Radalert

Nuclear Radiation Monitor
Operating Manual

Revised December, 1990.

Contents

1 Introduction

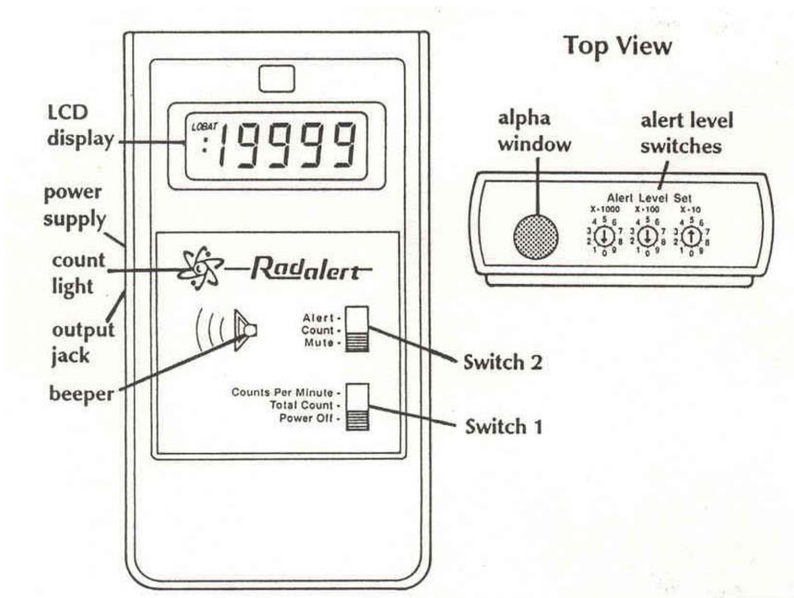
Congratulations! Now that you own the Radalert ™, you will never have to wonder whether you are being exposed to excess radiation. Just look at the LCD display and you can see immediately how the radiation level compares with the normal level. The Radalert is so compact that you can carry it with you anywhere. You can:

- Check your home or workplace for radioactive items--including clocks, static eliminators, and ceramicware.
- Check your workplace for leakage from X-ray machines or other sources.
- Detect routine emissions or leaks from nuclear power plants. Explore for deposits of radioactive minerals in the earth.
- Set the Radalert to Alert--if the radiation goes above a pre-set level, the alert beeper sounds to let you know. You can set the alert level wherever you want it.
- Connect the Radalert to a computer or data logger to record and tabulate your readings.

This manual gives complete instructions for using the Radalert and procedures for common applications of the Radalert. It also gives you basic information on radiation. Be sure to read this manual thoroughly so that you can gather and interpret your findings accurately.

2 The Radalert Features

The Radalert measures alpha, beta, gamma, and X-ray radiation. The following illustration shows the Radalert and its features.



The Geiger tube in the Radalert detects ionizing events, and the electronic circuit counts these events and displays the results on the **liquid crystal display** (LCD). You control how the counts are displayed by setting the display mode. The Radalert also contains an alert that sounds when the radiation exceeds a pre-set level that you can change for your purposes.

The Radalert measures radiation in counts. One count is one ionizing event detected in the Geiger tube.

Switch 1 allows you to choose either of two display modes and to turn the Radalert off. In **Counts per minute** mode, the number of counts detected each minute is displayed on the LCD. This number is updated each minute. During the first minute of operation in this mode, a flashing colon (:) tells you that the count is in progress. In **Total counts** mode, the LCD shows the accumulated counts, adding counts as they occur. The display can show up to 19,999 counts.

Whenever the Radalert is on, the red **count light** flashes each time a count is detected.

Switch 2 allows you to choose any of three audio modes. If you set the switch to **Count**, the Radalert beeps at each count. The **Mute** setting turns off the beep. In the **Alert** mode, the Radalert sounds a pulsating beep if the count reaches the alert level. In **Counts per minute** display mode, the alert sounds until the end of the one minute period. (It sounds again the next minute if the count reaches the alert level again.) In **Total count** display mode, the alert sounds until you either change switch 1 from **Total count** to **Counts per minute** or **Off**, or change switch 2 to **Mute**.

