Inspector

Nuclear Radiation Monitor

Operating Manual

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Contents

1 Introduction

The Inspector is a health and safety instrument that is optimized to detect low levels of radiation. It measures alpha, beta, and gamma radiation. Its applications include:

- Detecting and measuring surface contamination
- Monitoring possible radiation exposure while working with radionuclides
- Screening for environmental contamination
- Detecting noble gases and low energy radionuclides

How the Inspector Detects Radiation

The Inspector 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 Inspector displays the counts in the mode you choose: counts per minute (CPM), milliroentgens per hour (mR/hr), or total counts. In SI units, counts per second (CPS) and microsieverts per hour (μSv/hr) are used.

The number of counts detected by the Inspector varies from minute to minute due to the random nature of radioactivity. A reading is expressed more accurately as an average over time, and the average is more accurate over a longer time period.

Precautions

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

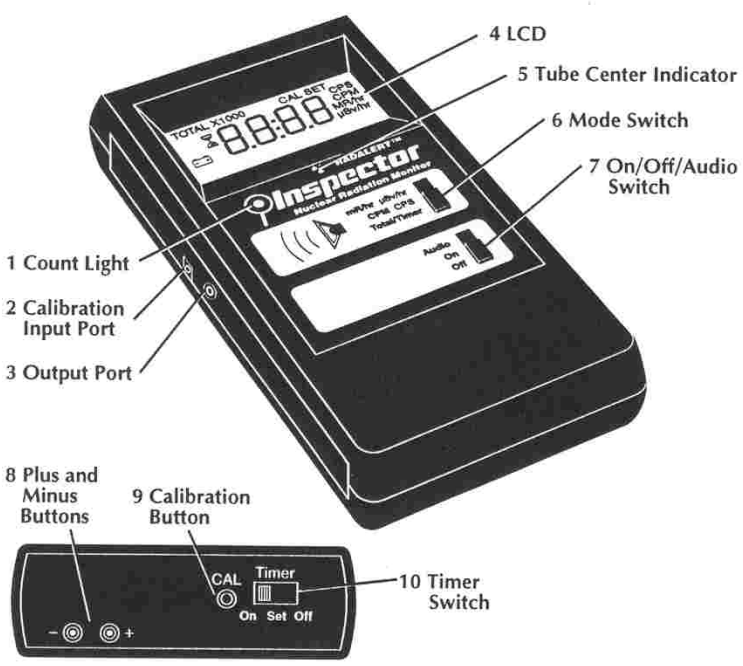
- Do not contaminate the Inspector by touching it to radioactive surfaces or materials. If contamination is suspected, you can replace the rubber strips above and below the rear label with the extra strips supplied with the Inspector.
- Do not leave the Inspector in temperatures over 100° F (38° C) or in direct sunlight for extended periods of time.
- Do not get the Inspector 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; this could affect the readings if the coating of the mica surface of the Geiger tube has been damaged by moisture or abrasion.
- Do not put the Inspector in a microwave oven. It cannot measure microwaves, and you may damage it or the oven.
- Avoid using the Inspector in high-intensity radio frequency, microwave, electrostatic, and electromagnetic fields; it may be sensitive to these fields and may not operate properly.
- If you expect to not use the Inspector 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.

2 Features

The Inspector measures alpha, beta, gamma, and x-ray radiation. It is optimized to detect small changes in radiation levels and to have high sensitivity to many common radionuclides. For more information, see Appendix A, "Sensitivity to Common Radionuclides."

This chapter briefly describes the Inspector's functions. For more information on how to use the Inspector, see Chapter 3, "Operation."

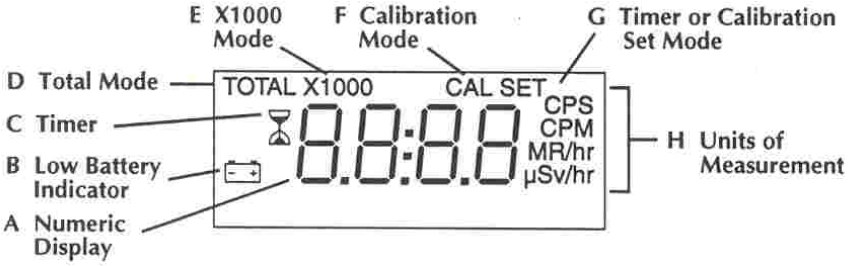


The Inspector counts ionizing events and displays the results on the liquid crystal display (LCD) (**4**). You control which unit of measurement is shown by using the mode switch.

