System Assessment and Validation for Emergency Responders (SAVER)

Handheld Radiation Survey Meters Market Survey Report

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System Assessment and Validation for Emergency Responders

Prepared by the National Urban Security Technology Laboratory

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community in an operationally useful form. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: "What equipment is available?" and "How does it perform?" These products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is managed and executed by the National Urban Security Technology Laboratory (NUSTL). NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, coordinating with other organizations, and ensuring flexibility and responsiveness to first responder requirements.

NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear, and explosive weapons detection; emergency response and recovery; and related equipment, instrumentation, and technologies. In support of this tasking, NUSTL conducted a market survey of commercially available handheld radiation survey meters, which fall under AEL reference number 07RD-01-HHSM, Meter, Survey, Handheld.

For more information on the SAVER Program or to view additional reports on handheld radiation survey meters or other technologies, visit www.dhs.gov/science-and-technology/SAVER.

POINT OF CONTACT

SAVER Program
National Urban Security Technology Laboratory
U.S. Department of Homeland Security
Science and Technology Directorate
201 Varick Street
New York, NY 10014-7447

E-mail: NUSTL@hq.dhs.gov

SAVER website: www.dhs.gov/science-and-technology/SAVER

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1. INTRODUCTION

First responder organizations are equipped with handheld radiation survey meters (HHRSMs) to provide their personnel with a means of measuring radiation levels in areas that may be radioactively contaminated as a result of an accidental or deliberate release of radioactive material into the environment. To help responder organizations make informed purchasing decisions about these instruments, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a market survey of commercially available HHRSMs.

Product information was obtained from internet searches, company literature, and information received in response to a government-issued Request for Information (RFI) posted on the Federal Business Opportunities Web site. This report is based on information gathered from December 2015 to September 2016.

For inclusion in this report, a HHRSM had to meet the following criteria:

- Commercial off-the-shelf (COTS) product
- Designed for handheld operation
- Capable of measuring gamma, beta, or alpha radiation (exposure rates or count rates) with measurement result displayed on the device
- Contains at least one internal radiation detector (may also connect to external detector probes).

Due diligence was performed to develop a report that is representative of products in the marketplace.

2. HHRSM OVERVIEW

HHRSMs are portable instruments that are used to measure ambient ionizing radiation levels and to check for radioactive contamination on surfaces. When people are exposed to ionizing radiation, the damage done to the living cells in their bodies can potentially cause illness or even death. The risk of harmful health effects increases with increasing exposure to ionizing radiation, hence the importance of determining ionizing radiation levels in radioactively contaminated areas. HHRSMs have long been used as a radiological survey tool by industrial, medical, and scientific users of radioactive materials to ensure that worker and public exposure to ionizing radiation is kept as low as can be reasonably achieved. In recent years, first responder organizations have been purchasing HHRSMs for use in responding to an incident involving an accidental or deliberate environmental release of radioactive material, such as a nuclear power reactor accident or the detonation of a radiological dispersion device. In such incidents, first responders would use HHRSMs for tasks such as determining the nature and extent of radioactive contamination, delineating radiation protection zones, and screening first responders and members of the public for radioactive contamination.

2.1 Types of Ionizing Radiation and Units of Measurement

The four types of ionizing radiation that HHRSMs are most commonly used to measure are alpha, beta, x-ray, and gamma radiation. Alpha radiation is produced when radionuclides, i.e., radioactive forms of the chemical elements, emit alpha particles, highly energetic positively

charged ions that are identical to the nucleus of a helium atom. Beta radiation is produced when radionuclides emit beta particles, which are essentially highly energetic electrons. Gamma-ray and x-ray radiation are produced when radionuclides emit electromagnetic energy.[1] The energy of ionizing radiation is typically expressed in units of thousands or millions of electron volts (keV and MeV, respectively). Alpha radiation ranges in energy from about 3 to 8 MeV. Alpha particles rapidly lose energy when passing through matter, therefore alpha radiation is the least penetrating of the four types of radiation. A few centimeters of air or a thin layer of solid material, such as the outermost layer of a person's skin, can fully stop even the most energetic alpha particles emitted by any radionuclide. Beta radiation can range in energy from a few keV to about 3 MeV. Beta particles with energies at the upper end of this range can pass through several meters of air, a few millimeters of aluminum, or about a centimeter of plastic. Gamma radiation ranges in energy from tens of keV to about 3 MeV, while x-ray radiation ranges in energy from a few keV to about 150 keV. Gamma and x-ray radiation is typically more penetrating compared to beta radiation, and may be able to pass through a few millimeters to many centimeters of steel, depending upon energy.

Survey meters may be used to quantify surface contamination levels and/or the ambient radiation field. Contamination is the presence of radioactive material where it is not wanted, such as radioactive fallout that is deposited on a surface. In contrast, the ambient radiation field is a measure of the ionizing radiation produced at a location by all radioactive sources in the local environment, both artificial and natural. Depending on the type of measurements, HHRSMs may report in one or more of several different units of measurement. For ambient radiation fields, one unit is *exposure*, which indicates the amount of electric charge produced in a volume of air exposed to an ionizing radiation source, and is expressed in units of roentgens (R). *Absorbed dose* indicates the amount of energy deposited per unit mass of matter. Absorbed dose depends upon the type and energy of the incident ionizing radiation and on the composition of the material absorbing the ionizing radiation. In the United States, absorbed dose measurements are often expressed in the units of rads; muscle tissue exposed to a medium-energy gamma radiation source producing an exposure rate of 1R per hour will receive an absorbed dose of about 1 rad. The international system (SI) unit for absorbed dose is the gray (Gy), which differs from the rad by a factor of 100, i.e., 1 Gy = 100 rad. Different kinds of radiation can produce different amounts of biological damage for the same absorbed dose; *dose equivalent* is the unit used to account for these biological effects. In the United States, dose equivalent measurements are often reported in units of roentgen equivalent man (rem), while the SI unit for dose equivalent is the Sievert (Sv); these differ by a factor of 100, i.e., 1 Sv = 100 rem. For ease of product comparison in this report, units of exposure rate (R/h) are used where possible.

For surface contamination measurements units of count rate are most commonly used, such as counts per minute (cpm) or counts per second (cps); total counts over a user-selected time interval may also be used. The counts indicated depend on the detector's efficiency, which is the percentage of counts detected per radioactive decay. A count rate reading can be converted to the radioactivity of the source if the detector efficiency is known. The SI unit of radioactivity is

[1] Gamma-ray photons, commonly referred to simply as gamma rays, originate from the nucleus of an atom undergoing radioactive decay, while x-ray photons, commonly referred to simply as x-rays, are emitted from the cloud of electrons orbiting such a nucleus. The terms "gamma-ray" and "x-ray" may be used interchangeably in this report.

the becquerel (Bq), which is defined as one disintegration per second (dps).[2] Quantifying the level of contamination can be complicated because radioactive material may be spread out over a surface, or concentrated in a small region, and readings can be affected by distance of the detector from the surface and how quickly the detector is moved over the surface. Some HHRSMs can factor in the instrument's detector area and its detection efficiency and so indicate surface contamination levels in units of disintegrations per minute per square centimeter (dpm/cm^2) or Bequerels per square centimeter (Bq/cm^2).[3]

2.2 Current Technologies

HHRSMs measure ionizing radiation using one or more of three well-established detectors technologies, which are described below.

2.2.1 Ionization Chambers

An ionization chamber, or ion chamber, is a gas-filled chamber containing an arrangement of negative and positive electrodes to which a voltage potential is applied. Ionizing radiation passing through the chamber produces ion pairs, i.e., positive ions and negative electrons, which are drawn to the electrodes, producing an electrical current whose magnitude is a function of the intensity of the incident radiation. The electrical current produced is measured and converted into the radiation exposure, dose, or dose-equivalent rate indicated to the instrument user. The gas inside an ionization chamber may be at atmospheric pressure or it may be pressurized; in the latter case, the ionization chamber is referred to as a pressurized ionization chamber. Pressurized ionization chambers are typically more sensitive than unpressurized ionization chambers, i.e., they are able to more accurately measure low levels of ionizing radiation, but the maximum level of ionizing radiation they can measure may not be as great. Some unpressurized ionization chamber survey meters have detector walls that are sufficiently thin that they can respond to medium- and high-energy beta radiation, or may have a detector wall that incorporates a thin 'window' with a retractable cover that permits beta radiation, and in some cases alpha radiation as well, to enter the detector and be measured when the window cover is retracted. Generally speaking, ion chamber survey meters are not calibrated to quantitatively measure beta radiation; the alpha/beta measurement capability is intended to be used to qualitatively determine the presence of alpha or beta radiation.

2.2.2 Geiger-Mueller Detectors

Like an ionization chamber, a Geiger-Mueller, or G-M, detector is a gas-filled chamber containing negative and positive electrodes. However, the pressure of the gas inside a G-M detector is reduced relative to atmospheric pressure and the voltage difference between electrodes is set to a higher value than in an ionization chamber. Under these conditions, ionizing particles striking the detector produce large numbers of ion pairs in the gas inside the detector. These ion pairs quickly accumulate at the electrodes, producing an electrical pulse. The rate at which electrical pulses are produced is a function of the intensity of incident ionizing

[2] The conventional unit of radioactivity is the curie (Ci), where 1 Bq = 27 $x10^{-12}$ Ci.

[3] Note that conversion between dpm and Bq involves a factor of 60, since there are 60 seconds in one minute. For example, 60,000 dpm per cm^2 = 1,000 Bq per cm^2.

radiation. This electrical pulse rate is measured and converted into the radiation level indicated to the instrument user as an exposure rate, count rate or other unit of measurement.

G-M detectors can be designed to measure different types of radiation by varying the thickness of and types of materials used in its detector walls. For instance, G-M detectors intended for measuring gamma and x-ray exposure rates typically feature steel walls thick enough to prevent alpha or beta particles striking the detector from producing ion pairs within the detector. Many G-M detectors intended for gamma and x-ray exposure rate measurements are *energy compensated*, i.e., their walls thicknesses have been designed to preferentially block low energy gamma and x-rays; this gives them a more uniform energy response. Absent energy compensation, G-M detectors tend to report inaccurately high values when measuring low energy (i.e., less than ~200 keV) gamma and x-ray radiation. G-M detectors designed to measure alpha and beta surface contamination feature a wall made of a thin layer of material, often mica, which allows alpha and beta particles to readily reach the interior of the detector and be measured. A very common G-M detector of this type is the disk-shaped *pancake detector*.

