*System Assessment and Validation for Emergency Responders (SAVER)*

# Handheld Radionuclide Identification Devices (RIDs) Market Survey Report

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SAVER

System Assessment and Validation for Emergency Responders

***Prepared by the National Urban Security and Technology Laboratory***

# 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 assessments and validations on commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community. 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 responder 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 knowledge 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 supported by a network of Technical Agents who perform assessment and validation activities. As a SAVER Program Technical Agent, the National Urban Security Technology Laboratory (NUSTL) has been tasked to provide expertise and analysis on 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 developed this report to provide emergency responders with information gathered during a market survey of commercially available radionuclide identification devices (RIDs), which fall under AEL reference numbers 07RD-01-RIID titled Identifier, Isotope, Radionuclide and 07RD-02-DRHS titled Detector, Radionuclide, High-Sensitivity.

Visit the SAVER website on First Responder.gov (www.firstresponder.gov/SAVER) for more information on the SAVER Program or to view additional reports on RIIDs or other technologies.

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# 1. INTRODUCTION

Handheld radionuclide identification devices are used by first responders to detect and measure gamma radiation and identify gamma-ray emitting radionuclides; some instruments may have related capabilities, such as the ability to measure neutron radiation or very high gamma-ray radiation levels. To provide emergency responders with information on handheld RIDs, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a market survey of these products, which fall under Authorized Equipment List (AEL) reference number 07RD-01-RIID. Some of the RIDs covered in this report can also be categorized as High-Sensitivity Radionuclide Detectors, which fall under AEL reference number 07RD-02-DRHS.

This market survey report is based on information gathered between June and December 2014 from government reports, trade and technical publications, manufacturer/vendor product literature, correspondence with manufacturers/vendors, and responses to a government-issued Request for Information (RFI) posted on the Federal Business Opportunities website (www.fbo.gov).

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

- Commercial off-the-shelf product
- Can be carried and operated by one person
- Can operate on internal battery power for at least 2 hours.

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

# 2. OVERVIEW

Many radionuclides emit gamma rays having a unique pattern of energies and intensities that distinguish them from all other radionuclides. RIDs are instruments that identify the radionuclides present in a radioactive source by identifying these characteristic gamma-ray emission patterns. A key RID component is its gamma-ray detector, which can be categorized as being either a scintillator detector or a semiconductor detector. Scintillator detectors produce light pulses when struck by gamma rays, while semiconductor detectors produce electrical pulses, and the amplitude of the pulses produced by either detector type is proportional to the energy deposited in the detector by electrons produced by the incident gamma rays. When incident gamma rays deposit their full energy within the gamma-ray detector (i.e., the gamma rays and all the electrons they produce are fully stopped within the detector), their energies can be determined by measuring the amplitudes of the pulses they produce. The RID’s electronics count these detector pulses, measure their amplitudes, and process these data into a plot of the number of gamma rays detected at different energies; such a plot is referred to as a gamma-ray spectrum (Figure 1). RID gamma-ray spectra typically extend to an upper limit of 3,000 kiloelectron volts (keV) to encompass the full range of gamma-ray energies emitted by radionuclides that first responders are likely to encounter.

There are hundreds of known gamma-ray emitting radionuclides, dozens of which first responders might conceivably encounter. In homeland security applications, radionuclides can be placed into four categories: medical, industrial, naturally occurring radioactive material (NORM), and special nuclear material (SNM). Medical radionuclides are used for treatment and imaging of medical patients; industrial radionuclides are used in weld inspection devices, soil density gauges, and other kinds of equipment. NORM radionuclides are naturally occurring radioactive forms of chemical elements such as potassium, uranium, and thorium, which are sometimes present in sufficiently high concentrations in commercial products such as ceramics or industrial chemicals to set off alarms in radiation screening devices. The SNM category consists of a handful of radionuclides that can be used to make a nuclear weapon. To help users quickly identify which of the many possible radionuclides are present in an unknown radioactive source, RIDs are equipped with spectrum analysis software that automatically indicates which radionuclides have been detected and to which of these categories each radionuclide belongs. Although RIDs are primarily used as an identification tool, they have a search mode capability that allows them to be used to locate gamma-ray radiation sources. In search mode, the intensity of measured gamma radiation is displayed in real time so that the user can home in on a radioactive source by noting how the radiation intensity changes as the user moves closer to or farther from the source.

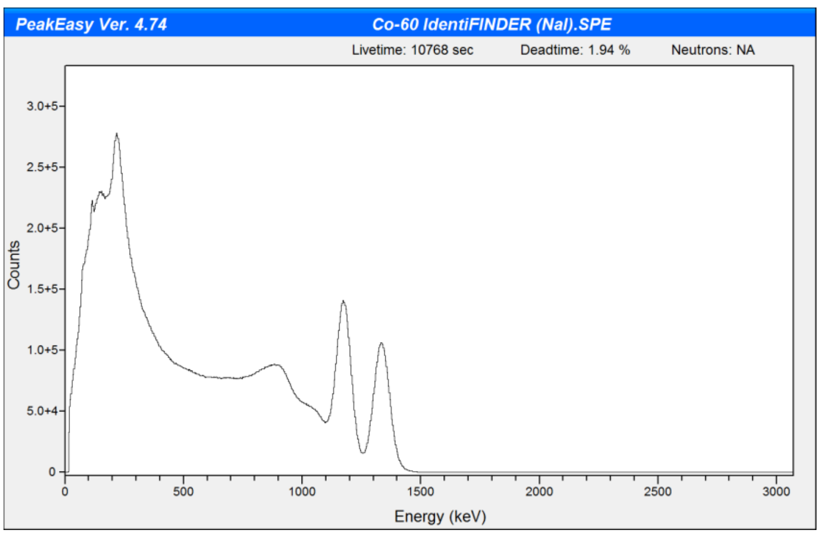


**Figure 2-1. Gamma-ray Spectrum of the Radionuclide Cobalt-60**

RIDs are designed to be carried and operated by one person and to operate for several hours on internal battery power. They are operated using a few simple controls and require only a few hours of instrument-specific training to enable users to operate them.

Although the term RID will be used consistently in this report, RIDs are frequently referred to by several other names, including radioactive isotope identification devices, RIIDs, radioisotope identifiers, radiation isotope identifiers, radioisotope identification devices, and radiation identifiers.

The words *radionuclide* and *radioisotope*, which are often used interchangeably by RID users and in product literature, have somewhat different meanings. The word *nuclide* refers to a particular form of an atom, as specified by the number of neutrons, protons, and energy state of its nucleus; a nuclide that can undergo radioactive decay is called a radionuclide, otherwise it is called a stable nuclide. The word *isotope* refers to the different nuclides of a particular chemical element; the different isotopes of a chemical element all have the same number of protons, but have different numbers of neutrons in their nuclei. Isotopes that can undergo radioactive decay are called radioisotopes; otherwise they are called stable isotopes. The chemical elements exist as 270 stable nuclides; several hundred additional radionuclides exist, but many of these have such short radioactive half-lives that they are never found outside of nuclear reactors or accelerator facilities. Most chemical elements exist as two or more stable or radioactive isotopes.

A recently developed type of device that is closely related to RIDs is the Spectroscopic Personal Radiation Detector (SPRD), which falls under AEL reference number 07RD-01-PDGA. An SPRD is essentially a smaller, wearable version of a RID. Due to their small size, SPRDs are limited in detection and radionuclide identification capabilities relative to RIDs. A SAVER Market Survey Report covering SPRDs, titled *Neutron Detecting Personal Radiation Detectors (PRDs) and Spectroscopic PRDs*, may be downloaded at the SAVER website (www.firstresponder.gov/saver).

## 2.1 Features, Capabilities, and Use Considerations

Energy resolution, i.e., how sharply defined the peaks are in acquired gamma-ray spectra, is a significant point of difference among commercially available RIDs. With better energy resolution, closely spaced peaks in gamma-ray spectra can be more readily distinguished from one another, and minor spectrum peaks are more likely to become apparent. Gamma-ray spectra with better energy resolution thus provide more detailed information about the pattern of gamma rays emitted by radioactive sources, which may translate into an improved radionuclide identification capability.

The energy resolution of the gamma-ray spectra produced by a RID depends on the material its gamma-ray detector is made of. Commonly used detector materials include thallium-doped sodium iodide (NaI(Tl)), high-purity germanium (HPGe), lanthanum bromide (LaBr), cerium bromide (CeBr), and cadmium zinc telluride (CZT). Figure 2 illustrates the difference in energy resolution of gamma-ray spectra obtained with RIDs based on four of these detector materials. The gamma-ray spectra obtained with NaI(Tl) RIDs have a poorer energy resolution than those obtained with other RID types, while HPGe RID gamma-ray spectra have considerably better energy resolution than those obtained with any other RID type. The energy resolution of LaBr, CeBr, and CZT RID gamma-ray spectra are better than those obtained with NaI(Tl) RIDs, but markedly inferior to those obtained with HPGe RIDs.

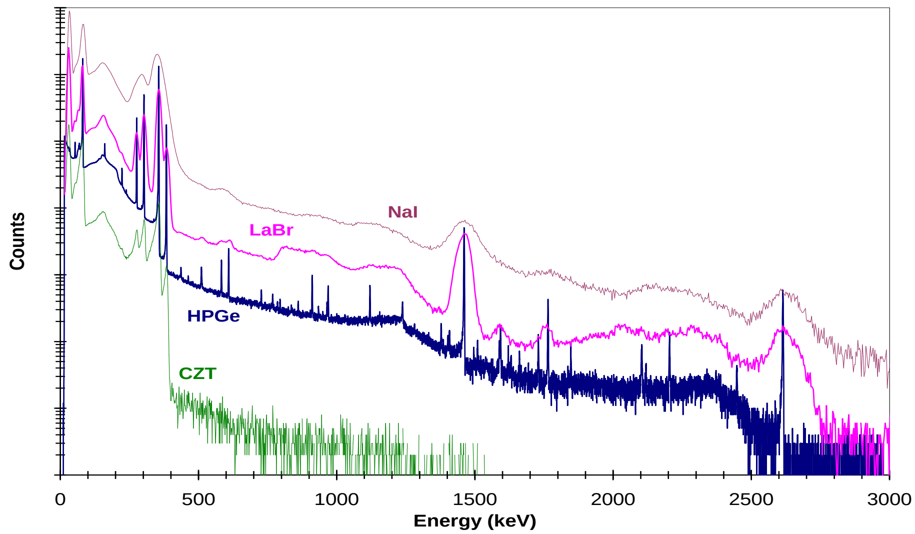


**Figure 2-2. Barium-133 Gamma-ray Spectra Acquired with NaI(Tl)-, LaBr-, HPGe-, and CZT-Based RIDs**

A widely used measure of energy resolution is the full width at half maximum (FWHM) of peaks in gamma-ray spectra acquired with a gamma-ray detector. FWHM is defined as the width of a gamma-ray peak at half of its highest point, and it can be expressed in absolute terms in units of energy, or in relative terms as a percentage of the energy of the peak. For example, the FWHM of the 662 keV peak in a RID gamma-ray spectrum could be stated to be 50 keV or, equivalently, as 7.5 percent (i.e., 100 × 50 keV ÷ 662 keV). Smaller FWHM values indicate more sharply defined gamma-ray peaks and, thus, better energy resolution. RID product literature typically states the measured energy resolution of the 662 keV peak in the gamma-ray spectrum of cesium-137 (Cs-137); Table 2-1 provides typical energy resolutions of different gamma-ray detector types employed in the RIDs included in this report, as reported by product manufacturers and vendors.

