Radalert 100

Nuclear Radiation Monitor

Operating Manual

Contents

1 Introduction

The Radalert™ 100 is a health and safety instrument that measures alpha, beta, and gamma radiation. With the Radalert 100, you can:

- Monitor possible radiation exposure while working near radionuclides
- Ensure compliance with regulatory standards
- Check for leakage from X-ray machines and other sources
- Set the alert level and use the Radalert 100 in Alert mode; if the radiation goes above the level you set, the alert beeper sounds to let you know
- Screen for environmental contamination or environmental sources of radioactivity
- Connect the Radalert 100 to a computer or data logger to record and tabulate your data

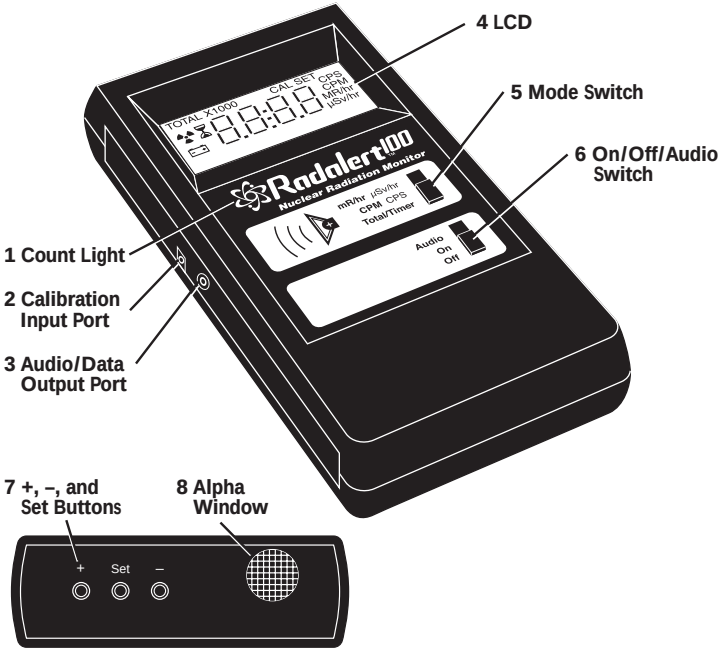
This manual gives complete instructions for using the Radalert 100 and procedures for common applications.

How the Radalert 100 Detects Radiation

The Radalert 100 uses a Geiger-Mueller tube to detect radiation. The Geiger tube generates a pulse of electrical current each time radiation passes through the tube and causes ionization. Each pulse is electronically detected and registers as a count. The Radalert 100 displays the counts in the mode you choose: counts per minute (CPM), milliroentgens per hour (mR/hr), or total counts for a timed period. In SI units, counts per second (CPS) and microsieverts per hour (μSv/hr) are used.

2 Features

The Radalert 100 measures alpha, beta, gamma, and x-ray radiation. This chapter briefly describes the Radalert 100's functions. For more information on how to use the Radalert 100, see Chapter 3, "Operation."

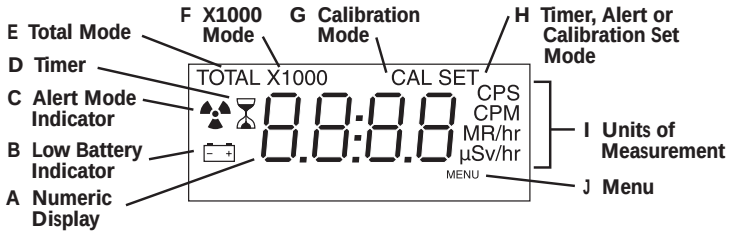


The Radalert 100 counts ionizing events and displays the results on the liquid crystal display (LCD) (**4**). You control which unit of measurement is shown by using the mode switch.

Whenever the Radalert 100 is operating, the red **count light** (**1**) flashes each time a count (i.e., an ionizing event) is detected.

The Display

Several indicators on the LCD show information about the mode setting, the current function, and the battery condition.



