
# Personal Radiation Detectors (PRDs) and Spectroscopic PRDs

## Market Survey Report

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System Assessment and Validation for Emergency Responders

The *Personal Radiation Detectors (PRDs) and Spectroscopic PRDs Market Survey Report* was prepared by the U.S. Department of Homeland Security, Science and Technology Directorate, National Urban Security Technology Laboratory.

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# FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on 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 response equipment.

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

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

NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear, and explosive weapons detection; emergency response and recovery; and related equipment, instrumentation, and technologies. In support of this tasking, NUSTL conducted a market survey of commercially available personal radiation detectors and spectroscopic personal radiation detectors. These fall under AEL reference number 07RD-01-PDGA titled Detector, Radiation, Alarming, Personal (Gamma and Neutron), though some spectroscopic personal radiation detectors could also fall under AEL 07RD-01-RIID, titled Identifier, Isotope, Radionuclide.

Visit the SAVER website at www.dhs.gov/science-and-technology/SAVER for more information on the SAVER Program or to view additional reports on personal radiation detectors and other technologies.

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# 1. INTRODUCTION

Personal radiation detectors (PRDs) are small electronic devices that alert the wearer to the presence of radiation for the purpose of intercepting illicit radioactive materials. Some PRDs, known as spectroscopic personal radiation detectors (SPRDs), also measure the energy spectrum of the radiation to identify the radionuclide. To provide emergency responders with information on PRDs and SPRDs, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a market survey.

This market survey report is based on information gathered between June and December 2016 from manufacturers, vendors, Internet research, industry publications, and a government-issued Request for Information (RFI) that was posted on the Federal Business Opportunities website. It is limited to commercially available devices with the following characteristics:

- Weighing less than 1 pound and designed to be worn by emergency responders while performing their duties
- Capable of operating in natural background radiation fields (a few microroentgen per hour (μR/h))
- Capable of alerting the wearer to changes above background levels of radiation using visible, audible and/or vibration alarms
- Having an internal gamma detector, with no neutron detector nor additional external detectors or probes
- Designed primarily for prevention missions (rather than consequence management)

These instruments fall under the Authorized Equipment List (AEL) category 07RD-01-PDGA, Detector, Radiation, Alarming, Personal (Gamma and Neutron). SPRDs could also fall under the AEL category 07RD-01-RIID, Identifier, Isotope, Radionuclide. Due diligence was performed to develop a report that is representative of products in the marketplace.

Information on related instruments is contained in other SAVER reports. PRDs that detect neutrons are covered in the *Neutron-Detecting PRDs and Spectroscopic PRDs Market Survey Report (February 2015).* Spectroscopic devices weighing more than 1 pound are covered in the *Handheld Radionuclide Identification Devices (RIDs) Market Survey Report (in press)*. Instruments that measure an individual's accumulated radiation dose are covered in the *Radiation Dosimeters for Response and Recovery Market Survey Report (January 2017).* Equipment for measuring radioactive contamination is covered in the *Handheld Radiation Survey Meters Market Survey Report (in press).* In addition, the *Portable Radiological Equipment Technical Guide (July 2012)* describes how these various types of equipment are applicable to different homeland security missions.[1]

[1] A few multifunctional products may be included in more than one SAVER market survey report. For example, the *Radiation Dosimeters for Response and Recovery Market Survey Report* includes some extended-range PRDs that are capable of measuring accumulated dose.

# 2. PERSONAL RADIATION DETECTOR OVERVIEW

PRDs and SPRDs are small, lightweight, and relatively inexpensive. They detect changes in the radiation level slightly above background with a fast response time to provide an alert for further investigation. They are worn by thousands of responders to detect and interdict the illicit movement of material that could be used in a radiological dispersal device or other radiological threat. Application scenarios include incidental monitoring concurrent with routine law enforcement foot patrols as well as screening people passing through a checkpoint. Most are designed to be clipped to the user's belt.[2]

SPRDs allow responders not only to detect radioactive materials, but also to potentially resolve radiation alarms by identifying the radionuclide emitting the radiation. If the radionuclide is identified, it can be classified as naturally occurring, medical, industrial, or nuclear, and its threat level assessed. In this report, "PRD" may be understood to include SPRDs; additional features that are unique to SPRDs are noted where applicable.

## 2.1 Radiation Measurement

Various quantities and units are used in the measurement of radiation. This report focuses on devices that measure gamma rays— electromagnetic radiation consisting of photons of a higher energy than visible light. The gamma rays emitted by radiological threat materials span a range of energies, measured in units of kilo-electron volts (keV) or mega-electron volts (MeV).

Gamma radiation is also referred to as ionizing radiation because of its ability to knock electrons out of atoms, leaving free electrons and charged atoms (ions). The amount of gamma radiation can therefore be measured by the amount of electric charge released in air per unit time, called *exposure rate*: the unit of exposure rate is roentgens per hour (R/h). Another way to measure radiation is by the amount of energy it deposits per mass in matter, particularly in the tissues of the human body. This is called *absorbed dose*: units of absorbed dose are rad or gray (Gy). A related quantity used in radiation protection is called the *personal dose equivalent*, in units of rem or sievert (Sv).

Different PRD products display a variety of measurement quantities and units. The exposure or dose rate display may include a prefix letter that indicates a submultiple, such as the lower case "m" for $10^{-3}$ or the Greek letter "μ" for $10^{-6}$. Some products display the gamma count rate in counts per second (cps). A few products display a unit-less integer value to indicate the relative radiation level based on a 10-bin scale from to 1 to 10 (or 0 to 9). These instruments typically have a table that may be used to convert the unit-less reading into an estimated exposure rate corresponding to the bin's range.

## 2.2 Current Technologies

The main internal components of a PRD are the radiation sensor, a power supply, electronics to process signals from the sensor, and software or firmware that typically includes an algorithm to determine an alarm condition. The sensor used in most PRDs is a scintillator, material that emits light when radiation is absorbed. A photodiode or

[2] PRDs are sometimes casually referred to as "radiation pagers"; however, "Radiation Pager" is also a product name registered by Sensor Technology Engineering, Inc.

photomultiplier tube is used to convert the light emission to an electronic signal. In SPRDs, the size of the scintillation light pulse is used to determine the incident gamma energy. The most common types of scintillators used in PRDs and SPRDs are cesium iodide (CsI) or sodium iodide (NaI); cadmium zinc telluride (CZT) and yttrium silicate (YSO) are also used.

Scintillators are capable of detecting small changes in the radiation level above the natural radiation background. This means that they operate in low-level radiation fields and may go off-scale in higher fields. To achieve an extended range, some PRDs include a secondary detector that can operate at higher exposure rates than scintillators, such as a Geiger-Mueller (GM) tube or a semiconductor. A GM detector is a sealed tube filled with gas between high-voltage electrodes. Semiconductor detectors include different types of "solid-state" devices with two terminals called diodes.[3] In these detectors, ionizing radiation causes a measurable current in the gas or the solid material. Some PRDs do not have a secondary detector but instead use proprietary circuitry to achieve an extended range.

PRDs have visual, auditory, or vibratory alarms that typically can be set for two or more thresholds. The threshold may be set in terms of a fixed exposure or count rate, or in terms of a multiple of the standard deviation above the radiation background, where the background may be automatically and regularly updated. Some products allow the user to select between "detect" or "search" operating modes: in search mode the count rate may be advantageous for rapid response, while in detect mode a longer integration time could provide more accurate exposure rate measurements. Other enhancements distinguish naturally occurring radioactive material (NORM), which may cause innocent[4] alarms, from threat material.

## 2.3 Standards and Testing

Two technical professional organizations in the United States publish industry standards for a broad range of technologies, the Institute of Electrical and Electronics Engineers (IEEE) and the American National Standards Institute (ANSI). Standards pertaining to radiation detection for homeland security missions may be downloaded for no charge at standards.ieee.org/about/get/. The IEEE/ANSI standards that focus on PRDs and SPRDs are shown Table 2-1. Both of these standards specify general, radiological, environmental, electromagnetic, and mechanical performance requirements and test methods.