2.2.3 Scintillation Detectors

Scintillation detectors contain materials that produce light pulses when exposed to radiation. The rate at which these light pulses are produced is a function of the intensity of ionizing radiation striking the scintillator. The light pulses are converted into electrical pulses by a photomultiplier tube or other light-sensitive device and the rate of production of these electrical pulses is measured and converted into the radiation level indicated to the instrument user. Scintillation detectors may be based on several different radiation-sensitive scintillator materials. Scintillation detectors used for alpha measurements often use silver-activated zinc sulfide, i.e., ZnS(Ag), as the scintillator. Because alpha radiation is blocked by all but very thin layers of solid material, alpha scintillation detectors feature a thin window of a material such as Mylar® that protects the scintillator material while permitting alpha radiation to reach it. Beta- and gamma- scintillation detectors are most often based on a plastic scintillator material. Some scintillator detectors contain two types of scintillator materials and measure two forms of radiation, such as alpha/beta and beta/gamma detectors; in some instruments, levels of the two forms of radiation can be measured simultaneously while in others, the user must switch between alpha and beta measurement modes.

2.3 Features and Use Considerations

The HHRSM models described in this report consist of a base unit containing operating controls, display screen, and an internal radiation detector. Some instruments can be connected to optional external detector probes whose measurement capabilities complement those of the internal detector. For instance, an instrument's internal detector may provide the capability to measure gamma and x-ray exposure rates while external probes are used to measure alpha and beta surface contamination. External probes are typically connected to the base unit by a cable that provides power to the probe and serves as the conduit for transmitting measurement data from the probe to the base unit. Some instrument manufacturers now offer external probes that are self-powered and can wirelessly transmit measurement data to the base unit. While traditional external probes must be calibrated for each base unit, these newer external probes often can be used with multiple base units using a probe-specific calibration.

In choosing an HHRSM, an organization must consider the range of radiation levels that it can measure; as its measurement range will determine how it can be used during the response to a radiological incident. An instrument whose measurement range does not extend to high radiation levels may be well suited for determining the outer perimeter of a radioactively contaminated area but may not be useful for measuring radiation levels encountered in more highly contaminated areas. The National Council on Radiation Protection (NCRP) report number 165[4] defines radiation control zone perimeters for emergency response to nuclear and radiological terrorism based on exposure rate and radioactive surface contamination levels. For example, the "hot zone" is an area with an exposure rate greater than 10 mR/h, or a beta/gamma surface contamination level of 60,000 dpm/cm^2, or an alpha surface contamination of 6,000 dpm. An instrument's operational range is typically specified in terms of exposure or dose rate; sometimes the detector's sensitivity is expressed as counts per second per mR/h (cps/mR/h).

Another potential selection factor is the gamma and x-ray energy response of the HHRSM's radiation detector. '*Standard Practice for Radiological Emergency Response*', ASTM standard 2601-15, recommends that instruments used for measuring gamma-ray exposure rates have, at a minimum, a measurement accuracy of 50 percent or better over an energy range extending from 60 keV and 1.33 MeV. HHRSM manufacturers typically calibrate their instruments to accurately measure exposure rates for gamma radiation in the middle of this energy range and provide information relating measurement accuracy at other energies compared to that for 662 keV gamma radiation produced by the radionuclide Cesium-137.

HHRSMs may indicate measurement results using a digital numeric display, or an analog needle-type meter; some instrument models can be configured with either type of display at the purchaser's preference. Instruments with digital display screens often allow the user to read measurement results in several different units of measurement, e.g., SI or non-SI units, while those with analog display screens are limited to the units of measurement printed on their meter faces. The spacing of interval markings on an analog meter face may determine the precision with which measurement results can be read. Display screens that can be illuminated may be useful for emergency response in low light conditions.

An HHRSM's alarm capabilities may be an important feature to many responder organizations. For example, responders may set alarms to indicate that a measured radiation level exceeds a threshold value significant to incident response, such as the 10 mR/h "hot zone" boundary recommended in NCRP guidance on response to radiological incidents. Over-range warnings, which indicate that radiation levels have exceeded the maximum value the instrument can accurately measure, are a very useful type of alarm that many instruments can produce. The manner in which alarms can alert the user, i.e., by visible, audible, and/or vibrational means, varies among different commercially available instruments.

Some HHRSMs can store measurement data in internal memory for later review or transfer to a personal computer. Depending on the instrument, it may be possible to save measurement data with additional relevant information, such as user comments, the Global Positioning System (GPS) coordinates of the measurement location, and bar code numbers.

[4] Published by the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814

Responders may need to make measurements or carry instruments in rainy or dusty conditions. Many HHRSMs have ingress protection (IP) ratings that indicate the degree of protection the instrument housing provides to entry by water and solids. IP standards are briefly described in section 2.5 and a key to the IP rating scale is given in Appendix A. Several manufacturers offer survey meters that are intrinsically safe, i.e., they can be safely used in atmospheres where flammable gases or dust are at potentially dangerous levels. These instruments may be certified in specific types of hazardous atmospheres and information on intrinsically safe certification can be found in the European Union's ATEX standard or the United States' UL913 standard.

2.4 Comparison to Other Types of Instruments

Several other types of commercially available handheld instruments besides HHRSMs can measure ionizing radiation, but are primarily intended for purposes other than conducting radiological surveys. These include electronic personal dosimeters (EPDs) for determining the accumulated radiation dose incurred by individuals, DHS Authorized Equipment List (AEL) category number 07RD-01-EPD, and alarming personal radiation detectors (PRDs), which are used for interdiction missions to alert law enforcement of elevated radiation levels (AEL 07RD-01-PDGA). Another type of handheld instrument, radionuclide identification devices, or RIDs (AEL 07RD-01-RIID), are used in interdiction missions, e.g., to identify improvised nuclear devices.[5] Some products do not directly align with an AEL category number, either because the manufacturer categorizes them differently or because the products' capabilities overlap multiple categories. For example, some products marketed as survey meters also measure and store the accumulated radiation dose. Other SAVER market survey reports cover EPDs, PRDs, and RIDs.

2.5 Standards/Regulations

Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers, NCRP Report No. 165 provides a comprehensive analysis of key decision points and information needed by organizations tasked with responding to radiological or nuclear terrorism incidents, including recommendations on establishment of radiation control zone perimeters based on measured exposure rates and surface alpha and beta contamination levels.

Radiation Protection Instrumentation – Ambient and/or Directional Dose Equivalent (rate) Meters and/or Monitors for Beta, X and Gamma Radiation – Part 1: Portable Workplace and Environmental Meters and Monitors, IEC 60846-1, published by International Electrotechnical Commission (IEC), Geneva, Switzerland, specifies design performance characteristics of instruments intended for the measurement of ambient dose equivalent (rate) and/or directional dose equivalent (rate) from external beta, x-ray, and gamma radiation. Some HHRSM manufacturers report the energy response or measurement range of their instruments relative to this standard.

Performance Criteria for Portable Radiation Detection Instrumentation for Homeland Security, ANSI/IEEE N42.33, specifies radiological, environmental, electromagnetic, and mechanical performance requirements for handheld survey meters. For instance, it requires a measurement

[5] Many RIDs can provide data on gamma radiation levels, but generally with less accuracy and precision and over a more limited range than HHRSMs.

range of 5 μR/h to 10 mR/h or more, an instrument weight of less than or equal to 6.6 pounds, and an operating temperature range of -20°C to 50°C.

Standard Practice for Radiological Emergency Response, ASTM E2601-15, published by ASTM International, West Conshohocken, Pennsylvania, provides guidance that can be incorporated into radiological emergency response planning, including guidance on capabilities of radiological survey instruments for exposure rate measurements. This document can be downloaded at: http://www.astm.org/cgi-bin/resolver.cgi?E2601

The ANSI/IEC 60529-2004 testing standard jointly adopted by ANSI and the International Electrotechnical Commission defines IP ratings for resistance to entry by water and solids. An IP rating is a two-digit number in which the first digit, which ranges from 0 to 6, indicates the degree of resistance to entry of dust and other solids, and the second digit, which ranges from 0 to 8, indicates the degree of resistance to entry of water; for both digits, higher numbers indicate a greater degree of resistance, thus an instrument with an IP 22 rating is less resistant to dust and water than an instrument with an IP 55 rating. A key to the IP rating scale is provided in Appendix A.

3. PRODUCT DATA

Table 3-1 summarizes key specifications and features of the HHRSMs identified in the market survey. This information was obtained from product manufacturers or their websites and has not been independently verified by the SAVER Program. Additional information about each instrument is provided in Sections 3.1 to 3.32. Product characteristics in Table 3-1 are defined as follows:

Company: The name of the survey meter manufacturer. Instruments are listed in alphabetical order by manufacturer. Some instruments may be available from multiple distributors.

Product: The name/model number of the instrument whose features are described in this table.

Internal Detector: Indicates the type of internal radiation detector with which the instrument is equipped. See Section 2 for a discussion of radiation detector types.

Type of Radiation Measured: Lists the kinds of ionizing radiation that can be measured with the internal detector, and where available, the external detector. "None" means that external detectors are not available.

Weight: The weight of the instrument in pounds, including batteries. For instruments with external detector probes this is the weight of the base unit only.

Exposure Rate Range: The instrument's gamma-ray exposure rate measurement range.

Battery Type, Life: The type of batteries used by the instrument and the typical operating time for alkaline batteries, according to the manufacturer.

Environmental: The operating temperature range and, where available, the IP rating (see Appendix A for IP rating definitions); also noted is whether the instrument is intrinsically safe.

Price: Refers to the manufacturer's suggested retail prices in dollars of the basic unit with various combinations of options. Volume discounts may be available.

GSA: Whether or not the unit is listed on the General Services Adminstration (GSA) price schedule.