Whenever the Inspector is operating, the red **count light** (**1**) flashes each time a count (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.
- An **hourglass** (**C**) appears to the left of the numeric display during a timed count or in the Cal mode.
- **TOTAL** (**D**) appears when the Inspector is in Total/Timer mode.
- **X1000** (**E**) appears when the radiation level is displayed in X1000 mode.
- **CAL** (**F**) appears while you are calibrating the Inspector.
- **SET** (**G**) appears when you are setting the timer (the numeric display shows the timed period instead of the current radiation level) and in the Cal mode (the numeric display shows the Cal factor instead of the current radiation level).
- The current **unit of measurement (H) CPM, CPS**, **mR/hr** or **µSv/hr** is displayed to the right of the numeric display.

The Switches

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

On/Off/Audio Switch (7)

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

On. The Inspector is operating, but audio is off.

Off. The Inspector is not operating.

Mode Switch (6)

mR/hr μSv/hr. The numeric display shows the current radiation level in milliroentgens per hour from .001 to 100. When SI units are used, it shows the current radiation level in microseiverts per hour, from .01 to 1000.

CPM CPS. The display shows the current radiation level in counts per minute from 0 to 300,000. When **X1000** is shown, multiply the numeric reading by 1000 to get the complete reading. When SI units are used, the display shows the current radiation level in counts per second from 0 to 5000.

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.

Timer Switch (10)

Off. The timer is not operating.

Set. You can now set the length of the timed period using the + and - buttons. If the timer is already operating, the display shows the time remaining in the timed period.

On. The timer is operating, and the display shows the total counts so far in the timed period.

CAL Button (9)

The CAL button is used to calibrate the Inspector. See "Calibration" in Chapter 5 for more information.

The CAL button is also used to make selections from the Utility Menu. See “The Utility Menu” in Chapter 3 for more information.

+ and - Buttons (8)

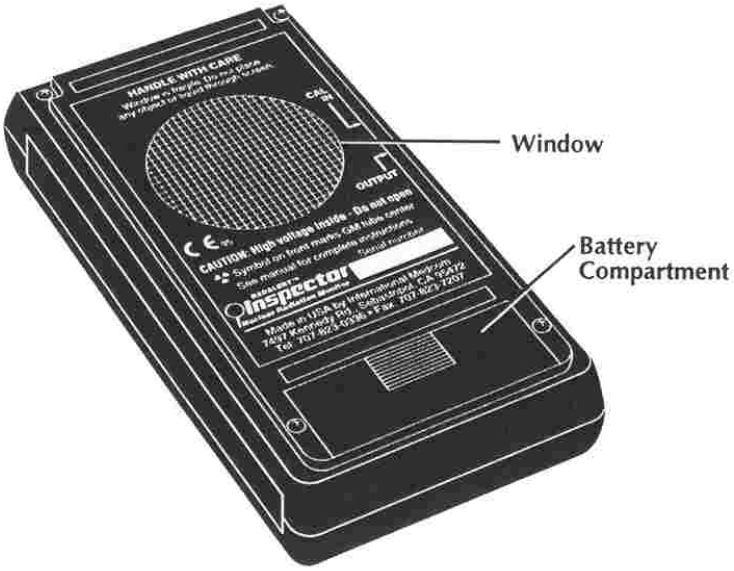
The + and - buttons are used to adjust the numeric display for timed counts and during calibration. For more information, see "Taking a Timed Count" in Chapter 3 and "Calibration" in Chapter 5.

The + and - buttons are also used to make selections from the Utility Menu. See “The Utility Menu” in Chapter 3 for more information.

The Detector

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

The Inspector uses a two-inch round Geiger tube, commonly called a "pancake tube." The screen on the back of the Inspector is called the **window**. It allows alpha and low-energy beta and gamma radiation, which cannot get through the plastic case and the stainless steel detector body, to penetrate the mica surface of the tube. The small radiation symbol (**5**) on the front label indicates the center of the Geiger tube.



The Input/Output Ports

There are two ports on the left side of the Inspector. Certain models have a third port on the end panel.

The **calibration input port (2)** on the side of the Inspector 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 Inspector to a computer, data logger, or other device. For more information, see "Interfacing to an External Device" in Chapter 3.

