SAN FRANCISCO FIRE DEPARTMENT
DIVISION OF TRAINING

TRAINING BULLETIN

TRAINING BULLETIN 19-2

CANBERRA PERSONAL RADIATION DETECTORS (PRD)

CANBERRA PERSONAL RADIATION DETECTORS
TRAINING BULLETIN 19-2

PURPOSES

- To familiarize personnel with the CANBERRA UltraRadiac™ Personal Radiation Detector (PRD)
- To provide directives for daily operational checks to be performed by personnel
- To provide action guidelines for use of the UltraRadiac™ PRD in the field

DEFINITIONS

Dose The total amount of radiation received. Also called Accumulated Dose. (Odometer)

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

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

rem Roentgen Equivalent Man. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray or gamma-ray exposure

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

Stay Time How much time remains in minutes, 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 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 prior to distribution. They are not programmable by field 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.

Every Engine, Truck and Rescue Squad will be issued an UltraRadiac™.

Support Services shall conduct periodic calibrations and maintain spares for units failing Daily Operations Checks.

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 (3 to 5 times backround)
- High Rate Alarm set at 2 mR/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

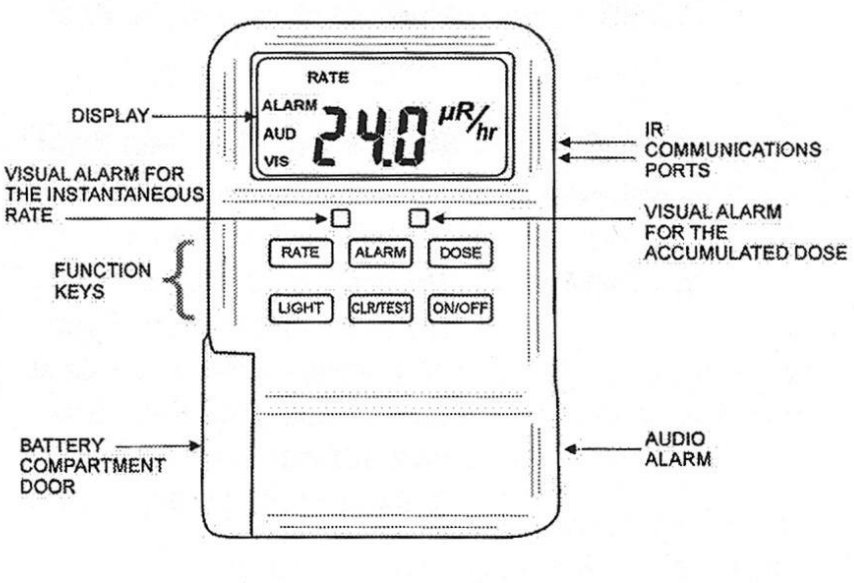


Figure 1 – The UltraRadiac™ Front Panel

The Function Keys

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

[DOSE] Press to select Dose Mode (default ON mode is RATE). Current accumulated dose is displayed in R.

[RATE] Press to select Rate Mode from Dose Mode. Current Rate is displayed in R/hr.

[ALARM] Press to see the Stay Time. (Stay Time is 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 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

- Periodic maintenance and calibration of the UltraRadiac™ PRDs will be handled by Support Services.
- Companies will perform Operational Checks on the units assigned to them daily.
- PRDs failing a Daily Operational Check shall be reported to Support Services immediately.

1. Check the calibration due date if it is within 30 days of expiration
   - coordinate with Support Services for transfer of unit for 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).

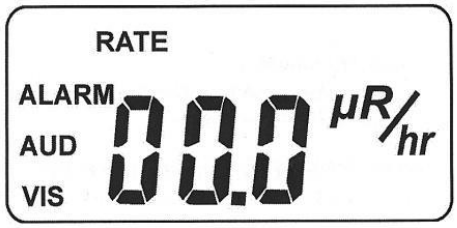


Figure 2 – The Rate Display

   - **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. In Dose Mode the word **DOSE** is displayed at the top right of the screen (Figure 3)

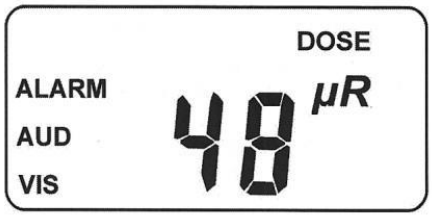


Figure 3 – The Dose Display

Press the **[RATE]** key to switch to Rate Mode. In Rate Mode the word **RATE** is displayed at the top left of the screen

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.

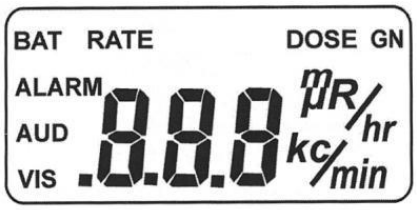


Figure 4 – The Test Display

During the CLR/TEST sequence of numbers:

- Press the **[RATE]** key – the audio alarm should sound and the Rate LED (left square below the display) should turn on.
- Press the **[DOSE]** key – the audio alarm should sound and the Dose LED (right square below the display) should turn on.
- Press the **[ALARM]** key – the audio alarm should sound and both LEDs should turn on.
- Once the alarms have been tested the sequence will start again.
- A set of numbers in the following order will appear. Check that all the numbers are displayed exactly as shown in Figure 5.

