min	8 min	10 min	12 min	16 min	20 min	30 min	40 min	2
200 R/hr	3 min	4 min	6 min	7 min	9 min	12 min	15 min	22 min	30 min	1.5

Example: The CANBERRA UltraRadiac™ measures a radiation dose-rate of 100 μR/hr (Low Dose-Rate Alarm). Personnel could work in that radiation field, at that rate, for 250,000 hours before absorbing the OSHA-determined dose limit for life-safety rescue (25 R). That is equivalent to working 28½ years, 24 hours a day, without break. Likewise, personnel can work 25 hours at the High Dose-Rate Alarm rate of 1 R/hr before reaching that limit.

Appendix III: Average Annual Absorbed Dose From Naturally-Occurring And Man-Made Sources

To put radiation exposure in perspective, consider some sources that everyone is exposed to, year after year:

Smoke detectors	0.008	mrem (8 µrem)
LCD wristwatch	0.06	mrem (60 µrem)
Porcelain crowns/dentures	0.07	mrem (70 µrem)
Jet plane travel	0.5	mrem per hour in air (Seattle to NY ~ 3.4 mrem)
Computer screen/TV	1	mrem
X-ray (extremities)	1	mrem
X-ray (chest)	6	mrem
Stone, brick, concrete	7	mrem
Cosmic space radiation	26	mrem
Food and water	40	mrem
Terrestrial radiation (Continental US)	63	mrem
X-ray (pelvis)	65	mrem
Naturally-occurring radon	200	mrem (0.2 rem)
X-ray (Upper GI)	245	mrem (0.245 rem)
Cigarettes (1 pack per day)	1300	mrem (1.3 rem)

The average annual dose per person from just environmental sources is about 360 mrem per year, 81% of which comes from natural sources of radiation. It is not, however, uncommon for persons to receive far more than that in a given year (largely due to medical procedures such as X-rays and CAT scans).

The human body largely has mechanisms for absorbing this dose with minimal risk of long-term negative effects.

http://www.doh.wa.gov/ehp/rp/factsheets/factsheets-htm/fs19resprad.htm

What Responders Need to Know About Radiation

Professional Personnel

It is possible that first responders to the scene may not recognize the radiological aspects of an event. It is recommended that emergency response personnel or response vehicles likely to be the first to respond to a scene be equipped with radiation detection equipment that would alert the responders they are entering a radiologically compromised environment. Emergency response personnel assigned to a scene with this equipment should be trained to operate the equipment and understand what the risks associated with exposure to radiation are. Radiation detection equipment should always be employed when first responders arrive on a scene for which there has been some indication that the area is contaminated with radioactive materials and to any site of an explosion.

Emergency response radiation exposure limits are the same as occupational workers annual exposure limits. 5 Rem (50 mSv) is the accepted exposure limit for emergency responders. For emergency workers to exceed 5 Rem requires a review and approval of the State Health Officer. Other limits requiring State Health Officer's approved exceptions are as follows:

Action	Dose Limit
For protecting property	10 Rem (100 mSv)
For life saving	25 Rem (250 mSv)
For life saving missions beyond 25 Rem	Any actions taken will be voluntary*

*Only volunteers fully aware of the risks should request exceeding this limit.

Radiation exposure can be from an external source, an internal source, or a combination of both. If radiation is present, there is also a good chance that the radioactive material is dispersed throughout the event scene. When radioactive contamination is deposited internally there is a constant source of exposure that normal counter measures such as time, distance, and shielding will not achieve. For emergency response personnel, the primary pathway for radioactive contamination to enter the body is by inhalation. Respiratory protection and Personal Protective Equipment (PPE) are the best methods to control the intake of radioactive contamination.

