Handheld Radionuclide Identification Devices

Assessment Report

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Homeland Security

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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 Federal, state and local responders.

The SAVER Program is managed 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. NUSTL developed this report to provide emergency responders with information obtained from an operationally oriented assessment of handheld radionuclide identification devices, which fall under AEL reference number 07RD-02-RIID titled Identifier, Isotope, Radionuclide.

For more information on NUSTL’s SAVER Program or to view additional reports on handheld radionuclide identification devices or other technologies, visit www.dhs.gov/science-and-technology/SAVER.

U.S. Department of Homeland Security

SAVER

System Assessment and Validation for Emergency Responders

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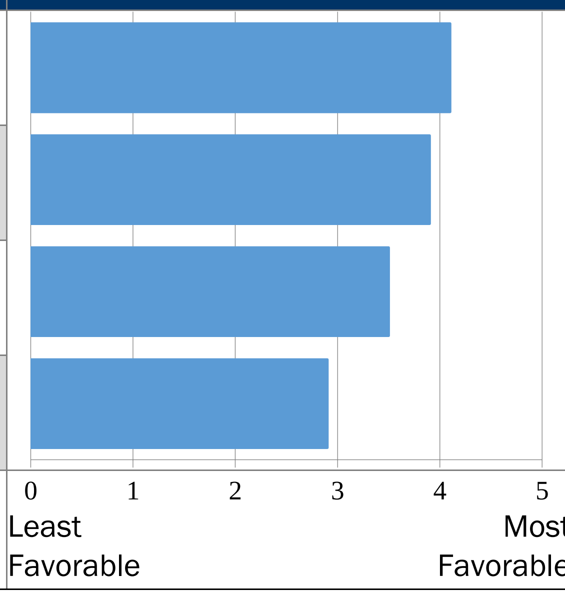
EXECUTIVE SUMMARY

In June 2017, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of handheld radionuclide identification devices (RIDs). Four RIDs were assessed by emergency responders at Brookhaven National Laboratory in Upton, New York. The criteria and scenarios used in this assessment were developed with the input from a focus group of emergency responders with experience using RIDs. The assessment addressed 29 evaluation criteria in five SAVER categories: Affordability, Capability, Deployability, Maintainability and Usability. The overall results of the assessment are highlighted in the table below.

Product	Overall Score	Overall	Affordability	Capability	Deployability	Maintainability	Usability
FLIR IdentiFinder R400-NGH		**4.1**	4.0	4.2	4.2	3.9	4.3
ThermoFisher Scientific RIIDEye X-GN		**3.9**	4.0	3.9	3.8	4.1	3.8
Smiths Detection RadSeeker CS		**3.5**	3.2	3.6	4.2	2.5	3.7
Mirion Technologies SPiR-ID NaI-LT		**2.9**	2.7	3.8	3.0	1.6	3.1



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1.0 INTRODUCTION

Handheld radionuclide identification devices (RIDs) are the primary tools that police, hazardous materials specialists and other first responder personnel use to identify the radionuclides present in radioactive material that has been previously detected with personal radiation detectors, radiation portal monitors or other radiation detection instruments. By determining the radioactive isotopes present in radioactive material, first responders are able to assess the level of threat it poses and take appropriate actions.

On June 6 and 7, 2017, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of four handheld RIDs. The purpose of this assessment was to obtain information on RIDs that would be useful to first responder agencies making operational and procurement decisions. This assessment was planned based on recommendations made by first responders experienced in using RIDs who participated in a SAVER focus group held in March 2016 at the National Urban Security Technology Laboratory (NUSTL).

1.1 Evaluator Information

Eight emergency responders from various jurisdictions who have substantial experience using RIDs (see Table 1-1) were selected to be evaluators for this assessment. Prior to the assessment, the evaluators signed a nondisclosure agreement, conflict of interest statement, photo release form and an informed consent form.