**Table 2-1. Typical Energy Resolutions of Different RID Gamma-Ray Detector Types**

| Detector Type | Full Width at Half Maximum (662 keV) |
|---|---|
| NaI(Tl) | 6 - 8 % |
| LaBr | 2 - 4 % |
| CeBr | 4 - 5 % |
| CZT | 1 - 2 % |
| HPGe | < 0.2 % |

The ability to acquire spectra with improved energy resolution quite literally comes at a price—RIDs with better energy resolution capabilities cost more than those with poorer energy resolution capabilities. Thus, several NaI(Tl) RIDs can be purchased for the price of an HPGe RID; LaBr, CeBr, and CZT RIDs cost somewhat more than NaI(Tl) RIDs, but substantially less than HPGe RIDs. The superior energy resolution capability of HPGe RIDs comes with additional trade-offs in terms of size, weight, and start-up time. HPGe gamma-ray detectors must be cooled to an extremely low temperature to operate, and the required internal refrigeration system makes HPGe RIDs considerably larger, heavier, and more power-hungry than other RID types. Also, while the start-up time of other RID types is typically 1 to 2 minutes, it may take 30 minutes or more to cool an HPGe detector to an operable state if it is at room temperature; HPGe RIDs can typically be kept in standby mode, in which the gamma-ray detector is continuously kept at operating temperature, but this requires the RID to remain continuously connected to an external alternating current (AC) or direct current (DC) power source.

In order to correctly identify the radionuclides present in a gamma-ray source, a RID must be calibrated to accurately measure the energy of the gamma rays it detects. In RIDs equipped with scintillator detectors, an energy calibration procedure is typically performed when the instrument is first turned on; this may occur automatically as part of the start-up procedure or it may need to be initiated by the user. In either case, the energy calibration is determined by acquiring a gamma-ray spectrum from a radioactive source that produces gamma rays of known energies. Depending on the RID, the gamma-ray source used for energy calibration may be an external radioactive check source, a radioactive source built into the RID, or natural background gamma radiation. RIDs containing CZT or HPGe semiconductor detectors may rely on a factory-set energy calibration programmed into the RID's operating software rather than an energy calibration determined during RID operation.

The initial energy calibration of a RID may no longer be accurate if the RID is subjected to significant changes in temperature. A major reason the energy calibration of scintillator-based RIDs is temperature-dependent is that the light output of scintillators varies significantly with changes in temperature. RID electronic components may also be sensitive to changes in temperature and thus contribute to changes in energy calibration. Many RIDs have an *energy stabilization* capability, i.e., the energy calibration is checked and updated as needed without the user's intervention. Energy stabilization is typically achieved by continuously monitoring the gamma-ray source used to perform the initial energy calibration; this occurs when the RID is not being used to acquire spectra. A recently developed energy stabilization technique used in some scintillator-based RIDs utilizes a built-in light-emitting diode (LED) to produce light pulses whose amplitudes match those produced in the scintillator by gamma rays of a specific energy; changes in energy calibration arising from the RID's electronic components are corrected for by measuring these LED light pulses. Changes in energy calibration arising from changes in the light output of the scintillator detector cannot be determined using the LED light source and must be determined separately. In some RID models, this is done by measuring the temperature inside the RID and applying a correction based on a manufacturer-determined correlation of scintillator light output with temperature. In other RID models, it is done by applying a correction based upon a manufacturer-determined correlation between scintillator light output and the width of scintillator light pulses produced by gamma rays. The energy calibration of CZT-based RIDs as a function of temperature is usually determined by the manufacturer, so that energy stabilization occurs based on measurements of the RID's internal temperature.

Sensitivity, i.e., how efficiently gamma rays are detected, is another significant point of difference among commercially available RIDs. With increasing sensitivity, gamma-ray emitting radionuclides can be detected in smaller quantities, at greater distances, and in less time. Sensitivity is determined by the size and composition of a RID's gamma-ray detector and varies with gamma-ray energy. As a general rule, for gamma-ray detectors made of the same material, the larger the detector, the better its sensitivity, because as detector size increases, a greater proportion of gamma rays emitted by a radioactive source will strike the detector. Smaller gamma-ray detectors may be particularly insensitive to high-energy gamma rays compared to larger gamma-ray detectors because their small size makes them unable to fully stop, and therefore, measure, the full energy of high-energy gamma rays. Due to manufacturing limitations, CZT gamma-ray detectors are typically much smaller than other detector types, thus CZT-based RIDs tend to be particularly insensitive to high-energy gamma rays, which may affect their ability to properly identify radionuclides whose characteristic gamma-ray peaks are emitted at high energies.

A RID's spectrum analysis software automatically identifies the radionuclides represented in an acquired gamma-ray spectrum by comparing it to an internal reference library of radionuclide gamma-ray spectra. Designing automated software to accurately analyze RID gamma-ray spectra is a challenging problem; government-supported test programs (see section 2.3) have demonstrated that spectrum analysis software in currently available RIDs do not always produce accurate results. Particular challenges include the analysis of gamma-ray spectra obtained from radioactive sources that are surrounded by shielding material and spectra obtained from radioactive sources containing multiple radionuclides. In the former case, acquired spectra may be unrecognizable due to the attenuation and broadening of measured gamma-ray peaks by shielding materials. In the latter case, the presence of gamma-ray peaks from multiple radionuclides may produce such a complex pattern of spectrum peaks that the characteristic peaks of particular radionuclides are no longer clearly distinguishable.

At present, experienced gamma-ray spectrometrists using interactive spectrum analysis tools can analyze RID gamma-ray spectra more accurately than automated RID gamma-ray spectrum analysis programs. First responders in many organizations are trained to send acquired RID spectra to a reachback resource for expert analysis when they believe that the analysis result provided by a RID may be inaccurate, or when the RID analysis result indicates the presence of a high-level threat such as an SNM radionuclide. Some organizations have developed an in-house reachback capability for their field personnel. A reachback resource available to all first responder organizations nationwide is the Radiological Triage Program of the National Nuclear Security Administration (NNSA). The Radiological Triage Program provides highly trained gamma-ray spectrometrists on a 24/7/365 basis to perform analyses of RID gamma-ray spectra at no cost. First responders can transmit RID spectra to Radiological Triage via the Internet and expect to receive analysis results within an hour. More information on the Radiological Triage program can be obtained by calling the NNSA at 1-800-586-5000. Organizations whose field personnel are trained to send RID spectra to a reachback resource may wish to consider what data export options (e.g., Universal Serial Bus (USB) ports, data cards, Wi-Fi, Bluetooth) are provided by different RID models under consideration for purchase, and whether RID data formats are compliant with established data format standards for homeland security applications (see Section 2.3 below).

Exposure to high doses of radiation may have serious health effects, therefore federal regulations limit the maximum radiation dose that workers may be exposed to on an annual basis. All RIDs included in this report are capable of indicating gamma radiation intensity and can therefore help first responders to limit their exposure to gamma radiation. Scintillator or semiconductor detectors used by RIDs to acquire gamma-ray spectra can measure gamma radiation levels that extend well above natural background levels, but they become overloaded and cannot measure levels at which a worker might exceed annual radiation dose limits in relatively short periods of time, i.e., in a few hours or less. Many RIDs are equipped with an additional detector specifically to measure these higher gamma-radiation levels. In most RIDs, the detector used for this purpose is a Geiger-Mueller (G-M) tube. A G-M tube is a sealed tube of gas with a thin wire in it that is kept at a high voltage relative to the walls of the tube. Gamma rays striking the tube ionize the gas, producing electrical pulses that are processed by the RID's electronics to indicate the ambient gamma-radiation level. Regardless of what detector type is used to measure gamma-radiation intensity, there is an upper limit beyond which the detector will fail to accurately measure the ambient gamma-radiation level; most RIDs indicate when such an over-range condition exists. RIDs may measure and display the gamma-radiation intensity in one or more of several different quantities and units, including the quantity *exposure rate* in Roentgens per hour (R/h) and the quantity *dose equivalent rate* in rem/hour (rem/h). For medium-energy gamma rays, the exposure rate and the dose equivalent rate are approximately equal, so for practical purposes 1 rem/h = 1 R/h. Though it confuses the units of two different quantities, product literature from manufacturers of RIDs may give either the exposure rate or dose rate ranges of their products in either of these two units.

A nuclear weapon containing plutonium emits neutrons as well as gamma rays; thus, RIDs that have a neutron detection capability provide an additional means by which to detect and identify plutonium. Organizations whose mission includes screening for illicit movements of SNM typically purchase RIDs that have a neutron detector as well as a gamma-ray detector. A neutron detector contains a material that produces charged particles when it absorbs neutrons; it is designed so that these charged particles produce pulses of light or electrical charge that are electronically processed and displayed as a neutron count rate. Three stable nuclides, helium-3 (He-3), lithium-6 (Li-6), and boron-10 (B-10), are particularly efficient at absorbing neutrons and producing charged particles, and all the neutron detectors in RIDs contain one of these three nuclides. Neutron detectors using He-3 gas as the neutron detector material have long been used in RIDs and are still the most common type found in RIDs. He-3 neutron detectors are gas proportional counters and function similarly to G-M tubes. He-3 is an isotope of helium that is very rare in nature. It is obtained from the decay of tritium that was produced in nuclear reactors for use in thermonuclear weapons. Because supplies of He-3 are limited and are in demand for other technologies such as medical imaging devices, RID manufacturers have increasingly used Li-6 based neutron detectors in their instruments. In a Li-6 neutron detector, the Li-6 takes the form of a glassy or crystalline solid that produces light pulses in response to neutrons.

Radionuclides emit neutrons typically having energies of several thousand keV; these are called *fast neutrons*. RID neutron detectors are surrounded by a moderator, a hydrogen-rich material that absorbs most of the energy of incident fast neutrons, converting them into *thermal neutrons*, which can be detected much more efficiently by a RID's neutron detector. The moderator typically consists of a layer of plastic surrounding the neutron detector, but in some RIDs the neutron detector is placed in the RID's handle so that the user's hand (containing hydrogen-rich water) serves as the neutron moderator. Readers interested in a more detailed discussion of neutron detection principles and neutron detector types are advised to obtain the SAVER *Neutron Detecting Personal Radiation Detectors (PRDs) and Spectroscopic PRDs Market Survey Report*.