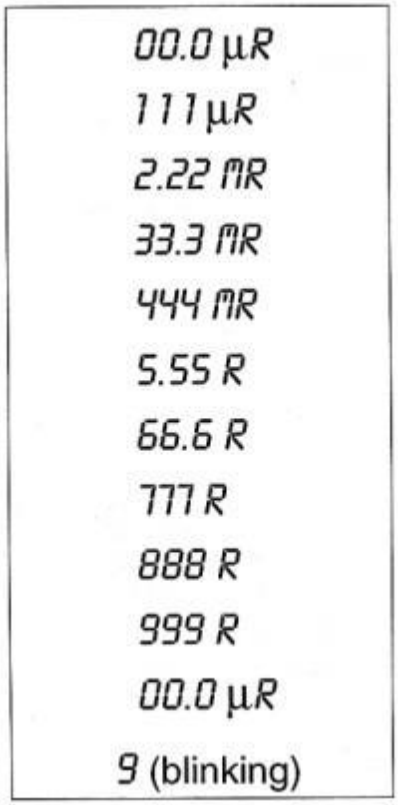


Figure 5 – Test Sequence

- The blinking 9 at the end of the sequence indicates that the unit passed all self-tests. A blinking 0 indicates a failure; contact Support Services 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. I**MPORTANT: Clear the accumulated dose each day during Daily Operational Check!** Press and hold **[DOSE]** and **[CLR/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

The UltraRadiac™ gives field personnel an additional tool to not only facilitate better recognition of radiological incidents, but to enhance participation in monitoring radiological incidents, making the scene safer for personnel. Field personnel – the most likely to recognize 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 radiological dispersal device. Place, time, occupancy, and other clues to the origin of an explosion will determine appropriate 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.

The PRD shall be stowed on the apparatus with power off.

CAUSES AND REASONS TO TURN ON PRD

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

- Haz-Mat incidents
- Responding to known radiological hazard sites (e.g. hospitals, cancer-care units, industrial sites, universities)
- 3rd party parcel transportation accidents (e.g. USPS, UPS, FedEX)
- Where NFPA 704 placards are involved
- Suspicious packages
- Responding to unexplained detonations (assume RDD) or any other inexplicable circumstances: USE GOOD SENSE
- Elevated Threat Level (local/national)
- Directed by a Chief Officer

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 field units is set at 100 µR/hr. Note that this is still a very small amount of radiation: 100 times less than the rate at which field personnel will be directed to turn back (10 mR/hr). See Appendix I 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 legitimate explanation for using a radioactive source (e.g. hospitals, labs, medical treatment centers, patients receiving radiation treatments/therapy)?
- 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, un-placarded vehicles, unattended packages)?

A verified Low-Level Rate Alarm (100 µR/hr) indicates an abnormal presence of radiation. If no reasonable explanation exists, make proper notifications up the chain of command. Do not initiate an investigation that could involve a possible confrontation with anyone without consulting the Subject Matter Expert (Battalion 2).

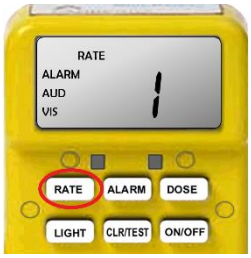
If initial readings send the PRD into High Rate Alarm (2 mR/hr) immediately, make proper notifications up the chain of command.

Localize

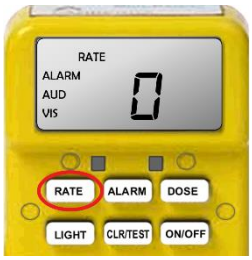
- By default, the PRD works in “silent mode”, visually and audibly alarming only when set rates and doses are achieved.
- “Source Finder Mode” activates an audible “ticking” which increases and decreases in frequency depending on the proximity of the Rad source.

Activating “Source Finder Mode”:

Holding down the rate button toggles the PRD from normal operation to Finder Mode.
A flashing “1” indicates Finder Mode is ON



A flashing “0” indicates Finder Mode is OFF (Normal Operation)



A verified alarm requires further investigation. Recall that the Low Alarm for the UltraRadiac™ is set at 100 µR/hr. Also recall that the safe general work Rate limit is determined to be 10 mR/hr, 100 times higher. Crews will have plenty of time in range to attempt to localize the source of the material before being required to turn back – localizing the source 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.).
- Use the PRD to determine safe routes of travel through a possible radiation field.
- **DO NOT use a PRD to attempt Technician-level identification or to mitigate.**

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 “home in” on the source. Caution must be taken to give the unit time to catch up to your forward motion. Crews should keep records of their progress. Use as much detail as possible to map your localization survey.