Table 3-1. Product Comparison Matrix–General Features and Capabilities

Company Product	Internal Detector	Type of Radiation Measured		Exposure Rate Range		Weight (lbs)	Battery Type, Life	Environmental	Price ($)	GSA
		Internal Detector	External Detector	Min (mR/h)	Max (R/h)					
Canberra **Colibri TTC**	G-M	Gamma X-ray	Alpha Beta Gamma X-ray	300	1,000	1.2	lithium ion (Li-ion) battery pack, 25 hours	-4°F to 122°F IP 67	3,700	No
Canberra **Colibri VLD**	CsI(Tl) Scintillator	Gamma X-ray	Alpha Beta Gamma X-ray	10	0.10	1.4	Li-ion battery pack, 25 hours	14°F to 104°F IP 67	4,500	No
Canberra **Radiagem 4000**	G-M	Gamma X-ray	Alpha Beta Gamma X-ray	30	10	0.66	Two AA, 80 hours	14°F to 122°F IP 67	1,200	No
Fisher Scientific **RadEye B20**	G-M	Alpha Beta Gamma X-ray	None	0.0001	0.20	0.7	Two AAA, 500 hours	-4°F to 122°F IP 32	1,240	Yes
Fisher Scientific **RadEye B20-ER**	G-M	Alpha Beta Gamma X-ray	None	0.0001	10	0.7	Two AAA, 500 hours	-4°F to 122°F IP 32	1,500	Yes
Fisher Scientific **RadEye G**	G-M	Gamma X-ray	None	0.0001	10	0.35	Two AAA, 600 hours	-4°F to 122°F IP 65	1,020	Yes
Fisher Scientific **RadEye G-Ex**	G-M	Gamma X-ray	None	.05	10	0.35	Two AAA, 600 hours	-4°F to 122°F IP 65 Intrinsically Safe	1,340	Yes
Fluke **451B**	Ion Chamber	Gamma X-ray Beta	None	0	50	2.5	Two 9V, 200 hours	-4°F to 122°F IP 40	2,910	Yes
Fluke **451P**	Ion Chamber	Gamma X-ray	None	0	5	2.4	Two 9V, 200 hours	-4°F to 122°F IP 40	3,110	Yes

Company Product	Internal Detector	Type of Radiation Measured		Exposure Rate Range		Weight (lbs)	Battery Type, Life	Environmental	Price ($)	GSA
		Internal Detector	External Detector	Min (mR/h)	Max (R/h)					
Fluke **ASM-992**	G-M	Gamma X-ray	None	0.1	1	2.1	Two D cells, 150 hours	14°F to 122°F	2,170	Yes
Fluke **ASM-993**	Two G-M	Alpha Beta Gamma X-ray	Alpha Beta Gamma X-ray	0.1	1	2.4	Two D cells, 150 hours	14°F to 122°F	3,170	Yes
Ludlum **Model 3-IS-1**	G-M	Gamma X-ray	None	0.1	1	3.5	Two D cells, 2,000 hours	-4°F to 122°F exceeds IP 24 Intrinsically Safe	1,814	No
Ludlum **Model 6**	G-M	Gamma X-ray	None	0	1	3.5	Two D cells, 600 hours	-22°F to 122°F	1,169	No
Ludlum **Model 14C**	G-M	Gamma X-ray	Alpha Beta Gamma X-ray	0	2	3.5	Two D cells, 2,000 hours	-4°F to 122°F	823	No
Ludlum **Model 26-1**	G-M	Alpha Beta Gamma X-ray	None	0	0.5	1.0	Two AA, 500 hours	-4°F to 122°F [1] IP 53	781	No
Ludlum **Model 79**	G-M	Gamma X-ray	None	1	1,000	2.3	Two AAA, 100 hours	-4°F to 122°F [1] IP 52	4,295	No
Ludlum **Model 2401-P DOSE**	G-M	Alpha Beta Gamma X-ray	None	0	0.015	0.9	One 9V, 250 hours	-4°F to 122°F [1]	1,053	No
Mirion **QuickSweep-Grand**	Plastic Scintillator	Beta	None	NI	NI	NI	Li-ion battery pack	41°F to 113°F IP 64	9,300	Yes
Mirion **RDS-31**	G-M	Gamma X-ray	Alpha Beta Gamma X-ray	0.001	10	0.49	Two AA, 3,000 hours	-40°F to 140°F IP 67	1,250	Yes

Company Product	Internal Detector	Type of Radiation Measured		Exposure Rate Range		Weight (lbs)	Battery Type, Life	Environmental	Price ($)	GSA
		Internal Detector	External Detector	Min (mR/h)	Max (R/h)					
Mirion **RDS-80**	G-M	Alpha Beta	None	NI	NI	0.73	Two AA, 2,000 hours	-13°F to 131°F IP 54	850	Yes
Mirion **RI-02**	Ion Chamber	Gamma X-ray Beta	None	0.1	100	3.0	Two C cells, 200 hours	23°F to 122°F	2,785	Yes
Mirion **Telepole 2**	Two G-M	Gamma X-ray	None	0.05	1,000	4.3	Four AA, 85 hours	-4°F to 122°F IP 67	5,500	Yes
SE International **Digilert 200**	G-M	Alpha Beta Gamma X-ray	None	0.001	0.2	0.5	One 9V, 2,000 hours	14°F to 122°F	465	Yes
SE International **Inspector USB**	G-M	Alpha Beta Gamma X-ray	None	0.001	0.1	0.6	One 9V, 1,200 hours	-4°F to 122°F	575	Yes
SE International **MC1K**	G-M	Gamma X-ray	None	0	1	0.5	One 9V, 2,000 hours	-4°F to 131°F	375	Yes
SE International **Monitor 4EC**	G-M	Alpha Beta Gamma X-ray	None	0	0.05	0.5	One 9V, 2,000 hours	-4°F to 131°F	400	Yes
SE International **Radiation Alert Frisker**	G-M	Alpha Beta Gamma X-ray	None	0.001	0.05	0.5	Two AA, 500 hours	14°F to 122°F	650	Yes
Technical Associates **TBM-IC-Mark V**	Ion Chamber	Alpha Beta Gamma X-ray	None	0.1	9.99	1.6	Six AA, 100 hours or ten CR-1220	-31°F to 167°F IP 63	1,595	No
Technical Associates **TBM-3SR-D**	G-M	Alpha Beta Gamma X-ray	None	0.01	0.1	1.75	Six AA, 100 hours	-31°F to 167°F IP 64	695	No

Company Product	Internal Detector	Type of Radiation Measured		Exposure Rate Range		Weight (lbs)	Battery Type, Life	Environmental	Price ($)	GSA
		Internal Detector	External Detector	Min (mR/h)	Max (R/h)					
Technical Associates **TBM-6SP-ST**	G-M	Alpha Beta Gamma X-ray	Gamma X-ray	0	0.15	2.5	One 9V, 100 hours	-31°F to 167°F IP 63	2,752	No
WB Johnson **DSM-501**	Plastic scintillator	Gamma X-ray	None	0.001	0.01	2.5	Six AA, 400 hours	-20°F to 140°F	1,459	Yes
WB Johnson **DSM-503**	G-M	Gamma X-ray	None	0.1	10	2.5	Six AA, 400 hours	-20°F to 140°F IP X4 [2]	999	Yes
WB Johnson **DSM-506**	G-M	Gamma X-ray	Alpha Beta Gamma X-ray	0	2	2.5	Six AA, 400 hours	-20°F to 140°F IP X4 [2]	1,059	Yes
X-Z Lab **RadPavise**	YSO Scintillator	Gamma X-ray	None	0.001	0.1	0.4	Li-ion battery pack, 240 hours	-4°F to 122°F IP 65	1,299	No

Notes:
NI Information on this feature was not available.
[1] Can be certified to a wider operating temperature range.
[2] It has been tested for water ingress, but not for ingress of solids

3.1 Canberra Industries Inc. Colibri TTC

Colibri TTC
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The Colibri TTC is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It can be connected to a variety of hot-swappable external probes produced by Canberra that provide alpha, beta, gamma, and x-ray radiation measurement capabilities complementing those of the internal G-M detector. The internal G-M detector provides an exposure rate measurement range of 300 µR/h to 1,000 R/h and meets IEC 60846 energy response requirements over an energy range of 48 keV to 1.5 MeV. Its sensitivity to 662 keV gamma rays is 438 cpm per mR/h. Canberra external detector probes save measurement data internally and can operate with any Colibri TTC, Colibri VLD, or Radiagem survey meter (see following sections) based on a single calibration, i.e., there is no need to perform a separate calibration for each survey meter.

The user interface consists of a backlit liquid crystal display (LCD) touchscreen, six control buttons (power, audio, backlight, menu up, menu down and menu enter), and three light emitting diode (LED) status and alarm indicator lights. Measurement results can be displayed in a range of SI and non-SI units, and are simultaneously displayed in the form of a bar graph as well as a numerical value. Users can make time-integrated measurements as well as rate measurements. The Colibri TTC can produce audible, vibration, and visible alarms when radiation levels exceed user-defined values, and it produces audible and visible warnings when an over-range condition occurs. Measurement data can be saved to its internal memory and exported via a waterproof cable or Bluetooth link. External detector probes can transmit measurement data to the Colibri TTC via a waterproof cable connection or Bluetooth link. The Calibri TTC can be configured with an internal GPS receiver at additional cost and can receive data from Bluetooth-enabled radio-frequency identification (RFID) or barcode readers.

The Colibri TTC weighs 1.2 pounds including batteries, and has dimensions of 7.6 x 3.9 x 2.7 inches. It operates on an integrated rechargeable Li-ion battery pack that provides approximately 25 hours of operating time in daytime usage. Its operating temperature range is from -4°F to 122°F, and it has an IP 67 rating for dust and water resistance. The manufacturer's product literature states that it remains waterproof when submerged in 1 meter of water for 30 minutes.

The manufacturer's suggested price of the Colibri TTC is $3,700; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.2 Canberra Industries Inc. Colibri VLD

The Colibri VLD is equipped with an internal thallium-doped cesium iodide [CsI(Tl)] scintillation detector for measuring gamma and x-ray radiation. It can be connected to a variety of hot-swappable external detector probes produced by Canberra that provide alpha, beta, gamma, and x-ray radiation measurement capabilities complementing those of the internal CsI(Tl) detector. The internal CsI(Tl) detector provides an exposure rate measurement range of 10 µR/h to 100 mR/h and meets IEC 60846 energy response requirements over an energy range

of 59 keV to 1.5 MeV. Sensitivity to 662 keV gamma rays is 27,000 cpm per mR/h. Canberra external detector probes save measurement data internally and can operate with any Colibri TTC, Colibri VLD, or Radiagem survey meter based on a single calibration, i.e., there is no need to perform a separate calibration for each survey meter.