Table 2-1 U.S. PRD and SPRD Standards

| Number (Year)Standard | Standard Title |
|---|---|
| ANSI N42.32 (2016) | American National Standard for Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security |
| ANSI N42.48 (2008) | American National Standard Performance Requirements for Spectroscopic Personal Radiation Detectors (SPRDs) for Homeland Security |

The general requirements cover features such as size, weight, controls, displays, user interface, alarms, and batteries. The radiological requirements cover how well the

[3] Product specifications for semiconductors may describe the element used, such as "silicon diode," or its layered structure, such as "PIN diode."

[4] Also call nuisance alarms, innocent alarms are distinct from false alarms. Innocent alarms reflect the accurate detection of increased radiation levels, while false alarms are caused by statistical fluctuations near the alarm threshold.

instruments detect radiation, including the time to alarm, rate of false alarms, accuracy, and over-range indication. For example, ANSI standard N42.32 requires an effective measurement range of 5 µR/h to at least 2 milliroentgen per hour (mR/h). It also requires PRDs to be capable of alarming within 2 seconds (s) after exposure to an increase in the ambient radiation level of 50 µR/h above background for radiation sources moving at a speed of 1.2 meters per second (typical walking speed) at a distance of closest approach of 1.5 meters. Another feature of PRDs covered in this standard is the range of gamma energies a device can measure, since the sensitivity of various radiation detectors typically varies across the energy range of interest. ANSI N42.32 tests the capability of PRDs to detect gamma rays with energies of 60 keV, 662 keV, and 1.25 MeV, selected to span the range of interest using mono-energetic or standard radionuclides. The SPRD standard N42.48 also tests the ability to identify 18 specified single radionuclides and a pair of radionuclides, as well as plutonium and highly enriched uranium masked by other radionuclides.

The U.S. Department of Homeland Security (DHS) Domestic Nuclear Detection Office (DNDO) has supported testing programs based on these standards. These include the Graduated Rad/Nuc Detector Evaluation and Reporting (GRaDER®) Program and the Illicit Trafficking Radiological Assessment Program + 10 (ITRAP+10).[5]

## 2.4 Emerging Technologies–Hybrid Devices and Smartphone Integration

The radiation detectors in most PRDs have been used for many years, but products continue to evolve with enhancements designed for homeland security missions. For example, some instruments are considered multi-function or hybrid devices because they combine the high sensitivity and fast response time needed for interdiction missions with capabilities that would be needed in consequence management missions, such as a higher maximum range or the measurement and storage of accumulated dose.[6] In such devices, the dose may be calculated over a longer measurement time period for better accuracy or a filter may be used that reacts more slowly to sudden changes.

Other features available in some products include dashboard charging cradles, intrinsically safe certification for use in explosive environments, and embedded Global Positioning System (GPS). Some products use integrated mesh networks to allow nearby PRDs to communicate with each other until one of them enters a network where data from all the detectors is automatically passed to a central depository using Wi-Fi.

Another development is the use of smartphones to augment PRD capabilities. Some PRDs are Bluetooth-enabled to wirelessly send data a short distance to the user's smartphone or a nearby tablet. The smartphone or tablet may then be used to analyze the data further to perform spectroscopic identification, or they may be used as a stepping stone to transmit

[5] See for example www.dhs.gov/guidance-grader-program and www.dhs.gov/illicit-trafficking-radiological-assessment-program-10-itrap10.

[6] Interdiction missions require the detection of radiation above the natural background field, which varies with location, but is typically about 10 µR/h or less. In contrast, radiological consequence management requires the capability to measure exposure rates at least one thousand times higher, from 10 mR/h to 10 R/h or more. See *Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers*, National Council on Radiation Protection and Measurements, NCRP No. 165 (2010).

the data to a remote central command station using Wi-Fi or a mobile phone network such as Global System for Mobile (GSM), a standard for second generation (2G) digital cellular networks, or other communications protocols. Such systems may make use of the phone's GPS to allow spatial mapping of radiation levels in real time. A variation of this is to eliminate the display on the detector: instead, data is displayed on a mobile phone or designed to be viewable only at central command.[7] In considering the use of such features, localities need to consider potential additional costs of such systems if mobile phones, tablets, and cellular network data contracts are needed.

# 3. PRODUCT COMPARISON INFORMATION

## 3.1 Overview and Market Analysis

The market survey identified 15 PRDs[8] and eight SPRDs. All have audible, visual, and vibrate alarms to alert the user of an exceeded threshold. Four of the PRDs can also provide radionuclide identification through connection to an external device, such as sending spectra wirelessly via Bluetooth to a smartphone. One PRD (GammaRAE II R) is intrinsically safe for use in explosive environments. The PRDs ranged in price from about $900 to $8,000. The SPRDs are typically more expensive, ranging from about $2,300 to $9,400.

While the primary purpose of PRDs and SPRDs is to detect small increases above background radiation for interdiction missions, seven of the PRDs and four of the SPRDs identified in this market survey have a maximum range that extends to higher radiation levels. In addition, six PRDs and two SPRDs are capable of measuring the wearer's accumulated dose.

Figure 3-1 and 3-2 provides graphical overviews of some of these features for the current market of PRDS and SPRDs.

[7] At the time of this publication, the Defense Advanced Research Agency (DARPA) SIGMA program completed a city-wide test of a blind monitoring system (no integrated display) using 1,000 gamma/neutron PRDs with Bluetooth communication to smart devices. The next steps "include continuing to test full city- and regional-scale, continuous wide-area monitoring capability in 2017 and then transition the operational system to local, state, and federal entities in 2018." (from http://www.darpa.mil/news-events/2016-10-11)

[8] In some cases, alternate model numbers indicate minor variations (such as additional Bluetooth capability) while in others they denote a significant capability difference (such as extended range). Product variants with significant capabilities were counted separately for the total of 15; if models with minor variations are included, the total is 18.

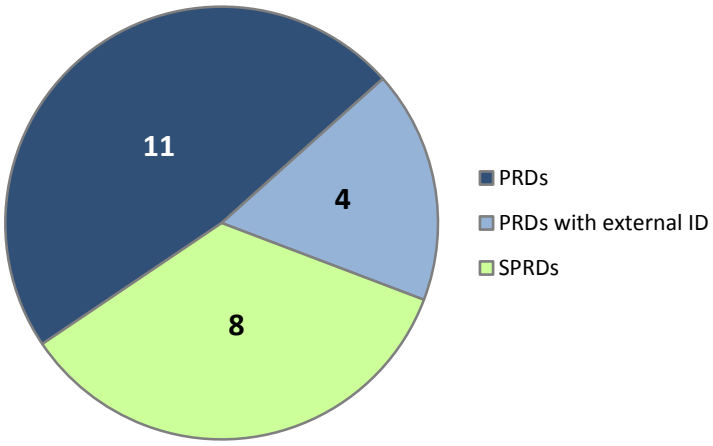



Figure 3-1 Graphical Representation of PRDs and SPRDs

Fifteen PRDs and eight SPRDs were identified in this market survey; four PRDs are capable of transmitting data for spectral analysis on an external device such as a smartphone or tablet.