- The **numeric display** (**A**) shows the current radiation level in the unit specified by the mode switch setting.
- A small **battery** (**B**) appears to the left of the numeric display to indicate low battery voltage.
- A **radiation symbol** (**C**) appears when the Alert feature is on.
- An **hourglass** (**D**) appears to the left of the numeric display during a timed count.
- **TOTAL** (**E**) appears when the Radalert 100 is in Total mode.
- **X1000** (**F**) appears when the radiation level is displayed in X1000 mode.
- **CAL** (**G**) appears while you are calibrating the Radalert 100.
- **SET** (**H**) appears when you are setting the timer, the Alert level, or the calibration factor, or working in the Utility Menu (the numeric display shows the setting you are adjusting instead of the current radiation level).
- The current **unit of measurement** (**I**) – **CPM, CPS**, **mR/hr** or **µSv/hr** – is displayed to the right of the numeric display.

- **MENU** (**J**) appears when you are in the Utility Menu.

The Switches

The Radalert 100 has two switches on the front, and three buttons on the end panel. Each switch has three settings, which are described below.

On/Off/Audio Switch (6)

Audio. The Radalert 100 is on, and it makes a clicking sound for each radiation event detected.

On. The Radalert 100 is operating, but audio is off.

Off. The Radalert 100 is not operating.

Mode Switch (5)

mR/hr µSv/hr. The LCD shows the current radiation level in milliroentgens per hour from .001 to 110 or, when SI units are used, in microsieverts per hour from .01 to 1100.

CPM CPS. The LCD shows the current radiation level in counts per minute from 0 to 350,000 or, when SI units are used, in counts per second from 0 to 3,500. When **X1000** is shown, multiply the numeric reading by 1000 to get the complete reading.

Total/Timer. The display shows the accumulated total of counts starting when the switch is turned to this position, from 0 to 9,999,000. When **X1000** is shown, multiply the numeric reading by 1000 to get the complete reading.

+, -, and SET Buttons (7) (on the end panel)

+ and – Buttons: These are used to adjust the numeric display for timed counts, alert settings, and calibration settings, and to scroll through the Utility Menu.

Set Button: This is used to set the alert, to set the correct calibration reading, and to select items in the Utility Menu.

For more information, see “Taking a Timed Count,” “Using the Alert,” and “The Utility Menu” in Chapter 3 and “Calibration” in Chapter 5.

The Detector

The Radalert 100 uses a Geiger tube to detect radiation. Alpha radiation does not penetrate most solid materials, so this Geiger tube has a thin disk of mica, which alpha radiation can penetrate, on its end. The screened opening at the top of the Radalert 100 is called the **alpha window** (**8**). It allows alpha and low-energy beta and gamma radiation to penetrate the mica end of the tube.

CAUTION: *The mica end surface of the Geiger tube is fragile. Be careful not to let anything penetrate the screen.*

The Ports

There are two ports on the left side of the Radalert 100.

The **calibration input port (2)** is used for calibrating electronically using a pulse generator. For more information, see “Calibrating Electronically” in Chapter 5.

The **output port (3)** below the calibration input port allows you to interface the Radalert 100 to a computer, data logger, earphones, or other device using a 3.5 mm stereo plug. For more information, see “Interfacing to an External Device” in Chapter 3.

3 Operation

The guidelines in this chapter describe how to use the Radalert 100.

Units of Measurement

The Radalert 100 is designed both for users of conventional units (milliroentgens per hour and counts per minute) and for users of SI units (microsieverts per hour and counts per second). To switch between conventional and SI units, use the Utility Menu. See "The Utility Menu" in this chapter.

Starting the Radalert 100

Be sure that a standard 9-volt alkaline battery is installed in the battery compartment in the lower rear of the Radalert 100. *Note:* When installing the battery, place the battery wires along the side of the battery and not under it.

To start the Radalert 100, set the top switch to the mode you want, and set the bottom switch to **On** or **Audio**. The Radalert 100 then does a four-second system check, displaying all the indicators and numbers.

After the system check, the radiation level is displayed in the selected mode. One minute after you start the Radalert 100, a short beep indicates that enough information has been collected to ensure statistical validity.

Operating Modes

When the mode switch is set to **mR/hr** or **CPM**, the numeric display is updated every three seconds. At low count rates, significant changes in the radiation level displayed can take up to one minute to stabilize. See "Operating Ranges and Response Times" in this chapter for more information.

CPM (or CPS) and timed total counts are the most direct methods of measurement; mR/hr (or µSv/hr) is calculated using a conversion factor optimized for Cesium-137, so this mode is less accurate for other radionuclides unless you have calibrated the instrument for a specific radionuclide using an appropriate source. It is more appropriate to measure alpha and beta activity using CPM than using mR/hr. Conversion for alpha and beta emitters is calculated differently, and the Radalert 100's reading in mR/hr may not be accurate.