The **alert level switches** on the top of the Radalert enable you to set and change the level at which the alert beeper sounds. The alert level is set to 9990 when you first receive the Radalert. See "Setting the Alert level" in the next chapter for instructions on how to change this setting.

The screen at the top of the Radalert is called the **alpha window**. It allows alpha rays and low-energy beta and gamma rays to penetrate the mica end of the tube. Alpha radiation does not penetrate most solid materials, so the Geiger tube used in the Radalert has a thin disk of mica, which alpha rays can penetrate, on its end. If you want to measure alpha radiation or low-energy beta and gamma radiation from an object, hold the object close to the alpha window.

> **CAUTION:** The mica end window of the Geiger tube is fragile. Be careful not to let anything push through the screen.

The top (and smaller) jack on the side of the Radalert enables you to connect the Radalert to a power supply that you can plug into a regular wall socket. We recommend that you use the RA-110 power supply, available from International Medcom. It is a 9-volt DC filtered regulated power supply with a miniature phone plug, tip positive. If you have a power failure while running the Radalert on AC current, the battery automatically takes over.

The lower jack allows you to interface the Radalert to a computer, data logger, external alert, or other device. For more information, see "Interfacing to External Devices" in the next chapter.

For more information on what ionizing radiation is and how the Radalert detects it, see Chapter 4, "Ionizing Radiation."

3 Using the Radalert

Starting the Radalert

Before you start the Radalert, be sure that a standard 9-volt battery installed in the battery compartment in the lower rear. One battery operates the Radalert continuously for three to six months at normal radiation levels. The LCD display warns you when the battery is getting low by displaying a LOBAT message at the upper left of the display.

Use Switch 1 to start the Radalert in **Counts per minute** mode. While the instrument accumulates the first minute's count, a blinking colon shows on the left side of the LCD display.

To keep your Radalert in good condition, handle it with care as you would any electronic instrument. Don't subject it to rough handling or get it wet. Observe the following precautions:

- Do not leave the Radalert in temperatures over 1000 F or in direct sunlight for extended periods of time (for example, on the dashboard in a closed car).
- Do not contaminate the Radalert by touching it to radioactive materials.
- **Do not put the Radalert in a microwave oven.** It cannot measure microwaves, and you may damage it or the oven.

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. Before you can interpret the readings you get on the Radalert, you must establish the normal background radiation level for your area.

To do this, turn the Radalert on and set the display mode to **Counts per minute**. (You can use any of the **Mute, Count,** or **Alert** audio modes.)

Notice that the count may change quite a bit from minute to minute; it may be 8 one minute and 16 the next. You can quickly determine the average in either of two ways:

- Note the counts for about ten minutes and average them.
- Change to **Total count** and wait exactly ten minutes. Then note the reading and divide it by ten for the average counts per minute.

A ten-minute average count is moderately accurate. You can repeat it several times and see how close the averages are. To establish a very accurate average, use the procedure for getting a 12-hour average described in "Checking for Small Increases" in Chapter 5.

Checking for Increased Radiation

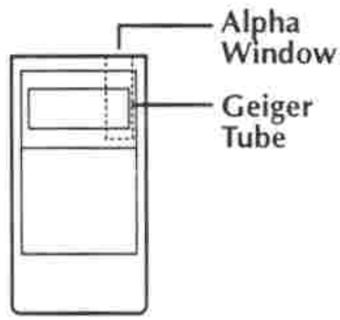
You can keep your Radalert on in **Counts per minute** mode whenever you want to monitor the ambient radiation, and look at it from time to time. Use **Alert** mode to warn you if the radiation increases above the alert level. If you plug the Radalert in to AC current, the electricity used is negligible; if you're using the battery, one battery lasts for three to six months of 24-hour use.