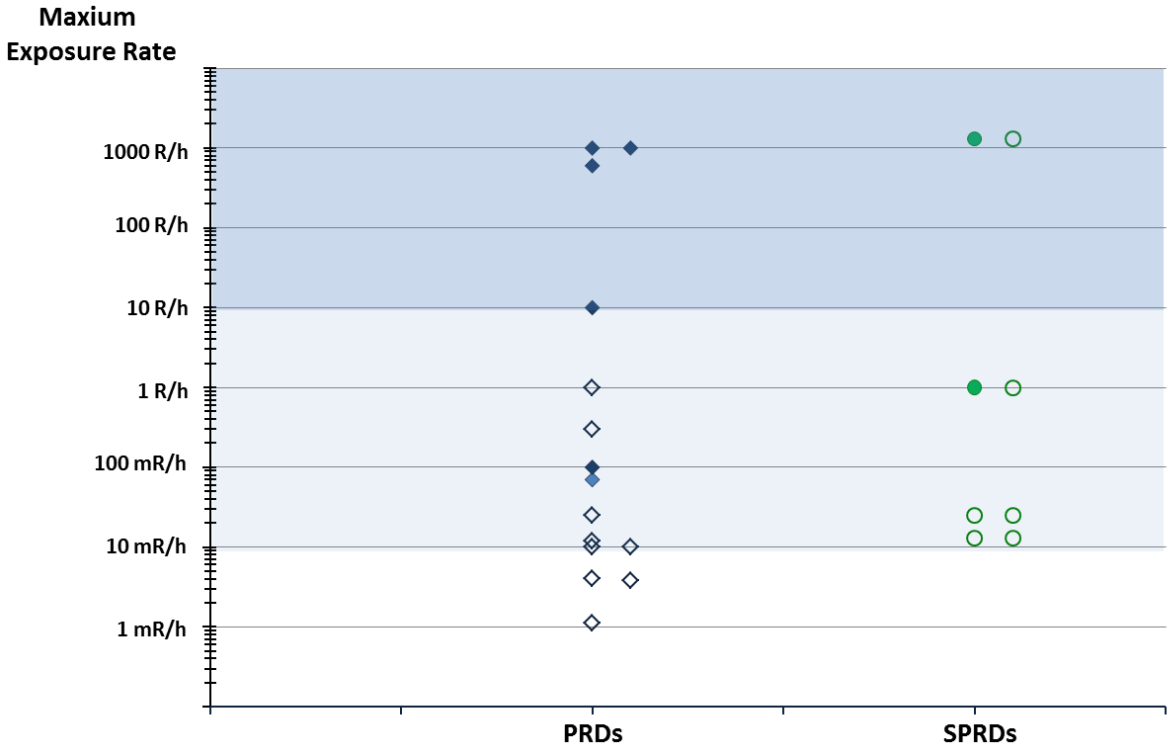



Figure 3-2 Graphical Comparison of Hybrid Features of PRDs and SPRDs

Each point represents a PRD (diamonds) or SPRD (circles), where the vertical position corresponds to the maximum exposure rate it can measure shown on a logarithmic scale. For context, the background shading indicates radiation control zones defined for consequence management: the light blue background indicates the Hot Zone exposure rate (> 10 mR/h), and the darker blue shading marks the Dangerous-Radiation Zone (>10 R/h). For interdiction missions, standards recommend an upper range of at least 2 mR/h, which is well within the Cold Zone (≤ 10 mR/h), shaded in white. Filled points denote products that are also capable of measuring and storing the wearer's accumulated dose.

## 3.2 PRD and SPRD Comparison Tables

This section provides separate summary tables for comparing the key features of commercially available PRDs and SPRDs. Only devices with integrated radionuclide identification are shown in the SPRD table; devices that have the ability to transmit spectra to a secondary device (such as a smartphone) for radionuclide identification are listed and noted in the PRD table. Subsequent sections provide additional information that describes each product in more detail. The product information presented was obtained directly from manufacturers, vendors, and their websites. The information has not been independently verified by the SAVER program.

In the tables, "Yes" indicates that the device is equipped with a feature, "No" indicates that the device is not equipped with a feature, and "NI" means that no information was available on this feature. For convenience, most of the numerical information about the products is given in conventional U.S. units: dimensions are in inches, weight in pounds, temperature in degrees Fahrenheit (°F), and radiation exposure rate in roentgens per hour (R/h).

Product characteristics in Table 3-1 are defined as follows, listed in column order:

**Photo:** A photograph of the device.

**Manufacturer and Product:** Products are listed in alphabetical order by manufacturer. The vendor is also noted where the vendor provided the product data for this report. Some of the products may be available from multiple vendors.

**Price:** Approximate manufacturer suggested retail price for one unit, in U.S. dollars; quantity discounts are typically available. Where noted, the General Services Administration (GSA) price is quoted.

**Detector:** The type of gamma radiation sensor used (CsI, NaI, YSO, CZT, GM, or diode).

**Display Quantity:** The quantity shown on the instrument display, i.e., exposure rate (μR/h), counts per second (cps), or a unit-less integer value; some products may display more than one quantity. (In some cases, customized displays may be special ordered; those are not shown here).

**Maximum Exposure Rate:** The maximum exposure rate that the product is capable of measuring. Since different products may display various units, where possible, the range is expressed in units of R/h to simplify product comparisons.[9] (All products report a minimum in their range that is consistent with nominal natural background radiation levels).

**Gamma Energy Range:** The range of gamma rays in units of MeV that the product can measure.

**Weight:** In ounces (oz), rounded to the nearest 0.1 ounce, including batteries.

**Battery:** The quantity and type of battery used to power the device; "Li ®" refers to a rechargeable lithium-ion battery.

**IP:** Ingress protection from dust or liquid. This is specified as a two-digit code for protection against (1) solid objects and (2) liquids where higher numbers indicate more protection. First digit: 3 = protected against tools, thick wires, etc.; 5 = function not affected by dust; 6 = dustproof. Second digit: 4 = device not harmed by splashing water from any direction; 5 = not harmed by low pressure water jets; 6 = not harmed by strong water jets; 7 = not

[9] Dose rates have been converted by using the approximation 1 R ≈ 1 rem ≈ 1 rad. Specifications in Gy or Sv were first multiplied by 100 to convert to rad or rem. Units of cps cannot be directly converted to exposure rate in this context.

damaged by temporary immersion up to 1 meter; 8 = not damaged by continuous immersion in water beyond 1 meter.

**External ID:** Wireless transmission of PRD data to a smartphone or tablet for isotope identification (in PRD table only).

**Hybrid:** Multi-functional instruments that have a maximum range of ≥100 mR/h are indicted by "ER" for "extended range," and those that are capable of measuring the wearer's accumulated dose are denoted "AD." The notation "N/A" stands for "not applicable" meaning the instrument is not considered a hybrid.

**Network:** Capable of wirelessly sending data to central command with situational awareness software.

## Table 3-1 Personal Radiation Detector Specifications

| PRD Photo | Manufacturer PRD Model | Price | Detector | Display Quality | Maximum Exposure Rate | Energy Range (MeV) | Weight | Battery | IP | External ID | Hybrid | Network |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | D-Tect Systems **Mini Rad-D*** | $1,095 | CsI | Unit-less | 1.1 mR/h | 0.030 to 3 | 6.4 oz | 2 AA | 65 | No | N/A | No |
|  | D-Tect Systems **MiniRad-DX*** | $1,950 | CsI | Exp. Rate Unit-less | 70 mR/h | 0.050 to 3 | 6.1 oz | Li ® | 65 | No | AD | Yes |
|  | FLIR Detection **IdentiFINDER R100*†** | $1,195 | GM | Exp. Rate | 1 R/h | 0.025 to 3 | 8.8 oz | 2 AA | 67 | No | ER | Yes |
|  | Passport Systems **SmartShield G300†** | $8,000 | CsI diode | Exp. Rate | 300 mR/h | 0.030 to 3 | 8.8 oz | Li ® | 63 | Yes | ER | Yes |
|  | Polimaster Inc. **PM1401MA‡/PM1401MB‡** | NI | CsI | Exp. Rate | 4 mR/h | 0.060 to 3 | 9.5 oz | 1 AA | 65 | Yes# | N/A | Yes# |
|  | Polimaster Inc. **PM1703M‡/PM1703MA‡** | $915 $1,315§ | CsI | Exp. Rate CPS | 9.9 mR/h | 0.033 to 3 | 6.3 oz | 1 AA | 65 | No | N/A | No |
|  | Polimaster Inc. **PM1703MB‡** | NI | CsI | Exp. Rate CPS | 9.9 mR/h | 0.033 to 3 | 8.1 oz | 1 AA | 65 | Yes | N/A | Yes |
|  | Polimaster Inc. **PM1703MO-1‡** | $1,281 | CsI GM | Exp. Rate | 1,000 R/h | 0.033 to 3 | 8.8 oz | 1 AA | 65 | No | ER AD | No |
|  | Polimaster Inc. **PM1703MO-1A‡/ PM1703MO-1B‡** | NI | CsI GM | Exp. Rate | 1,000 R/h | 0.033 to 3 | 8.8 oz | 1 AA | 65 | Yes# | ER AD | Yes |