The most immediate indicators of the radiation level are the count light, the audio beep, and the alert. It takes three seconds before an increase is shown on the numeric display in the dose rate modes.

Taking a Timed Total Count

The Radalert 100 can give you a total count for a timed period of from one minute to 40 hours.

A timed total count is useful for determining the average counts per minute over a period of time. The number of counts detected by the Radalert 100 varies from minute to minute due to the random nature of radioactivity. When a count is taken over a longer period, the average count per minute is more accurate, and any small increase is more significant.

Taking an average allows you to detect low-level contamination or differences in background radiation due to altitude or soil mineral content, and can be useful for educational purposes. For example, if one 10-minute average is one count higher than another 10-minute average, the increase may be due to normal variation. But over 12 hours, a one-count increase over the 12-hour background average is statistically significant.

To take a timed count, follow these steps:

1. With the Radalert 100 operating, set the Mode switch to **Total**. The display shows **SET**, the hourglass, and the most recent timing period used. The first time you use the timer, the setting is 00:01, which means one minute.

2. Use the + and – buttons to set the timing period. The timed period can be for 1 to 10 minutes in one-minute increments, for 10 to 120 minutes in ten-minute increments, or for 2 to 40 hours in one-hour increments.

3. Press the Set button. The Radalert 100 starts totaling the counts it registers, and the numeric display is updated each time a count is registered. The hourglass indicator flashes during the timed period.

   During the counting period, if you want to see how many minutes remain, press the Set button. The display counts down from the time setting in hours and minutes to zero. For example, if the display shows 00:21, 21 minutes remain.

4. At the end of the timed period, the Radalert 100 beeps three times, and repeats the beeping several times. The number displayed is the total count.

5. To find the average dose rate for the timed period, divide the total by the number of minutes.

   The average count is in counts per minute. To convert to mR/hr for Cesium-137, divide by 1000.

6. Move the Mode switch to one of the dose rate modes to return to normal operation.

If you move the Mode switch to one of the dose rate modes while the Radalert 100 is taking a timed count, the timed count will stop.

Operating Ranges and Response Times

The following table shows the radiation levels the Radalert 100 measures in each mode and how they are displayed. In some modes, when radiation levels increase over certain preset levels, the Radalert 100 uses autoranging, automatically changing to the X1000 scale. Whenever **X1000** is shown above the numeric display, multiply the displayed reading by 1000 to determine the radiation level.

Mode	Regular Range	X1000 Range
mR/hr	.001-110	NA
µSv/hr	.01-1100	NA
CPM	0-9999	10,000-350,000 (displayed as 10.00-350, with X1000 indicator)
CPS	0-3500	NA
Total/Timer	0-9999	10,000-9,999,000 (displayed as 10.00-9999, with X1000 indicator)

Maximum level. When the maximum level for the current mode is reached, the Radalert 100 beeps for three seconds, pauses for three seconds, and repeats that pattern. The numeric display flashes. The beeping pattern and the flashing continue until the level decreases or the Radalert 100 is turned off.

Display update and response time. In Total mode, the numeric display is updated each second. In the dose rate modes, the numeric display is updated every three seconds. When the radiation level is less than 1,000 CPM, the reading in any of the dose rate modes is based on the radiation detected in the immediately previous minute. In order to give a quicker response to changes, when the radiation level exceeds 1,000 CPM, the reading is based on the previous 3 seconds, as shown in the following table. This automatic change in response time is called auto averaging.

Radiation level	Basis for reading
< 1000 CPM or 1 mR/hr	1 minute
> 1000 CPM or 1 mR/hr	3 seconds

Note: You can set the response time to 3 seconds at all radiation levels using the Utility Menu; see "The Utility Menu" in this chapter.

Using the Alert

The Radalert 100 can sound an audible alert whenever the radiation reading reaches a certain level. The three buttons on the end of the Radalert 100 allow you to turn Alert mode on and off and to set the alert levels.

To use Alert mode, follow these steps:

1. Press the Set button on the end panel. The numeric display shows the current alert level (in CPM, CPS, mR/hr, or µSv/hr, depending on the current settings). The radiation symbol and **SET** icon are also displayed.
2. To change the displayed alert level, use the + and – buttons to adjust the level up or down.
3. When the desired alert level is displayed, press the Set button again to save the new level and to continue in Alert mode (the **SET** icon is no longer displayed).