If you suspect an increase in radiation (due to a your location, a nuclear power plant emission, or other reason), take a five or ten minute count. Once you've established your normal background level, it is easy to see an increase. You may want to take readings every hour (using **Total count** mode) and chart them.

If you want to check an object, just put the Radalert next to it. If the count is higher than normal, the object is radioactive. Put the alpha window next to the object to check for alpha radiation; you may miss it otherwise. If the object is radioactive, get readings at six inches, one foot, and two feet from it. Usually the radiation drops off sharply at a short distance.

The reading at any distance from the object indicates the radiation exposure you get at that distance.

The illustration at the right shows the position of the Geiger tube in the Radalert. When you are not using the alpha window, hold the Radalert so that the side wall of the tube is as close as possible to the object. The best position is with the top right of the back of the Radalert closest to the object.



Chapter 5, "Applications," gives suggestions and techniques for specific checks you can make.

Setting the Alert level

The alert level is the number of counts that sets off the audible alert. The three alert switches at the top of the Radalert set the alert level.

Use a small screwdriver to adjust the alert level switches. You can set the alert level at any multiple of 10 from 10 to 9990. The switch marked **x10** sets the tens value; the **x100** switch sets the hundreds value; and the **x1000** switch sets the thousands value. For example, to set the alert level to 130, set the x1000 switch to 0, the **x100** switch to 1, and the x10 switch to 3.

In **Counts per minute** operating mode, the alert sounds when the counts in the current minute reach the alert level. In **Total count** mode, the alert sounds when the total reaches the alert level. Keep in mind that if you set the alert level to, for example, 50 for **Counts per minute** operation, and you then run the Radalert in **Total count** mode, the alert will sound as soon as the accumulated count reaches 50.

The best alert level is one that rarely gives a false alarm, yet warns you when the radiation is higher than normal. The statistical formula outlined below shows one way to determine this level for your area in counts per minute.

You can experiment with different alert levels, or use another method to decide on the best alert level for your purposes.

First, find the standard deviation, using the following steps.

1 Use the Radalert in CPM mode to measure counts for 30 or more consecutive minutes. Note each count. (The more readings you take, the more accurate your result)

2 Add the readings and divide the sum by 30 (or the number of readings) to get the average.

3 Find the difference between each reading and the average. Square each of these differences (multiply it by itself).

4 Total the squares of the differences and divide the sum by 29 (or the number of readings minus one).

5 Find the square root of this sum. This number is the standard deviation.

To find the highest normal value you can expect, multiply the standard deviation by three and add it to the average from step 2 above.

For example, if the average counts per minute is 12.8 and the standard deviation is 4.3, add 3 X 4.3 to 12.8 to get 25.7. Set the Alert level at 30, the next higher level available.

Interfacing to Other Devices

You can interface the Radalert to an external device such as a data logger, computer, or warning device. The information given here is optional; you do not need to read it unless you want to use these functions.

The lower of the two jacks on the left side of the Radalert is a dual miniature jack that provides two outputs, which can be used to drive CMOS or TTL devices. They are:

- **Data out:** This output is the tip of the plug. It provides a positive (+5 volt) pulse each time the Geiger tube detects a count. You can use it to record the counts on a data logger, accumulating counter, computer, or printer. This interface makes it possible to record radiation levels over time.

- **Alert out**: This output is the ring of the plug. It provides a positive signal whenever the current alert level setting is exceeded (even if the audio switch is set to **Mute**.) The output can control devices such as a loud beeper or horn, a flashing light, or any combination of devices. It enables you to use the Radalert as an Area Monitor in a noisy location. It can also be used to signal an automatic telephone dialer to call a certain number if the alert level is exceeded.

A cable and software for interfacing the Radalert to an IBM PC compatible computer is available from Bud Cole, 614 Cedar Hill Rd. NE, Albuquerque, NM 87122.

4 Radiation and Its Measurement

This chapter briefly tells about what radiation is, how it is measured, and its effects on health. This information is very helpful in understanding how the Radalert works and in interpreting your readings.