| PRD Photo | Manufacturer PRD Model | Price | Detector | Display Quality | Maximum Exposure Rate | Energy Range (MeV) | Weight | Battery | IP | External ID | Hybrid | Network |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Rae Systems **GammaRAE II R*** | $1,360 | CsI diode | Exp. Rate CPS | 600 R/h | 0.060 to 3 | 9.5 oz | 2 AA | 67 | No | ER AD | Yes |
|  | Sensor Technology Engineering **Radiation Pager†** | $1,274§ | CsI | Unit-less | 3.8 mR/h | 0.045 to NI | 6 oz | 2 AA | NI | No | N/A | No |
|  | Sensor Technology Engineering **Radiation Pager-S†** | $1,960§ | CsI | Unit-less | 12 mR/h | 0.045 to NI | 6 oz | 2 AA | NI | No | N/A | No |
|  | Thermo Scientific **RadEye PRD*** | $2,130 | NaI | Exp. Rate CPS | 25 mR/h | 0.030 to 1.3 | 5.6 oz | 2 AAA | 65 | No | N/A | No |
|  | Thermo Scientific **RadEye PRD-ER*†** | $2,538 | NaI | Exp. Rate CPS | 10 R/h | 0.060 to 1.3 | 5.6 oz | 2 AAA | 65 | No | ER AD | No |
|  | **X-Z Lab RadPavise‡** | $1,299 | YSO | Exp. Rate | 100 mR/h | 20 to NI | 6.7 oz | Li ® | 65 | No | ER AD | No |

**Abbreviations:** accumulated dose (AD), cesium iodide (CsI), counts per second (CPS), exposure rate (Exp. Rate), extended range (ER), Geiger Mueller (GM), ingress protection (IP), lithium rechargeable (Li ®), mega-electron volt (MeV), milliroentgen per hour (mR/h), not applicable (N/A), no information (NI), ounce (oz), roentgen per hour (R/h), sodium iodide (NaI), and yttrium silicate (YSO).
* Information is from LAURUS Systems, a vendor of multiple products in this market survey.
† Information is from the manufacturer's response to questions in the RFI and web sources.
‡ Information is from prior SAVER documentation and web sources only; no information was submitted in response to this RFI.
§ GSA price.
# Polimaster products with wireless data transmission have the letter "B" in the product name.

## Table 3-2 Spectroscopic Personal Radiation Detector Specifications

| SPRD Photo | Manufacturer SPRD Model | Price | Detector | Display Quantity | Maximum Exposure Rate | Energy Range (MeV) | Weight | Battery | IP | Hybrid | Network |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | FLIR Detection **IdentiFINDER R200***† | $2,995 | CsI | Exp. Rate | 25 mR/h | 0.025 to 3 | 14 oz | Li ® | 67 | N/A | Yes |
|  | FLIR Detection **IdentiFINDER R300 (NanoRAIDER Z)*** | $9,395 | 3 CZT | Exp. Rate | 1 R/h | 0.030 to 3 | 12 oz | Li ® | 63 | ER | Yes |
|  | Polimaster Inc. **PM1704A**‡ | NI | CsI | Exp. Rate CPS | 13 mR/h | 0.033 to 3 | 7 oz | 1 AA | 65 | N/A | Yes |
|  | Polimaster Inc. **PM1704A-M**‡ | $3,484 | CsI GM | Exp. Rate CPS | 1,300 R/h | 0.033 to 3 | 11.6 oz | 1 AA | 65 | ER AD | Yes |
|  | Polimaster Inc **PM1704**‡ | $2,963§ | CsI | Exp. Rate CPS | 13 mR/h | 0.033 to 3 | 10.9 oz | 1 AA | 65 | N/A | No |
|  | Polimaster Inc. **PM1704M**‡ | $3,587 | CsI GM | Exp. Rate CPS | 1,300 R/h | 0.033 to 3 | 12.9 oz | 1 AA | 65 | ER | No |
|  | Radcomm **Mspec*** | $5,000 | CsI | Exp. Rate CPS | 1 R/h | 0.20 to 3 | 7 oz | Li ® | NI | ER AD | No |
|  | Thermo Scientific **RadEye SPRD***† | $2,346 | CsI | Exp. Rate CPS | 25 mR/h | 0.040 to 3 | 5.2 oz | 2 AAA | 65 | N/A | No |

**Abbreviations**: accumulated dose (AD), cadmium zinc telluride (CZT), cesium iodide (CsI), counts per second (CPS), exposure rate (Exp. Rate), extended range (ER), Geiger Mueller (GM), ingress protection (IP), lithium rechargeable (Li ®), mega-electron volt (MeV), milliroentgen per hour (mR/h), not applicable (N/A), no information (NI), ounce (oz), roentgen per hour (R/h), and sodium iodide (NaI).

* Information is from LAURUS Systems, a vendor of multiple products in this market survey.

† Information is from the manufacturer's response to questions in the RFI and web sources.

‡ Information is from prior SAVER documentation and web sources only; no information was submitted in response to this RFI.

§ GSA price.

# 4. INDIVIDUAL PRODUCT DESCRIPTIONS—PRDS

## 4.1 D-Tect Systems Mini Rad-D

The MiniRad-D uses a CsI scintillator (0.5 inch diameter x 1.5 inches length) with a photomultiplier tube. It is worn on a belt using a clip or holster. Its dimensions are 3.7 x 2.5 x 1.2 inches. A single digit from 1 to 9 is displayed on the light-emitting diode (LED) screen to indicate the intensity of detected radiation. An alarm level guide with the corresponding dose rate values, ranging from 35 µrem/h to 1.1 mrem/h, is printed on the side. A single switch is used to set the device to audible alarm mode, vibrate alarm mode, or to turn it off.


Mini Rad-D
*Image courtesy of LAURUS Systems*

The MiniRad-D is powered by two AA batteries with a 2-year battery life. Low battery condition is indicated by an "L" on the LED screen. A small Phillips-head screwdriver is required to access the battery compartment. The device operates within a temperature range of -10°F to 122°F and passes a 3-foot drop test onto a concrete floor.

## 4.2 D-Tect Systems MiniRad-DX

The MiniRad-DX uses a 6 cubic centimeter CsI scintillator with an integrated photomultiplier tube and has a gamma sensitivity of 1.93 cps/µrem/h. It has been available since 2014. The plastic housing has rubber molding and is worn using a clip or holster. Its dimensions are 2.4 x 1.2 x 4.2 inches without the holster. It has two display screens: critical information is viewable on the top organic light-emitting diode (OLED) screen while the device is holstered, and more detailed information and setting adjustments are shown on the front color liquid-crystal display (LCD) screen. The MiniRad-DX can save and display accumulated dose as well as dose rate, in units of rem or Sv. The user selects audible or vibrating alarms that can be acknowledged with the press of a button, but the visual warning remains until the device is reset. It is powered by a lithium-ion battery that is recharged via a universal serial bus (USB) charger and has a 130-hour battery life in non-alarming status. The charge status is indicated by a battery icon on both displays; audible and visual alarms indicate a low-battery condition. No special tools are required to access the battery compartment. The MiniRad-DX has a self-check feature. It operates in a temperature range from -10°F to 122°F and it passes a 1.5-meter drop test onto a concrete floor.


MiniRad-DX
*Image courtesy of LAURUS Systems*

While the MiniRad-DX can act as a standalone radiation detector, it also contains an integrated GPS-tracking and a mesh network capability that allows it to connect to other detectors within 1,000 meters. Multiple devices can be monitored via a Wi-Fi connection to a central location, e-mailing, or texting alerts to critical personnel. Position/dose logs can be

automatically updated in real time, allowing a dose rate map to be maintained in real time on a personal computer (PC) or tablet. Two software options are available for monitoring a network of MiniRad-DX units: the PC-based DX-View runs locally and the internet-based DX-Dashboard can be used on PCs, smartphones, and tablets to monitor the network anywhere there is internet accessibility. The DX-Dashboard can also be configured behind a firewall to support secure closed networks with no access to the internet.