   The radiation symbol is displayed to show that the Radalert 100 is in Alert mode.
4. If you want to reset the alert level while you are in Alert mode, press the Set button twice (Off, then Set), and repeat #2 and #3.
5. To turn off Alert mode, press the Set button once.

When you start Alert mode, the Radalert 100 restarts counting.

When you first start the Radalert 100, the alert levels are preset at .10 mR/hr, and the equivalent in CPM, µSv, and CPS. If you set the alert level in one mode, the settings for the other modes are automatically updated to the equivalent values. When you change to or from SI units, the alert level is reset to the defaults.

The best alert level is one that rarely gives a false alarm, yet warns you when the radiation is higher than normal.

The Utility Menu

The Utility Menu allows you to change the default settings for several operating parameters. A new setting remains in effect until changed again through the Utility Menu.

- To activate the Utility Menu, hold down the + button on the end panel while you turn on the Radalert 100; the word **MENU** will appear at the bottom right of the numeric display. When you release the + button, a 1 (indicating menu option 1) will appear above **MENU**.
- Scroll through the menu by pushing the + or – buttons.
- To select an option, push the Set button. Use the + and – buttons to toggle between choices, and press the Set button again to enter the chosen value.
- To exit the Utility Menu at any time, select option 0. The Radalert 100 continues with the normal start-up routine.

The options are:

0 **Resume normal operation.**

1 **Auto Averaging. on** (the default) selects Auto averaging; **oFF** selects 3-second (fast response) averaging at all radiation levels.

2 **Units of measurement. CPM mR/hr** selects counts per minute and milliroentgens per hour; **CPS µSv/hr** selects counts per second and microsieverts per hour.

3 **Cal 100 Reset.** Automatically resets the calibration factor to 100 and restarts the instrument.

4, 5, 6 Reserved for future options.

7 **Cal Factor Adjust.** Displays the current calibration factor and allows this factor to be adjusted. See "Calibration" in Chapter 5.

8 **Factory Default Reset.** Automatically resets to Auto averaging, CPM and mR/hr, and CAL 100.

9 **Revision #.** Displays the software version number.

Interfacing to an External Device

The lower output jack on the left side of the Radalert 100 is a dual miniature jack that provides a data output that can be used to drive external devices. You can use it to record the counts on a computer, data logger, or accumulating counter. Use a 3.5 mm stereo plug to access this port.

The outputs provide a positive pulse (9 volt peak, 1 kOhm impedance) each time the Geiger tube detects a count. At the tip of the plug, the pulse is approximately 1mS wide and is well suited for chart recorders and audio output. The ring signal is approximately 80µS wide and is suitable for high speed counting and RS-232 interfacing.

A cable with an RS-232 connector (capacitor coupled) for an IBM PC-compatible computer serial port and accompanying software are available from International Medcom. For 4.5V logic compatible output, externally connect a 1 kOhm resistor from the output to ground. A standard stereo or mono headphone can be plugged directly into the jack. For some types of headphone, external volume control may be needed.

4 Common Procedures

The following sections give guidelines for several commonly-used procedures. With any procedure, the user must determine the suitability of the instrument or procedure for that application.

Establishing the Background Count

Normal background radiation levels vary at different locations, according to altitude and other factors, such as types of minerals in the ground. Levels vary at different distances from the ground, and may differ even in different areas of the same room. To accurately interpret the readings you get on the Radalert 100, it is a good idea to establish the normal background radiation level for each area you plan to monitor. You can do this with a total / timed count. Use the steps shown in "Taking a Timed Total Count" in Chapter 3 to get a ten-minute average.

A ten-minute average is moderately accurate. You can repeat it several times and see how close the averages are. To establish a more accurate average, take a one-hour count. In some locations, you may want to take a longer count (for example, 12 hours). If you need to determine whether there is prior contamination, take averages in several locations and compare the averages.

Environmental Area Monitoring

You can keep the Radalert 100 in CPM or mR/hr mode whenever you want to monitor the ambient radiation, and look at it from time to time to check for elevated readings. You can also use Alert mode to warn you if the radiation increases above the alert level.

Note: CPS mode is not recommended for monitoring ambient radiation due to inadequate resolution.