This chapter is just an introduction to these subjects; many books are available if you want to find out more. For an in-depth reference, we recommend *Radiation and Human Health* by Dr. John Gofman.

Ionizing Radiation

Ionizing radiation is radiation that changes the structure of individual atoms by ionizing them. Ionization is the process by which electrically neutral atoms are changed to positively and negatively charged ions (atoms and subatomic particles). 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 is uranium.

Ionizing radiation is categorized into four types of rays:

X-rays are 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 an extremely short wavelength, less than 0.1 billionths 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. They also act on photographic film as light does. These two properties have made X-rays a powerful tool in the medical and physical sciences.

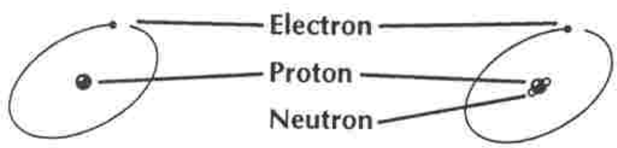
Gamma rays are naturally occurring radiation that is almost identical to X-rays. A gamma ray is the photon emitted when an electron is added to the nucleus of an atom. Gamma rays generally have a shorter wavelength than X-rays.

Beta rays also occur in nature. A beta ray is actually a particle, an electron emitted from an atom. It has more mass and less energy than a gamma ray, so it doesn't penetrate matter as far as Gamma and X-rays.

Alpha rays are another naturally occurring form of ionizing radiation. An alpha ray is a particle that consists of two protons and two neutrons, the same as the nucleus of a helium atom. It is emitted when an atom decays.

When an atom emits an alpha, beta, or gamma ray, it becomes a different type of atom. This process is called decay. Radioactive substances may go through several stages of decay before they change into a stable form.

An element may have several forms, called isotopes, that differ in the number of neutrons and/or electrons in the atom. A radioisotope is a radioactive form of an element. Each radioisotope 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.

For example, Thorium 234 (the isotope of thorium with the atomic weight of 234) has a half-life of 24 days. If you start with one gram of Thorium 234, after 24 days, 1/2 gram will have decayed into Proactinium 234 by emitting beta rays.

Theoretically the thorium takes an infinite time to decay completely, because for each succeeding half-life, only half the remaining material decays. After seven times the half-life, 99% of the original material has decayed, and after ten times the half-life, 99.9% has decayed.

The isotope produced when a radioisotope decays may also be radioactive. In this example, Thorium 234 and Proactinium 234 are part of the radioactive decay chain for Uranium 238. Uranium and its decay products are the most common radioactive materials in the ground. 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 radioisotopes 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 microseconds	Pb-21 0	Lead
Pb-21 0	beta	21 years	Bi-210	Bismuth
Bi-210	beta	5 days	Po-21 0	Polonium
Po-210	alpha	138 days	Pb-206	Lead

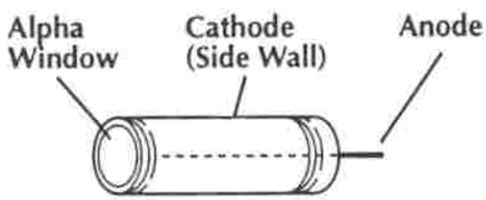
All the isotopes in the uranium decay chain are solids except for radon, a gas. After radon is produced, it migrates through the ground to enter the atmosphere.

Measuring Radiation

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

The Radalert uses a Geiger tube, which is a commonly used method of detecting ionizing radiation. The Geiger tube consists of an anode and a cathode (positive and negative electrodes) separated 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 electronically processes these pulses and displays a count on its display.



Determining the Radiation Dose

Several different units are used to measure radiation exposure and dosage. The most commonly used units are the rad and the rem.

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 Roentgen is the amount of X-radiation or gamma radiation that produces one electrostatic unit of charge in one cc of dry air at 00 C and 760 mm of mercury atmospheric pressure.)