## 4.3 FLIR Detection IdentiFINDER R100

The identiFINDER R100 uses an energy-compensated GM tube with a gamma sensitivity of 17 cps/mR/h and is designed for detection and interdiction. It has been available since 2016. It is belt-worn and has dimensions of 5.3 x 2.2 x 1.5 inches. It has a transflective[10] monochrome LCD display. It is powered by two AA batteries with a 125-hour battery life in dose rate mode with dimmed display backlight. The battery condition is indicated by an icon. The identiFINDER R100 operates within a -4°F to 122°F temperature range and from 10 to 93 percent relative humidity, non-condensing. It passes a 1.5-meter drop test. It has a recommended factory maintenance interval of 5 years and an annual dose rate calibration interval.


identiFINDER R100
*Image courtesy of FLIR Detection*

The identiFINDER R100 uses USB and Mini-B USB for wired communication. In addition, it has integrated Bluetooth for connection to a smart device to enable networking. It automatically generates and sends dose rate reports to a central command for continuous situational awareness. Its companion mobile application can display real-time output with geotag information.

## 4.4 Passport Systems SmartShield™ G300

The SmartShield G300 radiation detector is part of the SmartShield system, a scalable network that utilizes gamma radiation detectors, smartphones with embedded software, and a base control laptop. The system is designed for automatic integration of individual detectors into a network that continually provides radiation detection, localization, identification, and background estimation over the area covered. The SmartShield G300 radiation detector is based on a 3.8 cubic centimeter CsI scintillator and a PIN diode. Its dimensions are 1.1 x 2.8 x 5 inches and it has a protective rubber case. It is powered by an integrated lithium-ion battery that is recharged using a micro-USB 2.0 port (up to 700 recharge cycles). It has a 60-hour battery life in surveillance mode. It operates within a -4°F to 104°F temperature range and from 0

SmartShield G300
*Image courtesy of Passport Systems*

[10] "Transflective" LCD displays are designed to function in both bright and dim lighting conditions – the liquid crystals transmit and reflect light.

to 95 percent relative humidity, non-condensing. It passes a 1.5-meter drop test. The G300 has a monochrome LCD display on the top edge that displays dose rate, an analog bar graph of dose rate, battery level, Bluetooth connectivity, and isotopes identified via a secondary device. Detailed output can also be displayed on a separate smartphone synched with the detector.

Data communication is achieved with Bluetooth wireless connection to an external smartphone. The smartphone provides the computational capability for detection, identification, and localization algorithms; user interface; GPS for localization of detectors; and cellular connection to a server. The paired detector and smartphone automatically join a SmartShield Network and initiate operation without intervention. The server on the laptop provides bi-directional communication to each detector node and redistributes the information between nodes. The base control laptop also has software that combines and analyzes information from all detectors for continuous visualization and mapping and real time data decision making. SmartShield Systems are sold as systems, comprised of one or more G300 detector(s) paired with a smartphone running the SmartShield application, connection to a cloud server and a computer running the SmartShield tactical Computer Software; different configurations drive the cost.

## 4.5 Polimaster Inc. PM1401MA and PM1401MB

The PM1401MA and PM1401MB share the same functions, except the PM1401MB also contains a Bluetooth module for communication with an external device. Both are based on a CsI scintillator with a gamma sensitivity of 1 cps/μR/h. They measure 2.3 x 4.3 x 1.3 inches. The display is an LCD screen with a fluorescent backlight. The instruments' processing algorithm enables the user to update the background levels and setup alarm thresholds depending on the probability of detection and false alarm rate requirements. They are additionally designed to ensure adequate adaptation to the background level so that the instruments can locate a radioactive source in changing environments.


PM1401MA
*Image courtesy of Polimaster Inc.*

The devices have hermetic cases. Each is powered by one AA battery with up to 800 hours battery life. A low-battery condition is indicated on the LCD screen. The devices store up to 1,000 events in nonvolatile memory and use Infrared Data Association (IRDA) protocols for communication to a PC. The devices operate within a -22°F to 122°F temperature range and pass a 0.7-meter (2.3 feet) drop test onto a concrete floor.

In addition to IRDA communication, the PM1401MB has Bluetooth capability for communication with a PC or device. This device, running Polimaster proprietary software, can be used for radionuclide identification.

## 4.6 Polimaster Inc. PM1703M and PM1703MA

Both the PM1703M and the PM1703MA models use a CsI scintillation detector, but the PM1703MA version is more sensitive. The PM1703M has a gamma sensitivity of 0.85 cps/µR/h for Cs-137 and 1 cps/µR/h for Am-241. The PM1703MA has a gamma sensitivity of 1 cps/µR/h for Cs-137 and 2 cps/µR/h for Am-241. The other specifications described here are the same.


PM1703MA
*Image courtesy of Polimaster Inc.*

The devices are designed to detect gamma radiation and adapt to changing background levels. They have hermetic cases measuring 2.8 x 1.3 x 3.4 inches. The models have LCD displays with a fluorescent backlight and two-button operation. Each is powered by one AA battery having a battery life of up to 1,000 hours. A low-battery condition is indicated on the LCD. A coin may be used to access the battery compartment. The devices record 10,000 data points in nonvolatile memory and communicate with a PC using IRDA. The devices operate over a temperature range from -22°F to 122°F, and up to 98 percent relative humidity at 104°F. They pass a 1.5-meter drop test with a protective cover, and a 0.7-meter drop test without the cover.

## 4.7 Polimaster Inc.PM1703MB

The PM1703MB has the same features as the Polimaster PM1703MA, with the addition of a Bluetooth module for communication with an external PC or device. The PM1703MB has a CsI detector with gamma sensitivity of 1 cps/µR/h for Cs-137 and 2 cps/µR/h for Am-241. It is designed to detect gamma radiation and adapt to changing background levels. Its hermetic case measures 2.8 x 1.3 x 3.4 inches. The PM1703MB has an LCD display with a fluorescent backlight and two-button operation. It is powered by one AA battery having a battery life of up to 1,000 hours. A low-battery condition is indicated on the LCD. A coin may be used to access the battery compartment. The device operates over a temperature range from -22°F to 122°F and up to 98 percent relative humidity at 104°F. It passes a 1.5-meter drop test with a protective cover, and a 0.7-meter drop test without the cover.


PM1703MB
*Image courtesy of Polimaster Inc.*

The PM1703MB can record 10,000 data points in nonvolatile memory and communicate with a PC using IRDA. In addition, it is equipped with Bluetooth to exchange information with an external device such as a smartphone or PC. The external device, running proprietary PoliIdentify software, can be used to identify and classify the radionuclide detected. Data can also be exchanged to a wider network through GSM communication from the smartphone. Polimaster's Nuclear Protection Network (NPNET™) software allows reachback to radiation experts and viewing of real-time information about dose rates, spectra, GPS location, and live mapping.

## 4.8 Polimaster Inc.PM1703MO-1

Compared to other Polimaster PRDs, the PM1703MO-1 has expanded measurement range and a larger LCD display. It uses CsI and GM detectors with gamma sensitivity of 0.85 cps/µR/h for Cs-137 and 1.0 cps/µR/h for Am-241. The PM1703MO-1 is designed to be used for both gamma radiation detection and dose rate measurement and stores the accumulated dose.


PM1703MO-1
*Image courtesy of Polimaster Inc.*

It measures 2.8 x 1.3 x 3.4 inches and can be worn by belt clip or with a web loop holster. It is powered by one rechargeable or alkaline AA battery with 1,000-hour battery life. The PM1703MO-1 also has an optional vehicle-mounted charging cradle for installation on a vehicle dashboard. The LCD display has 0.9-inch font and a backlight. Visual and audible indicators signal a low-battery condition. A self-test procedure and background calibration are initiated on startup. Calibration is expected to last 8 years under routine use and 8 years in storage. The device retains 2,000 data points and can communicate through an infrared (IR) interface. Its operating range is -22°F to 122°F and up to 95 percent relative humidity at 95°F. The device is drop tested to 0.7 meters.