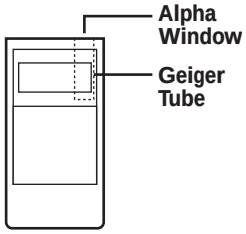
If you suspect an increase in ambient radiation, use the timer to take a five or ten minute count, and compare the average to your average background count. If you suspect an increase that is too

small to detect with a short timed reading, you can take a longer count (for example 6, 12, or 24 hours).

Checking an Object

To check an object, place the Radalert 100 next to it with the end window facing and near the object; otherwise you may miss alpha and low-level beta radiation. To determine if an object is slightly radioactive, place the Radalert 100 next to it and take a timed count over an appropriate period of time.

When not using the end window, hold the Radalert 100 so that the side wall of the tube is as close as possible to the object. The best position is with the top right corner of the back of the Radalert 100 closest to the object.



Position of Geiger tube

To measure as much as possible of the radioactivity of an object, place the Radalert 100 as close as you can without touching the object. The radiation level for gamma radiation from a localized source decreases according to the inverse square law. If you move to twice the distance from the object, the radiation drops by a factor of four.

CAUTION: Never touch the Radalert 100 to an object that may be contaminated. You may contaminate the instrument. A contaminated instrument will not be accepted for repair or servicing.

5 Maintenance

The Radalert 100 should be handled with care and can be calibrated as necessary to comply with regulations. Use the following guidelines to maintain the Radalert 100 properly.

Calibration

The Radalert 100 should be calibrated as often as your regulations require. The best way to calibrate is using a calibrated source. If no source is available, it is possible to calibrate electronically using a pulse generator.

The standard radionuclide for calibration is Cesium-137. A certified calibration source should be used. To calibrate the Radalert 100 for another radionuclide, you must use a calibrated source for that radionuclide or the appropriate conversion factor referenced to Cs-137.

CAUTION: *In calibration mode, the smallest increment that can be adjusted is .001, which prevents fine adjustment of the calibration factor. Thus, errors can occur if you use a low-level source or background to set the calibration factor.*

Calibrating Using a Source

Before you calibrate the Radalert 100, make sure the distance between the Radalert 100 and the source is correct to produce the appropriate dose rate. Place the Radalert with the end panel facing the source and the center of the alpha window aligned with the center of the source. When using Cs-137 for gamma calibration, place the Radalert with the rear of the instrument facing the source (to filter the beta emissions through the metal tube wall) and the center of the Geiger tube (indicated by the center of the atom on the rear label) aligned with the center of the source.

Follow these steps:

1. Start with the Radalert 100 turned off and the Mode switch set to **mR/hr.**

2. Hold down the – button on the end panel while you turn the On/Off/Audio switch to **On**. (Don't use the **Audio** setting.)

   The display shows **CAL**, and the Radalert 100 counts down for 15 seconds, beeping each second. This delay gives you a chance to move out of the field and then expose the source. At the end of the 15 seconds, the Radalert 100 beeps several times.

3. The Radalert 100 collects data for 60 seconds, beeping as it does so, with **CAL** and the hourglass indicator flashing. At the end of the 60 seconds, it beeps several times. The display shows **CAL** and **SET**. You can now seal or close the source.

4. Press the + and - buttons to adjust the reading to what it should be. When the reading is correct, press the Set button. The new calibration factor is automatically calculated from the adjustment you make.

5. The new calibration factor is displayed for several seconds, then the Radalert 100 beeps and resumes regular operation.

The calibration factor is set to 100 (percent) at the factory. If you change the reading, for example, to 20% higher than the factory reading, the new calibration factor would be 120. The current calibration factor is displayed during the system check when the Radalert 100 is first turned on.

Calibrating Electronically

You can calibrate electronically using a pulse or function generator. Electronic calibration requires a cable with a 2.5 mm plug, with the tip carrying the signal. Follow these steps:

1. Set the signal height to 3.3 volts (positive pulse) and the pulse width to 80 microseconds.

   CAUTION: *Do not inject a pulse when the Radalert 100 is turned off. Do not exceed 5 volts.*

2. Plug the cable into the upper jack.

3. Use the following table to check the Radalert 100's accuracy. The table shows appropriate pulse generator count rates to calibrate for Cs-137. If the accuracy is not within desired limits, follow steps 4-7. Note that the Radalert 100 automatically compensates for lost counts due to GM tube dead time. Thus, the display reading in CPM mode does not equal the input frequency. You can display uncompensated counts in CPM mode by continuously holding down the – button; the reading now corresponds to the input frequency.