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

Radiation is often measured in a dose rate, generally in millirems per hour. For example, if a person is exposed to radiation at 10 millirems per hour for one hour, his or her dose is 10 millirems; if the person is exposed for half an hour, the dose is 5 millirems.

The average dose per person from background radiation was until recently thought to be about 100 millirems per year. Recently, the National Council on Radiation Protection and Measurement (NCRP) released their Report No. 93, "Ionizing Radiation Exposure of the Population of the United States." This report takes into account sources such as radon exposure and occupational exposure, and sets the average at 360 millirems whole body dose per year. The occupational exposure limit in the United States is 1% rems (1250 millirems) per quarter (5 rems per year) whole body dose under normal conditions.

Different radioactive materials produce different types (and combinations of types) of rays. Also, the energy levels and types of radiation differ in different radioisotopes. Thus, the counts recorded in a Geiger tube represent different levels of radiation from different materials. Geiger counters that measure radiation in Roentgens or rads are calibrated for a specific type of radioactive source; for example, Cesium 137. The reading is most accurate for that isotope; if the radiation is coming from a different type of material, the reading is not as accurate.

The counts per minute reading that the Radalert gives does not give you a measurement in rads, Roentgens, or rems; the actual exposure and dosage produced by a specific number of counts depends on the isotopes that are producing the radiation. If you want to convert the Radalert counts per minute reading to the dosage in mR (milliRoentgens) per hour, you need to know the isotopes that are producing the radiation.

The Geiger tube in the Radalert has been calibrated for Cobalt 60 and Cesium 137 (gamma). To convert for Cobalt 60, divide the counts per minute by 1300. For Cesium 137, divide the counts per minute by 1000. For example, if you measure 1675 CPM and you know the source is Cesium 137, the mR measurement is 1675 divided by 1000, or 1.675 mR per hour.

If you have access to calibrated sources of other isotopes, you can determine the appropriate conversion factor for those isotopes.

Effects of Radiation on Health

Animals and plants are made up of cells of living material. Each cell is made up of complex combinations of molecules, which are made up of complex combinations of atoms.

When radiation hits a living cell, it may ionize an atom, which may break chemical bonds within the cell. This can result in cellular or chromosomal injuries. Radiation can cause cancer or leukemia. It can also cause genetic mutation if it hits the genetic material in a reproductive cell. In high doses, it can burn the skin, make hair fall out, and cause radiation sickness and death.

At levels of exposure that are not high enough to produce obvious immediate damage, the effects may not be visible for years. It is almost impossible to prove that one person's radiation exposure produced, for example, a cancer 20 years later. Studies on large populations show a definite statistical relationship between radiation exposure and cancer and leukemia.

Many experts used to think that if radiation exposure was under a certain threshold, a person would have no harmful effects. Although some still believe this theory, evidence is adding up that there is no minimum radiation level that can be considered safe.

In many medical applications, the benefits of radiation are widely regarded to outweigh the risk. X-rays are often used for diagnosis in medicine and dentistry. Radioisotopes are also used for diagnosis. A radioisotope behaves in the same way in chemical reactions as the stable isotope of the same element. When a radioisotope is injected or ingested, doctors can follow the activity of the element in the body by tracking the radiation. Radiation is also used in cancer therapy. A measured dose is aimed at the cancer or leukemia cells to kill them.

5 Applications

This chapter goes into detail about specific items you can test and methods you can use. It contains suggestions that can also be helpful in other applications.

Checking for Small Increases

To check for small differences in radiation (for example, between outdoors and indoors), use **Total count** mode. Find the total count for a 12-hour period in each location.

Take two 12-hour measurements outdoors. For the first measurement, place the Radalert on a safe place on the ground in an unpaved area. (Make sure it does not get wet, overheated, or frozen.) For the second measurement, place it about four to six feet above the ground. With this procedure, you can detect alpha radiation from the earth that rapidly dissipates in air.

You can also take 12-hour measurements at several locations in your house. For suggestions, see the next section, "Checking for Radon."