## 4.9 Polimaster Inc.PM1703MO-1A and PM1703MO-1B

The PM1703MO-1A and PM1703MO-1B contain dual detectors (CsI and GM) for detection, identification, and dosimetry functions. The devices are the same with the exception of their communication capability: the PM1703MO-1A has USB, and the PM1703MO-1B has Bluetooth. Both have sensitivity of 1 cps/µR/h for Cs-137 and 2 cps/µR/h for Am-241.


PM1703MO-1A
*Image courtesy of Polimaster Inc.*

The devices measure 3 x 1.4 x 3.8 inches. They have LCD displays with two-button operation. Each is powered by one AA battery having a battery life of up to 1,000 hours. The battery compartment can be accessed with a coin. A low-battery condition is indicated on the LCD. The devices operate over a temperature range from -22°F to 122°F, and pass a 0.7-meter drop test.

The devices can record 2,000 data points in nonvolatile memory and communicate with a PC using IRDA. An external device such as a smartphone running PoliIdentify software can identify and classify the radionuclide detected. Data can be exchanged to a wider network through communication from the smartphone. Polimaster's NPNET software allows reachback to radiation experts, and viewing of real-time information about dose rates, spectra, GPS location, and live mapping.

## 4.10 RAE Systems by Honeywell GammaRAE II R

The GammaRAE II R is designed for both detection and dosimetry and has been available since 2007. It uses CsI and PIN diode detectors with gamma sensitivities of 1 cps/µR/h and about 0.2 cps/mR/h, respectively. In Search Mode, the alarm threshold is based on variations in the local background level, where background reference level is set automatically on start-up, and can be user initiated as needed. In Safety Mode, the alarm thresholds are based on user-programmable dose rate and accumulated dose. It has a buzzer alarm and vibration alarm, and two LED lights on both sides of the LCD display. The LCD display is on top and may be inverted for viewing by the user.


**GammaRAE II R**
*Image courtesy of LAURUS Systems*

The GammaRAE II R measures 4.9 x 2.7 x1.4 inches and is worn by a metal belt clip or wrist strap. It is powered by two rechargeable or AA batteries with battery life of 600 hours. A screwdriver is used to open the battery compartment, and a low-battery condition is visually indicated. The device has a backlit display and self-diagnostics. Calibration is expected to last 2 years under routine use and 3 years in storage. The device retains 30,000 data points and can communicate via cable or Bluetooth for data-log download and configuration changes. Remote command center software, the ProRAE Guardian system, can integrate instrument data from up to 512 devices on a single dynamic map that can be shared through an internet connection and viewed on a PC, smartphone, or tablet. The operating range is -4°F to 122°F and up to 95 percent relative humidity (non-condensing). Temperatures above 122°F will cause a high temperature error message. It is intrinsically safe and drop tested to 1.5 meters.

## 4.11 Sensor Technology Engineering Radiation Pager®

The Radiation Pager uses a CsI scintillator crystal (0.5-inch diameter x 1.5-inches length) and a miniature photomultiplier tube. Its dimensions are 4.1 x 2.4 x 0.9 inches and it can be worn on a belt or carried in a pocket. It has a single-digit LED display and a flashing yellow LED alarm. A modulated audio tone indicates radiation intensity. It is powered by two AA alkaline batteries with a 1-year operating life. The Radiation Pager's operation range is -13°F to 122°F.

**Radiation Pager**
*Image courtesy of Sensor Technology Engineering*

## 4.12 Sensor Technology Engineering Radiation Pager®-S

The Radiation Pager-S is based on a CsI scintillator crystal (0.5-inch diameter x 1.5 inches long) and a miniature photomultiplier tube. The case is worn on a belt or it may be carried in a pocket. Its dimensions are 4.1 x 2.4 x 0.9 inches. It has a single digit LED display. It is powered by two AA batteries with a 2-month battery life. The device has a self-diagnostics indication. The Radiation Pager-S operates in a temperature range of -13°F to 122°F.

Radiation Pager-S
*Image courtesy of Sensor Technology Engineering*

It has a push-button background update switch. A duty-cycle-based audio tone or silent vibration alarm assists with searching for source location.

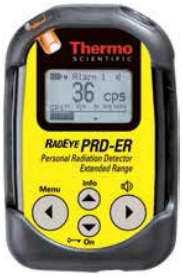
## 4.13 Thermo Scientific RadEye™ PRD

The RadEye PRD uses a NaI detector with gamma sensitivity of 1.5 cps/µR/h for Cs-137, and it has a particular emphasis for photons below 400 keV, with a sensitivity of 30 cps/µR/h for Am-241. Proprietary circuitry allows energy-compensated dose and dose rate measurements with a single detector. It uses patented Natural Background Rejection (NBR) technology designed to eliminate nuisance alarms from naturally occurring radiation sources (such as granite).


RadEye PRD
*Image courtesy of LAURUS Systems*

The device measures 3.8 x 2.4 x 1.2 inches without the case and holster, and approximately 4.3 x 2.8 x 1.6 inches with case and holster. It is worn using the holster's clip. It is powered by two AAA batteries (rechargeable or standard) with up to 600-hour battery life. A low-battery condition is indicated by a low battery symbol, a text "low batt" warning, and an audible chirp. No tools are required to access the battery compartment, though use of a coin is recommended. The display has a backlight feature that stays on for 10 seconds after any button press or can be locked on. A heartbeat graphic shows the status of the device's self-check for the detector, voltage, electronics, and data. Calibration lasts 2 to 3 years under routine use. The last 1,600 mean and maximum values of the dose rate and count rate, the last 250 alarms, and errors and configuration changes are recorded internally and can be read out via a serial interface. Data communication is through cable with Bluetooth as an option using an external device. The RadEye PRD operates within -4°F to 122°F, 10 to 95 percent relative humidity, and passes a 1.5-meter drop test with the protective sleeve.

## 4.14 Thermo Scientific RadEye™ PRD-ER




**RadEye PRD-ER**
*Image courtesy of Thermo Scientific*

The RadEye PRD-ER is an extended-range personal radiation detector designed to detect low to medium levels of gamma radiation quickly, for both interdiction and response missions. It automatically records and monitors the user's total accumulated dose and alarms when a set limit is exceeded. It has been available since 2009. It has a NaI detector with gamma sensitivity of 1.5 cps/µR/h for Cs-137. Proprietary circuitry allows energy-compensated dose and dose rate measurements with a single detector. Patented NBR technology is designed to eliminate nuisance alarming due to naturally occurring radiation sources such as granite in urban environments. It automatically discriminates between natural and artificial gamma radiation, allowing users to make quicker decisions. This algorithm allows the RadEye PRD-ER to have its alarm thresholds reduced, allowing it to alarm faster and with lower gamma count rates without increasing the false positive rate.

The RadEye PRD-ER measures 3.8 x 2.4 x 1.2 inches without the case and holster and approximately 4.3 x 2.8 x 1.6 inches with case and holster. It is worn using the holster's clip and several styles of holsters are offered. It is powered by two rechargeable or alkaline AAA batteries with greater than 800 hours of battery life. A low-battery condition is indicated by a low battery symbol, a text "low batt" warning, and an audible chirp. No tools are required to access the battery compartment. The display has a backlight feature that stays on for 10 seconds after any button press or can be locked on. A heartbeat graphic shows the status of the device's self-check for the detector, voltage, electronics, and data. Calibration lasts 2 to 3 years under routine use and 3 to 5 years in storage. Data is stored in flash memory, and consists of 1,600 data points and 250 log book entries. Data communication is through cable, IR, and optional Bluetooth adapter, with Wi-Fi as an option using an external device. The device operates within -4°F to 122°F, 20 to 90 percent relative humidity, and passes a 1.5-meter drop test.