Table 1-1 Evaluator Information

Evaluator	Work Experience (Years)	State
Radiation Protection and Response	27	FL
Firefighter/HAZMAT Chief	15	NY
Police/Counterterrorism Instructor (Retired)	17	NY
Police/Counterterrorism Trainer (Retired)	17	NY
Firefighter/HAZMAT	17	NY
Police	15	NY
Police Supervisor	14	NJ
Police/Counterterrorism Trainer	14	NY

1.2 Assessment Products

The four RID models selected for this assessment are listed in Table 1-2. The following recommendations provided by the RIDs focus group were considered in selecting among the available RID models:

- Assess only RIDs that include a neutron detector
- Assess only RIDs whose libraries meet relevant national standards

- Assess only RIDs that can save data in a format compliant with ANSI N42 standards
- Assess only RIDs that report dose/exposure rates in the U.S. customary units (non-SI units)
- Assess only RIDs having an over-range alarm capability (i.e., they indicate when the dose rate exceeds the upper measurable limit of the instrument)
- Do not assess RIDs based on high purity germanium (HPGe) gamma-ray detectors
- Try to include RIDs based upon different (other than HPGe) gamma-ray detector materials

All four RID models conform to all but the last of these recommendations. While each of these RID models is available in variants containing either a thallium-doped sodium iodide (NaI(Tl)) or lanthanum bromide (LaBr) gamma-ray detector, only RID model variants containing a NaI(Tl) gamma-ray detector were obtained for this assessment. RIDs based on different gamma ray detector materials will acquire gamma ray spectra with different energy resolutions, and might for this reason differ in their radionuclide identification capabilities. Selecting RIDs configured with the same detector material eliminated this potential source of variability among assessed instruments.

Three of these instruments, the Mirion Technologies SPiR-ID NaI-LT, the Smiths Detection RadSeeker CS and the ThermoFisher Scientific RIIDEye X-GN, were previously tested by the Domestic Nuclear Detection Office (DNDO) Human Portable Radiation Detection System Program against DNDO technical standards for RIDs. This report provides complementary assessment data on these three RID models from the standpoint of first responder operational use considerations.

Table 1-2 Assessed Products

Vendor	Product	Product Image
FLIR Systems	IdentiFinder R400-NGH	
Mirion Technologies	SPiR-ID NaI-LT	
Smiths Detection	RadSeeker CS	
Thermo Fisher Scientific	RIIDEye X-GN	

2.0 EVALUATION CRITERIA

The SAVER Program assesses products based on criteria in five established categories:

- **Affordability** groups criteria related to the total cost of ownership over the life of the product. This includes purchase price, training costs, warranty costs, recurring costs and maintenance costs.
- **Capability** groups criteria related to product features or functions needed to perform one or more responder relevant tasks.
- **Deployability** groups criteria related to preparing to use the product, including transport, setup, training and operational/deployment restrictions.
- **Maintainability** groups criteria related to the routine maintenance and minor repairs performed by responders, as well as included warranty terms, duration and coverage.
- **Usability** groups criteria related to ergonomics and the relative ease of use when performing one or more responder relevant tasks.

The RIDs focus group identified 45 evaluation criteria on which RIDs might be assessed and assigned each evaluation criterion to one of the five SAVER assessment categories. They assigned a weight for each evaluation criterion's level of importance using a numerical weighting scale ranging from 1 to 5, with a '1' indicating an evaluation criterion of minor importance and a '5' indicating an evaluation criterion of utmost importance. The focus group also indicated the relative importance of the five SAVER assessment categories using a percentage scale that totaled to 100 percent. These weightings were factored into the calculation of numerical assessment scores using the formulas in Appendix A. Table 2-1 lists the evaluation criteria identified by the RIDs focus group, the assessment categories they were assigned to and the weightings assigned to the evaluation criteria and assessment categories. Evaluation criteria definitions can be found in Appendix B of this report.