Colibri VLD
Photo reproduced with permission, Canberra Industries Inc.

The Colibri VLD's user interface is identical to the Colibri TTC; there are six control pushbuttons, a backlit LCD display screen, and three LED status and alarm indicator lights. Measurement results can be indicated in a range of SI units and non-SI units, and are simultaneously displayed in the form of a bar graph as well as a numerical value. Users can make time-integrated measurements as well as rate measurements.

The Colibri VLD can produce audible, vibration, and visible alarms when radiation levels exceed user-defined values, and it produces audible and visible warnings when an over-range condition occurs. Measurement data can be saved to internal memory and exported via waterproof cable or Bluetooth link. External detector probes can transmit measurement data to the Colibri TTC via a waterproof cable connection or a Bluetooth link. The Calibri VLD can be configured with an internal GPS receiver at additional cost and can receive data from Bluetooth-enabled RFID or barcode readers.

The Colibri VLD weighs 1.4 pounds including batteries, and has dimensions of 7.6 x 3.9 x 2.7 inches. It operates on a rechargeable Li-ion battery pack that provides approximately 25 hours of operating time in daytime usage. Its operating temperature range is from 14°F to 104°F, and it has an IP 67 rating for water and dust resistance. The manufacturer's product literature states that it remains waterproof when submerged in 1 meter of water for 30 minutes.

The manufacturer's suggested price of the Colibri VLD is $4,500; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.3 Canberra Industries Inc. Radiagem 4000

The Radiagem 4000 is equipped with an internal G-M detector for measuring gamma and x-ray radiation. It can be connected to a variety of hot-swappable external detector probes produced by Canberra that provide alpha, beta, gamma and x-ray radiation measurement capabilities complementing those of the internal G-M detector. The internal G-M detector provides a measurement range of 10 µR/h to 10 R/h and meets IEC 60846 photon energy response requirements over an energy range of 40 keV to 1.5 MeV. Sensitivity to 662 keV gamma rays is 50 cpm per mR/h. Canberra external detector probes save measurement data internally and can operate with any Colibri TTC, Colibri VLD, or Radiagem survey meter based on a single calibration, i.e., there is no need to perform a separate calibration for each specific survey meter.

Radiagem 4000
Photo reproduced with permission, Canberra Industries Inc.

The Radiagem 4000's user interface consists of four control pushbuttons and a backlit LCD display screen. Measurement results are simultaneously displayed in the form of a bar graph and a numerical value. Users can make time-integrated measurements as well as rate measurements. The Radiagem 4000 indicates measurement results in a range of non-SI units; Canberra also offers the Radiagem 2000, which is identical to the Radiagem 4000 except that measurements are indicated in SI units. The Radiagem 4000 can produce audible and visible alarms when measured radiation levels exceed user-defined values. Audible and visible warnings are produced when an over-range condition occurs. Measurement data can be saved to internal memory and can be exported via a waterproof cable connector.

The Radiagem 4000 weighs less than 11 ounces including batteries, and has dimensions of 5.9 x 3.3 x 1.8 inches. It operates on two AA batteries; alkaline AA batteries typically provide greater than 80 hours operating time. Its operating temperature range is from 14°F to 122 °F, and it has an IP 67 rating for dust and water resistance.

The manufacturer's suggested price of the Radiagem 4000 is $1,200; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.4 Fisher Scientific Inc. RadEye B20/B20-ER

The RadEye B20 is an all-in-one instrument that is equipped with an internal uncompensated pancake-type G-M detector with a 2-inch diameter window. It provides an exposure rate measurement range of 0.1 µR/h to 200 mR/h and a count rate measurement range of 0 to 600,000 cpm. It is also available as an extended range variant, the RadEye B20-ER, which is identical to the RadEye B20 but provides higher exposure and count rate measurement ranges, 0.1 µR/h to 10 R/h, and 0 to 30 million cpm, respectively. An energy compensation filter for gamma and x-ray radiation measurements and a filter that provides alpha-beta discrimination capability can be purchased at additional cost. With the energy compensation filter in place, energy response to gamma and x-ray radiation meets IEC 60846 requirements over an energy range of 17 keV to 3 MeV.

RadEye B20
Photo reproduced with permission, Fisher Scientific Inc.

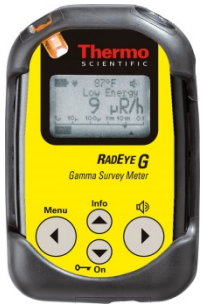
The RadEye B20's user interface consists of a four-button keypad on the front of the instrument, a pushbutton on its side, and a backlit LCD display screen. Measurement results can be displayed in a range of SI and non-SI units. Users can make time-integrated measurements as well as rate measurements. The RadEye B20 can be set to produce audible chirps at a rate proportional to the measured radiation count rate. It can produce audible, visible, and vibrational alarms when radiation levels exceed user-determined values, and provides a visible warning should an over-range condition occur. Measurement data can be saved to internal memory and transmitted to an external device via internal infra-red or Bluetooth devices that are available at additional cost. Software for viewing and analyzing measurement on a Windows-based computer is also available at additional cost. Fisher offers several different extension handles and telescoping poles with lengths of up to 12.5 feet that the RadEye B20 can be mounted on to permit users to remain at a distance from strong radioactive sources or to measure hard-to reach locations.

The RadEye B20 and B20-ER each weigh 0.7 pounds and have dimensions of 5.2 x 2.8 x 2.4 inches. They operate on two AAA batteries that typically provide over 500 hours of operating time under normal usage. They have an operating temperature range of -4°F to 122°F, and an IP 32 rating for dust and water resistance.

The manufacturer's suggested price of the RadEye B20 and B20-ER are $1,240 and $1,500, respectively; they are listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours.

3.5 Fisher Scientific Inc. RadEye G/G-Ex

The RadEye G is an all-in-one instrument that is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It is also available in an intrinsically safe variant, the RadEye G-Ex, which is identical to the RadEye G in features and capabilities, except that the RadEye G provides an exposure rate measurement range of 0.1 µR/h to 10 R/h, while the RadEye G-Ex provides an exposure rate measurement range of 50 µR/h to 10 R/h. The energy response of the RadEye G to gamma and x-ray radiation meets IEC 60846 requirements over an energy range of 45 keV to 3 MeV, and its sensitivity to 662 keV gamma rays is 1020 cpm per mR/h.



RadEye G
Photo reproduced with permission, Fisher Scientific Inc.

The user interface of the RadEye G consists of a four-button keypad on the front of the instrument, a pushbutton on its side, and a backlit LCD display screen. Measurement results can be displayed in a range of SI and non-SI units. Users can make time-integrated measurements as well as rate measurements. The RadEye G can be set to produce audible chirps at a rate proportional to the measured radiation count rate. It can produce audible, visible, and vibrational alarms when radiation levels exceed user-determined values, and it provides a visible warning should an over-range condition occur. Measurement data can be exported via internal infra-red or Bluetooth devices available at additional cost. Software for viewing, analyzing, and saving measurement on a Windows-based computer is also available at additional cost. Fisher offers extension handles and telescoping poles of lengths up to 12.5 feet that the RadEye G and G-Ex can be mounted on to permit users to remain at a distance from strong radioactive sources and to measure hard-to reach locations.

The RadEye G weighs 0.35 pounds and has dimensions of 3.75 x 1.2 x 2.4 inches. It operates on two AAA batteries that typically provide 600 hours of operating time under normal usage. The RadEye G and RadEye G-Ex have an operating temperature range from -4°F to 122°F, and an IP 65 rating for water/dust resistance.

The manufacturer's suggested list price of the RadEye G and RadEye G-Ex are $1,020 and $1,340, respectively; they are listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours.

3.6 Fluke Electronics Corporation 451B

The 451B is an all-in-one unpressurized ion chamber survey meter that is designed to measure gamma, x-ray, and beta radiation. It provides an exposure rate measurement range of

0 to 50 R/h. Beta radiation measurements are made using a thin Mylar window with a retractable cover.

The user interface consists of power and mode buttons and a backlit LCD screen that displays measurements in the form of a bar graph as well as a numerical value. The 451B is available in two variants that are identical except that one reports measurement results in roentgens, the other, in Sieverts. It can make time-integrated measurements as well as rate measurements, and it can also indicate the peak exposure rate obtained during a measurement period.

Fluke 451B
Photo reproduced with permission, Fluke Electronics Corporation

The 451B can produce audible alarms when radiation levels exceed a user-defined value, and it produces a visible warning if an over-range condition occurs. Measurement data can be exported to a personal computer via an RS-232 port and viewed with manufacturer-provided software that creates a virtual instrument display with audible and visible alarms.

The 451B weighs 2.5 pounds and has dimensions of 4 x 8 x 6 inches. It operates on two 9 volt alkaline batteries which provide about 200 hours operating time. Its operating temperature range is from -4°F to 122°F, and it has an IP 40 rating for dust and water resistance.

The manufacturer's suggested price of the 451B is $2,910; it is listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.7 Fluke Electronics Corporation 451P

The Fluke 451P is all-in-one pressurized ion chamber survey meter designed to measure gamma and x-ray radiation that provides an exposure rate measurement range of 0 to 5 R/h.

The user interface consists of power and mode buttons and a backlit LCD screen that displays measurements as a bar graph as well as a numerical value. The 451P is available in two variants that are identical except that one reports measurement results in Roentgens, the other, in Sieverts. It can make time-integrated measurements as well as exposure rate measurements, and it can also indicate the peak exposure rate obtained during a measurement period.

The 451P can produce audible alarms when radiation levels exceed a user-defined value, and it produces a visible warning if an over-range condition occurs. Measurement data can be exported to a personal computer via an RS-232 port and viewed with manufacturer-provided software that creates a virtual instrument display with audible and visible alarms.

Fluke 451P
Photo reproduced with permission, Fluke Electronics Corporation

The 451P weighs 2.4 pounds and has dimensions of 4 x 8 x 6 inches. It operates on two 9-volt alkaline batteries, which provide about 200 hours operating time. It has an operating temperature range from -4°F to 122°F and an IP 40 rating for dust and water resistance.

The manufacturer's suggested price of the 451P is $3,110; it is listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours on weekdays.