A useful comparative measure of the neutron detection capability of different RIDs is their thermal-neutron detection sensitivity. This can be stated in units of counts-cm$^2$/neutron, or equivalently, cps/nv. The latter expression is often used in product literature; cps is counts per second and nv is the number density of neutrons times their average velocity. Higher values indicate a better sensitivity. As a general rule, for a given neutron detector type, the larger the detector, the better its neutron detection sensitivity, because larger detectors will intercept a relatively greater proportion of the neutrons emitted by a neutron source. In the case of He-3 neutron detectors, neutron sensitivity also increases with the fill pressure of the He-3 gas in the detector; however, the increased detection sensitivity provided by higher He-3 fill pressures may come with a disadvantage in terms of air transportability. U.S. Department of Transportation regulations (CFR 49 Part 173, Subpart G) sets limits on pressures and quantities of contained gases permitted to be carried on passenger aircraft; contained gases exceeding these limits must be transported on cargo-only aircraft. Organizations purchasing a RID with a He-3 detector may wish to determine whether RID models under consideration for purchase are excepted from these regulations.

RID neutron detectors can falsely report a positive neutron count rate when exposed only to an intense gamma ray source, particularly when the source emits gamma rays having high energies. The tendency of a neutron detector to mischaracterize gamma-ray counts as neutron counts is referred to as the gamma-rejection ratio, and is typically stated by instrument manufacturers as the observed neutron count rate when the instrument is exposed to a specific gamma-ray exposure rate (typically produced by a cobalt-60 source); a lower neutron count rate at a higher gamma exposure rate is better.

## 2.2 Applications

Perhaps the largest group of RID users is law enforcement and customs personnel who are equipped with RIDs as part of a national strategy to interdict illicit movements of SNM and other radioactive materials. These users occasionally employ RIDs in search mode to detect and locate radioactive materials, but they typically use RIDs to identify the specific radionuclides present in a radioactive source that has been detected with a screening device lacking a radionuclide identification capability, such as a personal radiation detector or a radiation portal monitor. This task is complicated by the fact that radionuclides have many legitimate uses and are therefore in wide public circulation. Radiation screening devices therefore often alarm on innocuous radiation sources, such as medical patients who have received radionuclides for therapeutic purposes, shipments of ceramics containing high concentrations of NORM, or vehicles that are transporting engineering equipment containing an industrial radionuclide. Legitimate carriers of radioactive materials must be distinguished from threats such as an improvised nuclear device (IND) or a radiological dispersion device (RDD); RIDs are the primary tool law enforcement and customs personnel use to determine whether the radioactive materials they encounter constitute such a threat.

Firefighters, hazardous materials response teams, and radiological safety personnel are the other significant group of RID users. They use RIDs to identify the specific radionuclides present at the scene of a radiological incident. While past incidents have been quite limited in scale, they potentially could be of a greater scale, for instance an intentional release of radioactivity by an RDD. In many jurisdictions, RIDs would provide the first indication of what radionuclides have been released and thus would be an early source of information useful in guiding incident response decisions.

## 2.3 Standards and Testing Programs

American National Standards Institute (ANSI) standard ANSI N42.34-2006 specifies a wide range of features and capabilities of RIDs used for homeland security applications. Specifications relating to field usability include the ability to operate on internal batteries for at least 2 hours, instrument displays that are readable under different lighting conditions, manual controls that can be operated while wearing gloves, and the ability to export acquired spectra via a communications port or removable memory card. Specifications related to radionuclide detection include the ability to correctly identify and categorize a wide range of medical, industrial, NORM, and SNM radionuclides. This standard can be downloaded at http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=4079478 or http://standards.ieee.org/getN42/download/N42.34-2006.pdf.

As a supplement to ANSI N42.34-2006, the DHS Domestic Nuclear Detection Office (DNDO) has published a standard that establishes technical performance requirements for the detection of specific SNM and shielded radioactive sources by handheld instruments with radionuclide identification capabilities. This standard, titled *Technical Capability Standard for Handheld Instruments Used for the Detection and Identification of Radionuclides*, can be downloaded at www.dhs.gov/sites/default/files/publications/dndo-technical-capability-standard-for-handheld-final.pdf.

The DNDO standard is used in conjunction with the ANSI N42.34-2006 standard to conduct independent testing of RIDs for the DNDO's Graduated Rad/Nuc Detector Evaluation and Reporting (GRaDER) program. GRaDER oversees independent testing of RIDs to these standards and produces test reports that are provided to instrument manufacturers. First responder organizations may inquire about obtaining GRaDER test reports via a point of contact listed on the GRaDER website (www.dhs.gov/guidance-grader-program).

The Illicit Trafficking Radiological Assessment Program+10 (ITRAP+10) is a program that was initiated by the European Union to evaluate and compare the performance of commercially available radiation detection equipment, including RIDs, against ANSI and related international standards. The DHS leads the U.S. Government's participation in ITRAP+10, with DNDO serving as the implementing office. A key goal of ITRAP+10 is to allow the United States and European partners to better understand how commercially available radiation detection equipment performs and drive instrument manufacturers to technological advances. ITRAP+10 is producing test reports that will be available to first responder agencies; however, as of the date of publication of this SAVER market survey report, no ITRAP+10 reports on RIDs have yet been approved for release. More information about ITRAP+10 can be found at: www.dhs.gov/illicit-trafficking-radiological-assessment-program-10-itrap10.

To facilitate communication of gamma spectra and other data to reachback services, the ANSI N42.34 standard requires that RID data be in the format specified in a separate standard: ANSI N42.42, *American National Standard Data Format Standard for Radiation Detectors Used for*

*Homeland Security*. The current version is ANSI N42.42-2012. This standard can be downloaded at http://standards.ieee.org/getN42/download/N42.42-2012.pdf.

Many manufacturers report ingress protection (IP) ratings for resistance to entry by water and solids; these are defined in the ANSI/IEC 60529-2004 testing standard jointly adopted by ANSI and the International Electrotechnical Commission. 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 INFORMATION

Table 3-1 summarizes key specifications and features of RIDs identified in the market survey. This information was obtained from product manufacturers and has not been independently verified by the SAVER Program. Additional information about each RID is provided in Sections 3.1 to 3.19 The product characteristics listed in Table 3-1 are defined as follows:

| | |
|---|---|
| **Company** | The name of the RID manufacturer or distributor. Products are listed in alphabetical order by manufacturer. Some RIDs may be available from multiple distributors. |
| **Product Name/Model** | The name/model number of the specific RID variant whose features are provided in this table. |
| **Gamma-ray Detector Type, Size (inches)** | Indicates the RID's gamma-ray detector type and dimensions (diameter × length), in inches. Detector types include cerium bromide (CeBr), lanthanum bromide (LaBr), and sodium iodide (NaI) scintillators, and cadmium zinc telluride (CZT) and high-purity germanium (HPGe) semicoductor detectors. |
| **Neutron Detector** | Indicates whether the RID is equipped with a neutron detector. |
| **G-M Detector** | Indicates whether the RID is equipped with a Gieger-Mueller detector or other device for measuring high dose rates. |
| **Dimensions** | The RID's length, width, and height, rounded to the nearest 0.1 inch. |
| **Weight** | The RID's weight in pounds (lbs), including batteries, rounded to the nearest tenth of a pound. For instruments with a detachable probe, this is the total weight of base unit and probe(s). |
| **Battery Types** | Indicates battery sizes and types the RID can be powered by; some RIDs may additionally be capable of operating on battery types not listed here. |
| **Run Time** | Indicates the typical operating time stated by the manufacturer or vendor, in hours, when powered by the specified battery type. Operating times in actual use will depend on factors such as the operating mode selected, |

| | |
|---|---|
| | whether the display is dimmed, and whether communications are on or off. |
| **Temperature Range (°F)** | The RID's operating temperature range, in degrees Fahrenheit (°F). |
| **IP Rating** | Indicates the Ingress Protection (IP) rating of the RID; see Section 2.3 and Appendix A for more inforation about IP ratings. |
| **Price** | Indicates the manufacturer's suggested price for one unit, as quoted by the manufacturer or vendor, in U.S. dollars. |