Zoning the event scene into Hot, Warm, and Cold Zones will help reduce radiation exposures and aid in controlling the spread of radioactive contamination. The size of the event scene will determine the size of the zones and the control points needed. The Hot Zone barrier should be established where the radiation dose rate is below 5 mRem/hr (0.05 mSv/hr). If other hazardous conditions exist, the Hot Zone barrier can be established at a lower dose rate. The outer perimeter of the Warm Zone should be established where contamination levels are at background levels when measured with a count rate meter. If this is not practical because of the size of the event, adjustments can be made if deemed necessary. The Warm Zone can be utilized for decontamination efforts. The Cold Zone barrier should be established at a location that all access to and from the Warm Zone will be continuously monitored and all personnel are accounted for.

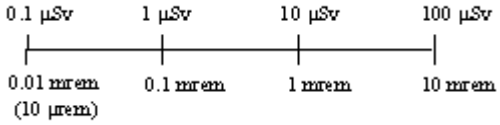
http://www.uottawa.ca/services/ehss/ionizconversion.htm

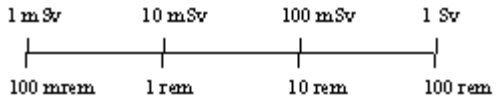
Dose Equivalent:

Dose equivalent is the absorbed dose into biological matter taking into account the interaction of the type of radiation and its associated linear energy transfer through specific tissues. The working SI unit is the sievert (Sv), while the traditional unit is roentgen equivalent man (rem).

1Sv = 1 rads x quality factor x any other modifying factors
1rem = 1 gray x quality factor x any other modifying factors

1 Sv =100 roentgen equivalent man (rem)
1 rem = 0.01Sv = 10mSv





http://www.jlab.org/div_dept/train/rad_guide/dose.html

DOE DOSE LIMITS AND FACILITY ADMINISTRATIVE CONTROL LEVELS

The facility administrative control levels for radiological workers are more conservative than the DOE limits and are established to ensure the DOE limits are not exceeded and to support the ALARA concept.

The DOE dose limits and TJNAF administrative control levels are as follows:

- **Whole body**

The *whole body* extends from the top of the head down to just below the elbow and just below the knee. This is the location of most of the blood-producing and vital organs. Since the whole body contains the most radiation-sensitive organs, it has the lowest limit.

DOE whole body dose limit for routine exposures = 5 rem/year.

TJNAF's administrative control level for whole body = 1 rem/year.

Limits are based on the sum of internal and external exposure. When individual organs are exposed, the following limits apply (the whole body dose limit must still be met).

Summary of organ dose limits and TJNAF control levels.

ORGAN	DOE DOSE LIMIT	TJNAF ADMIN LIMIT
Extremities	50 rem/year	10 rem/year
Skin and other organs	50 rem/year	10 rem/year
Lens of the eye	15 rem/year	3 rem/year

Annual limit on intake (**ALI**) is the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the intake of a given radionuclide in a year that would result in:

- a committed effective dose equivalent of 0.05 Sv (5 rems) for a "reference human body", or
- a committed dose equivalent of 0.5 Sv (50 rems) to any individual organ or tissue,

whatever dose is the smaller.[9]

http://en.wikipedia.org/wiki/Radiation_poisoning

Phase	Symptom	Exposure (Sv)				
		1–2Sv	**2–6Sv**	**6–8Sv**	**8–30Sv**	**>30Sv**
Immediate	**Nausea and vomiting**	5–50%	50–100%	75–100%	90–100%	100%
	Time of onset	2–6h	1–2h	10–60m	<10m	immediate
	Duration	>24h	24–48h	<48h	<48h	48h–death
	Diarrhea	None	Slight (10%)	Heavy (10%)	Heavy (90%)	Heavy (100%)
	Time of onset	—	3–8h	1–2h	>1h	<30m
	Headache	Slight	Mild (50%)	Moderate (80%)	Severe (80–90%)	Severe (100%)
	Time of onset	—	4–24h	3–4h	1–2h	<1h
	Fever	Slight–None	Moderate (50%)	High (100%)	Severe (100%)	Severe (100%)
	Time of onset	—	1–3h	>1h	>1h	>30m
	CNS function	No impairment	Cognitive impairment 6–20 h	Cognitive impairment <20 h	Rapid incapacitation	Seizures, Tremor, Ataxia
Latent Period		28–31 days	7–28 days	>7 days	none	none
Overt illness		Mild Leukopenia; Fatigue; Weakness	Leukopenia; Purpura; Hemorrhage; Infections; Epilation	Severe leukopenia; High fever; Diarrhea; Vomiting; Dizziness and disorientation Hypotension; Electrolyte disturbance	Nausea; Vomiting; Severe diarrhea; High fever; Electrolyte disturbance; Shock	Death
	Mortality without medical care	0–5%	5–100%	95–100%	100%	100%
	Mortality with medical care	0–5%	5–50%	50–100%	100%	100%