The optional probe port on the end panel (present on some Inspector models) allows you to use the Inspector with an external probe. See "Using an External Probe" in Chapter 3.

3 Operation

The guidelines in this chapter describe how to use the Inspector.

Units of Measurement

The Inspector 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 Inspector

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

Before you start the Inspector, make sure the timer switch on the end panel is set to **Off**.

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

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

When using the Inspector, always be sure there is no obstruction between the detector window and the source you are surveying or monitoring.

Operating in Dose Rate Modes

When the mode switch is set to **mR/hr μSv/hr** or **CPM CPS**, the numeric display is updated every three seconds. At low count rates, significant changes in the radiation level displayed can take up to 30 seconds to stabilize. See “Operating Ranges and Response Times” in this chapter for more information.

CPM (or CPS) and 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 Inspector for a specific radionuclide using an appropriate source.

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

Operating in Total/Timer Mode

When the mode switch is set to **Total/Timer**, the Inspector starts totaling the counts it registers, and the numeric display is updated twice a second.

Taking a Timed Count

When a timed count is taken over a longer period, the average count per minute is more accurate, and any small increase is more significant. 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 may be statistically significant.

The Inspector can give you a total count for a timed period of from one minute to 24 hours. Follow these steps:

1. With the Inspector operating, set the Mode switch to **Total/Timer**. The display shows **TOTAL**.
2. Set the Timer switch on the end panel to **Set**. 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.
3. 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 50 minutes in ten-minute increments, or for 1 to 24 hours in one-hour increments.

4. Set the Timer switch to **On**. The Inspector beeps three times and starts counting. The hourglass indicator flashes during the timed period.

   If you want to see how many minutes remain, set the Timer switch to **Set**. The display counts down from the time setting in hours and minutes to zero. For example, if the display says 00:21, 21 minutes remain. Be sure to set the switch back to **On** to see the total count when the timed period is finished.

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

6. To find the average counts per minute for the timed period, divide the total by the number of minutes.

7. Set the Timer switch to **Off** to return to normal operation.

As long as the Timer switch is set to **On**, the timer mode is active in the background even when the Mode switch is set to one of the dose rate modes. For example, during and after the timed period, you can switch back and forth between **Total/Timer** and **mR/hr**; when the timed period is over, the total is displayed whenever you switch back to **Total/Timer**. The hourglass indicator is shown on the display in any mode setting; it is blinking while the timer is totaling counts.

Taking a Total Count

The timer can take timed counts of up to twenty-four hours. In certain situations, you may want to take a total count without the timer; for example, taking a count for longer than twenty-four hours. Follow these steps:

1. Place the Inspector in the location where you plan to take the count.

2. Note the time.

3. Immediately when you note the time, set the mode switch to **Total/Timer**.

4. At the end of the time period, note the time and the number of counts on the numeric display.
5. Subtract the starting time from the ending time to determine the exact number of minutes in the timing period.
6. To get the average count, divide the total counts by the number of minutes in the timing period.

Operating Ranges and Response Times

The following table shows the radiation levels the Inspector measures in each mode and how they are displayed. In certain modes, when radiation levels increase over certain preset levels, the Inspector 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	.001-100	NA
μSv/hr	.01-1000	NA
CPM		0-2999 3000-300,000 (displayed as 3.000-300, with X1000 indicator)
CPS	0-5000	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 Inspector 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 Inspector is turned off.

Display update and response time. In Total/Timer mode, the numeric display is updated twice a second. In the dose rate modes, the numeric display is updated every three seconds. When the radiation level is less than 6,000 CPM, the reading in any of the dose rate modes is based on the radiation detected in the immediately previous 30 seconds. In order to give a quicker response to changes, when the radiation level exceeds 6,000 CPM in any 30-second period, the reading is based on the previous 6 seconds, and when it exceeds 12,000 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 (after first 30 seconds)**
<6000 CPM or <1.75 mR/hr (<100 CPS)	30 seconds
6000-12000 CPM or 1.75-3.6 mR/hr (100-200-CPS)	6 seconds
>12000 CPM or >3.6 mR/hr (>200 CPS)	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.

The Utility Menu

The Utility Menu allows you to change the default settings for several operating parameters. When you change a setting, it remains in effect after you turn off the Inspector and until you change it again.