**Table 3-1. Product Comparison Table**

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Berkeley Nucleonics | SAM 940-2-G | External NaI(Tl) 2 × 2 | N | N | 13 × 10 × 6 | 5.5 | AA alkaline | 8 | -4 to 122 | IP 56 | 11,275 |
| Berkeley Nucleonics | SAM 940-2-GN | External NaI(Tl) 2 × 2 | Y | N | 13 × 10 × 6 | 5.5 | AA alkaline | 8 | -4 to 122 | IP 56 | 13,200 |
| Berkeley Nucleonics | SAM 940-3-G | External NaI(Tl) 3 × 3 | N | N | 14 × 10 × 6 | 8.5 | AA alkaline | 8 | -4 to 122 | IP 56 | 12,650 |
| Berkeley Nucleonics | SAM 940-3-GN | External NaI(Tl) 3 × 3 | Y | N | 14 × 10 × 6 | 8.5 | AA alkaline | 8 | -4 to 122 | IP 56 | 14,575 |
| Berkeley Nucleonics | SAM 940-2-CB | External CeBr 1.5 × 1.5 | N | N | 13 × 10 × 6 | 4.8 | AA alkaline | 8 | -4 to 122 | IP 56 | 17,600 |
| Berkeley Nucleonics | SAM 940-2-CBH | External CeBr 1.5 × 1.5 | Y | N | 14 × 10 × 7 | 6.3 | AA alkaline | 8 | -4 to 122 | IP 56 | 24,200 |
| Berkeley Nucleonics | SAM 945-G | NaI(Tl) 3 × 3 | N | Y | 10 × 5 × 6 | 8.0 | Li-ion | 20 | -4 to 122 | IP 65 | 13,695 |
| Berkeley Nucleonics | SAM 945-GN | NaI(Tl) 3 × 3 | Y | Y | 10 × 5 × 6 | 8.3 | Li-ion | 20 | -4 to 122 | IP 65 | 17,695 |
| Berkeley Nucleonics | SAM 945-CG | CeBr 1.5 × 1.5 | N | Y | 10 × 5 × 6 | 6.3 | Li-ion | 20 | -4 to 122 | IP 65 | 30,300 |
| Berkeley Nucleonics | SAM 945-CGN | CeBr 1.5 × 1.5 | Y | Y | 10 × 5 × 6 | 6.5 | Li-ion | 20 | -4 to 122 | IP 65 | 33,135 |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Canberra | Falcon 5000-20 | HPGe 2.4 × 1.2 | N | Y | 17.3 × 16.9 × 6.8 | 34.1 | Li-ion | 8 | -4 to 122 | N/A | N/A |
| Canberra | Falcon 5000-N20 | HPGe 2.4 × 1.2 | Y | Y | 17.3 × 16.9 × 6.8 | 37.1 | Li-ion | 8 | -4 to 122 | N/A | N/A |
| D-tect Systems | Rad-ID-G | NaI(Tl) 1.13 × 1.5; + four CZT 0.2 × 0.2 × 0.2 | N | Y | 7.5 × 11.2× 5.3 | 7.5 | D alkaline | 12 | 5 to 130 | IP 54 | 11,300 |
| D-tect Systems | Rad-ID-GN | NaI(Tl) 1.13 × 1.5; + four CZT 0.2 × 0.2 × 0.2 | Y | Y | 7.5 × 11.2× 5.3 | 7.5 | D alkaline | 12 | 5 to 130 | IP 54 | 14,815 |
| D-tect Systems | Rad-ID-G | NaI(Tl) 1.13 × 1.5; + eight CZT 0.2 × 0.2 × 0.2 | N | Y | 7.5 × 11.2× 5.3 | 7.5 | D alkaline | 12 | 5 to 130 | IP 54 | 12,995 |
| D-tect Systems | Rad-ID-GN | NaI(Tl) 1.13 × 1.5; + eight CZT 0.2 × 0.2 × 0.2 | Y | Y | 7.5 × 11.2× 5.3 | 7.5 | D alkaline | 12 | 5 to 130 | IP 54 | 16,505 |
| FLIR Systems | IdentiFINDER R400-NG | NaI(Tl) 2 × 1.4 | N | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 11,975 |
| FLIR Systems | IdentiFINDER R400-NGH | NaI(Tl) 2 × 1.4 | Y | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 17,725 |
| FLIR Systems | IdentiFINDER R400-ULCS-NG | NaI(Tl) 2 × 1.4 | N | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 15,930 |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FLIR Systems | IdentiFINDER R400-ULCS-NGH | NaI(Tl) 2 × 1.4 | Y | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 21,680 |
| FLIR Systems | IdentiFINDER R400-ULK-NG | NaI(Tl) 2 × 1.4 | N | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 15,930 |
| FLIR Systems | IdentiFINDER R400-ULK-NGH | NaI(Tl) 2 × 1.4 | Y | Y | 9.8 × 3.7 × 3.0 | 2.6 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 21,680 |
| FLIR Systems | IdentiFINDER R400-UW-NG | NaI(Tl) 2 × 1.4 | N | Y | 10.6 × 3.7 × 3.2 | 3.0 | AA NiMH | 8 | -4 to 131 | IP 68 | 20,725 |
| FLIR Systems | IdentiFINDER R400-UW-NGH | NaI(Tl) 2 × 1.4 | Y | Y | 10.6 × 3.7 × 3.2 | 3.0 | AA NiMH | 8 | -4 to 131 | IP 68 | 26,475 |
| FLIR Systems | IdentiFINDER R400-UW-ULCS-NG | NaI(Tl) 2 × 1.4 | N | Y | 10.6 × 3.7 × 3.2 | 3.0 | AA NiMH | 8 | -4 to 131 | IP 68 | 24,680 |
| FLIR Systems | IdentiFINDER R400-UW-ULCS-NGH | NaI(Tl) 2 × 1.4 | Y | Y | 10.6 × 3.7 × 3.2 | 3.0 | AA NiMH | 8 | -4 to 131 | IP 68 | 30,430 |
| FLIR Systems | IdentiFINDER R400-LG | LaBr 1.2 × 1.2 | N | Y | 9.8 × 3.7 × 3.0 | 2.3 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 25,430 |
| FLIR Systems | IdentiFINDER R400-LGH | LaBr 1.2 × 1.2 | Y | Y | 9.8 × 3.7 × 3.0 | 2.3 | AA NiMH or alkaline | 8 | -4 to 131 | IP 53 | 31,180 |
| FLIR Systems | IdentiFINDER R500-ULCS-NG | NaI(Tl) 4 × 0.7 | N | Y | 5.1 × 8.3 × 12.7 | 6.4 | AA NiMH or alkaline | 8 | -4 to 131 | IP 54 | 18,645 |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FLIR Systems | IdentiFINDER R500-ULCS-NGH | NaI(Tl) 4 × 0.7 | Y | Y | 5.1 × 8.3 × 12.7 | 6.4 | AA NiMH or alkaline | 8 | -4 to 131 | IP 54 | 24,895 |
| FLIR Systems | IdentiFINDER R500-UL-LGH | LaBr 1.5 ×1.5 | N | Y | 5.1 × 8.3 × 12.7 | 5.4 | AA NiMH or alkaline | 8 | -4 to 131 | IP 54 | 30,550 |
| FLIR Systems | IdentiFINDER R500-UL-LG | LaBr 1.5 × 1.5 | Y | Y | 5.1 × 8.3 × 12.7 | 5.4 | AA, NiMH or alkaline | 8 | -4 to 131 | IP 54 | 36,800 |
| Innovative Physics | SM2000ID Gamma only | External, four CZT, 0.4 × 0.4 × 0.4 | N. | Eq. | 11 × 6.3 × 6.3[*]<br>9.0 × 1.2[†] | <4 | Li-ion | 15[*]<br>12[†] | -4 to 122 | IP 68[*]<br>IP 67[†] | 25,000 |
| Innovative Physics | SM2000ID Gamma/neutron | External, four CZT 0.4 × 0.4 × 0.4 | Y | Eq. | 11 × 6.3 × 6.3[*]<br>9.0 × 1.2[†]<br>6.7 × 1[‡] | <5 | Li-ion | 15[*]<br>12[†] | -4 to 122 | IP 68*<br>IP 67[†] | N/A |
| Kromek | Raymon10 | CZT 0.4 × 0.4 × 0.4 | N | N | 7 × 7.5 × 6[§]<br>9.5 × 1.8 × 1.8[‖] | 2.3 | Li-ion | 15 | -22 to 122 | IP 68[§]<br>IP 65[‖] | 15,510 |
| Leidos | Exploranium GR-135 Plus | NaI(Tl)[**] | Y | Y | 9 × 4 × 6.8 | 4.8 | D alkaline<br>D NiMH | 12<br>8 | 14 to 122 | N/A | N/A |
| Mirion Technologies | SPiR-ID NaI | NaI(Tl) 3 × 1.5 | Y | Y | 12.5 × 5.6 × 6.8 | 10.8 | Li-ion, C alkaline, or NiMH | 12 (all three types) | -4 to 122 | IP 65 | 32,000 |
| Mirion Technologies | SPIR-ID NaI-LT | NaI(Tl) 2 × 2 | Y | Y | 12.5 × 5.6 × 5.9 | 6.4 | Li-ion | 12 | -4 to 122 | IP 54 | 26,000 |
| Mirion Technologies | SPIR-ID LaBr | LaBr 1.5 × 1.5 | Y | Y | 12.5 × 5.6 × 6.8 | 8.9 | Li-ion or C, alkaline or NiMH | 12 (all three types) | -4 to 122 | IP 65 | 42,000 |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mirion Technologies | SPIR-ID LaBr-LT | LaBr 1.5 × 1.5 | Y | Y | 12.5 × 5.6 × 5.9 | 6.2 | Li-ion | 12 | -4 to 122 | IP 54 | 36,000 |
| Morpho Detection | SourceID (gamma-only) | CZT array, six 0.6 × 0.6 × 0.4 | N | N | 3.5 × 2.2 × 10.1 | 2.0 | Li-ion | 4.5 | -4 to 122 | IP 67 | 32,000 |
| Morpho Detection | SourceID (gamma/neutron variant) | CZT array,six 0.6 × 0.6 × 0.4 | Y | N | 3.5 × 2.2 × 16.3 | 2.5 | Li-ion | 4.5 | -4 to 122 | IP 67 | 36,000 |
| Ortec | Detective-DX-100T | HPGe 2.6 × 2 | N | Y | 15.5 × 6.6 × 13.8 | 24.4 | NiMH | 3 | 14 to 104 | IP 53 | 85,000 |
| Ortec | Detective-EX-100T | HPGe 2.6 × 2 | Y | Y | 15.5 × 7.2 × 13.8 | 26.3 | NiMH | 3 | 14 to 104 | IP 53 | 98,150 |
| Ortec | Micro-Detective-DX | HPGe 2 × 1.6 | N | Y | 14.7 × 5.75 × 11 | 15.0 | Li-ion | 5 | 14 to 104 | IP 53 | 88,133 |
| Ortec | Micro-Detective-EX | HPGe 2 × 1.6 | Y | Y | 14.7 × 5.75 × 11 | 15.2 | Li-ion | 5 | 14 to 104 | IP 53 | 96,640 |
| Ortec | Micro-Detective-HPRDS | HPGe 2 × 1.6 | Y | Y | 14.7 × 5.75 × 11 | 15.2 | Li-ion | 5 | 14 to 104 | IP 65 | 96,640 |
| Polimaster | PM1410 | NaI(Tl) 1 × 1 | Y | Y | 7.0 × 4.7 × 7.1 | 7.0 | Li-ion | 8 | -4 to 122 | IP 65 | 12,680 |
| Polimaster | PM1410A | NaI(Tl) 1 × 1 | Y | Y | 7.0 × 4.7 × 7.1 | 6.2 | Li-ion | 8 | -4 to 122 | IP 65 | 11,500 |
| Polimaster | PM1410M | NaI(Tl) 1 × 1 | N | Y | 7.0 × 4.7 × 7.1 | 5.1 | Li-ion | 8 | -4 to 122 | IP 65 | 9,500 |
| Polimaster | PM1410P | NaI(Tl) 1 × 1 | Y | Y | 7.0 × 4.7 × 7.1 | 6.6 | Li-ion | 8 | -4 to 122 | IP 65 | N/A |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Radcomm | Syclone | NaI(Tl) 1.5 × 2 | N | Y | 7.8 × 2.5 × 5.6 | 3.7 | Li-ion | 8 | -4 to 140 | IP 54 | 9,950 |
| Radcomm | Syclone-N | NaI(Tl) 1.5 × 2 | Y | Y | 7.8 × 2.5 × 5.6 | 3.7 | Li-ion | 8 | -4 to 140 | IP 54 | 15,935 |
| Radiation Solutions | RS-220 | NaI(Tl) 2 × 2 | N | N | 10.2 × 3.2 × 3.8 | 4.4 | AA NiMH or alkaline | 8 (both types) | -4 to 122 | IP 55 | 11,900 |
| Radiation Solutions | RS-220G | NaI(Tl) 2 × 2 | N | Y | 10.2 × 3.2 × 3.8 | 4.6 | AA NiMH or alkaline | 8 (both types) | -4 to 122 | IP 55 | 12,500 |
| Radiation Solutions | RS-220GN | NaI(Tl) 2 × 2 | Y | Y | 10.2 × 3.2 × 3.8 | 4.6 | AA NiMH or alkaline | 8 (both types) | -4 to 122 | IP 55 | 15,225 |
| Radiation Solutions | SR-10 | NaI(Tl) 2 × 2 | Y | Y | 11.3 × 3.2 × 6.5 | 5.0 | Li-ion or AA, NiMH | 8 (Li-ion) | -4 to 122 | IP 55 | 18,750 |
| Smiths Detection | RadSeeker CL | LaBr 1.5 × 1.5 | Y | N | 12 × 4.5 × 7 | 5.0 | Li-ion | 8 | -25 to 122 | IP 65 | 35,000 |
| Smiths Detection | Radseeker CS | NaI(Tl) 2 × 2 | Y | N | 12 × 4.5 × 7 | 5.2 | Li-ion | 8 | -25 to 122 | IP 65 | 24,500 |
| Smiths Detection | Radseeker CS-G | NaI(Tl) 2 × 2 | N | N | 12 × 4.5 × 7 | 5.0 | Li-ion | 8 | -25 to 122 | IP 65 | N/A |
| Thermo Fisher Scientific | RIIDEye X-G | NaI(Tl) 2 × 2 | N | N | 11 × 4.7 × 8.6 | 5.0 | AA alkaline | 8-12 | 0 to 122 | IP 65 | 9,850 |
| | | | | | | | AA NiMH | 8-10 | | | |

| Company | Product Name/ Model | Gamma-ray DetectorType, Size (inches) | Neutron Detector | G-M Detector | Dimensions (inches) | Weight (pounds) | Battery Types | Run Time (hours) | Temperature Range (°F) | IP Rating | Price ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Thermo Fisher Scientific | RIIDEye X-GN | NaI(Tl) 2 × 2 | Y | N | 11 × 4.7 × 8.6 | 5.3 | AA alkaline | 8-12 | 0 to 122 | IP 65 | 12,950 |
| | | | | | | | AA NiMH | 8-10 | | | |
| Thermo Fisher Scientific | RIIDEye X-H | LaBr 1.5 × 1.5 | N | N | 11 × 4.7 × 8.6 | 5.0 | AA alkaline | 8-12 | 0 to 122 | IP 65 | 22,950 |
| | | | | | | | AA NiMH | 8-10 | | | |
| Thermo Fisher Scientific | RIIDEye X-HN | LaBr 1.5 × 1.5 | Y | N | 11 × 4.7 × 8.6 | 5.3 | AA alkaline | 8-12 | 0 to 122 | IP 65 | 25,950 |
| | | | | | | | AA NiMH | 8-10 | | | |