3.8 Fluke Electronics Corporation ASM-992

The ASM-992 is an equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It can be connected to a variety of hot-swappable external alpha, beta, and gamma probes that provide measurement capabilities complementing those of the internal G-M detector. The internal G-M detector provides an exposure rate measurement range of 0.1 mR/h to 1 R/h and has an energy response to x-ray and gamma radiation that is within 20 percent of that for 662 keV gamma radiation over an energy range of 70 keV to 1.3 MeV. Its sensitivity to ~1.3 MeV gamma radiation is 210 cpm per mR/h.

ASM-992
Photo reproduced with permission, Fluke Corporation

The user interface of the ASM-992 consists of a multi-button touchpad and a backlit LCD display screen. Measurement results can be displayed in a range of SI and non-SI units and are simultaneously displayed in the form of a bar graph. Users can make time-integrated measurements as well as rate measurements. The peak rate determined during a measurement period can also be displayed. The ASM-992 can produce audible and visible alarms when radiation levels exceed a user-defined value. It also produces audible and visible warnings if an over-range condition occurs. Measurement data can be saved to internal memory and exported via an internal infra-red transmitter. The ASM-992 can be configured with an internal barcode reader at additional cost.

The ASM-992 weighs 2.1 pounds and has dimensions of 10.9 x 4.1 x 2.5 inches. It operates on two D cell batteries; alkaline D cells typically provide 150 hours operating time at normal background radiation levels. It has an operating temperature range of 14°F to 122°F; the manufacturer does not report an IP rating; however, product literature states that the ASM-992 is splash proof.

The manufacturer's suggested price of the ASM-992 is $2,170, and it is listed on GSA price schedule. The purchase price includes a 1-year warranty. Technical support is provided during normal weekday business hours.

3.9 Fluke Electronics Corporation ASM-993

The ASM-993 is equipped with the same internal energy compensated G-M detector for measuring gamma and x-ray radiation as the ASM-992 (see previous product description for details). It is also equipped with an internal uncompensated G-M detector with a 1.5-inch diameter mica window for measuring alpha and beta surface contamination. It can be connected to a variety of hot-swappable external alpha, beta, and gamma probes that complement the measurement capabilities of the internal G-M detector.

ASM-993
Photo reproduced with permission, Fluke Corporation

The user interface consists of a multi-button touchpad and a backlit LCD display screen. Measurement results are numerically displayed in a range of SI and non-SI units and are simultaneously indicated in the form of a bar graph. Users can make time-integrated measurements as well as rate measurements. The peak rate determined during a measurement period can also be recorded. The ASM-993 can produce audible and visible alarms when the measured radiation level exceeds a user-defined value. It also produces audible and visible warnings if an over-range condition occurs. Measurement data can be saved to internal memory and exported via an internal infra-red transmitter. The ASM-993 can be configured at additional cost with an internal barcode reader at additional cost.

The ASM-993 weighs 2.4 pounds and has dimensions of 10.9 x 4.1 x 2.5 inches. It operates on two D cell batteries; alkaline D cells typically provide 150 hours operating time at normal background radiation levels. The operating temperature range is from 14°F to 122°F; the manufacturer does not report an IP rating; however it states that the ASM-993 is splash proof.

The manufacturer's suggested price of the ASM-993 is $3,170; it is listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.10 Ludlum Measurements Inc. Model 3-IS-1

The Model 3-IS-1 is an intrinsically safe all-in-one survey meter that is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It provides an exposure rate measurement range of 0.1 mR/h to 1,000 mR/h and has a sensitivity to 662 keV gamma rays of 100 cpm per mR/h.

Measurement results are displayed on an analog, needle-type, display screen reading in units of mR/h. Users can set the Model 3-IS-1 to produce an audio output that varies with the intensity of measured radiation levels. Operating controls include a multi-position rotary switch (off, battery check, and four scale multipliers), an audio on/off switch, and a button to quickly reset the display screen needle to zero. The Model 3-IS-1 does not produce alarms when radiation levels exceed a user-defined level. Measurement data cannot be saved to internal memory.

Model 3-IS-1
Photo reproduced with permission, Ludlum Measurements Inc.

The Model 3-IS-1 weighs 3.5 pounds, including batteries, and has dimensions of 6.5 x 3.5 x 8.5 inches. It operates on two D-cell alkaline batteries that provide more than 2,000 hours of operating time under typical usage. It has an operating temperature range of -4°F to 122°F and exceeds the dust and water resistance requirements corresponding to an IP 24 rating.

The manufacturer's suggested price of the Model 3-IS-1 is $1,814; it is not listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.11 Ludlum Measurements Inc. Model 6

The Model 6 is an all-in-one survey meter that is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It provides an exposure rate

measurement range of 0 to 1,000 mR/h, and its energy response to gamma and x-ray radiation is within 15% of that for 662 keV gamma radiation over an energy range of 60 keV to 3 MeV.

Model 6
Photo reproduced with permission, Ludlum Measurements Inc.

The Model 6 is operated using a single multi-position rotary switch (off, battery check, and three scale multipliers). Measurement results are displayed on an analog needle display screen that at the time of purchase can be chosen to read in either SI or non-SI units. An instrument handle containing an LED light to illuminate the display screen can be purchased at extra cost. The display scale needle deflects to full scale when an over-range condition occurs; a meter face with an overload indicator light is available at additional cost. The Model 6 cannot produce alarms when radiation levels exceed a user-defined level. Measurement data cannot be saved to internal memory.

The Model 6 weighs 3.5 pounds, including batteries, and has dimensions of 6.5 x 3.5 x 8.5 inches. It operates on two D cell batteries; alkaline D cells typically provide more than 600 hours operating time at normal background radiation levels. The Model 6 has an operating temperature range from -22°F to 122°F; Ludlum does not report an IP rating for this instrument; however it states that it is splash proof.

The manufacturer's suggested price of the Model 6 is $1,169; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.12 Ludlum Measurements Inc. Model 14C

The Model 14C is equipped with an internal energy compensated G-M detector that is used to measure gamma and x-ray radiation. It can also be connected to a range of external probes for making alpha, beta, and gamma measurements. The internal G-M detector provides an exposure rate measurement range of 0 to 2,000 mR/h and has an energy response to x-ray and gamma radiation that is within 15 percent of that for 662 keV gamma radiation over an energy range of 60 keV to 3 MeV.

Model 14C
Photo reproduced with permission, Ludlum Measurements Inc.

Measurement results are displayed on an analog, needle-type, display screen that can be furnished reading in SI or non-SI units. An instrument handle containing an LED light to illuminate the display screen is available at extra cost. Users can set the Model 14C to produce audio output that varies with the intensity of measured radiation level. Operating controls include a multi-position rotary switch (off, and five scale multipliers), internal/external detector selector switch, and audio on/off selector switch, a battery check button, and a reset button that quickly drives the display scale needle to zero.

The Model 14C cannot produce alarms when radiation levels exceed a user-defined level; a meter face with an over-range indicator light can be purchased at additional cost. Measurement data cannot be saved to internal memory.

The Model 14C weighs 3.5 pounds including batteries and has dimensions of 6.5 x 3.5 x 8.5 inches. It operates on two D cell batteries; alkaline batteries typically provide more than 2,000 hours operating time at normal background radiation levels. The operating temperature range of the Model 14C is from -4°F to 122°F; Ludlum does not report an IP rating for this instrument.

The manufacturer's suggested price of the Model 14C is $823; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.13 Ludlum Measurements Inc. Model 26-1

The Model 26-1 is an all-in-one instrument intended for measuring gamma and x-ray radiation and for making alpha and beta surface contamination measurements. It provides an exposure rate measurement range of 0 to 500 mR/h, and a count rate measurement range of 1 to 999,000 cpm. It is equipped with a pancake-type G-M detector that has a 2-inch diameter window. Energy compensation filters available at extra cost can be placed over the detector window when measuring gamma and x-ray exposure or ambient dose equivalent rates. With the proper filter in place, exposure rate measurements are within 20 percent of those for 662 keV gamma radiation over an energy range of 33 keV and 1.2 MeV, and ambient dose equivalent rate measurements are within 20 percent of those for 662 keV gamma rays over an energy range of 20 keV to 1.2 MeV.

Model 26-1
Photo reproduced with permission, Ludlum Measurements Inc.

The user interface consists of a three-button keypad (on/off/quiet, mode, and measurement unit selector), a backlit LCD display screen, and an LED alarm indicator light. Measurements can be displayed in a range of SI and non-SI units. The Model 26-1 can make time-integrated measurements as well as rate measurements, and it also can indicate the peak value obtained during a measurement period. Users can set the Model 26-1 to produce an audible output that varies with the intensity of measured radiation levels. It produces audible and visible alarms when radiation levels exceed a user-defined value, and it produces a visible warning if an over-range condition occurs. Measurement data cannot be saved to internal memory.

The Model 26-1 weighs 1 pound and has dimensions of 1.8 x 2.7 x 10.7 inches. It operates on two AA alkaline batteries that provide about 500 hours operating time under normal usage. The Model 26-1 has operating temperature range is from -4 to 122 °F; it can be certified for operation from -40°F to 150°F. It has an IP 53 rating for dust and water resistance.

The manufacturer's suggested price of the Model 26-1is $781; it is not listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.14 Ludlum Measurements Inc. Model 79

The Ludlum Model 79 consists of an energy compensated G-M detector mounted at the end of a telescoping carbon fiber pole that can be extended to a length of 15 feet, and a control module mounted on the pole handle. It provides an exposure rate measurement range of 1 mR/h to 1,000 R/h and has an energy response to gamma and x-ray radiation that is within 25 percent of that for 662 keV gamma radiation over an energy range of 60 keV to 3 MeV.

Model 79
Photo reproduced with permission, Ludlum Measurements Inc.

The control module's user interface consists of an automatically backlit LCD display screen, three push buttons (on/off, mode, and measurement unit selector), and several LED alarm lights. Measurement results can be displayed in a range of SI or non-SI units. The Model 26-1 can make time-integrated measurements as well as rate measurements, and it can also indicate the peak value obtained during a measurement period. The Model 79 can be set to produce an audible output that varies with the intensity of the measured radiation level. It produces audible and visible alarms when measured radiation levels reach user-defined values, and produces a visible warning if an over-range condition occurs. Measurement data can exported to a computer via a mini-universal serial bus (USB) port and viewed in real time using Ludlum-provided software.