To activate the Utility Menu, hold down the + button while you turn on the Inspector. The numeric display shows a single digit indicating one of the options. To scroll through the menu, push the plus (+) and minus (–) buttons on the end panel. To select an option, push the CAL button on the end panel. Once an option is selected, use the + and – buttons to toggle between settings. After you choose the setting you want, push the CAL button to save the new setting and resume operation.

The options are:

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

2 **mR/Sl. CPM mR/hr** selects counts per minute and milliroentgens per hour; **CPS μSv/hr** selects counts per second and microseiverts per hour.

3 **Cal 100 Reset.** Selecting this option automatically resets the calibration factor to 100.

4, 5, 6 Reserved for future options.

7 **Cal Factor Adjust.** Displays the current calibration factor, which you then adjust to the new factor you want. See “Calibration” in Chapter 5.

8 **Factory Default Reset.** Selecting this option automatically resets the items 1, 2, and 3 to Auto averaging, CPM and mR/hr, and 100.

9 **Revision #.** Shows the version number of the programmed microprocessor.

Interfacing to an External Device

The lower output jack on the left side of the Inspector is a dual miniature jack that provides a data output that can be used to drive a CMOS or TTL device. 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 output at the tip of the plug provides a positive (5 volt) pulse each time the Geiger tube detects a count.

Using an External Probe

If the model of the Inspector you have has a jack on the end panel, you can connect an external probe that is compatible with the Inspector to the jack. See the documentation for the probe for more information.

4 Common Procedures

The following sections give instructions 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, even in different areas of the same room. To accurately interpret the readings you get on the Inspector, 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 timed count. Use the following steps to get a ten-minute average.

1. With the Inspector operating, set the Mode switch to **Total/Timer**.
2. Set the Timer switch on the end panel to **Set**. The display should read 00:01, which means one minute.
3. Press the + button nine times. The display should read 00:10, for ten minutes.
4. Set the Timer switch to **On**. The Inspector beeps three times and starts counting.

   If you want to see how much of the ten minutes remains, set the Timer switch to **Set**. The display counts down from ten minutes to zero. For example, if the display says 00:03, seven minutes have passed and three minutes remain. Reset the switch to **On** to return to the radiation level display.
5. At the end of the ten minutes, the Inspector beeps three times, and repeats the beeping several times. Note the total reading.
6. To find the average counts per minute, divide the total by ten (the number of minutes).

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 timed count. If you need to determine whether there is prior contamination, take averages in several locations and compare the averages.

For more information on using the timer, see "Taking a Timed Count" in Chapter 3.

Environmental Area Monitoring

You can keep the Inspector 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.

If you suspect an increase in ambient radiation, use the timer and 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 for Surface Contamination

To check a surface, hold the Inspector with the alpha window facing and close to the surface. If you want to find out if a surface is slightly radioactive, place the Inspector next to it and take a timed count or a longer accumulated count.

CAUTION: *Never touch the Inspector to a surface that may be contaminated. You may contaminate the instrument. The rubber strips on the back can be replaced if they become contaminated. Replacement strips are supplied with the Inspector.*

5 Maintenance

The Inspector requires regular calibration and careful handling. Use the following guidelines to maintain the Inspector properly.

Calibration

The Inspector should be calibrated as often as your regulations require, or in any case, at least once a year. 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 Inspector 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 .010, 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 Inspector, make sure the distance between the Inspector and the source is correct to produce the appropriate dose rate. Then follow these steps:

1. Be sure the On/Off/Audio switch is set to **On**, not Audio, so that you can hear the countdown timer sound.
2. Set the Mode switch to **mR/hr μSv/hr**.
3. Press the CAL button on the top of the Inspector.

   The display shows **CAL**, and the Inspector counts down for 15 seconds, chirping 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 Inspector beeps.
4. The Inspector collects data for 30 seconds, chirping every 2 seconds, with **CAL** and the hourglass indicator flashing. At the end of the 30 seconds, it beeps. The display shows **CAL**, and **SET** is flashing. You can now seal or close the source.

5. Press the + and - buttons to adjust the reading to what it should be. When the reading is correct, press the CAL button. You can set the calibration factor anywhere between 001 and 199.

   The new calibration factor is displayed for several seconds, then the Inspector 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 Inspector 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 5 volts (negative pulse) and the pulse width to 75 microseconds.