Notes:

AC = Alternating current
CeBr = Cerium bromide
CZT = Cadmium zinc telluride
DC = Direct current
Eq. = Product offers a different, but equivalent feature; see product description for details
HPGe = High purity germanium
LaBr = Lanthanum bromide
Li-ion = Lithium ion
N = Product does not offer this feature
N/A = Information on this feature is not available
NaI(Tl) = Thallium-doped sodium iodide
NiMH = Nickel-metal hydride
Y = Product does offer this feature

* – applies to SM2000ID tablet computer
† – applies to SM2000ID standard probe
‡ – applies to SM2000ID neutron probe
§ – applies to Raymon10 base unit
‖ – applies to Raymon10 probe
** – GR-135 gamma-ray detector dimensions not available

## 3.1 Berkeley Nucleonics SAM 940

SAM 940

*Photo courtesy of Berkeley Nucleonics*

The SAM 940 has a modular design consisting of a base unit that can be configured with a variety of different external detector probes. Available configurations include probes equipped with a 2 × 2 inch or 3 × 3 inch NaI(Tl) detector or a 1.5 × 1.5 inch CeBr detector. The two NaI(Tl) probes can additionally be fitted with a Li-6 neutron detector. The CeBr probe cannot be fitted with a neutron detector; however, it can be operated in tandem with a separate He-3 neutron detector probe. In all probe configurations, the SAM 940 acquires gamma-ray spectra spanning an energy range of 18 to 3,000 keV, and energy calibration is established and stabilized using a naturally radioactive potassium compound. The SAM 940 is not equipped with a G-M tube or other device for measuring high gamma-radiation levels; however, the external NaI(Tl) and CeBr detectors are capable of measuring gamma dose-equivalent rates of up to 10 millirem/hour (mrem/h), and an over-range indication is produced if this upper limit is exceeded.

The user interface consists of a seven-key, thumb-operated keypad and a 3.5-inch diagonal color display screen; users can set audible and visual alarms. Cables of various lengths are available to allow the user to extend the reach of the probes. An auxiliary port is provided to allow the use of third-party Global Positioning System (GPS) or Bluetooth devices. Acquired data can be exported via serial, USB, or Ethernet ports, or with a memory card in an ANSI N42.42-2006 compliant data format.

All SAM 940 variants have an operating temperature range of -4 to 122ºF and an IP 56 rating for water and dust resistance. Weights (including batteries) range from 4.8 to 8.5 pounds, and the external dimensions also vary.

Manufacturer's suggested list prices of the different variants range from $11,275 to $24,200. The purchase price includes a 1-year parts and labor warranty. Technical support is available at no cost during normal business hours regardless of whether the instrument is under warranty. A 1-day user training course is also included in the purchase price.

## 3.2 Berkeley Nucleonics SAM 945

The SAM 945 is available in four different variants (G, GN, CG, CGN). It can be purchased with either a 3 × 3 inch NaI(Tl) gamma-ray detector (G, GN) or a 1.5 × 1.5 inch CeBr gamma-ray detector (CG, CGN); instruments equipped with either detector type can be purchased with a Li-6 neutron detector having a thermal-neutron sensitivity of 3 cps/nv. All variants of the SAM 945 acquire gamma-ray spectra spanning an energy range from 20 to 3,000 keV; energy calibration is established and stabilized using natural background radiation. All four SAM 945 variants are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to10 rem/h; an over-range indication is produced if this upper limit is exceeded.

The SAM 945 is operated using a smart phone running a manufacturer-supplied application. The smart phone, which operates under the Android operating system, can be supplied by the manufacturer or by the user. All instrument controls and displays are accessed via the touch screen of the smart phone. Users can set visible, audible, and vibration alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via a USB port or by Wi-Fi or Bluetooth links in an ANSI N42.42-2006 compliant format. Power is provided by lithium ion (Li-ion) batteries that can be recharged using 12-volt DC or standard AC power outlets; the typical operating time on battery power is greater than 20 hours.

SAM 945

*Photo courtesy of Berkeley Nucleonics*

All variants of the SAM 945 have an operating temperature range of -4 to 122ºF, an IP 65 rating for water and dust resistance, and the same external dimensions, 10 × 5 × 6 inches. Weights of the different variants range between 6.3 and 8.3 pounds including batteries.

Manufacturer's suggested list prices range from $13,695 to $33,135. A 1-year parts and labor warranty is included in the purchase price. Technical support is available during business hours at no cost, regardless of whether an instrument is under warranty. Training is provided at additional cost at a Berkeley Nucleonics facility or at the customer's location.

## 3.3 Canberra Falcon 5000

The Falcon 5000 is available in two variants, the Falcon 5000-20 and the Falcon 5000-N20, both of which are equipped with a 2.4 × 1.2 inch HPGe gamma-ray detector that acquires gamma-ray spectra spanning an energy range from 20 to 3,000 keV. Both variants are equipped with a G-M tube. The Falcon 5000-N20 is additionally equipped with a He-3 neutron detector.

The Falcon 5000 is operated using a ruggedized tablet computer via a WiFi link or an Ethernet cable connection; users can set audible and visual alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via a wireless link, Ethernet cable, or a USB port in an ANSI N42.42-2006 compliant format.

Operating power is provided by two hot-swappable, 6.4 ampere-hour, internal Li-ion battery packs, each of which provides approximately 4 hours of operating time starting with a fully cooled HPGe detector. Operating power can alternately be supplied by a universal AC or 12-volt DC power adaptor. Smaller capacity (4 ampere-hour) Li-ion travel batteries that are compatible with air transport regulations for Li-ion batteries may also be purchased at additional cost; a set of two travel batteries provides 5 hours of operating time. The tablet PC operates on an internal rechargeable Li-ion battery pack that provides up to 3 hours of operating time.

Both variants of the Falcon 5000 have an operating temperature range of -4 to 122ºF. The Falcon 5000-20 and Falcon 5000-N20, weigh 34.1 and 37.1 pounds, respectively, including batteries. Both variants have the same external dimensions, 17.3 × 16.9 × 6.8 inches.

Pricing information for the Falcon 5000 was not available. Newly purchased instruments come with a 1-year warranty; a 5-year warranty on the internal refrigeration unit is also available. Technical support is available during business hours for all instruments, whether or not under warranty; training at the customer's location or at a Canberra facility is available at an additional cost to the price of the instrument.

### 3.4 D-tect Systems Rad-ID


Rad-ID
*Photo courtesy of D-tect Systems*

The Rad-ID is available in four different variants, each of which contains a 1.13 × 1.5 inch NaI(Tl) gamma-ray detector and an array of either four or eight 0.2 × 0.2 × 0.2 inch CZT gamma-ray detectors. Gamma-ray spectra are acquired over an energy range of 20 to 400 keV using the CZT detector, and from 25 to 3,000 keV using the NaI(Tl) detector. A manufacturer-provided external check source is used to establish the energy calibration of the NaI(Tl) detector; the user is prompted to recalibrate when the temperature changes significantly. The energy calibration of the CZT detector is set by the manufacturer and automatically adjusts for changes in temperature. Spectra acquired with the two detector types are jointly used by the Rad-ID's spectrum analysis software. All four variants of the Rad-ID are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded. Two variants of the Rad-ID additionally contain a He-3 neutron detector with a thermal-neutron sensitivity of 11 cps/nv.

The user interface consists of three control buttons and a 3.6-inch-diagonal backlit display screen; users can set audible and visual alarms. The Rad-ID does not have GPS location measurement capability. Acquired data can be exported via Bluetooth or an infrared data link; data formats are not compliant with the ANSI N42.42-2006 format. Power is provided by three alkaline D-cell batteries, which typically provide 12 hours of operating time.

All four Rad-ID variants have an operating temperature range of 5 to 130ºF and an IP 54 rating for water and dust resistance; they weigh about 7.5 pounds, including batteries, and have external dimensions of 7.5 × 11.2 × 5.3 inches.

Manufacturer's suggested list prices of the different Rad-ID variants range from $11,300 to $16,505; all four model variants are listed on the GSA price schedule. The purchase price includes a 2-year parts and labor warranty; extended warranties are also available. Technical support is available during normal business hours for all instruments under warranty at no extra cost. User training is available at extra cost.

### 3.5 FLIR Systems IdentiFINDER R400

The IdentiFINDER R400 is available in a number of different gamma-ray and neutron detector configurations. It can be purchased with either a 2 × 1.4 inch NaI(Tl) detector or a 1.2 × 1.2 inch LaBr detector. Gamma-ray spectra acquired with either detector type span an energy range of 20 to 3,000 keV. Energy calibration is established using an internal radioactive source in instruments having 'CS' in their variant designations and with natural background radiation in instruments that have 'K' in their variant designations. All variants stabilize their energy calibration. Instruments with 'UL' in their variant designations, are energy stabilized using an LED light source combined with scintillator pulse width analysis; in other variants, the internal check source or natural background radiation used for energy calibration is also used for energy stabilization.

Variants of the IdentiFINDER R400 equipped with either gamma-ray detector type can be purchased with or without a He-3 neutron detector that provides a thermal-neutron detection sensitivity of 2.6 cps/nv. All variants of the IdentiFINDER R400 are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded.

The user interface consists of three control buttons, a 2.7-inch diagonal color display screen, and several LED indicator lights. Users can set audible, visual, and vibration alarms. Location data provided by an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via a USB port or a Bluetooth link in an ANSI N42.42-2006 compliant format. All variants of the IdentiFINDER R400 can be powered by rechargeable nickel-metal hydride (NiMH) AA batteries that provide 8 or more hours of operating time; many variants can also operate on alkaline AA batteries.

All variants of the IdentiFINDER R400 have an operating temperature range of -4 to 131ºF, and have either IP 53 or IP 68 ratings for water and dust resistance. Their weights range from 2.3 to 3.0 pounds, including batteries, and their external dimensions also vary.