Ultra Radiac

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From Science to Solutions™

Personal Radiation Monitor

Radiation Monitor

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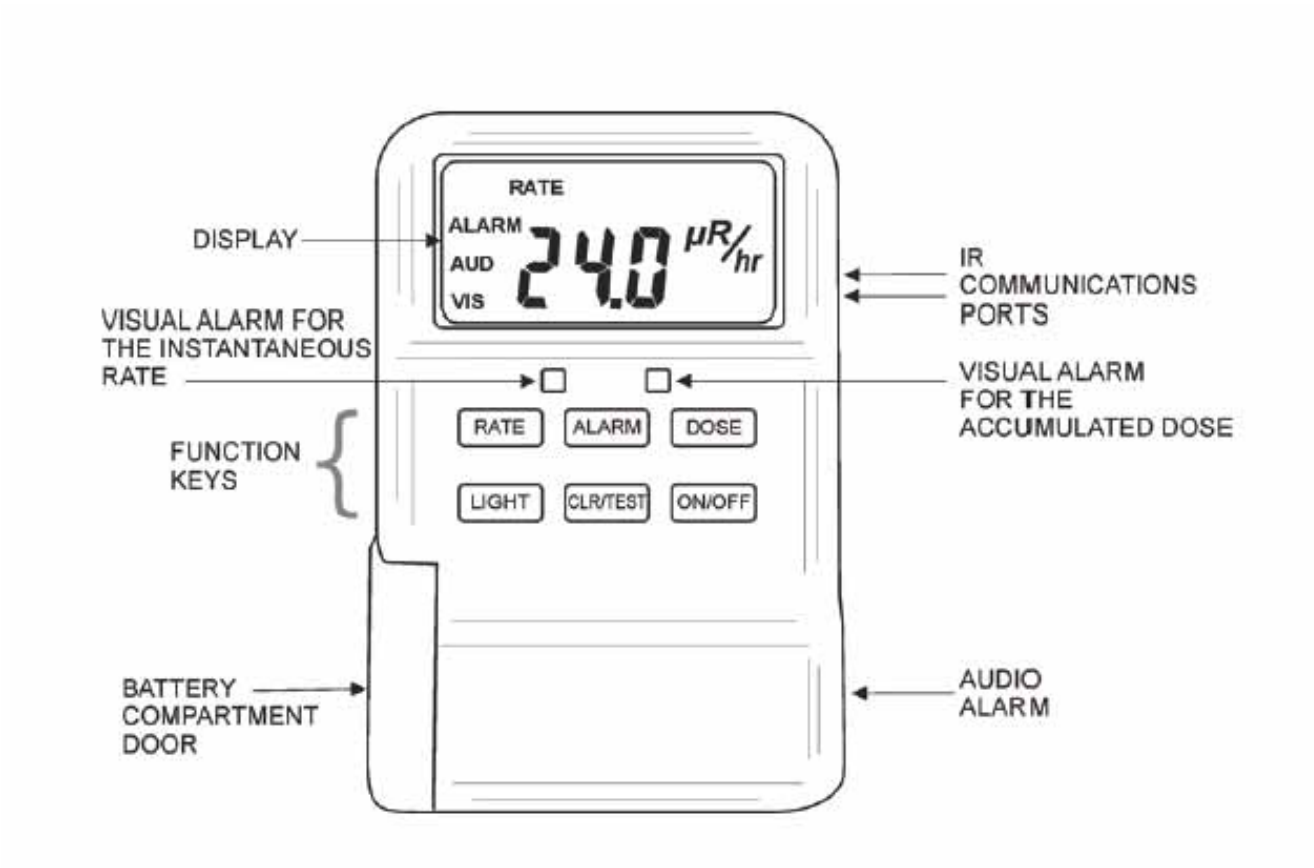
- Capabilities
  - Measures and records gamma/x-ray dose and rate
  - Multiple user features, data logger, PC download
- Limitations
  - Does not detect alpha, beta, neutrons
- Best uses
  - Personal dosimeter and rate meter
  - Used by decon team outdoors