4. Start with the Radalert 100 turned off and the Mode switch set to **mR/hr.** Hold down the – button on the end panel while you turn the On/Off/Audio switch to **On**. (Don't use the **Audio** setting.)

   The display shows **CAL**, and the Radalert 100 counts down for 15 seconds, chirping each second. At the end of the 15 seconds, the Radalert 100 beeps several times.

5. The Radalert 100 collects data for 60 seconds, beeping as it does so, with **CAL** and the hourglass indicator flashing. At the end of the 60 seconds, it beeps several times. The display shows **CAL** and **SET**.

Pulse Generator Input (PPM)	CPM	mR/hr	µSv/hr	CPS
9,778	10,000	10	100	167
19,133	20,000	20	200	333
44,910	50,000	50	500	833
67,720	80,000	80	800	1333
81,522	100,000	100	1,000	1667

6. Press the + and - buttons to adjust the reading to what it should be. When the reading is correct, press the Set button. The new calibration factor is automatically calculated from the adjustment you make.
7. The new calibration factor is displayed for several seconds, then the Radalert 100 beeps and resumes regular operation.

Precautions

To keep the Radalert 100 in good condition, handle it with care and observe the following precautions:

- Do not contaminate the Radalert 100 by touching it to radioactive surfaces or materials.
- Do not leave the Radalert 100 in temperatures over 122° F (50° C) or in direct sunlight for extended periods of time.
- Do not get the Radalert 100 wet. Water can damage the circuitry and the coating of the mica surface of the Geiger tube.
- Avoid making measurements with the detector window in direct sunlight if the mica surface of the Geiger tube has been damaged by moisture or abrasion; this could affect the readings.
- Do not put the Radalert 100 in a microwave oven. It cannot measure microwaves, and you may damage it or the oven.
- If you expect to not use the Radalert 100 for longer than one month, remove the battery to avoid damage from battery corrosion.
- Change the battery promptly when the battery indicator appears on the display.

Troubleshooting

The Radalert 100 is a highly reliable instrument. If it does not seem to be working properly, look through the following chart to see if you can identify the problem.

Problem	Possible Cause	What to Check
Display is blank	battery: dead, missing, or poor connection	install and firmly connect a new 9-volt battery
	broken LCD	if count light and audio work, the LCD may need to be replaced
Display works, but no counts are registered	damaged Geiger tube	if mica surface of the tube has wrinkles or visible breaks, it needs to be replaced
Reading is high, but another instrument has a normal reading in the same location	contamination	scan Radalert 100 with another instrument; clean instrument with a damp cloth and mild detergent
	moisture	the circuit board may be wet; dry the instrument in a warm dry place; if it still has a problem, it requires factory service

Problem	Possible Cause	What to Check
Instrument has false high reading	photosensitivity	remove from direct sunlight and ultraviolet sources; if the high count drops, the mica coating on the Geiger tube may be damaged and the tube needs to be replaced
	continuous discharge	the Geiger tube needs to be replaced
	electro-magnetic field	move the instrument away from possible sources of electromagnetic or radio frequency radiation

If the Radalert 100 requires servicing, please contact your distributor or the manufacturer at the following address:

International Medcom
6871 Abbott Ave.
Sebastopol, CA 95472
707-823-0336, fax 707-823-7207

Do not attempt to repair the Radalert 100; it contains no user-serviceable parts and you could void your warranty.

CAUTION: *Do not send a contaminated instrument for repair under any circumstances.*

6 Basics of Radiation and Its Measurement

This chapter briefly tells what radiation is and how it is measured. This information is provided for users who are not already familiar with the subject. It is helpful in understanding how the Radalert 100 works and in interpreting your readings.

Ionizing Radiation

Ionizing radiation is radiation that changes the structure of individual atoms by ionizing them. The ions produced in turn ionize more atoms. Substances that produce ionizing radiation are called radioactive.

Radioactivity is a natural phenomenon. Nuclear reactions take place continuously on the sun and all other stars. The emitted radiation travels through space, and a small fraction reaches the Earth. Natural sources of ionizing radiation also exist in the ground. The most common of these are uranium and its decay products.

Ionizing radiation is categorized into four types:

X-rays are usually manmade radiation produced by bombarding a metallic target with electrons at a high speed in a vacuum. X-rays are electromagnetic radiation of the same nature as light waves and radio waves, but at extremely short wavelength, less than 0.1 billionth of a centimeter. They are also called photons. The energy of X-rays is millions of times greater than that of light and radio waves. Because of this high energy level, X-rays penetrate a variety of materials, including body tissue.