IdentiFINDER R400

*Photo courtesy of FLIR Systems*

The manufacturer's suggested list prices range from $11,975 to $31,180. All variants of the IdentiFINDER R400 are also listed on the GSA price schedule. A 1-year warranty is included in the purchase price of all instruments; extended warranties are available at extra cost. Technical support is provided whether or not an instrument is under warranty. User training is offered at additional cost and can be held at the manufacturer's facility or at the customer's location.

## 3.6 FLIR Systems IdentiFINDER R500

The IdentiFINDER R500 is available in four different variants. It can be purchased with either a 4 × 0.7 inch NaI(Tl) gamma-ray detector or a 1.5 × 1.5 inch LaBr gamma-ray detector. Instruments equipped with either gamma-ray detector type can be purchased with or without a He-3 neutron detector having a thermal-neutron detection sensitivity of 9 cps/nv. Gamma-ray spectra acquired with either gamma-ray detector type span an energy range of 20 to 3,000 keV. An internal radioactive source is used to establish the energy calibration. Energy stabilization is achieved using an LED light source combined with scintillator pulse-width analysis. All variants of the IdentiFINDER R500 are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded.


IdentiFINDER R500

*Photo courtesy of FLIR Systems*

The user interface consists of three control buttons, a 2.7-inch diagonal backlit color display screen, and several LED indicator lights. Users can set audible, visual, and vibration alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported in an ANSI N42.42-2006 compliant format via a USB port or a Bluetooth link. The IdentiFINDER 500 operates on alkaline or rechargeable NiMH AA batteries that provide 8 or more hours of operating time.

All four IdentiFINDER R500 variants have an operating temperature range of -4 to 131ºF, IP 54 ratings for water and dust resistance, and external dimensions of 5.1 × 8.3 × 12.7 inches. Variants equipped with a NaI(Tl) detector weigh 6.4 pounds, while variants equipped with a LaBr detector weigh 5.4 pounds; these weights include batteries.

The manufacturer's suggested list prices range from $18,645 to $36,800; all variants are listed on the GSA price schedule. A 1-year warranty is included in the purchase price; extended warranties are available at extra cost. Technical support is provided whether or not the instrument is under warranty. User training is offered at additional cost and can be held at the manufacturer's facility or at the customer's location.

## 3.7 Innovative Physics SM2000ID

SM2000ID

*Photo courtesy of Innovative Physics*

The Innovative Physics SM2000ID has a modular design consisting of a tablet device that is used to control and acquire data from one or more radiation detector probes. Gamma-ray spectra are acquired with a standard probe containing an array of four 0.4 × 0.4 × 0.4 inch CZT detectors. Gamma-ray spectra acquired with the CZT detector array span an energy range of 50 to 3,000 keV. The energy calibration of the CZT detector is pre-set by the manufacturer and is automatically adjusted for changes in temperature. The standard probe contains a separate cesium iodide (CsI) gamma-ray detector that is used in search mode to locate gamma-radiation sources. Probes containing different numbers of CZT detectors can be provided by the manufacturer to meet the customer's needs. The CZT detector in the standard probe is capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded. A probe containing a cadmium telluride detector capable of measuring gamma dose-equivalent rates up to 400 rem/h is also available. A probe containing a B-10 neutron detector having a thermal-neutron detection sensitivity of 9 cps/nv may also be purchased.

The configuration of the SM2000ID described by Innovative Physics for this report features a tablet computer with an 8-inch diagonal touch screen as the user interface; other touch-screen devices based on the Android operating system, such as smart phones, could also be used. The tablet computer can be carried in a holster or attached to a holder to which the detector probes can also be attached. The detector probes communicate with the tablet computer wirelessly and can be carried in a backpack, fixed to a telescoping pole, or mounted in remotely operated vehicles. Users can set the SM2000 to produce audible, visible, and vibration alarms. A GPS receiver in the tablet computer acquires location measurement data that can be stored with radiation measurement data; a GPS receiver can be placed inside a detector probe at the customer's request. Acquired data can be exported from the tablet computer via Bluetooth or Wi-Fi links, or via a USB port, in an ANSI N42.42-2006 compliant format. The standard detector probe operates on rechargeable Li-ion batteries that provide 12 or more hours of operating time; the tablet computer operates on rechargeable Li-ion batteries that typically provide 15 or more hours of operating time.

The SM2000ID has an operating temperature range of -4 to 122ºF; the tablet computer has an IP 65 rating and the standard probe an IP 67 rating for water and dust resistance. Together, the tablet computer and the standard CZT/CsI probe weigh less than 4 pounds, including batteries. Equipped with the optional neutron probe it weighs 1 pound more. The tablet computer's external dimensions are 11 × 6.3 × 6.3 inches; the standard probe is 9.0 inches long and 1.2 inches in diameter, and the neutron probe is 6.7 inches long and 1 inch in diameter.

The manufacturer's suggested list price of the SM2000ID, configured with the standard CZT/CsI detector probe and tablet computer, is $25,000; the price when equipped with the optional neutron-detector probe was not available at the time of preparation of this report. A 1-year warranty is included in the purchase price. Technical support is available for all instruments under warranty on a 24/7/365 basis. A 1-day training course at the manufacturer's facility is included in the purchase price; this course can be provided at the customer's location at extra cost.

## 3.8 Kromek Raymon10

The Raymon10 has a modular design consisting of a base unit and a detachable probe containing a 0.4 × 0.4 × 0.4 inch CZT gamma-ray detector. Acquired gamma-ray spectra span an energy range of 30 to 3,000 keV. The energy calibration of the CZT detector is pre-set by the manufacturer and is automatically corrected for changes in temperature. The Raymon10 is not equipped with a G-M tube or other device for measuring high gamma-radiation levels; however, the Raymon10's CZT detector is capable of measuring gamma dose-equivalent rates of up to 0.1 rem/h; an over-range indication is produced if this upper limit is exceeded. The Raymon10 does not have a neutron detector either as a standard or an optional feature.

Raymon10
*Photo courtesy of Kromek*

The base unit's operating interface consists of a multi-button control pad and a 3.5-inch diagonal backlit color display screen. The gamma-ray probe and base unit can be operated as a single unit attached to a pistol-style grip; alternatively, the base unit and probe can be detached from the handle and operated separately. Users can set audible and visible alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via a USB port, Wi-Fi, or a Bluetooth link in an ANSI N42.42-2006 compliant format. It operates on rechargeable Li-ion batteries that typically provide 15 hours of operating time; the batteries can be recharged using a universal AC or a 12-volt DC charger.

The operating temperature range of the Raymon10 is between -22 and 122ºF. The base unit has an IP 68 rating and the probe an IP 65 rating for water and dust resistance. The base unit weighs

1.7 pounds including batteries; the probe weighs 0.55 pounds. The external dimensions of the base unit are 7 × 7.5 × 6 inches and 9.5 × 1.8 × 1.8 inches for the probe.

The manufacturer's suggested list price is $15,510. The list price includes a 1-year warranty. Technical support is available at no charge for instruments under warranty by phone and e-mail. Training at the manufacturer's facility in the United States is included in the purchase price of the instrument; training at the customer's location is available at additional cost.

## 3.9 Leidos Exploranium GR-135 Plus

The Exploranium GR-135 Plus is equipped with a NaI(Tl) gamma-ray detector; acquired gamma-ray spectra span an energy range of 20 to 3,000 keV. Energy calibration is established and stabilized using a radioactive source built into a docking station that also serves to charge the instrument when it is not in use. It is also equipped with a He-3 neutron detector and a G-M tube capable of measuring gamma exposure rates of up to 10 R/h.

The user interface consists of a thumb-operated joystick in the instrument's handle and a 2.6-inch diagonal display screen. Users can set audible and visible alarms. Acquired data can be exported via an RS-232 connection through the docking station. Power is provided by two alkaline or rechargeable NiMH D-cell batteries; operating times are 8 hours on rechargeable batteries and 12 hours on alkaline batteries. The docking station is powered by standard AC electrical outlets.

The operating temperature range of the Exploranium GR-135 Plus is between 14 and 122ºF. It weighs 4.8 pounds, including batteries, and its external dimensions are 9 × 4 × 6.8 inches.

## 3.10 Mirion Technologies SPiR-ID

The SPiR-ID is available in four different variants. The two standard variants of the SPiR-ID are designed to be more rugged than the two light variants (identified by -LT in the variant name). The standard variants are equipped with either a 3 × 1.5 inch NaI(Tl) or a 1.5 × 1.5 inch LaBr gamma-ray detector, while the light variants are available with either a 2 × 2 inch or a 1.5 × 1.5 inch LaBr gamma-ray detector. Gamma-ray spectra acquired with all four variants of the SPiR-ID span an energy range of 25 to 3,000 keV; energy calibration is established and stabilized using natural background radiation. All four variants are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded. A Li-6 neutron detector is a standard component of all four SPiR-ID variants. External probes for measuring alpha and beta surface contamination are available at additional cost.

SPiR-ID

*Photo courtesy of Mirion Technologies*

The user interface consists of four control buttons, several LED indicator lights, and a 3.5-inch diagonal display screen. Users can set audible, visible, and vibration alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data files. Acquired data can be exported via an SD card or a USB interface in an ANSI N42.42-2006 compliant format. Standard variants of the SPiR-ID can be powered by a rechargeable Li-ion battery pack, NiMH batteries, or alkaline C-cells, while light variants of the SPiR-ID can only operate on the Li-ion battery pack. The manufacturer reports typical run times of 12 hours with these different battery types.

All four variants of the SPiR-ID have an operating temperature range of -4 to 122ºF; the standard variants have IP 65 ratings for water and dust resistance; the light variants have IP 54 ratings. Their weights range from 6.2 to 10.8 pounds, including batteries. External dimensions of the standard variants are 12.5 × 5.6 × 6.8 inches; the light variants have external dimensions of 12.5 × 5.6 × 5.9 inches.

Manufacturer's suggested list prices of the different SPiR-ID variants range from $26,000 to $42,000; they are not listed on the GSA price schedule. A 1-year warranty is included in the purchase price; extended warranties are available at extra cost. Technical support is available for instruments under warranty during business hours. User training is offered at additional cost and can be held at the manufacturer's facility or at the customer's location.

### 3.11 Morpho Detection SourceID

The SourceID is equipped with an array of six 0.6 × 0.6 × 0.4 inch pixilated CZT gamma-ray detectors that acquire gamma-ray spectra spanning an energy range from 30 to 3,000 keV. The energy calibration of the CZT detector is pre-set by the manufacturer and is automatically adjusted for changes in temperature. The manufacturer states that the CZT detector array enables the SourceID to point to the direction of gamma radiation sources. The SourceID does not contain a G-M tube or other device to measure high gamma-radiation levels; however, the CZT detector array is capable of measuring gamma exposure rates up to 25 milli-R/hour (mR/h). An over-range indication is produced if this upper limit is exceeded. The SourceID can be equipped with a He-3 neutron detector at additional cost.

SourceID

*Photo courtesy of Morpho Detection*

The user interface consists of a four-button touch pad and a 3-inch diagonal color display screen; users can set audible and visible alarms. Location data provided by an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via Wi-Fi, Bluetooth, or USB connections in an ANSI N42.42-2006 compliant data format. The SourceID operates on a hot-swappable Li-ion battery pack that provides 4.5 hours of operating time.