## 4.15 X-Z Lab Inc. RadPavise


**RadPavise**
*Image courtesy of X-Z Lab Inc.*

The RadPavise is designed to function as a dose equivalent rate meter, accumulated dose meter, radiation survey meter, and radiation source locator. It uses a silicon photomultiplier and YSO scintillator with gamma sensitivity of 340 cps/mrem/h for Cs-137. It has been available since 2012. It measures 4.4 x 2.8 x 0.9 inches and is handheld, with an optional case for clip attachment to the user. It has an OLED display and uses a rechargeable lithium-ion battery with 240-hour battery life between charges. A low-battery condition is signaled by an icon on the display screen. The device performs a self-check upon start up. Calibration lasts at least a year under routine use or in storage. Up to

43,800 data points and 5,000 work log items can be stored in flash memory. Data transfer may be through USB or radio frequency identification (RFID) depending on the version of the device chosen. The instrument's operating range is -4°F to 122°F and up to 95 percent relative humidity. It has been drop tested to 1 meter on each face onto concrete covered by a 4 millimeter hard rubber sheet.

# 5. INDIVIDUAL PRODUCT DESCRIPTIONS—SPRDS

## 5.1 FLIR Detection IdentiFINDER R200

The identiFINDER R200 uses an 18-cubic-millimeter CsI detector with a silicon photomultiplier tube and has a gamma sensitivity of 3 cps/µrem/h. It has a typical resolution of ≤ 7.5 percent full width at half maximum (FWHM) at 662 keV. The device provides detection and radionuclide identification with integrated web server and Bluetooth capabilities.


IdentiFINDER R200
*Image courtesy of FLIR Detection*

The identiFINDER R200 is worn on a belt and measures 5.7 x 2.2 x 1.9 inches. It has a transflective monochrome LCD display and a three-button user interface. It is powered by an internal rechargeable lithium-ion battery with a 36-hour battery life. Recharge time is less than 6 hours using an alternating current or USB power source. Battery condition is indicated by an icon. An additional, external battery compartment for extended field situations is available. The device performs automatic calibration and stabilization. The recommended factory maintenance interval is 5 years, with an annual dose rate calibration interval. The device operates within a temperature range from -4°F to 122°F, 93 percent relative humidity (non-condensing), and passes a 1.5-meter drop test.

The identiFINDER R200 stores up to 5,000 spectra in internal memory. USB connections are used for communication. In addition, through its integrated web server and a Bluetooth connection to a compatible cell phone, the device can wirelessly transmit spectroscopic data and information to other personnel by pressing one button. This "one touch reachback" allows experts anywhere in the world to have access to spectroscopic data and other detailed device information without physical connection to a computer or sending e-mails.

## 5.2 FLIR Detection IdentiFINDER R300 (NanoRAIDER Z)

The identiFINDER R300, also called the NanoRAIDER Z, is based on three semiconductor CZT detectors. Two of the CZT crystals are used in the dose-rate channel and one is used in the identification channel. The instrument has a gamma sensitivity of 0.47 cps/µR/h in the identification channel and 0.81 cps per µR/h in the dose rate channel. It has a typical resolution of ≤ 3.5 percent FWHM at 662 keV. The device provides detection, radionuclide identification, and integrated Bluetooth, web server, and GPS capabilities.


IdentiFINDER R300 (NanoRAIDER Z)
*Image courtesy of LAURUS Systems*

The identiFINDER R300 can be worn on a belt and has dimensions of 2.8 x 1.3 x 4.9 inches. It has a transflective color LCD display and two-button user interface. It is powered by an internal, rechargeable lithium-ion battery, and operates for 24 hours in dose rate mode with a dimmed display backlight and GPS switched off. It takes 3 hours to recharge when turned off and connected to a direct-current power charger, or 5.5 hours when powered by USB. The rechargeable battery is expected to last from 3 to 5 years. The instrument operates within a temperature range from -4°F to 122°F, but the temperature change must not exceed 15.1°F per minute. The operating relative humidity range is 10 to 90 percent, non-condensing. It is drop tested to 1 meter.

The identiFINDER R300 stores data for up to 600,000 identifications and spectra and over a million alarms. USB 2.0 or the mini-B socket can be used for an external connection. In addition, through its integrated web server and a Bluetooth connection to a compatible cell phone, the device can wirelessly transmit spectroscopic data, device information, time, and GPS location to other personnel by pressing one button.

## 5.3 Polimaster Inc. PM1704A

The PM1704A contains a single, built-in spectroscopic CsI detector with a dose rate range up to 13 mR/h. (The PM1704A-M described in the next section is the extended-range version of this model, with an additional detector and a dose rate up to 1,300 R/h). The PM1704A combines radiation detector and radioisotope identifier capabilities. It has a built-in GPS for data logging and Bluetooth communication for connection to smartphones or other devices.


PM1704A
*Image courtesy of Polimaster Inc.*

The PM1704A measures 2.9 x 3.4 x 1.5 and is equipped with a removable belt clip or web loop holster. It can be powered by a rechargeable or alkaline AA battery with a battery life of 300 hours. Visual and audible indicators signal a low battery condition. The display screen is a transflective LCD with backlight. The device has a self-check, and calibration lasts 6 months under routine use or in storage. The device can store up to 1,000 gamma spectra and up to 15,000 events in

nonvolatile memory. Radionuclide identification is displayed on the LCD screen. Data can also be exchanged in real-time with a user's mobile device via Bluetooth. Built in GPS allows for geocached data logging. The instrument has an operating range of -4°F to 122°F, up to 98 percent relative humidity, and it is drop tested to 1.5 meters.

## 5.4 Polimaster Inc. PM1704A-M

The PM1704A-M uses CsI and GM detectors with gamma sensitivity of no less than 1 cps/µrem/h. It differs from the PM1704A described above by having an additional gamma detector and an extended dose rate range up to 1,300 R/h. It has been available since 2015 and combines radiation detector, radioisotope identifier, and dosimeter capabilities.

**PM1704A-M**
*Image courtesy of Polimaster Inc.*

It measures 5.1 x 2.3 x 1.9 inches and is equipped with a removable belt clip or web loop holster. It can be powered by a rechargeable or alkaline AA battery with a battery life of 300 hours. Visual and audible indicators signal a low battery condition. The display screen is a transflective LCD with backlight. The device has a self-check, and calibration lasts 6 months under routine use or in storage. The device can store up to 1,000 gamma spectra and up to 15,000 events in nonvolatile memory. Communication is via cable and Bluetooth, and data can be exchanged in real time with a user's mobile device. The instrument has an operating range of -4°F to 122°F, up to 98 percent relative humidity, and it is drop tested to 1.5 meters.

The PM1704A-M has the capability to detect and localize radiation sources, as well as identify radionuclides and measure dose rate and personal exposure. It displays the radionuclides identified on its LCD screen. Data can also be exchanged in real-time with a user's mobile phone or device via Bluetooth. A built-in GPS capability allows for geocached data logging.

## 5.5 Polimaster Inc. PM1704

The PM1704 is a basic model of the PM1704 product line containing a single, spectroscopic CsI detector with a 13 mR/h maximum exposure rate range (versus 1,300 R/h for the PM1704M described below). It has a gamma sensitivity of 1 cps/µrem/h. The PM1704 functions as a radiation detector and also provides spectroscopic identification of the radionuclide detected.

**PM1704**
*Image courtesy of Polimaster Inc.*

It measures 5.2 x 2.3 x 1.9 inches and is equipped with a removable belt clip or web loop holster. It is powered by one AA alkaline battery with a battery life of 300 hours. Visual and audible indicators signal a low battery condition. The display screen is a color LCD with backlight. The device has a self-check, and calibration lasts 6 months under routine use. It can store up to 100

gamma spectra and up to 50,000 events in nonvolatile memory, with a limit of 1,600 events per day. Communication with a computer is via USB cable. The instrument has an operating range of -4°F to 122°F, up to 98 percent relative humidity, and it is drop tested to 1.5 meters.

The PM1704 uses algorithms for detection and primary radionuclide identification of the radioactive sources. Identified radionuclides are shown on the display along with their related class: i.e., NORM, medical isotopes, and industrial sources of radiation (special nuclear materials optionally available). The device has a built-in dictaphone to record comments for the measured spectra.

## 5.6 Polimaster Inc. PM1704M

The PM1704M uses a CsI and an energy-compensated GM detector, with a gamma sensitivity of 1 cps/µrem/h. The PM1704M also provides spectroscopic identification of the radionuclide detected. It differs from the PM1704 (described above) by containing an additional detector, allowing an extended maximum exposure rate range of 1,300 R/h.