The RID models selected for assessment were evaluated against 30 of the 45 evaluation criteria identified by the RIDs focus group. Two evaluation criteria—*Cost of Calibration and Repair* and *In-House Optimization Capability*—were combined into a single evaluation criterion that was designated *Third-Party Maintenance* and placed in the Affordability assessment category. Fourteen evaluation criteria were not assessed. Nine of these evaluation criteria—*Isotope Library, Dose Rate Accuracy, Energy Resolution, Over-Range Indication, N42-Compliant Data, Administrator Controls, Intrinsic Safety, Ease of Calibration and User-Defined Thresholds*—were eliminated because all four assessed RIDs models were effectively identical with regard to these features based on manufacturer-provided specifications. Four evaluation criteria—*Mean Time between Failure, Training Options, Ruggedness* and *Calibration/Optimization Contract*—were eliminated because insufficient information was available to compare the RIDs. One evaluation criterion—*Susceptibility to Radio Frequency Interference*—was eliminated because it was considered impractical to properly evaluate this feature during the assessment.

Table 2-1 Evaluation Criteria

SAVER CATEGORIES				
Affordability	**Capability**	**Deployability**	**Maintainability**	**Usability**
Overall Weight 25%	Overall Weight 20%	Overall Weight 20%	Overall Weight 15%	Overall Weight 20%
Evaluation Criteria				
Initial Cost*	**High Energy Gamma#**	**Weight**	**COTS Batteries***	**Ease of Data Transfer (Software)**
Weight: 5	Weight: 5	Weight: 4	Weight: 3	Weight: 5
GSA Schedule*	**Isotope Identification**	**Size**	**Trade-In Options***	**Intuitive Menus and Screens**
Weight: 4	Weight: 5	Weight: 4	Weight: 2	Weight: 4
Software Updates*	**Data Transfer (Hardware)#**	**One-Handed Operation**	**Decontaminability**	**User-Friendly Controls**
Weight: 3	Weight: 5	Weight: 4	Weight: 2	Weight: 4
Third Party Maintenance*	**Non-Volatile Memory**	**Water/Dust Resistance***	**Ease of Battery Change-Out**	**Screen Visibility (Bright/Dark)**
Weight: 3	Weight: 3	Weight: 4	Weight: 1	Weight: 4
	Neutron Sensitivity*	**Form Factor**		**Display Screen Size, Resolution and Legibility**
	Weight: 3	Weight: 4		Weight: 4
	High Dose Rate Measurements*	**Battery Life***		**Visible, Audible and Vibration Alarms**
	Weight: 1	Weight: 4		Weight: 3
		Temperature Range*		**Computer Configurability***
		Weight: 4		Weight: 2
				Operation with Gloves
				Weight: 1
Criteria marked with an asterisk (*) were assessed by specification; criteria marked with a pound sign (#) were assessed both operationally and by specification; all other criteria were assessed operationally				

3.0 ASSESSMENT METHODOLOGY

The handheld RIDs assessment took place on June 6 and 7, 2017, at Brookhaven National Laboratory (BNL) in Upton, New York. The assessment began with a safety briefing, which was followed by an overview of the assessment plan. The eight evaluators were then paired off into four two-person teams. Through a series of rotations, each team sequentially assessed all four RIDs over the 2 days of the assessment. Each RID was assessed in a three-part process consisting of a familiarization session, a hands-on operational assessment and an evaluator debrief session, as described below. All assessment activities took place under the guidance of NUSTL personnel.

3.1 Familiarization Session

In this session, a representative from each RIDs manufacturer provided the evaluators with an overview of the RIDs' features and capabilities and trained them on how to operate the device. The evaluators gained experience acquiring gamma ray spectra, reading spectrum analysis results produced by the instrument and changing instrument settings such as display screen brightness, gamma dose rate alarm levels and spectrum acquisition times. They also replaced the batteries and verified that its memory was nonvolatile (i.e., acquired spectra were not lost when the batteries were replaced). Camping lantern mantles—a consumer product containing a small amount of the naturally occurring radionuclide thorium-232—were used as radiation sources.