To compare radiation levels from 12-hour counts, it's best to convert the total counts to counts per minute. You can reliably detect differences as low as one count per minute by comparing 12-hour counts. Differences might result from radon (either indoors or outdoors) or concentrations of radioisotopes in the earth.

You can also use 12-hour counts to check for small differences over time. These differences might be due to solar flares (the sun is a huge nuclear reactor), low-level leaks from a nearby power plant, or higher-level leaks from distant plants. Keep the Radalert operating continuously in **Total count** mode and take readings every 12 hours; for example, at 7 AM and 7 PM. After you take each 12-hour reading, switch from Total count to Counts per minute, then back to Total count to reset the display to zero.

Screening for Radon

Geiger counters are not approved by the EPA for radon detection. You should consider any data collected with the Radalert to be experimental.

Preliminary testing with the Radalert indicates that the average counts per minute rise and fall proportionally with the concentration of radon gas. The radiation detected is a combination of emissions from the radon and its decay products.

The most likely entrance points for radon in homes or other buildings are cracks or openings in the floor around pipes or conduit, unsealed wall-floor joints, and underground hollow block walls. Dirt floors in basements are particularly likely places. Unventilated basements or closets normally have higher levels of radon than well-ventilated areas. For best results, keep air exchanges between indoors and outdoors at a minimum for 12 hours before testing and during testing. Keep in mind that measurements tend to be higher at night than in the day, and that winter measurements tend to be higher than those made in the summer.

You can use the Radalert to screen for the best location for doing radon testing using standard methods. Place the Radalert near a suspected entrance point. Set it to **Total count** and accumulate the count for 12 hours, then average the reading to counts per minute. Repeat this test at each location you want to check.

If the average count per minute at any location is at least one count higher than your usual outdoor count, you have a significant increase in radiation. EPA-approved testing methods can determine whether or not the source of the radiation is radon.

Checking Household Items

You may be surprised to find that you have radioactive items in your house or workplace. Here are some items you can check:

Clocks and watches Radium and tritium have been used for luminous dials on many clocks or watches. Radium is no longer used, but many older clocks have radium dials. Radium emits beta and high-energy gamma rays, which can be detected easily. Tritium emits low-energy beta radiation which generally cannot penetrate the glass face, so you may not be able to detect it.

Smoke detectors Most smoke detectors contain a small amount of americium, an alpha emitter. To detect this radiation, you must remove the outer case of the smoke detector and hold the alpha window of the Radalert close to the detector (within an inch or less).

Ceramicware Certain orange glazes used in older plates, cups, etc., contain uranium oxide.

Static eliminators Static eliminators for records and photographic film may contain polonium. Polonium is an alpha emitter, so hold the static eliminator near the alpha window.

Mantles for camping lanterns Mantles for gas camping lanterns contain thorium. It's best not to handle the mantle directly; keep it in its plastic bag while measuring.

Measuring Radiation on Airplanes

At higher altitudes, there is considerably more radiation from outer space than on the ground. The next time you travel on an airplane, take your Radalert and note the increase. The radiation level at 35,000 to 40,000 feet may be as much as 30 to 50 times the normal background level on the ground.

At times of solar flares, the radiation level may be even higher. Supersonic aircraft, which fly as high as 60,000 feet, have radiation monitoring equipment to alert the pilot to move the plane to a lower altitude if the radiation reaches a certain level.

You can send the Radalert through the airport security X-ray machine. (If it's on and set to Alert, the alert will go off.)

Checking for X-ray leakage

If you work in a medical or dental office or an industrial plant with an X-ray machine, you can detect radiation that leaks through the shielding to any area.

Note: Due to the powerful intensity and short duration of X-rays from X-ray machines, specialized equipment is necessary to get calibrated measurements. The Radalert cannot give an accurate qualitative or quantitative measurement, but it can indicate reliably whether leakage occurs.