The Model 79 weighs 2.3 pounds including batteries; the telescoping pole is 45 inches long when fully retracted. It operates on two AAA batteries; alkaline batteries provide approximately 100 hours of operating time. The operating temperature range of the Model 79 is from -4 to 122 °F; Ludlum states that it can be certified for operation from -40°F to 150°F. It has an IP 52 rating for dust and water resistance.

The manufacturer's suggested price of the Model 79 is $4,295; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.15 Ludlum Measurements Inc. Model 2401-P DOSE

The Model 2401-P DOSE is an all-in-one survey meter that is equipped with a G-M detector with a 2-inch diameter mica window. It provides an exposure rate measurement range of 0 to 15 mR/h, and a count rate measurement range of 0 to 50,000 cpm. A built-in energy compensation filter slides over the mica window to flatten its energy response when making gamma and x-ray exposure rate measurements. With the energy compensation filter in place, energy response to gamma and x-ray radiation is within 20 percent of that for 662 keV gamma radiation over an energy range of 20 keV to 1.2 MeV.

Model 2401-P
Photo reproduced with permission, Ludlum Measurements Inc.

Operating controls include one multi-position switch for selecting measurement range and a second multi-position switch for power on, audio output, and battery check settings. Measurement results are displayed on an analog, needle-type, display screen. At the time of purchase, users may choose to configure the Model 2401-P DOSE with a

meter face reading in either SI or non-SI units. Users can set the Model 2401-P DOSE to produce an audible output that varies with changes in measured radiation level; it cannot produce radiation level alarms. Measurement data cannot be saved to internal memory.

The Model 2401-P DOSE weighs 14 ounces including batteries and has dimensions of 1.8 x 23.3 x 5.3 inches. It operates on one 9-volt battery; operating time at normal background radiation levels is typically about 250 hours. The operating temperature range is from -4°F to 122 °F, and can be certified for operation from -40°C to 150°F. The manufacturer does not report an IP rating for this instrument.

The manufacturer's suggested price of the Model 2401-P DOSE is $1,053; it is not listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours on weekdays.

3.16 Mirion Technologies Inc. QuickSweep™- Grand

The QuickSweep-Grand is an all-in-one survey meter designed for measuring beta surface contamination. It is equipped with two plastic scintillator detectors that provide a detection area of 150 square inches.

QuickSweep-Grand
Photo reproduced with permission, Mirion Technologies Inc.

It has a simple user interface consisting of an on/off button and audible, visible (LED), and vibration alarms that activate when measured beta radiation levels exceed threshold values preconfigured by the manufacturer. Optionally, an Android-based smartphone running a Mirion-produced application (App) can be used as a more advanced interface that displays measurement results in SI or non-SI units and allows users to save measurement data, annotated with comments and photos, and to change settings such as alarm thresholds.

The QuickSweep-Grand has dimensions of 18 x 9.3 x 6.0 inches. It can be mounted on a telescoping pole that extends up to 4 feet. The QuickSweep-Grand operates on a rechargeable Li-ion battery pack; information on typical operating times between charges was not available. The QuickSweep-Grand has an IP 64 rating for dust and water resistance and an operating temperature range of 41°F to 113°F.

The manufacturer's suggested price of the QuickSweep-Grand is $9,300; it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.17 Mirion Technologies Inc. RDS-31

The RDS-31 is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It can also be connected to a variety of hot-swappable external alpha, beta, and gamma detector probes. The internal G-M detector provides an exposure rate measurement range of 1 µR/h to 10 R/h, and has a sensitivity of 1,080 cpm per mR/h for 662 keV gamma radiation.

RDS-31
Photo reproduced with permission, Mirion Technologies Inc.

User controls consist of two rubberized pushbuttons with embossed surfaces for ease of use with gloves. Measurement results are displayed on a backlit organic light-emitting diode (OLED) display screen. Measurements can be displayed in SI or non-SI units. The RDS-31 can produce audio, visible, and vibration alarms when measured radiation levels exceed a user-defined value, and it produces audible and visible warnings if an over-range condition occurs. Measurement data can be saved to internal memory and exported via a custom USB cable. An internal radio communication module can be installed at additional cost to transmit measurement data wirelessly to a central location.

The RDS-31 weighs 0.49 pounds and has dimensions of 3.9 x 2.6 x 1.3 inches. It operates on AA batteries; alkaline AA batteries provide more than 3,000 hours continuous operating time at normal background radiation levels. The RDS-31 has an operating temperature range of -40°F to 140 °F and an IP 67 rating for dust and water resistance.

The manufacturer's suggested price of the RDS-31 is $1,250, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

The RDS-31 can be purchased as a variant containing an internal silicon diode detector rather than a G-M detector. The silicon diode detector provides a higher measurement range and better tolerance to long-term use in high radiation fields.

3.18 Mirion Technologies Inc. RDS-80

The RDS-80 is an all-in-one survey meter intended for making surface alpha and beta contamination measurements. It contains an internal G-M detector with a thin mica window that has an area of 15 square centimeters, and provides a measurement range is from 1 to 100,000 cps.

RDS-80
Photo reproduced with permission, Mirion Technologies Inc.

The user interface consists of a single push button and a backlit LCD display screen that displays measurement results in SI units. The RDS-80 can be set to produce an audible output that varies with measured radiation intensity. It can produce audible and visible alarms when measured radiation levels exceed a user-defined value and will produce audible and visible warnings should an over-range condition occur.

Measurement data can be saved to internal memory and exported using an internal infra-red device that can also be used to change instrument settings via a computer running Mirion-provided software.

The RDS-80 weighs 0.73 pounds including batteries and has dimensions of 3.1 x 5.0 x 2.2 inches. It operates on two AA alkaline batteries that provide more than 2,000 hours of operating time at normal background radiation levels. It has an operating temperature range of -13°F to 131°F, and an IP 54 rating for dust and water resistance.

Information on the suggested list price of the RDS-80 is $850; it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.19 Mirion Technologies Inc. RI-02

The RI-02 is an all-in-one unpressurized ion chamber survey meter that provides a gamma and x-ray exposure rate measurement range of 0.1 mR/h to 100 R/h. It can also be used to measure cumulative exposure to an upper limit of 1,000 R. Its gamma and x-ray energy response relative to 662 keV Cs-137 gamma rays is within 20 percent over an energy range of 20 keV to 1.3 MeV. A sliding aluminum cover can be retracted from a portion of the ion chamber wall to allow users to measure beta radiation through a 50 square centimeter Mylar window.

RI-02
Photo reproduced with permission, Mirion Technologies Inc.

The user interface consists of four pushbuttons and measurements and a backlit LCD screen. Measurement results can be displayed in a range of SI and non-SI units. The instrument has a 'freeze mode' feature that indicates the peak measured radiation level obtained during a measurement period. The RI-02 can produce visible and audible alarms when radiation levels exceed a user-defined value. It will also produce visible and audible warnings should an over-range condition occur. Data can be exported to a computer via a USB port; a radio communication module available at additional cost can be used to transmit data wirelessly and makes it possible to operate the RI-02 as a remote monitoring station.

The RI-02 weighs 3 pounds and has dimensions of 8.25 x 4.5 x 6 inches. It has an operating temperature range of 23°F to 122 °F. It operates on two C cell alkaline batteries that provide over 200 hours operating time.

The manufacturer's suggested price of the RI-02 is 2,785; it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.20 Mirion Technologies Inc. Telepole 2

The Telepole 2 is designed for measuring gamma and x-ray radiation. It is equipped with two energy compensated G-M detectors in a probe located at the end of a telescoping pole, and a third energy compensated G-M detector located within a detachable control unit on the pole handle.

Telepole 2
Photo reproduced with permission, Mirion Technologies Inc.

The two G-M detectors in the probe combine to provide a measurement range of 50 µR/h to 1000 R/, while the control unit's internal G-M detector provides a measurement range of 50 µR/h to 1.5 R/h. The energy response of the instrument's G-M detectors to gamma and x-ray radiation is within 25 percent of that for 662 keV gamma rays over an energy range of 65 keV to 2 MeV.

The control unit's user interface consists of four buttons and a backlit LCD display screen; measurement data from both the control unit and the probe's G-M detectors can be viewed simultaneously. Measurement data is displayed in units of R/h. Users can make time-integrated measurements as well as rate measurements. The highest measured radiation level determined during a measurement period can also be displayed.

Users can set the Telepole 2 to produce audible and visible alarms when measured radiation levels exceed user-selected values; a Bluetooth enabled bracelet that provides a vibration alarm can be purchased at additional cost. The control unit will produce a visible warning should an over-range condition occur.

Measurement data can be saved to internal memory and can be exported via a USB port on the control unit. The control unit can be equipped with a radio communication module at additional cost that can be used to transmit data wirelessly to a central location.

The combined weight of all components is 4.3 pounds; the control unit has dimensions of 3.7 x 5.8 x 2.2 inches. The telescoping pole can be extended to a length of 11 feet and is less than four feet long when fully collapsed. The Telepole 2 has an operating temperature range of -4°F to 122°F and an IP 67 rating for dust and water resistance. It operates on four AA-type alkaline batteries that provide approximately 85 hours operating time. An LED flashlight is incorporated into the end of the telescoping pole, allowing users to illuminate dimly lit areas.

The manufacturer's suggested list price of the Telepole 2 is $5,500; it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.21 S.E. International Inc. Digilert 200

The Digilert 200 is an all-in-one survey meter that is equipped with an internal uncompensated G-M detector with a 0.5-inch diameter mica window. It provides an exposure rate measurement range of 1µR/h to 200 mR/h and a count rate measurement range of 0 to 214,000 cpm. Its sensitivity to 662 keV gamma radiation is 1070 cpm per mR/h.

Digilert 200
Photo reproduced with permission, S.E. International Inc.

Its user interface consist of two multi-position slider switches on the front of the instrument, three pushbuttons on its side, and a backlit LCD screen. Measurements results can be displayed in SI or non-SI units. The Digilert 200 can be set to produce an audible output that varies with measured radiation level; an LED light on the front panel flashes at a rate that increases with increasing radiation levels. It can produce audible and visible alarms when radiation levels exceed a user-defined value, and it will produce a visible warning should an over-range condition occur. Measurement data can be exported to a computer via the USB port. Software available from the manufacturer at an additional cost can be used to view and analyze exported measurement data.