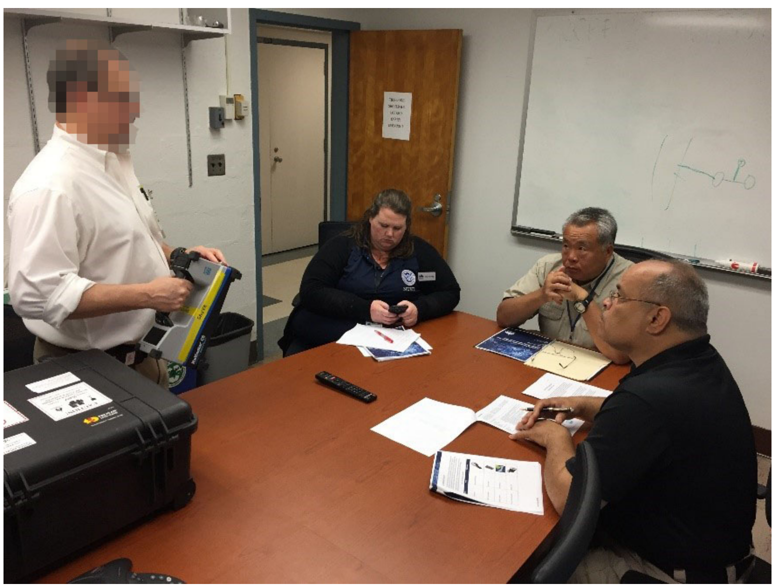


Figure 3-1 RadSeeker CS Familiarization Session

3.2 Hands-on Operational Assessment Session

This session took place in a suite of rooms within a BNL laboratory building. Four laboratory stations were configured for spectrum acquisition as described below; spectra were acquired in these laboratory rooms or in hallways adjacent to them. A nearby conference room was used as a spectrum export station. A NUSTL staff member guided each evaluator team through the tasks it was to perform at each station. A representative from each RID manufacturer was available to provide technical support to the evaluators regarding instrument operation when needed.

3.2.1 Spectrum Acquisition Stations

The radioactive sources deployed at the spectrum acquisition stations represented several different radioactive source configurations that first responders might encounter during field operations. RIDs focus group recommendations were taken into account in configuring these stations.

Figure 3-2 Evaluators at a Spectrum Acquisition Station

- Station 1: This station was configured with a radioactive source containing depleted uranium that could alternately be moved into and out of a container that partially shielded the gamma radiation it emitted. Evaluators acquired gamma ray spectra from this source and attempted to identify it both when partially shielded and unshielded. This source configuration conformed with a RIDs focus group recommendation that evaluators attempt to identify a partially shielded gamma radiation source.
- Station 2: This station was configured with a radioactive source containing barium-133, a man-made radionuclide, placed within a pile of fertilizer bags containing a high concentration of the naturally occurring radionuclide potassium-40 (K-40). This source configuration conformed with a RIDs focus group recommendation that evaluators attempt to identify radioactive material containing more than one radionuclide.
- Station 3: This station was configured with two radioactive sources containing small quantities of special nuclear material (SNM) radionuclides. SNM radionuclides are those which, when amassed in sufficient quantity, form the primary component of a nuclear weapon. One of the radioactive sources at this station contained enriched uranium (i.e., uranium enriched in the isotope U-235) while the other radioactive source contained two plutonium isotopes: Pu-239 and Pu-240. These two sources were positioned at sufficient distance from one other that gamma ray spectra acquired with a RID in proximity to one source were not influenced by the gamma radiation emitted by the other source. The primary reason that law enforcement organizations throughout the nation have been equipped with RIDs is to enhance their ability to determine whether radioactive materials they encounter contain SNM. This station's source configuration was therefore relevant to the use of RIDs by law enforcement personnel for the critical mission of preventing acts of nuclear terrorism.
- Station 4: This station was configured with a Troxler gauge, a commercial engineering device that produces neutron and gamma radiation. A Troxler gauge produces neutron radiation when an internal alpha radiation source and a beryllium metal target are brought in proximity with one another, while gamma radiation is produced primarily by an internal radioactive source containing cesium-137, a man-made radionuclide. This station provided