**PM1704M**
*Image courtesy of Polimaster Inc.*

The PM1704M has been available since 2014. It measures 5.2 x 2.3 x 1.9 inches and is equipped with a removable belt clip or web loop holster. It is powered by one AA alkaline battery with a battery life of 300 hours. Visual and audible indicators signal a low battery condition. The display screen is a color LCD with backlight. The device has a self-check, and calibration lasts 6 months under routine use. It can store up to 100 gamma spectra and up to 50,000 events in nonvolatile memory, with a limit of 1,600 events per day. Communication with a computer is via USB cable. The instrument has an operating range of -4°F to 122°F, up to 98 percent relative humidity, and it is drop tested to 1.5 meters.

The PM1704M uses algorithms for detection and primary radionuclide identification of the radioactive sources. Identified radionuclides are shown on the display along with their related class: i.e., NORM, medical isotopes, and industrial sources of radiation (special nuclear materials optionally available). The device has a built-in dictaphone to record comments for the measured spectra.

## 5.7 Radcomm MSpec

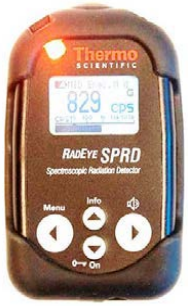
The MSpec has a CsI scintillator (0.5 x 1.5 inches) with a gamma sensitivity of 1,300 cps/mR/h. Its dimensions are 4.8 x 2.5 x 1.2 inches. It has two operation modes: automatic or manual. In automatic mode, the MSpec searches for and detects radioactive material, then identifies the isotope. In manual mode, a user can increase the scan time for increased accuracy. The MSpec has an LCD display with a push-button backlight. The display has a menu-driven user interface controlled by five push-buttons. The display shows a real-time spectrum and/or the following messages: move closer, move away, CPS exceeds threshold, Stabilization Off, No ID, Stabilization required, Memory is Full, or Scanning. The device can measure accumulated dose to 1,000 R (10 Sv) and has a radiation warning level at 1.14 mR/h (10 µSv/h).


**MSpec**
*Image courtesy of LAURUS Systems*

The MSpec is powered by an internal, rechargeable lithium-ion battery that uses a mini USB connector for charging, and has a 4.5-hour recharge time. With the backlight continuously on, the battery life is 6 hours. A low-battery condition is indicated by a visual warning message and flashing indicator; at 10-percent battery capacity, an audio beep sounds at one minute intervals. The system will turn off at 5-percent battery capacity. The MSpec can store 300 spectra. A USB connection to PC is used for spectra download and instrument configuration. It uses RadComm's exclusive RadView software on a PC to display the recorded scans in histogram format. The device operates within a 14°F to 113°F temperature range, and it passes a 1-meter drop test.

## 5.8 Thermo Scientific RadEye™ SPRD

The RadEye SPRD contains a CsI scintillator (0.5 inch diameter x 1.2 inches long) with gamma sensitivity of 1,000 cps/mR/h. It has a resolution of 7.5 percent FWHM at 662 keV. It provides detection and radionuclide identification and uses a patented NBR technology designed to eliminate nuisance alarms from naturally occurring radiation sources.




**RadEye SPRD**
*Image courtesy of Thermo Scientific*

The RadEye SPRD is 3.8 x 2.4 x 1.2 inches in size including its rubber shock-protecting case. It has an LCD display and four raised push-buttons on the front of the device. It is powered by two AAA batteries with 180 hours of battery life (145 hours with Bluetooth transmissions). Battery condition is indicated by a graphic on the display screen. No special tools are required to access the battery compartment. The device has a self-check feature and passes a 1.5-meter drop test. Data communication is via USB to IRDA. An optional, external cover that allows wireless Bluetooth connection to a computer is also available.

When an alarm on the device indicates the presence of radiation, the RadEye SPRD can be put into nuclide identification mode to analyze the radionuclide and classify it as a threat, industrial, NORM, or medical source.

# 6. VENDOR CONTACT INFORMATION

Additional information on the devices included in this market survey report can be obtained from the vendors listed in Table 6-1. Products may be available from multiple vendors.

Table 6-1 Vendor Contact Information

| Manufacturer/Vendor | Address/Phone Number | Website/E-Mail Address |
|---|---|---|
| D-Tect Systems | 11814 Election Road, Ste 200<br>Draper, UT 84020<br>(801) 260-4000 | www.dtectsystems.com<br>info@dtectsystems.com |
| FLIR Detection | 1024 S. Innovation Way<br>Stillwater, OK 74074<br>(877) 692-2120 | www.flir.com<br>detection@flir.com |
| LAURUS Systems | 3460 Ellicott Center Drive, Ste 101<br>Ellicott City, MD 21043<br>(410) 465-5558 | www.laurussystems.com<br>information@laurussystems.com |
| Passport Systems | 70 Treble Cove Road, 1st Floor<br>Billerica, MA 01862<br>(978) 263-9900 | www.passportsystems.com<br>smartshield@passportsystems.com |
| Polimaster Inc. | 44873 Falcon Place, Ste 128<br>Sterling, VA 20166<br>(866) 560-7654 | www.polimaster.com<br>info@polimaster.us |
| Radcomm | 602 East Lincolnway Avenue<br>Valparaiso, IN 46383<br>(800) 588-5229 ext.251 | www.radcommsystems.com<br>jhunter@radcommsystems.com |
| RAE Systems | 3775 North First Street<br>San Jose, CA 95134<br>(877) 723-2878 | www.raesystems.com |
| Sensor Technology Engineering | 70 S. Kellogg Avenue<br>Goleta, CA 93117<br>(805) 964-9507 | www.radiationpager.com<br>sb_sensor_tech@email.msn.com |
| Thermo Scientific* | 300 Industry Drive<br>Pittsburg, PA 15275<br>(800) 556-2323 | www.thermoscientific.com<br>customer.service.rmsi@thermofisher.com |
| X-Z Lab Inc. | 2440 Camino Ramon, Ste. 264<br>San Ramon, CA 94583<br>(925) 359-6908 | www.x-zlab.com<br>contact@x-zlab.com |

*Fisher Scientific holds the U.S. General Services Administration (GSA) schedule.

# 7. SUMMARY

This market survey identified 15 commercially-available Personal Radiation Detectors by 8 manufacturers. Prices range from about $900 to $8,000. Of the PRDs identified:

- All have audible, visual, and vibrate alarms to alert the user of an exceeded threshold.
- Seven are capable of sending PRD data to central command with situational awareness software.
- Four of the PRDs are capable of transmitting data wirelessly via Bluetooth for further spectral analysis on an external device such as a smartphone or tablet.
- Twelve display the exposure or dose rate; six of these optionally also display counts per second and/or a unit-less integer. Three products display only a unit-less integer.
- One PRD offers built-in GPS.
- One PRD is intrinsically safe for use in explosive environments.
- Ten are water resistant (not harmed by low pressure water jets) and two are immersible (not harmed by temporary immersion in water to a depth of 1 meter).
- Products' weight range from about 6 ounces to 9.5 ounces.
- Seven PRDs have maximum ranges ≥100 mR/h.
- Six are capable of measuring the wearer's accumulated dose.

Eight SPRDs were identified in this market survey ranging in price from about $2,300 to $9,400. Of the SPRDs identified in this report:

- All have audible, visual, and vibrate alarms to alert the user of an exceeded threshold.
- Four have Bluetooth capability for wirelessly sending data to a central command with situational awareness software.
- All display the exposure or dose rate; six of these optionally also display counts per second.
- Three SPRDs offer built-in GPS.
- Five are water resistant and one is immersible.
- Products' weight range from about 5 ounces to 14 ounces.
- Four SPRDs have maximum ranges ≥100 mR/h.
- Two are capable of measuring the wearer's accumulated dose.

Emergency responder agencies that consider purchasing PRDs or SPRDs should carefully research each product's overall capabilities and limitations in relation to their agency's operational needs.