The SourceID has an operating temperature range of -4 to 122ºF and an IP 67 rating for water and dust resistance. The gamma-only variant weighs 1.95 pounds and has external dimensions of 3.5 × 2.2 × 10.1 inches; the neutron-detecting variant weighs 2.5 pounds and has external dimensions of 3.5 × 2.2 × 16.3 inches.

The manufacturer's suggested list price is $32,000 for the gamma-only variant, and $36,000 if purchased with the optional neutron detector. The SourceID is not on the GSA price schedule. The purchase price includes a 1-year warranty covering parts and labor. Free technical support for instruments under warranty is available on a 24/7 basis. Training is included in the purchase price and is held at the manufacturer's Wilmington, MA factory; on-site training is available at additional cost.

### 3.12 Ortec Detective-100T

The Detective-100T is available in two variants, the DX-100T and the EX-100T, each of which contains a 2.6 × 2 inch HPGe gamma-ray detector. Acquired gamma-ray spectra span an energy range of 40 to 3,000 keV. The energy calibration of the HPGe detector is pre-set by the manufacturer and is stabilized using natural background gamma radiation; users may also establish an energy calibration using an external check source. Both variants of the Detective-100T are equipped with a G-M tube that is capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded. The Detective-EX-100T is also equipped with a neutron detector containing four He-3 tubes.

Detective-100T
*Photo courtesy of Ortec*

The user interface consists of a 3.5-inch diagonal backlit color touch screen; users can set audible and visible alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via a USB port, SD card, Bluetooth, or Wi-Fi in an ANSI N42.42 compliant data format.

An internal NiMH battery pack provides greater than 3 hours of operating time when starting with a fully cooled HPGe detector. Power can also be provided by external 10 to 17 volt DC power sources or a universal AC power adaptor. An external rechargeable Li-ion battery pack that provides 10 or more hours of run time is available at additional cost.

Both variants of the Detective-100T have an operating temperature range of 14 to 104ºF and IP 53 ratings; a protective cover is available from Ortec which may improve its ability to withstand dust and water but an IP rating for operation with the protective cover has not been determined. The Detective-DX-100T weighs 24.4 pounds, including internal NiMH battery pack, and its external dimensions are 15.5 × 6.6 × 13.8 inches. The Detective-EX-100T weighs 26.3 pounds, including internal NiMH battery pack, and its external dimensions are 15.5 × 7.2 × 13.8 inches.

The manufacturer's suggested list price of the Detective-DX-100T and Detective-EX-100T are $85,000 and $98,150, respectively; Ortec indicates that it is in the process of adding these instruments to the GSA price schedule. A 1-year warranty is included in the purchase price, and extended warranties of up to 5 years may be purchased at additional cost. Technical support by telephone or email is available for instruments under warranty. User training is offered at additional cost and can be held at an Ortec facility or the customer's location.

### 3.13 Ortec Micro-Detective

The Micro-Detective is available in three different variants: the Micro-Detective-EX, Micro-Detective-DX, and Micro-Detective-HPRDS. All three variants are equipped with a 2 × 1.6 inch HPGe gamma-ray detector. Acquired gamma-ray spectra span an energy range from 40 to 3,000 keV. The energy calibration of the HPGe detector is pre-set by the manufacturer and is stabilized using natural background gamma radiation; users may also establish an energy calibration using an external check source. All three variants of the Micro-Detective are equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h; an over-range indication is produced if this upper limit is exceeded. The Micro-Detective-EX and the Micro-Detective-HPRDS are additionally equipped with He-3 neutron detectors.

The user interface consists of a 3.5-inch diagonal backlit color touch screen; users can set audible and visible alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Acquired data can be exported via USB, SD card, Bluetooth, and Wi-Fi in an ANSI N42.42 compliant data format.


Micro-Detective
*Photo courtesy of Ortec*

The Micro-Detective-HPRDS has several features not available in the other two variants that are intended to enhance operation with one hand or by users wearing gloves. It can be operated using two handle-mounted buttons as well as with the touch screen, and it has a vibration alarm built into the handle and several LED lights in the housing that indicate the specific radionuclide category (NORM, medical, industrial, or SNM) identified by the spectrum analysis program. It also provides search and survey mode options not available in the other two variants.

An internal 14.4 volt, 6.2 amp-hour, Li-ion battery pack provides up to 5 hours of run time when starting with a fully cooled HPGe detector. Power can also be provided by external 10 to 17 volt DC power sources or a universal AC power adaptor. An external rechargeable Li-ion battery pack that provides 10 or more hours of run time can be purchased at additional cost.

All three variants of the Micro-Detective have an operating temperature range of 14 to 104ºF. The Micro-Detective-EX and -HPRDS variants both weigh 15.2 pounds, while the DX variant weighs 15 pounds; these weights include an internal Li-ion battery pack. All three variants have the same external dimensions, 14.7 × 5.8 × 11 inches. The EX and DX variants have an IP 53 rating for water and dust resistance; a protective cover is available from Ortec which may improve its ability to withstand dust and water but an IP rating for operation with the protective cover has not been determined. The HPRDS variant has an IP 65 rating.

The manufacturer’s suggested list price for the Micro-Detective-DX is $88,133; the price for both the Micro-Detective-EX and the Micro-Detective-HPRDS is $96,640. A 1-year warranty is included in the purchase price, and extended warranties of up to 5 years are available at additional cost. Technical support by telephone or email is provided for instruments under warranty. User training is offered at additional cost and can be offered at an Ortec facility or the customer’s location.

## 3.14 Polimaster PM1410

The PM1410 is available in four different variants, each of which is equipped with a 1 × 1 inch NaI(Tl) gamma-ray detector. Acquired gamma-ray spectra span an energy range of 25 to 3,000 keV. Energy calibration is established using an external check source, and it is stabilized using an internal LED light source and monitoring of the internal temperature of the RID. All four variants are also equipped with a G-M tube capable of measuring gamma dose-equivalent rates of up to 10 rem/h; an over-range indication is produced if this upper limit is exceeded.

The PM1410 contains two He-3 tubes, the PM1410A contains one He-3 tube, and the 1410P contains a Li-6 neutron detector; the thermal-neutron detection sensitivities of these three instruments are 7.0, 3.5, and 5.0 cps/nv, respectively. The PM1410M does not contain a neutron detector. Optional probes for measuring external surface alpha or beta contamination measurements can be purchased at additional cost.

PM1410
*Photo courtesy of Polimaster*

The user interface consists of 11 control buttons built into the instrument handle and case and a 3.5-inch diagonal color display screen; users can set audible and visible alarms. Location data obtained with an internal GPS receiver can be saved with radiation measurement data. Data can be exported via USB, Bluetooth, or Wi-Fi connections in an ANSI N42.42-2006 compliant format. Operating power is provided by rechargeable Li-ion batteries, which provide a typical operating time of 8 hours.

All four PM1410 variants have an operating temperature range of -4 to 122ºF, IP 65 ratings for water and dust resistance, and external dimensions of 7 × 4 × 7.1 inches. Their weights range from 5.1 to 7.0 pounds, including batteries.

Manufacturer's suggested list prices of the PM1410, PM1410A, and PM1410M are $12,680, $11,500, and $9,500, respectively; these variants, as well as the PM1410P, are listed on the GSA price schedule. Pricing information for the PM1410P was not available at the time of preparation of this report. The purchase price includes a 1-year parts and labor warranty; extended warranties of up to 3 years in duration can be purchased at additional cost. Free technical support by telephone during business hours and by email is provided for the life of the instrument; a 1-day training course is available at the manufacturer's facility at additional cost.

## 3.15 Radcomm Syclone

The Syclone is available in two variants, the Syclone and the Syclone-N, both of which are equipped with a 1.5 × 2 inch NaI(Tl) gamma-ray detector. Acquired gamma-ray spectra span an energy range from 20 to 3,000 keV. An external check source is used to determine the energy calibration, and the user is notified if the calibration should be redetermined due to a change in temperature. Both variants of the Syclone are also equipped with a G-M tube capable of measuring gamma exposure rates of up to 1 R/h and produce an over-range indication if this upper limit is exceeded. The Syclone-N is additionally equipped with a He-3 neutron detector having a thermal-neutron detection sensitivity of 5.1 cps/nv; the manufacturer indicates that it will soon be offering a version of the Syclone containing a Li-6 detector.


Syclone
*Photo courtesy of Laurus Systems*

The user interface consists of a handle-mounted joystick and a backlit 3.5-inch diagonal color display screen; users can set audible and visible alarms. The Syclone does not have a GPS location measurement capability. Acquired data can be exported via RS-232 or USB ports, or by a Bluetooth link, in an ANSI N42.42 compliant data format. Operating power is provided by internal rechargeable Li-ion batteries, which provide 8 hours of operating time.

Both variants have an operating temperature range of -4 to 140ºF and an IP 54 rating for water and dust resistance. Both variants weigh 3.7 pounds, including batteries, and have external dimensions of 7.8 × 2.5 × 5.6 inches.

The manufacturer's suggested list prices of the Syclone and the Syclone-N are $9,950 and $15,935, respectively. Both variants are listed on the GSA price schedule. Included in the purchase price is a 1-year warranty covering parts and labor; extended warranties are available at additional cost. Technical support is available by phone during business hours for instruments under warranty. Training is available at extra cost.

### 3.16 Radiation Solutions RS-220

The RS-220 is available in three variants, the RS-220, RS-220G, and RS-220GN, all of which are equipped with a 2 × 2 inch NaI(Tl) gamma-ray detector. Acquired gamma-ray spectra span an energy range of 30 to 3,000 keV; energy calibration is established and stabilized using natural background gamma radiation. The RS-220 contains no other type of radiation detector, while the RS-220G additionally contains a G-M tube to measure high gamma-radiation levels, and the RS-220GN contains both a G-M tube and a He-3 neutron detector. The G-M tubes in the RS-220G and RS-220GN are capable of measuring gamma dose-equivalent rates of up to 1 rem/h, while the RS-220 can measure gamma dose-equivalent rates of up to 8 mrem/h using its NaI(Tl) detector. All three variants will produce an over-range indication if the measureable range is exceeded.

RS-220

*Photo courtesy of Radiation Solutions*

The user interface consists of a thumb-activated multi-position control button and a 2.4 × 1.1-inch display screen; users can set audible and visible alarms. An optional external GPS receiver can be linked via Bluetooth to provide location data that can be stored with radiation measurement data. Acquired data can be exported via a USB port or a Bluetooth link; data formats are not ANSI N42.42-2006 compliant.

Operating power is provided by rechargeable NiMH or alkaline AA batteries, both of which typically provide an operating time of 8 hours. Batteries can be recharged internally using standard AC or 12-volt DC power supplies.

All three variants of the RS-220 have an operating temperature range of -4 to 122ºF, IP 55 ratings for water and dust resistance, and external dimensions of 10.2 × 3.2 × 3.8 inches. The RS-220 weighs 4.4 pounds, while the RS-220G and RS-220GN both weigh 4.6 pounds; these weights include batteries.