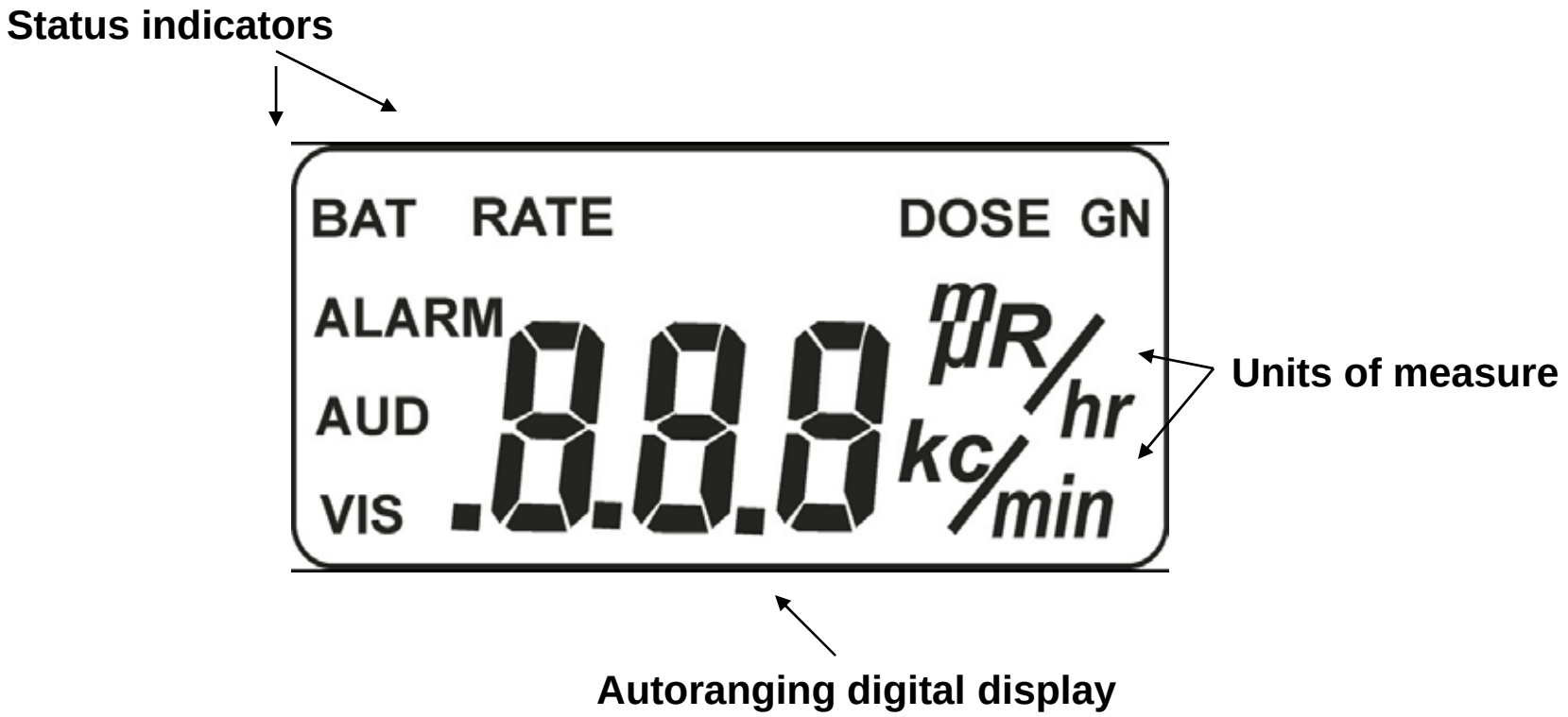
Equipment Safety Precautions

- Do not submerse, but can withstand decon operations

Controls and Indicators



Digital Display



Function Keys

- Rate and Dose keys: Display dose rate or dose
- Alarm key: Display “stay time” in minutes
- Light key: Power On backlight
- Clear/Test key: Perform operational test
- On/Off key: Power On and Off

Keys have other functions for advanced users

Battery Life Indicator

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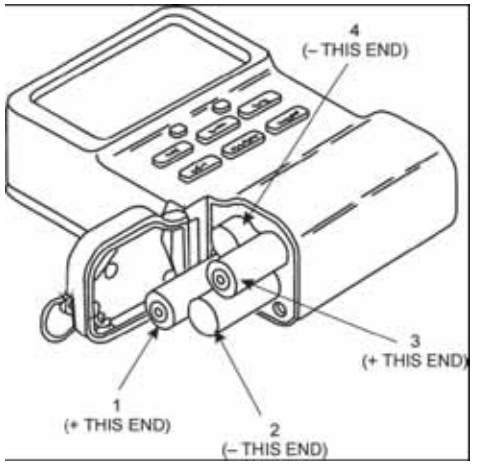
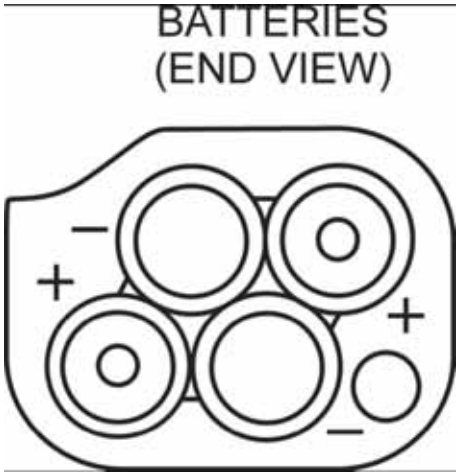
- Low battery: Flashing “BAT” in upper left corner
  - Less than 10 hours left
  - Press Clear/Test key to display minutes of battery left
- Dying battery: Flashing “b” on blank display
  - Normal operation stopped

Prepare for Operation

- Before-operation checks
  - Look for obvious damage
- Install batteries: 4 AAA
  - Observe polarity indicator
  - Starts “sleep” mode
- Power up
  - Press On/Off key





Prepare for Operation (cont.)