To determine if there is X-ray leakage in a specific location such as a nurses' or technicians station near an X-ray machine, use the following procedure. *Remember that X-ray equipment should be operated only by a trained operator who understands safety procedures and health risks.*

1 Turn the Radalert on in Total count mode and set the audio switch to Count. Place it in the location you want to check.

2 Move to a safe shielded location. Use a lead apron and other shielding if necessary.

3 Activate the X-ray machine for a short period of time. 400 milliseconds is generally a good period.

4 You will hear the Radalert beep rapidly if it is detecting X-rays.
Repeat the test at other locations if needed.

6 High Radiation levels

If your Radalert shows abnormally high radiation levels and you are not measuring a known source of radiation, try to confirm your readings. Public Health Departments, hospital health physics or nuclear medicine departments, Civil Defense offices, EPA offices, and police or fire departments may have monitoring equipment with which they can check your finding.

You can also determine if the radiation source is localized or if the increase is general. A localized source could be, for example, an item you are checking, an excavation that has uncovered radioactive deposits, or a truck that contains radioactive materials.

The radiation level from a localized source decreases according to the inverse square law. If you move to twice the distance from the source, the radiation drops by a factor of four. If you move and the radiation level goes up by a factor of four, your distance from the source is half of that where you started. If you find a strong localized source, get as far away from it as you can and notify the appropriate authorities.

Make every effort to minimize your radiation exposure. If you can leave the area, do so as soon as possible. Use the Radalert to check your clothing and yourself for contamination. If you find it, dispose of the clothing and shower thoroughly to remove any radioactive particles. With a general source of radiation, you may not be able to leave the area to reduce your exposure. Be aware that radiation from airborne radioactive particles is less in an enclosed building.

The Radalert display shows up to 19,999 counts. If you measure a higher count, the display still reads 19999. To obtain a relative indication of the dose rate, put the Radalert in **Total count** mode, use a watch to determine the length of time from 0 to 19,999 counts, and convert the reading to counts per minute.

At extremely high radiation levels (above 1 Roentgen per hour), Geiger tubes can become saturated, or "jam," causing the instrument to give false low readings. The Radalert contains special circuitry for "jam protection." Still, it is advisable to avoid high radiation levels and not to depend on any single instrument in such a hazardous situation. A 125 milliRoentgen per hour radiation level (with a Cesium 137 source) would be 125,000 counts per minute on the Radalert. In **Total count** mode, 19,999 counts would be reached in about ten seconds.

Appendix A
Technical Specifications

Display:	4 ½ digit liquid crystal display, O.4-inch digits
Operating Range:	0-19999 accumulated counts or 0-19999 counts per minute (approx. 0-20 mR/hr)
Sensor:	Internal halogen-quenched Geiger-Mueller tube with mica end window (LND 712 or equivalent). End window density is 1.5-2.0 mg/cm2. Side wall is .012” #446 stainless steel.
Size:	5.9” x 3.15” x 1.2" (150 x 80 x 30 mm)
Weight:	9.5 oz. (270 grams) including battery
Power:	Internal: 9-volt alkaline battery gives up to 6 months continuous operation depending on radiation levels. External: Optional 9-volt AC wall-mount adapter plugs into jack on side of instrument. Battery automatically takes over if power fails.
Beeper:	Can be set by switch to either Count or Alert. Output sound pressure level is 75 dB at 12 inches (3 kHz).
Count light:	Red LED flashes with each count (ionizing event).
Alert:	Alert level can be set with switches to any 10-count increment from 10 to 9990 counts per minute. Alert is indicated with a pulsating beep.
Outputs:	Dual miniature jack provides two outputs for driving CMOS or TTL devices: 1) counts to computer or data logger 2) alert to external warning device
Temperature Range:	0 to 500 ° C (32 to 122 ° F)

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 and LCD display, which are 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. 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.

This warranty applies to the fully assembled Radalert only; it does not apply to the Radalert in kit form.

International Medcom
6871 Abbott Avenue
Sebastopol, CA 95472
Tel: 707-823-0336
Fax: 707-823-7207