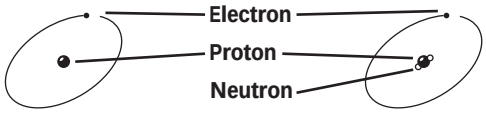
Gamma rays occur in nature and are almost identical to X-rays, but generally have a shorter wavelength than X-rays. Gamma rays are very penetrating; thick lead shielding is generally required to stop them.

Beta radiation. A beta particle consists of an electron emitted from an atom. Beta particles penetrate matter less deeply than gamma or X-rays, but they are biologically significant because they can be more effective than gamma radiation at disrupting cellular material.

Alpha radiation. An alpha particle consists of two protons and two neutrons, the same as the nucleus of a helium atom. It generally can travel no more than 1 to 3 inches in air before stopping, and can be stopped by a piece of paper.

When an atom emits an alpha or beta particle or a gamma ray, it becomes a different type of atom. Radioactive substances may go through several stages of decay before they change into a stable, or non-radioactive, form.

An element may have several forms, or isotopes. A radioactive form of an element is called a radioisotope or radionuclide. Each radionuclide has a half-life, which is the time required for half of a quantity of the material to decay.



A hydrogen atom has one electron and one proton. The most common isotope has no neutrons and is stable.

Tritium is a radioactive isotope of hydrogen. It has two neutrons in its nucleus.

The following chart shows the complete decay chain for Uranium 238, which ends with a stable isotope of lead. Notice that the half-life of the radionuclides in the chain range from 164 microseconds to 4.5 billion years.

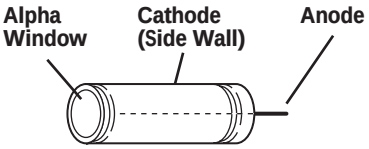
Isotope	Emits	Half-life	Product	
U-238	alpha	4.5 billion years	Th-234	Thorium
Th-234	beta	24.1 days	Pa-234	Proactinium
Pa-234	beta	1.17 minutes	U-234	Uranium
U-234	alpha	250,000 years	Th-230	Thorium
Th-230	alpha	80,000 years	Ra-226	Radium
Ra-226	alpha	1,602 years	Rn-222	Radon
Rn-222	alpha	3.8 days	Po-218	Polonium
Po-218	alpha	3 minutes	Pb-214	Lead
Pb-214	beta	26.8 minutes	Bi-214	Bismuth
Bi-214	beta	19.7 minutes	Po-214	Polonium
Po-214	alpha	164 micro-seconds	Pb-210	Lead
Pb-210	beta	21 years	Bi-210	Bismuth
Bi-210	beta	5 days	Po-210	Polonium
Po-210	alpha	138 days	Pb-206	Lead

Measuring Radiation

Alpha, beta, gamma, and x-rays ionize material they strike or pass through. The amount of radiation is generally determined by measuring the resulting ionization.

The Geiger tube used in the Radalert 100 consists of an anode (positive electrode) positioned in the center of a tubular cathode (negative electrode) filled with a mixture of argon, neon, and either chlorine or bromine gases. The cathode is a thin-walled metallic cylinder sealed at each end with an insulating disk to contain the gas. The anode is a wire that extends into the cylinder. A high voltage is applied to the electrodes to create an electrical field within the chamber. When radiation passes through the chamber

and ionizes the gas, it generates a pulse of current. The Radalert 100 electronically processes these pulses to display the radiation level.



Radiation Measurement Units

Several different units are used to measure radiation, exposure to radiation, and dosage.

A **roentgen** is the amount of X-radiation or gamma radiation that produces one electrostatic unit of charge in one cc of dry air at 0° C and 760 mm of mercury atmospheric pressure. The Radalert 100 displays readings in milliroentgens per hour (mR/hr). A milliroentgen is one one-thousandth of a roentgen.

A **rad** is the unit of exposure to ionizing radiation equal to an energy of 100 ergs per gram of irradiated material. This is approximately equal to 1.07 roentgen.

A **rem** is the dosage received from exposure to a rad. It is the number of rads multiplied by the quality factor of the particular source of radiation. The rem and millirem (one one-thousandth of a rem) are the most commonly-used measurement units of radiation dose in the U.S. One rem is generally considered to equal one rad.