evaluators with an opportunity to assess the ability of the RIDs to detect neutron radiation, as recommended by the RIDs focus group. The detection of above-background levels of neutron radiation is a potential indicator of the presence of SNM; therefore, this station provided a further opportunity to assess the utility of RIDs as tools for identifying SNM. The Troxler gauge's Cs-137 source was capable of producing a higher gamma radiation dose rate than any of the other radioactive sources at the other three spectrum acquisition stations, permitting the evaluators to assess the gamma dose rate alarm feature of the RIDs at an operationally relevant 2-millirem-per-hour threshold level.

Operating the RIDs at the four spectrum acquisition stations provided the evaluators with multiple opportunities to assess the suitability of visual, audible and vibrational alarms, screen readability, the layout of control buttons and the ease of navigating through instrument settings accessed via the instrument's display screen. The evaluators acquired spectra in proximity to each radioactive source and observed whether the RIDs correctly identified the radionuclides present at each station. The radioactive sources at some stations were placed in somewhat hard-to-reach locations to allow the evaluators to assess how instrument size, weight and form factor affected their ability to operate each RID. Room lights were turned off so that the readability of the instrument display screen and controls under low lighting levels could be assessed. Cloudy conditions during the assessment generally prevented evaluators from assessing screen visibility in direct sunlight, so at one station a halogen lamp was set up so that the evaluators could assess screen readability under brightly illuminated conditions. Evaluators also assessed the ease of operating each RID using the gloves they would normally wear while on duty.

3.2.2 Spectrum Export Station

Each team visited the spectrum export station after completing activities at one or more of the spectrum acquisition stations. Evaluators exported gamma-ray spectrum files acquired at spectrum acquisition stations from the RIDs to a NUSTL-furnished laptop computer via a data cable or data card. Exported spectrum files were viewed using PeakEasy spectrum analysis software[i] to verify that the spectrum files had been successfully exported. RIDs manufacturer representatives described and demonstrated other methods of exporting spectra from their instruments, for instance wireless data export via a smart phone. These activities conformed with a RIDs focus group recommendation that evaluators assess RID data export capabilities.

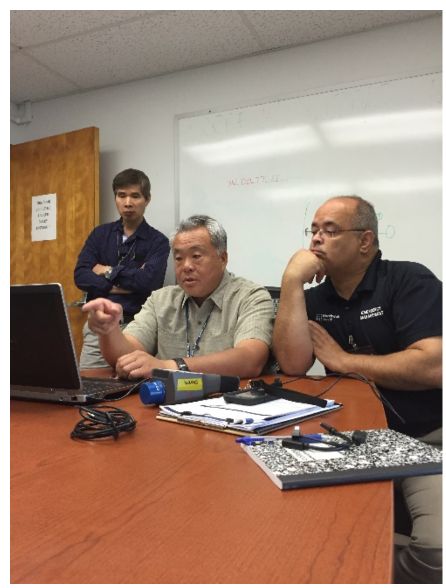


Figure 3-3 Evaluators Exporting Spectrum Files to a Personal Computer

[i] PeakEasy version 4.74. Los Alamos National Laboratory

3.3 Data Gathering and Analysis

Each evaluator was issued a folder containing vendor-provided information, specifications and product score sheets. Evaluators used the following 1 to 5 scale to score the criteria for each product:

1) The product *meets none* of my expectations for this criterion.
2) The product *meets some* of my expectations for this criterion.
3) The product *meets most* of my expectations for this criterion.
4) The product *meets all* of my expectations for this criterion.
5) The product *exceeds* my expectations for this criterion.

Refer to Appendix B for evaluation criteria definitions. The evaluators were encouraged to provide written feedback on each of the evaluation criteria and to provide any other comments they considered relevant regarding the advantages and disadvantages of each RID. Once assessment activities were completed, evaluators had an opportunity to review their criteria ratings and comments for each RID and make adjustments as necessary.