The Digilert 200 weighs 7.7 ounces and has dimensions of 5.9 x 3.1 x 1.2 inches. It operates on one 9 volt alkaline battery that typically provides about 2,000 hours operating time at normal background radiation levels. Its operating temperature range is from 14°F to 122°F; the manufacturer does not report an IP rating for this instrument. A rubber boot, available at additional cost (seen in the product photo above), provides an improved grip and protection against mechanical damage.

The manufacturer's suggested price of the Digilert 200 is $465, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours on weekdays.

3.22 S.E. International Inc. Inspector USB

Inspector USB
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The Inspector USB is an all-in-one survey meter that is equipped with an internal uncompensated G-M pancake detector with a 2-inch diameter mica window. It provides an exposure rate measurement range of 1µR/h to 100 mR/h and a count rate measurement range of 0 to 350,000 cpm. Its sensitivity to 662 keV gamma radiation is 3340 cpm per mR/h.

Its user interface consist of two multi-position slider switches on the front of the instrument, three pushbuttons on its side, and a backlit LCD screen. Measurements results can be displayed in SI or non-SI units. The Inspector USB can be set to produce an audible output that varies with measured radiation levels, and an LED light on the front panel flashes at a rate that increases with increasing radiation levels. Users can set the Inspector USB to produce audible and visible alarms when radiation levels exceed a user-defined value, and it will produce a visible warning should an over-range condition occur. Measurement data can be exported to a computer via the USB port. Software available from the manufacturer at an additional cost can be used to view and analyze exported measurement data.

The Inspector USB weighs 10 ounces and has dimensions of 5.9 x 3.1 x 1.2 inches. It operates on one 9 volt alkaline battery that provides about 1,200 hours operating time at normal background radiation levels. The operating temperature range is from -4°F to 122°F. The manufacturer does not report an IP rating for this instrument. The mica window has a protective door that can be shut to cover the window when not needed for making alpha or beta surface contamination measurements. A rubber boot, available at additional cost, provides an improved grip and protection against mechanical damage.

The manufacturer's suggested price of the Inspector USB is $575, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.23 S.E. International Inc. MC1K

MC1K
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The MC1K is an all-in-one survey meter that is equipped with an internal energy compensated G-M detector that provides an exposure rate measurement range of 0 to 1,000 mR/h with an energy response to gamma and x-ray radiation that is within 20 percent of that for 662 keV gamma rays over an energy range of 40 keV to 1.5 MeV.

Its user interface consists of two multi-position switches (on-off-audio, and x1, x10, x100, and x1000 scale multipliers) and an analog, needle-type display screen that cannot be illuminated under low light conditions. At the time of purchase, the MC1K can be configured with a screen reading in either SI or non-SI units. The MC1K can be set to produce an audio output that varies with changes in measured radiation levels. Measurement data can be exported via an optional USB port available at an additional cost. Software available

from the manufacturer at an additional cost can be used to view and analyze exported measurement data.

The MC1K weighs 8.3 ounces and has dimensions of 8.25 x 2.75 x 1.88 inches. It operates on one 9 volt alkaline battery that provides about 2,000 hours operating time at normal background radiation levels. The operating temperature range is from -4°F to 131°F. The manufacturer does not report an IP rating for this instrument.

The manufacturer's suggested price of the MC1K is $375, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.24 S.E. International Inc. Monitor 4EC

The Monitor 4EC is an all-in-one survey meter that is equipped with G-M detector with a 0.5-inch diameter mica window and energy compensated side walls. It provides an exposure rate measurement range of 0 to 50 mR/h, and a count rate measurement range of 0 to 50,000 cpm. Its sensitivity to 662 keV gamma rays is approximately 1,000 cpm per mR/h. Its energy response to gamma and x-ray radiation, relative to 662 keV gamma rays, is +35% or -17% over an energy range of 40 keV to 1.3 MeV when radiation enters the internal G-M detector through its sidewalls.

Monitor 4EC
Photo reproduced with permission, S.E. International Inc.

Its user interface consists of two multi-position switches (on-off-audio, and x1, x10, and x100 scale multipliers) and an analog needle that cannot be illuminated under low light conditions. At the time of purchase, the Monitor 4EC can be configured with a screen reading in either SI or non-SI units. The Monitor 4EC can be set to produce an audio output that varies with changes in measured radiation level. Measurement data can be exported via an optional USB port that is available at additional cost.

The Monitor 4EC weighs 8.7 ounces and has dimensions of 8.25 x 2.75 x 1.88 inches. It operates on one 9 volt alkaline battery that provides about 2,000 hours operating time at normal background radiation levels. The operating temperature range is from -4°F to 131°F.

The manufacturer's suggested price of the Monitor 4EC is $400, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.25 S.E. International Inc. Radiation Alert® Frisker

The Radiation Alert Frisker is an all-in-one survey meter that has an uncompensated G-M pancake detector with a 2-inch diameter mica window. It provides an exposure rate measurement range of 1µR/h to 50 mR/h and a count rate measurement range of 0 to 175,000 cpm; its sensitivity to 662 keV gamma rays is 3,340 cpm per mR/h.

Its user interface consists of a two-button keypad on the front of the instrument and a three-position switch on the instrument handle, and a backlit LCD screen. Measurement results can be

displayed in either SI or non-SI units. An LED light on the handle flashes at a rate proportional to the measured radiation level; the Radiation Alert Frisker can also be set to emit audible beeps at a rate proportional to the radiation count rate. It can produce audible and visible alarms when radiation levels exceed a user-defined value, and it will produce a visible warning should an over-range condition occur.

Radiation Alert Frisker
Photo reproduced with permission, SE International Inc.

The Radiation Alert Frisker weighs 7.7 ounces and has dimensions of 10.9 x 1.75 x 2.5 inches. It operates on two AA alkaline batteries that provide about 500 hours operating time at normal background radiation levels. The operating temperature range is from 14°F to 122°F.

The manufacturer's suggested price of the Radiation Alert Frisker is $650; it is listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.26 Technical Associates TBM-IC-Mark V

The TBM-IC-Mark V is an all-in-one survey meter containing an unpressurized ion chamber. It provides an exposure rate measurement range of 0.1 mR/h to 9.99 R/h with an energy response to gamma and x-ray radiation that is with 10 percent of that for 662 keV gamma rays over an energy range of 10 keV to 3 MeV. Users can make time-integrated measurements as well as rate measurements. The ion chamber has a 2-inch diameter Mylar window that can be uncovered to permit measurement of alpha radiation, low energy beta, and x-ray radiation.

Operating controls include toggle switches for instrument power and measurement mode (exposure rate or integrated exposure) a battery check button and a zero reset button for integrated exposure measurements. The TBM-IC-Mark V is available in two versions, one which reports measurement in SI units, the other, in non-SI units. An LED light on the front of the instrument pulses at a rate that is proportional to the measured radiation exposure rate and changes color if an over-range condition occurs. Measurement data cannot be saved to internal memory.

TBM-IC-Mark V
Photo reproduced with permission, Technical Associates

The TBM-IC-Mark V operates on six AA or ten CR-1220 button batteries; alkaline AA batteries typically provide about 100 hours of operating time. It weighs 1.6 pounds, including AA batteries, and has dimensions of 5.5 x 3.5 x 8 inches. Its operating temperature range is from -31°F to 167°F, and it has an IP 63 rating for dust and water resistance.

The manufacturer's suggested price of the TBM-IC-Mark V is $1,595; it is not listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours on weekdays.

3.27 Technical Associates TBM-3SR-D

The TBM-3SR-D is an all-in-one survey meter that is equipped with an internal uncompensated G-M detector with a 1.75-inch diameter mica window; a built-in protective cover slides over the mica window when it is not needed for making alpha/beta measurements. The TBM-3SR-D provides an exposure rate measurement range of 0.01 to 100 mR/h and has a sensitivity to 662 keV gamma radiation of 3500 cpm per mR/h.

TBM-3SR-D
Photo reproduced with permission, Technical Associates

Operating controls include a three-position toggle switch (on/off/battery check) and an audio output volume knob. Measurement results are displayed in SI units on a backlit LCD display screen. Users can make time-integrated measurements as well as rate measurements. An LED light on the front of the instrument pulses at a rate that is proportional to the measured radiation exposure rate and changes color if an over-range condition occurs. Measurement data cannot be saved, but can be exported to a data logging device via an optional serial port available at additional cost.

The TBM-3SR-D weighs 1.75 pounds including batteries and has dimensions of 3 x 5 x 3.5 inches. It operates on six AA alkaline batteries that typically provide 100 hours of operating time. Its operating temperature range is from -31°F to 167°F, and it has an IP 64 rating for dust and water resistance.

The manufacturer's suggested price of the TBM-3SR-D is $695; it is not listed on GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal weekday business hours.

3.28 Technical Associates TBM-6SP-ST

The TBM-6SP-ST is equipped with an internal energy uncompensated G-M detector with a 1.75-inch diameter mica window and an external 1 x 1 inch NaI(Tl) scintillator detector probe; an external Bismuth Germanium Oxide (BGO) detector with a higher gamma radiation sensitivity is available at additional cost. A built-in sliding cover protects the G-M detector's mica window when not needed for making alpha/beta measurements. The internal G-M detector is intended for conducting gamma and x-ray radiation surveys and for measuring surface alpha and beta contamination, while the external scintillator probe is intended for searching for gamma radiation sources and for making exposure rate measurements at near-background levels. The internal G-M detector provides an exposure rate measurement range of 0 to 150 mR/h and a count rate measurement rate range of 0 to 500,000 cpm and has a measurement sensitivity of 3500 cpm per mR/h for 662 keV gamma radiation.

TBM-6SP-ST
Photo reproduced with permission, Technical Associates

Instrument controls include a six position rotary selection knob (off, battery check, and four scale selectors), an audio output control knob, and an internal/external detector toggle switch. Measurement results are displayed on an analog, needle-type, display screen that does not self-illuminate. A meter face reading in SI or non-SI units must be selected at the time of purchase. The TBM-6SP-ST can be set to produce audible clicks at a rate that is proportional to the intensity of measured radiation level. It cannot be set to produce radiation level alarms. Measurement data cannot be saved to internal memory.