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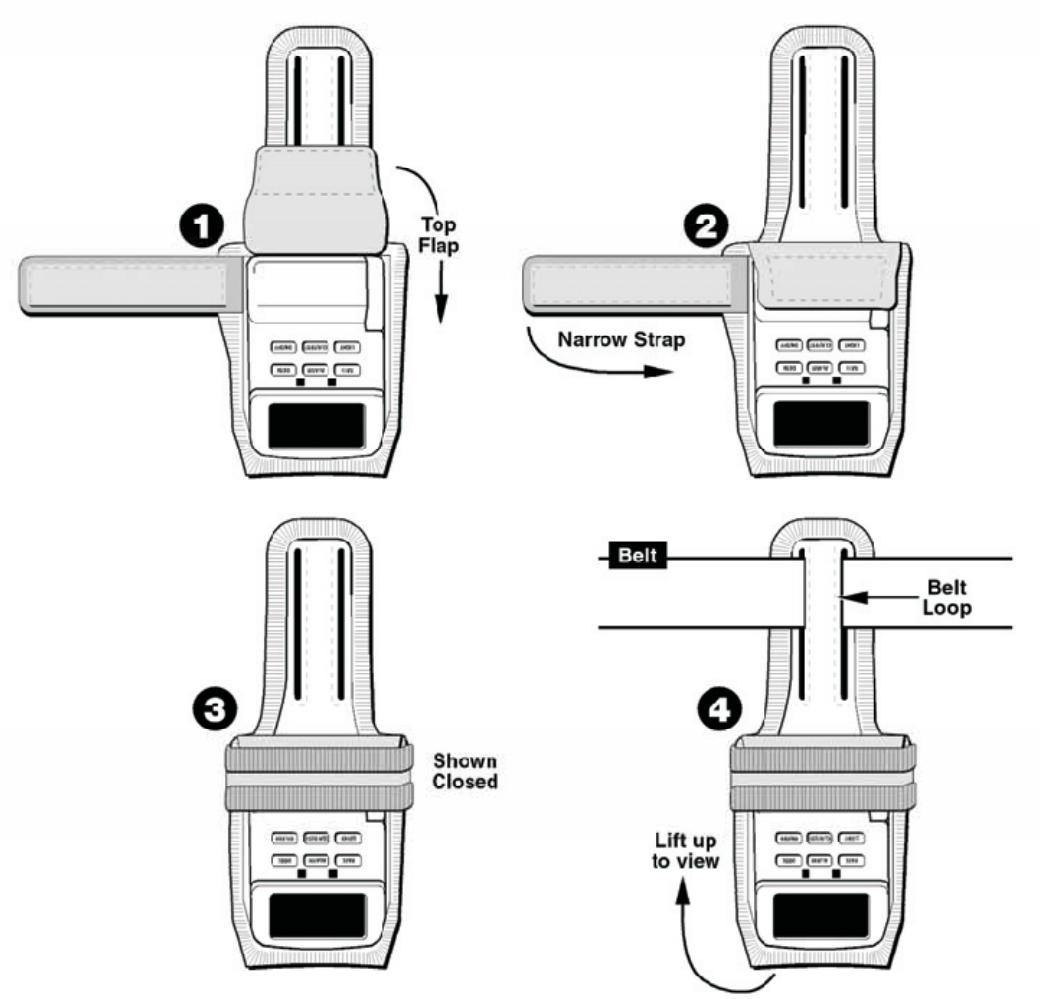
- Perform operational test
  - Hold Clear/Test key until “888” appears
  - Test alarm: Press Rate, Dose, or Alarm keys
  - After self-test: Flashing “9” = pass or “0” = fail
  - Press Clear/Test key
- Check the dose is 0.00

Attach Carry Case



Basic Operating Procedures

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- Check dose and dose rate
- Turn on back light
- Check stay time
- Data logging
- Alarms

Check Dose and Dose Rate

- Current dose rate
  - Normal default reading
  - Press Rate key from dose display

- Total dose
  - Press Dose key
  - Returns to rate after 10 sec.

Backlight

- Press Light key
  - Blue light for 10 sec.
- Why can’t I see the light?

Check Stay Time

- Stay time = number of minutes to safely remain at current dose rate and not sound dose alarm
  - Based on current dose rate and dose alarm setting
- Press Alarm button
  - Normal background = “999”
  - If rate increases with low dose alarm set point, stay time decreases

Data Logging

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- Log data point at:
  - Any dose alarm
  - End of normal shift
- Records up to 300 events
  - Records date, time, dose, rate, etc.
- Logging a data point
  - Power On, rate displayed
  - Hold Rate + Dose keys until number stops flashing
  - New number = log sequence

Alarms

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Type Alarm	Visual (flashing)	Audible (if enabled)	Vibration (if enabled)
High rate	Entire display, Left LED red	Beep quickly	Vibrate
Low rate	Rate and Alarm indicators, Left LED green	Beep slowly	Vibrate
High dose	Dose and Alarm indicators, Right LED red	Beep quickly	Vibrate
Low dose	Dose indicator, Right LED green	Beep slowly	Vibrate