At the conclusion of assessment activities, an overall assessment score, as well as category scores and criteria scores, were calculated for each RID using the scoring formulas referenced in **Error! Reference source not found.**. In addition, evaluator comments for each RID were reviewed and summarized in Section 4 of this report.

4.0 ASSESSMENT RESULTS

Overall scores for the assessed products ranged from 2.9 to 4.1. Table 4-1 provides the overall assessment and category scores for each instrument. Calculation of the overall assessment score uses the raw scores for each category, prior to rounding.

Table 4-1 Overall Ratings

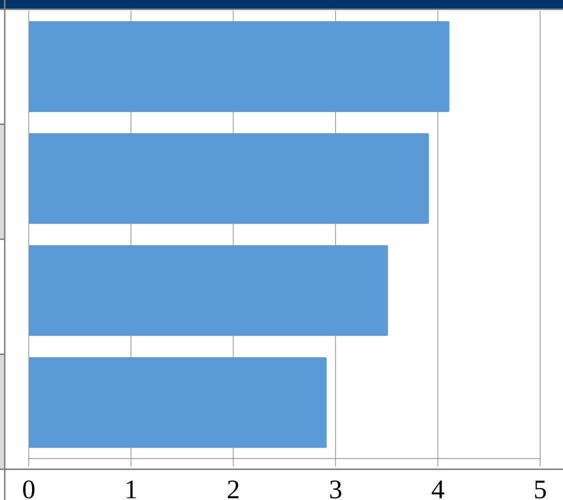
Product	Overall Score	Overall	Affordability	Capability	Deployability	Maintainability	Usability
FLIR IdentiFinder R400-NGH		**4.1**	4.0	4.2	4.2	3.9	4.3
ThermoFisher Scientific RIIDEye X-GN		**3.9**	4.0	3.9	3.8	4.1	3.8
Smiths Detection RadSeeker CS		**3.5**	3.2	3.6	4.2	2.5	3.7
Mirion Technologies SPiR-ID NaI-LT		**2.9**	2.7	3.8	3.0	1.6	3.1
	Least Favorable … Most Favorable						

Table 4-2 graphically represents the individual evaluation criteria ratings for each RID model using colored and shaded circles. A fully shaded green circle represents the highest rating, while an unshaded red circle represents the lowest rating. Refer to Appendix B for evaluation criteria definitions.

Table 4-2 Criteria Ratings

Key: Lowest Rating → Highest Rating: ○ ◔ ◑ ◕ ●

Category	Evaluation Criteria	IdentiFinder R400 NGH	RIIDEye X GN	RadSeeker CS	SPiR ID NaI LT
Affordability	Initial Cost	◕	◕	◑	◔
	GSA Schedule	◕	◕	◕	◑
	Software Updates	●	◕	◑	◑
	Third-Party Maintenance	◕	◑	◑	◑
Capability	High Energy Gamma	◕	◕	◕	◕
	Isotope Identification	◕	◕	◑	◕
	Data Transfer (Hardware)	●	◕	◕	◕
	Nonvolatile Memory	◕	◕	◕	◑
	Neutron Sensitivity	◕	◕	◕	◕
	High Dose Rate Measurements	◕	◑	◑	◕
Deployability	Weight	●	◕	●	◑
	Size	●	◕	◕	◑
	One-Handed Operation	●	◕	◕	◑
	Water/Dust Resistance	◑	◕	◕	◑
	Form Factor	◕	◕	◕	◔
	Battery Life	◕	◕	◕	◑
	Temperature Range	◕	◑	◕	◕
Maintainability	COTS Batteries	◕	◕	◔	○
	Trade-In Options	◑	◕	◔	○
	Decontaminability	◕	◕	◑	◑
	Ease of Battery Change-Out	●	◕	◕	○
Usability	Ease of Data Transfer (Software)	◕	◕	◑	◕
	Intuitive Menus and Screens	◕	◕	◕	◑
	User-Friendly Controls	●	◕	◕	◑
	Screen Visibiity (Bright/Dark)	●	◕	◕	◑
	Display Screen Size, Resolution and Legibility	◕	◕	◕	◑
	Visible, Audible and Vibration Alarms	◕	◕	◕	◕
	Computer Configurability	●	◑	◑	◑
	Operation with Gloves	●	◕	◕	◑

Key vendor-provided specifications for the assessed RIDs are summarized in Table 4-3 below.