A **sievert** is the standard international measurement of dose. One sievert is equivalent to one hundred rems. A microsievert (μSv) is one millionth of a sievert.

A **curie** is the amount of radioactive material that decays at the rate of 37 billion disintegrations per second, approximately the decay rate of one gram of radium. Microcuries (millionths of a curie) and picocuries (trillionths of a curie) are also often used as units of measurement.

A **bequerel** (Bq) is equivalent to one disintegration per second.

Higher Than Normal Readings

Due to the random nature of radioactivity, the Radalert 100 reading varies from minute to minute. In one location with only background radiation, the reading in mR/hr might vary from .007 to .018 in ten minutes and from .004 to .021 in an hour. Averages for both periods would be very close.

Normal radiation levels in different locations can vary greatly due to soil composition, altitude, and other factors. For example, normal background at 10,000 feet might be double that at sea level. On an airplane, the radiation at 35,000 to 40,000 feet may be as much as 30 to 50 times the normal level on the ground.

When monitoring radiation levels in one location, it is useful to determine the highest reading you can normally expect to see in that location. If you use Alert mode, you want to set the alert level to one that rarely gives a false alarm, yet sounds the alert when the radiation is higher than normal.

A single alert may occur occasionally and is not significant unless there is also an elevation in the average count. If you suspect an elevation and you have previously taken an average background count in the same location, you can take a total count to get the current average count for 30 minutes or another time period. You can then compare the current average to the previous average to see whether there is an elevation. See "Taking a Timed Total Count" in Chapter 3 for more information.

Appendix A
Technical Specifications

Sensor:	Halogen-quenched Geiger-Mueller tube with mica end window (LND 712 or equivalent). Mica window density 1.5-2.0 mg/cm^2. Side wall is .012″ #446 stainless steel.
Display:	4-digit liquid crystal display with mode indicators
Operating Range:	mR/hr: .001 to 110 CPM: 0 to 350,000 Total: 1 to 9,999,000 counts µSv/hr: .01 to 1100 CPS: 1 to 3,500
Energy Sensitivity:	1000 CPM/mR/hr referenced to Cs-137
Accuracy:	±10% typical, ±15% max. (mR/hr and µSv/hr modes)
Alert Range:	mR/hr: 0 to 50 CPM: 0 to 160,000 Beeper sounds the alert.
Count light:	Red LED flashes with each count
Beeper:	Chirps for each count (operational in audio mode only – can be muted)
Ports:	Dual miniature jack sends counts to CMOS-compatible devices, including computers, data loggers, earphones, and educational data collection systems. Submini jack provides calibration input.
Output:	Dual 3.5 mm jack provides output pulse for each count for interface to computers, data loggers, earphones, and educational

	data collection systems. 0-9 V, 1 kOhm impedance.
Calibration Input:	2.5 mm mono jack provides calibration input. 0-3.3 V, > 5 µs width, rising edge triggered.
Anti-Saturation:	"Jam" protection allows readout to hold at full scale in high radiation fields
Temperature Range:	-20° to +50° C , -4° to +122° F
Power:	One 9-volt alkaline battery; battery life is average 2160 hours at normal background, average 625 hours at 1mR/hr with beeper off
Size:	150 x 80 x 30 mm (5.9" x 3.2" x 1.2")
Weight:	225 grams (8 oz) including battery
CE Certifications:	Emissions: EN 55011:98 + A2 (Class B emissions limits); EN 61326: 98 (Class B) RF Emissions
	Immunity: EN 61326: 98 (Annex C) Portable Test and Measurement Equipment; EN 61000-4-2: 95 (ESD); EN 61000-4-3: 97 (EM); ENV 50204: 95

Warranty

This product is warranted to the original owner to be free from defects in materials and workmanship for one year from the date of purchase, except for the Geiger tube, which is warranted for 90 days. The battery is not included in the warranty. International Medcom will repair or replace your instrument if it fails to operate properly within this warranty period provided it has not been subjected to misuse, abuse, or neglect. Modification or repair of this instrument by anyone other than International Medcom voids this warranty. International Medcom is not responsible for incidental or consequential damages arising from the use of this instrument.

Contamination of the instrument with radioactive materials voids this warranty. Contaminated instruments will not be accepted for servicing at our repair facility.

The user is responsible for determining the usefulness of this product for his or her application.

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