Resetting Alarms

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- High rate alarms
  - Press Clear/Test key to still vibration alarm
  - Back away to stop audible and display alarms
- Low rate alarms
  - Press Clear/Test key to still audible/vibration alarms
  - Back away until display alarm stops
- Dose alarms
  - Press Clear/Test key to still audible/vibration alarms
  - **Log the data point**

Respond to Alarms

Type of Alarm	Required Action
• High dose/rate alarm	• Take immediate action to reduce exposure • Silence and reset alarm
• Low dose/rate alarm	• Warn others of increased exposure • Silence and reset alarm
• Low battery alarm	• Change batteries

Equipment Application

- Decon line use
  - Personal exposure record
  - Alert user of high dose or dose rate
  - Use “source finder” mode as survey meter
- Wear on belt
  - Instrument upside down, face out – flip up to read

After Operating

- Power down
  - Hold On/Off key until display shows “OFF” then “- - -”
- Perform after-operation maintenance
- Storage
  - Remove batteries
  - Store in carry case
  - Store IR reader with RSO

Operator Care and Cleaning

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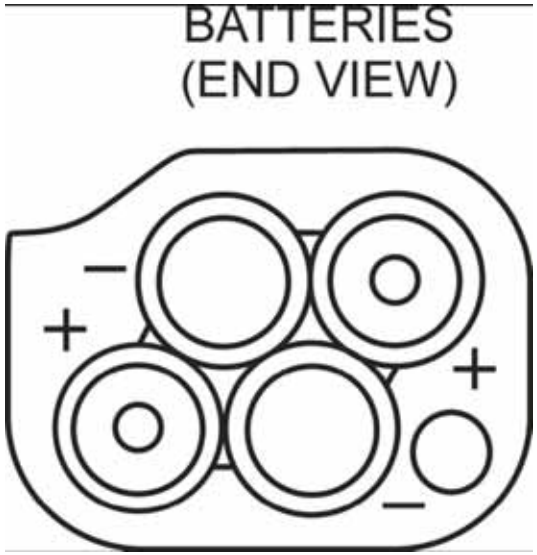
- Wipe exterior surfaces clean
- Do not submerse—not water tight
- Avoid harsh solvents—may damage plastic case

Change Batteries

- Replace batteries if low battery alarm
- Power Off; change batteries; power On
  - Ensure correct orientation
  - Dose reading and settings not lost
- Sleep mode starts automatically
  - Power On then Off to prevent battery drain



- To put radiation exposure in perspective, consider some sources that everyone is exposed to, year after year:
- Smoke detectors 0.008 mrem (8 µrem)
- LCD wristwatch 0.06 mrem (60 µrem)
- Porcelain crowns/dentures 0.07 mrem (70µrem)

- Jet plane travel 0.5 mrem per hour in air
  (Seattle to NY ~ 3.4 mrem)
- Computer screen/TV 1 mrem
- X-ray (extremities) 1 mrem
- X-ray (chest) 6 mrem

- Stone, brick, concrete 7 mrem
- Cosmic space radiation 26 mrem
- Food and water 40 mrem
- Terrestrial radiation (Continental US) 63 mrem
- X-ray (pelvis) 65 mrem

- Naturally-occurring radon 200 mrem (0.2 rem)
- X-ray (Upper GI) 245 mrem (0.245 rem)
- Cigarettes (1 pack per day) 1300 mrem (1.3 rem)

The average annual dose per person from just environmental sources is about 360 mrem per year, 81% of which comes from natural sources of radiation. It is not, however, uncommon for persons to receive far more than that in a given year (largely due to medical procedures such as X-rays and CAT scans).

The human body largely has mechanisms for absorbing this dose with minimal risk of long-term negative effects.

Ultra Radiac Summary

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- Understand capabilities, limitations, uses
- Recognize components, controls, indicators
- Perform basic operation
- Understand operator maintenance