Localization surveys shall be conducted up to the point that a PRD reports 10 mR/hr
The result of the localization process is the identification and approximate direction towards the radioactive source. Once the environment is surveyed, “safe corridors” to victims can be mapped out. The localization process also develops valuable information pointing to the origin of the radioactivity, dissemination of the radioactivity, and contamination of the surrounding area.

Always remember that you may continue to safely move closer towards the source during a localization survey until the PRD detects rates at 10 mR/hr. If this happens, backtrack to the safe area (where the rate is below 10 mR/hr).

Measure

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

- Without exceeding 10 mR/hr, 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; consider your tactical objectives
  - If conducting a localization survey, turn back
  - Isolate and deny entry
- 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.

If you are unable to measure due to above conditions, report the following 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.

Important Note: The "Turnback Rate" of 10 mR/hr applies to crews conducting localization operations. However, personnel may work in a higher field to achieve important tactical objectives. Equipped with a PRD crews can have more confidence and better information to guide them toward the safe completion of high-value objectives. Life-safety operations and other high-value mission-specific objectives can safely be performed at rates greater than 10 mR/hr with proper monitoring and planning. 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 (may be 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. Crews must at all times practice the ALARA Principle (As Low As Reasonably Achievable) and at no time should crews exceed the 25 rem OSHA exposure limits for life safety actions. 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 responders while safely performing their duties at emergency scenes. As with any other operation, no one tool can replace proper planning, monitoring and judiciousness. Understanding the abilities and the limitations of the PRD will help responders make more informed decisions when dealing with a radiological event. Performing the daily operations check and regularly practicing with the UltraRadiac™ will foster familiarity with the instrument. Understanding the basic principles governing radiological response: Time; Distance; and Shielding, along with instrument familiarity will be life savers should you be called upon to assist the HazMat team at an actual radiological incident.

APPENDIX I

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 II

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.

APPENDIX III

CANBERRA ULTRARADIAC
DAILY CHECK SHEET

All companies will perform Daily Operational Checks on the UltraRadiac™ PRD units assigned to them.

1. Check the calibration due date. If calibration is within 30 days of expiration, coordinate with Support Services 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.
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.
   - The unit will start counting and displaying the instantaneous Rate.
4. 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.
   - Press the RATE key to switch to Rate Mode.
5. While in Rate Mode, press and hold the CLR/TEST key until you see the test display (approximately four seconds), and release the key.
   - A set of numbers in order will appear. Check that all of the numbers are exactly as shown
   - 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.
   - A blinking *9* indicates that the unit passed all self-tests. A blinking *0* indicates a failure; contact Support Services immediately to arrange replacement.

6. Press the LIGHT key; the display's backlight will turn on for about 5 seconds.
7. **IMPORTANT: CLEAR ACCUMULATED DOSE EACH DAY AT CHANGE OF SHIFT!** 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.
8. Press and hold the ON/OFF key.
   - – – – will then be displayed. Release the ON/OFF key; the unit will power off.

When To Use It:

- Haz-Mat Involvement
- Responding to known HazMat incidents or to known hazard sites (for example hospitals, cancer-care units, industrial sites, universities, etc.)
- Transportation accident (USPS, UPS, FedEX)
- Where placards are involved
- Suspicious package
- Responding to unexplained detonations (assume RDD) or any other inexplicable circumstances: USE COMMON SENSE
- Elevated Threat Level (local/national)
- Directed by a Chief Officer

Operational Reminders:

- Power on the PRD and clear any accumulated Dose every day.
- Crews are directed to not go beyond the 10 mR/hr threshold while **surveying**.
- Operations and other high-value mission-specific objectives can still be performed at higher rates with commonsense precautions. OSHA specifies the following lifetime exposure limits for emergency workers in radiation fields:
    - 5 rem any work
    - 10 rem to protect property
    - 25 rem to protect life (exceed voluntarily with knowledge of risks)
- 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).

Dead Battery: If no display is shown after pushing the Run button in Idle mode, a new battery may be needed. Replace the battery and push the "Run" button. The previous alarm settings will still be set.

Monthly Checks: The dosimeters should be checked monthly to make sure the batteries are still good. Each team will be responsible for the battery checks.

Decontamination: If no dosimeters enter a contaminated area where there has been a release of radioactive particulates, the dosimeters can be decontaminated using a wet cloth. Do not immerse the dosimeter in water.

San Francisco Fire Department
Division of Training
Training Bulletin Index

90-7 Roof Ventilation Utilizing the XL-98
91-5 Elevator Rescue
93-1 Civil Disturbance Operations
93-2 Safety Considerations, XL-98
93-3 MRI Systems Safety
95-3 Size Up
95-7 Garage Door Precautions and Forcible Entry
96-3 Confined Space Operating Guidelines
96-5 Occupational Safety
97-1 Instructional Methodology
97-4 Electrically Powered Vehicles
02-1 Bomb & Bomb Threat Procedures
04-2 Safe Haven for Newborns
07-2 End-Tidal CO_2 Monitor Device
13-1 Incident Support Crew
18-1 Siemens LRV4 Safe Lifting Guide
18-2 Portable Radio Training
19-1 Thermal Imaging Cameras
19-2 Canberra Personal Radiation Detectors