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

2. Turn on the Inspector and set the mode switch to **mR/hr μS/hr**.
3. Plug the cable into the upper jack.
4. Use the following table to check the Inspector's accuracy. The table shows appropriate pulse generator count rates to calibrate for Cs137. If the accuracy is not within desired limits, follow steps 5-7. Note that the Inspector 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 – (minus) button; the reading now corresponds to the input frequency.

Pulse Generator Input (PPM)	CPM	mR/hr	μSv/hr	CPS
33,860	43,620	10	100	727
58,196	67,110	20	200	1,119
110,902	160,200	50	500	2,670
145,090	258,400	80	800	4,307
160,199	over range	100	1,000	over range

5. Press the CAL button on the top of Inspector.

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

6. The Inspector collects data for 30 seconds, chirping every 2 seconds, with **CAL** and the hourglass indicator flashing. At the end of the 30 seconds, it beeps. The display shows **CAL**, and **SET** is flashing.

7. Press the + and – buttons to adjust the reading to what it should be. When the reading is correct, press the CAL button. You can set the calibration factor anywhere between 001 and 199.

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

Troubleshooting

The Inspector 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	no battery, dead battery, poor battery connection	make sure a new 9-volt battery is firmly connected
	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	look through the window to check the mica surface of the tube; if it is wrinkled or a break is visible, it needs to be replaced
Reading is high, but another instrument has a normal reading in the same location	contamination	check the Inspector with another instrument; clean the instrument with a damp cloth with mild detergent and replace the rubber strips on the back of the instrument
	photosensitivity	remove from direct sunlight and ultraviolet sources; if the high count drops, the mica window coating may have washed off the Geiger tube due to getting wet; the tube will need to be replaced
	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
	continuous discharge	replace the Geiger tube
	Electromagnetic field	move the instrument away from possible sources of electromagnetic or radio frequency radiation

Service

If the Inspector 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 Inspector; it contains no user-serviceable parts and you could void your warranty.

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

Appendix A
Technical Specifications

Detector:	Halogen-quenched Geiger-Mueller tube. Effective diameter 1.75" (45 mm). Mica window density 1.5-2.0 mg/cm^2.
	Optional: External scintillation probe
Efficiency:	Sr-90: approx. 45%; C-14: approx. 11%
Energy Sensitivity:	3500 CPM/mR/hr referenced to Cs-137
Display:	4-digit liquid crystal display including mode indicators
Averaging Periods:	Display updates every 3 seconds, showing the average for the past 30-second time period at normal levels. The averaging period decreases as the radiation level increases.
Operating Range:	mR/hr: .001 to 100.0 CPM: 0 to 300,000 Total: 1 to 9,999,000 counts μSv/hr: .01 to 1,000 CPS: 0 to 5,000
Timer:	Can set 1-10 minute sampling periods in one-minute increments, 10-50 minute sampling periods in 10-minute increments, and 1-24 hour sampling periods in 1-hour increments
Accuracy:	mR/hr: ±15% up to 50 mR/hr ±20% up to 100 mR/hr CPM: ±15% up to 130,000 CPM ±20% from 130,000 to 300,000 CPM
Anti-Saturation:	Readout holds at full scale in fields up to 100 times the maximum reading
Temperature Range:	-10° to +50° C , 14° to 122° F
Power:	One 9-volt alkaline battery; battery life is minimum 200 hours at normal background, minimum 24 hours at 1 mR/hr
Size:	150 x 80 x 30 mm (5.9" x 3.2" x 1.2")
Weight:	272 grams (9.6 oz) including battery

Appendix B Sensitivity to Common Isotopes

The following table shows typical GM tube efficiency for 2 Pi geometry.

Isotope	E max. keV	Efficiency
Beta		
C-14	156	30%
Pm-147	225	40%
Tc-99	294	60%
Cl-36	1142	65%
Sr-90	2282	90%
Alpha		
Am-241	5400	50%

Appendix C 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 Inspector 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 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. Gamma rays 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. It has more mass and less energy than a gamma ray, so it doesn't penetrate matter as deeply as gamma and X-rays.

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-ionizing, form.

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

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 microseconds	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

Radiation Measurement Units

Several different units are used to measure radiation, exposure to it 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 Inspector displays readings in milliroentgens per hour (mR/hr).

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 are the most commonly-used measurement units of radiation dose in the U.S. In most cases, one rem equals 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.

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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