The TBM 6SP-ST weighs 2.5 pounds, including the external NaI(Tl) probe and batteries. It has dimensions of 3.0 x 5.25 x 2.25 inches (excluding external probe). It operates on one 9 volt battery; an alkaline 9 volt battery typically provides 100 hours operating time. Its operating temperature range is from -31°F to 167°F, and it has an IP 63 rating for dust and water resistance.

The manufacturer's suggested price of the TBM 6SP-ST is $2,752, including the external NaI(Tl) detector probe; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during normal business hours on weekdays.

3.29 WB Johnson Instruments LLC DSM-501

The DSM-501 is an all-in-one survey meter that is equipped with a 1 x 1 inch internal plastic scintillator detector for measuring gamma and x-ray radiation. It provides an exposure rate measurement range of 1 μR/h to 10 mR/h.

DSM-501
Photo reproduced with permission, WB Johnson Instruments LLC

The user interface consists of a three-position rotary selector knob, several toggle switches, and a backlit LCD display screen. Measurement results can be displayed in a range of SI and non-SI units. The DSM-501 can be set to produce audible clicks at a rate proportional to the measured radiation level. It can produce audible and visible alarms when radiation levels exceed a user-defined value and produces audible and visible warning if an over-range condition occurs. Measurement data cannot be saved to internal memory; however, at the time of purchase at no cost the DSM-501 can be configured with an RS-232 port to allow data to be exported to a data logging device.

The DSM-501 weighs 2.5 pounds and has dimensions of 5.25 x 4 x 7 inches. It operates on six AA batteries; alkaline AA batteries provide approximately 400 hours of operating time. It has an operating temperature range of -20°F to 140 °F; the manufacturer does not report an IP rating for this instrument in its product literature.

The manufacturer's suggested price of the DSM-501 is $1,459, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.30 WB Johnson Instruments DSM-503

The DSM-503 is an all-in-one survey meter that is equipped with an internal energy compensated G-M detector for measuring gamma and x-ray radiation. It provides an exposure rate measurement range of 0.1 mR/h to 10 R/h. The energy response of the internal G-M

detector to gamma and x-ray radiation is within 10 percent of that for 662 keV gamma rays over an energy range of 50 keV to 2 MeV.

The user interface consists of a three-position rotary selector knob, several toggle switches and pushbuttons, and a backlit LCD display screen. Measurement results can be displayed in a range of SI or non-SI units. The DSM-503 can be set to produce audible clicks at a rate proportional to the measured radiation level. It can produce audible and visible alarms when radiation levels exceed a user-defined value. It also produces audible and visible warnings if an over-range condition occurs. Measurement data cannot be saved in internal memory; however, at the time of purchase at no cost, the DSM-503 can be configured with an RS-232 port to allow data to be exported to a data logging device.

DSM-503
Photo reproduced with permission, WB Johnson Instruments LLC

The DSM-503 weighs 2.5 pounds and has dimensions of 5.25 x 4 x 7 inches. It operates on six AA batteries; alkaline AA batteries provide about 400 hours of operating time. The DSM-503 has an operating temperature range of -20°F to 140°F; it has an IP X4 rating, i.e., it has been tested for water ingress, but not for ingress of solids.

The manufacturer's suggested price of the DSM-503 is $999, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.31 WB Johnson Instruments DSM-506

The DSM-506 is equipped with an internal energy compensated G-M detector for measuring gamma- and x-ray radiation and can be connected to a wide range of external alpha, beta, gamma, and x-ray measurement probes. The internal G-M detector provides an exposure rate measurement range of 0 to 2,000 mR/h, and has an energy response that is within 10 percent of that for 662 keV gamma rays over an energy range of 5 keV to 2 MeV.

DSM-506
Photo reproduced with permission, WB Johnson Instruments LLC

The user interface consists of a multi-position rotary selector knob, several toggle switches and pushbuttons, and a backlit LCD display screen. Measurements can be displayed in a range of SI or non-SI units. The DSM-506 can be set to produce audible clicks at a rate proportional to the measured radiation level. It can produce audible and visible alarms when measured radiation levels exceed a user-defined value, and it produces audible and visible warnings if an over-range condition occurs. Measurement data cannot be saved to internal memory; however, at the time of purchase at no additional fee, the DSM-506 can be configured with an RS-232 port to allow measurement data to be exported to a data logging device.

The DSM-506 weighs 2.5 pounds and has dimensions of 5.25 x 4 x 7 inches. It operates on six AA batteries; alkaline AA batteries provide about 400 hours of operating time at normal

background radiation levels. Its operating temperature range is from -20°F to 140°F; it has an IP X4 rating, i.e., it has been tested for water ingress, but not for ingress of solids.

The manufacturer's suggested price of the DSM-506 is $1,059, and it is listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

3.32 X-Z Lab RadPavise

The RadPavise is an all-in-one instrument that is equipped with an internal Yttrium Orthosilicate (YSO) scintillation detector for measuring gamma and x-ray radiation. It provides an exposure rate measurement range of 1 μR/h to 100 mR/h with an energy response to gamma and x-ray radiation that is within 20 percent of that for 662 keV gamma rays over an energy range of 20 keV and 3 MeV. Its sensitivity to 662 keV gamma rays is 20,400 cpm per mR/h. The RadPavise can also make time-integrated exposure measurements to an upper limit of 10,000 R.

RadPavise
Photo reproduced with permission, X-Z Lab Inc.

The RadPavise is operated using four control buttons, two on the front of the instrument and two on its side. Measurement data can be displayed in units of rem/h, Sv/h, or cpm, on an OLED display screen that is visible in low light.

The RadPavise can produce audible, visible, and vibrating alarms when radiation levels exceed user-defined limits, and it will provide visible and audible warnings should an over-range condition exists. Measurement data can be saved in internal memory and exported to a computer via a USB cable connection.

The RadPavise weighs 6.7 ounces, including batteries, and has dimensions of 4.4 x 2.8 x 0.9 inches. It operates on a rechargeable Li-ion battery pack that provides up to 240 hours of operating time when operated at background radiation levels. Its operating temperature range is from -4°F to 122°F, and it has an IP 65 rating for dust and water resistance.

The manufacturer's suggested price of the RadPavise is $1,299; it is not listed on the GSA price schedule. The purchase price includes a 1-year warranty and technical support during business hours.

4. VENDOR CONTACT INFORMATION

Additional information on the products included in this market survey report can be obtained from the vendors listed in Table 4-1.

Table 4-1. Vendor Contact Information

Company	Address/Phone Number	E-Mail/Website
Canberra Industries Inc.	800 Research Parkway Meriden, CT 06450 (800) 243-3955	www.canberra.com customersupport@canberra.com
Fisher Scientific Inc.*	300 Industry Drive Pittsburg, PA 15275 (800) 556-232	www.thermoscientific.com customer.service.rmsi@thermofisher.com
Fluke Electronics Corporation Biomedical Division	6920 Seaway Boulevard Everett, WA 98203 (425) 347-6100	www.flukebiomedical.com info@flukebiomedical.com
Laurus Systems Inc. (Vendor for Mirion Technologies)	3460 Ellicot Center Drive Ellicot City, MD 21043 (410) 465-5558	www.laurussystems.com information@laurussystems.com
Ludlum Measurements Inc.	P.O. Box 810 Sweetwater, TX 79556 (800) 622-0828	www.ludlums.com ludlum@ludlums.com
Mirion Technologies Inc.	5000 Highlands Parkway Suite 150 Smyrna, GA 30082 (800) 251-3331	www.mirion.com info@mirion.com
S.E. International Inc.	436 Farm Road Summertown, TN 38483 (931) 964-3561	www.seintl.com radiationinfo@seintl.com
Technical Associates (A division of U.S. Nuclear Corporation)	7051 Eton Avenue Canoga Park, CA 91303 (818) 883-7043	www.tech-associates.com
WB Johnson Instruments LLC	3998 Commerce Circle Idaho Falls, ID 83401 (208) 557-6945	www.jradmeters.com buyjohnson@jradmeters.com
X-Z Lab Inc.	2440 Camino Ramon Suite 264 San Ramon, CA 94583 (925) 359-6908	www.x-zlab.com contact@x-zlab.com

*Fisher Scientific is a subsidiary of Thermo Fisher Scientific Inc. Fisher Scientific holds the U.S. General Services Administration (GSA) schedule.

5. SUMMARY

This report provides an overview of HHRSM technologies, applications, and use considerations, and presents information on the features and capabilities of over thirty HHRSM models produced by nine different manufacturers.

There are considerable differences among these instruments with regard to features and capabilities such as types of ionizing radiation that can be measured, measurement range, display format, alarm capabilities, data export options, weight, and battery types and lifetimes. Manufacturer's suggested list prices range from $375 to more than $9,300.

Careful assessment of the characteristics of various commercially available HHRSMs will allow agencies to acquire the instrument best suited for their particular needs. Product specifications and features may change with time; therefore, agencies should contact equipment manufacturers to obtain the most up-to-date information before purchasing a specific instrument.

APPENDIX A.

The International Electrotechnical Commission (IEC) Ingress Protection (IP) Rating is composed of two digits. The first number in the rating refers to protection against solid objects, and the second number refers to protection against water. The highest possible rating is IP 68.

Table A-1. Meaning of IP Rating Numbers

Protection Against Solids	
First Digit (0-6)	Meaning
0	No protection.
1	Protected against solid objects over 50 mm (e.g. accidental touch by hand).
2	Protected against solid objects over 12 mm (e.g. accidental touch by finger).
3	Protected against solid objects over 2.5 mm (e.g. tools, wires).
4	Protected against solid objects over 1 mm (e.g. small wires).
5	Protected against dust—limited ingress (no harmful deposit).
6	Totally protected against all dust.

Protection Against Water	
Second Digit (0-8)	Meaning
0	No protection.
1	Protected against water falling vertically.
2	Protected against direct sprays up to 15 degrees from vertical.
3	Protected against direct sprays up to 60 degrees from vertical.
4	Protected against sprays from all directions. Limited ingress permitted.
5	Protected against low pressure jets of water from all directions. Limited ingress permitted.
6	Protected against strong jets of water. Limited ingress permitted (e.g. acceptable for use on ships on decks).
7	Protected against temporary effects of immersion between 15 cm and 1 m for 30 minutes.
8	Protected against long periods of immersion under pressure.