Manufacturer's suggested list prices of the RS-220, RS-220G, and RS-220GN are $11,900, $12,500, and $15,225, respectively. These instruments are not listed on the GSA price schedule. Included in the purchase price is a 1-year warranty against defects in parts and workmanship. Technical support is available during business hours for all instruments, whether or not under warranty. Training at the customer location is available at extra cost.

## 3.17 Radiation Solutions SR-10

The SR-10 is equipped with a 2 × 2 inch NaI(Tl) gamma-ray detector, and acquired gamma-ray spectra cover an energy range from 40 to 3,000 keV. Energy calibration is established and stabilized using natural background gamma radiation. It is also equipped with a He-3 neutron detector with a thermal-neutron detector sensitivity of 15 cps/nv, and a G-M tube capable of measuring gamma dose-equivalent rates of up to 1 rem/h. An over-range indication is produced if this upper limit is exceeded.


SR-10

*Photo courtesy of Radiation Solutions*

The user interface consists of a multi-position thumb button and a backlit 3.4-inch diagonal display screen; users can set audible and visible alarms. Location data obtained with an internal GPS receiver can be saved with measurement data, and there is a built-in microphone that allows users to record verbal information along with measurement data. Data can be exported via a USB port, Wi-Fi, or Bluetooth links in an ANSI N42.42-2006 compliant format. Power can be provided by an internal Li-ion battery pack or rechargeable NiMH AA batteries; the Li-ion battery pack typically provides 8 or more hours of operating time. The Li-ion battery pack can be recharged with an internal charger that can run from standard AC or 12-volt DC external electrical sources.

The SR-10 has an operating temperature range of -4 to 122ºF and an IP 55 rating for water and dust resistance. It weighs 5.0 pounds, and its external dimensions are 11.3 × 3.2 × 6.5 inches.

The manufacturer's suggested list price is $18,750; it is not listed on the GSA price schedule. Included in the purchase price is a 1-year warranty against defects in parts and workmanship. Technical support is available during business hours for all instruments, whether or not under warranty. Training at the customer location is available at extra cost.

## 3.18 Smiths Detection RadSeeker

The RadSeeker is available in three different variants, the RadSeeker CL, CS, and CS-G. The RadSeeker CL is equipped with a 1.5 × 1.5 inch LaBr detector, while RadSeeker CS and CS-G are equipped with a 2 × 2 inch NaI(Tl) detector. The RadSeeker CS-G does not contain a neutron detector, while the RadSeeker CL and CS are both equipped with a He-3 neutron detector. The gamma-ray spectra acquired with all three variants of the RadSeeker span an energy range from 25 to 3,000 keV. Energy calibration is pre-set by the manufacturer and is stabilized using an internal radioactive source. None of the three variants is equipped with a G-M tube or other device for measuring high gamma levels. However, gamma dose-equivalent rates of up to 12 mrem/h can be measured with the NaI(Tl) detector in the RadSeeker CS and CS-G, and gamma dose-equivalent rates of up to 20 mrem/h can be measured with the RadSeeker CL's LaBr detector; an over-range indication is produced if these upper limits are exceeded.

The user interface consists of three control buttons mounted on the instrument's handle and a 3.5-inch diagonal color display screen. Users can set audible, visible, and vibration alarms. Location data obtained with an internal GPS receiver can be stored with measurement data. Data can be exported in an ANSI N42.42-2006 data format via a USB port or a Wi-Fi link; measurement data can also be exported via a satellite phone (not included in the purchase price). Power is provided by rechargeable Li-ion batteries, which provide 8 or more hours of operating time; power can also be provided by external 12-volt DC electrical sources. Batteries can be recharged while in the instrument or using an external battery charger.


RadSeeker

*Photo courtesy of Smiths Detection*

All three variants of the RadSeeker have an operating temperature range of -25 to 122ºF, IP 65 ratings for water and dust resistance, and external dimensions of 12 × 4.5 × 7 inches. The RadSeeker CS weighs 5.2 pounds, while the RadSeeker CL and CS-G both weigh 5.0 pounds.

The manufacturer's suggested list price of the RadSeeker CS and RadSeeker CL are $24,500 and $35,000, respectively; they are also listed on the GSA price schedule; pricing information on the RadSeeker CS-G was not available. The purchase price includes a 1-year warranty covering parts and labor; extended warranties are available at extra cost. Free technical assistance is available on a 24/7/365 basis for all instruments under warranty. A 1-day training class is available at the customer's location or at Smiths Detection at extra cost.

## 3.19 Thermo Fisher Scientific RIIDEye X

The RIIDEye X is available in four different model variants. The RIIDEye X-G and X-GN are both equipped with a 2 × 2 inch NaI(Tl) gamma-ray detector, and the RIIDEye X-H and X-HN are equipped with a 1.5 × 1.5 inch LaBr gamma-ray detector. Instruments with an 'N' in the model designation are additionally equipped with Li-6 neutron detectors. Acquired gamma-ray spectra span an energy range of 20 to 3,000 keV. Energy calibration is established and stabilized using internal sources of radiation. In the X-G and X-GN variants, this is a naturally radioactive potassium compound, while in the X-H and X-HN, a lanthanum radioisotope naturally present in the LaBr detector serves this purpose. None of the four model variants are equipped with a G-M tube or other device for measuring high gamma-radiation levels. However, each variant is capable of measuring gamma-radiation exposure rates of up to 30 mR/h using the NaI(Tl) or LaBr detector; an over-range indication is produced if this upper limit is exceeded.


RIIDEye X

*Photo courtesy of Thermo Fisher Scientific*

The user interface consists of a seven-key touch pad and a 3.5-inch diagonal color display screen; users can set audible and visible alarms. An internal GPS receiver can be installed at extra cost. Data can be exported via serial or USB connections or a removable compact flash card; a satellite phone export option is available at additional cost. Data formats are ANSI

N42.42-2006 compliant. Operating power can be provided by eight rechargeable NiMH AA batteries, which provide a typical run time of 8 to 10 hours, eight AA alkaline batteries, which provide a typical run time of 8 to 12 hours, or standard AC electrical power outlets.

All four RIIDEye X variants have an operating temperature range of 0 to 122ºF, IP 65 ratings for water and dust resistance, and external dimensions of 11 × 4.7 × 8.6 inches. The X-G and X-H variants weigh 5.0 pounds, while the X-GN and X-HN variants weigh 5.3 pounds.

Prices range from $9,850 to $25,950. A 1-year parts and labor warranty is included in the purchase price; extended warranties are available at additional cost. Free technical support is available for all instruments under warranty, either by telephone during business hours or by email on a 24/7/365 basis. A 1-day training class at the customer’s location or at the manufacturer’s facility is available at extra cost.

# 4. VENDOR CONTACT INFORMATION

Additional information on the RIDs included in this market survey report can be obtained from the companies listed in Table 4-1. Some of these instruments may be available from other vendors not listed here.

## Table 4-1. Vendor Contact Information

| Vendor | Product | Location | Website/E-Mail /Telephone |
|---|---|---|---|
| Berkeley Nucleonics Corporation | SAM 940<br>SAM 945 | San Rafael, CA | www.berkeleynucleonics.com<br>info@berkeleynucleonics.com<br>(415) 453-9955 |
| Canberra Industries, Inc. | Falcon 5000 | Meriden, CT | www.canberra.com<br>customersupport@canberra.com<br>1-800-243-3955 |
| D-tect Systems, Inc. | Rad-ID | Draper, UT | www.dtectsystems.com<br>info@dtectsystems.com<br>801-260-4000 |
| FLIR Systems, Inc. | IdentiFINDER R400<br>IdentiFINDER R500 | Stillwater, OK | www.flir.com<br>radiation.support@flir.com<br>877-692-2120 |
| Innovative Physics, Ltd. | SM-1000 | Shanklin, Isle of Wight, UK | www.inphys.com<br>info@inphys.com<br>44 1983 865810 |
| Kromek | Raymon10 | Sedgefield, Durham, UK | www.kromek.com<br>sales@kromek.com<br>44 1760 625255 |
| Laurus Systems, Inc. (distributor for RadComm Systems) | Syclone | Ellicott City, MD | www.LaurusSystems.com<br>rad.info@LaurusSystems.com<br>410-465-5558 |
| Leidos, Inc. | GR-135 Plus | Vista, CA | www.leidos.com/products/security<br>sectrans@leodos.com<br>866-723-8726 |
| Mirion Technologies, Inc. | SPIR-ID | Smyrna, GA | www.mirion.com<br>www.mirion.com/contact/<br>770-432-2744 |
| Morpho Detection, LLC | SourceID | Newark, CA | www.morpho.com/detection<br>info@morphodetection.com<br>(510) 739-3903 |
| Ortec | Detective 100T<br>Micro-Detective | Oak Ridge, TN | www.ortec-online.com<br>ortec.info@ametek.com<br>865-482-4811 |
| Polimaster, Inc. | PM1410 | Sterling, VA | www.polimaster.us<br>info@polimaster.us<br>703-261-5075 |
| Radiation Solutions, Inc. | SR-10<br>Super-Ident RS-220 | Mississauga, Ontario, Canada | www.radiationsolutions.com<br>sales@radiationsolutions.ca<br>905-890-1111 |
| Smiths Detection | RadSeeker | Edgewood, MD | www.smithsdetection.com<br>410-844-5373 |
| Thermo Fisher Scientific, Inc. | RIIDEye X | Franklin, MA | www.thermoscientific.com<br>800-274-4212 |

# 5. SUMMARY

This report provides an overview of RID technologies, applications, and use considerations, and presents information on the specifications and features of over 60 variants of 19 RID models produced by 15 manufacturers.

There are considerable differences among these instruments with regard to price, gamma-ray detector type and size, neutron detection capability, data export options, instrument weight, operating time on battery power, and other characteristics. List prices range from less than $10,000 to almost $100,000. Gamma-ray detector types include NaI(Tl) scintillators with sizes from 1 × 1 inch to 3 × 3 inches, LaBr scintillators with sizes of 1.2 × 1.2 inches or 1.5 × 1.5 inches, 1.5 × 1.5-inch CeBr scintillators, and CZT and HPGe solid-state detectors. Weights range from 2 pounds to 37 pounds.

Careful assessment of the characteristics of various commercially available RIDs 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. INGRESS PROTECTION (IP) RATINGS

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**

| First Digit | Meaning | Second Digit | Meaning |
|---|---|---|---|
| (Refers to protection against solids) | | (Refers to protection against water) | |
| 0 | No protection. | 0 | No protection. |
| 1 | Protected against solid objects over 50 mm (e.g. accidental touch by hand). | 1 | Protected against water falling vertically. |
| 2 | Protected against solid objects over 12 mm (e.g. accidental touch by finger). | 2 | Protected against direct sprays up to 15 degrees from vertical. |
| 3 | Protected against solid objects over 2.5 mm (e.g. tools, wires). | 3 | Protected against direct sprays up to 60 degrees from vertical. |
| 4 | Protected against solid objects over 1 mm (e.g. small wires). | 4 | Protected against sprays from all directions. Limited ingress permitted. |
| 5 | Protected against dust—limited ingress (no harmful deposit). | 5 | Protected against low pressure jets of water from all directions. Limited ingress permitted. |
| 6 | Totally protected against all dust. | 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. |