Table 4-3 Key Specifications

Specification	FLIR IdentiFinder R400-NGH	ThermoFisher Scientific RIIDEye X-GN	Smiths Detection RadSeeker CS	Mirion Technologies SPiR-ID NaI-LT
Gamma Detector Type, Size	NaI(Tl) 2 × 1.4 inches	NaI(Tl) 2 × 2 inches	NaI(Tl) 2 × 2 inches	NaI(Tl) 2 × 2 inches
Neutron Detector	He-3	Li-6	He-3	Li-6
Dimensions	9.8 × 3.7 × 3.0 inches	11 × 4.7 × 8.6 inches	12 × 4.5 × 7 inches	12.5 × 5.6 × 5.9 inches
Weight	2.6 pounds	5.3 pounds	5.2 pounds	6.4 pounds
Display Screen	2.7-inch LCD	3.5-inch OLED	3.5-inch LCD	3.5-inch LCD
Battery Types	COTS AA Alkaline or NiMH	COTS AA Alkaline or NiMH	Proprietary Li-ion Removable Battery Pack	Proprietary Li-ion Non-Removable Battery
Run Time on Batteries	8 hours	8-12 hours (Alkaline) 8-10 hours (NiMH)	8 hours	12 hours
IP Rating	IP 53	IP 65	IP 65	IP 54
Operating Temperature Range	-4°F to 131°F	0°F to 122°F	-25°F to 122°F	-4°F to 122°F
Price	$17,725	$12,950	$24,500	$26,000
GSA Schedule	Yes	Yes	Yes	No

Abbreviations:

°F = Degrees Fahrenheit
COTS = Commercial, off-the-shelf
GSA = General Services Administration
He-3 = Helium-3 based neutron detector
IP Rating = International Electrotechnical Commission rating for resistance from infiltration from water and solid particles. See Appendix C for details.
Li-6 = Lithium-6 based neutron detector
LCD = Liquid crystal display
Li-ion = Lithium ion
NaI(Tl) = Thalium- doped sodium iodide
OLED = Organic light-emitting diode

The following sections present assessment results, broken out by SAVER assessment category, for each of the four assessed RIDs. Product information that provides context to the evaluator feedback summarized below is also provided.

4.1 FLIR Systems IdentiFinder R400-NGH

The IdentiFinder R400-NGH received an overall assessment score of 4.1. It is equipped with a 2-x-1.4-inch NaI(Tl) gamma detector and a He-3 neutron detector. It has a Geiger-Mueller (G-M) detector capable of measuring gamma dose-equivalent rates of up to 1 rem per hour (rem/h). The user interface consists of three control buttons, a 2.7-inch diagonal color liquid crystal display (LCD) display screen, and two light emitting diode (LED) lights that indicate the intensity of measured gamma- and neutron-radiation. Acquired spectrum files can be transferred to a personal computer via a universal serial bus (USB) cable. Spectrum files can also be transferred to a smart phone via a USB cable or a wireless Bluetooth link.

Figure 4-1 IdentiFinder R400-NGH

4.1.1 Affordability

The R400-NGH received an Affordability score of 4.0. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators indicated that the R400-NGH's features generally met or exceeded their expectations and so they considered it to be a good value at the manufacturer's list price.
- The R400-NGH is listed on the General Services Administration (GSA) price schedule. Evaluators indicated that this is beneficial because many state and local responder organizations seek to purchase equipment at reduced cost through GSA schedule contracts.

4.1.2 Capability

The IdentiFinder R400-NGH received a Capability score of 4.2. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators were generally able to correctly identify the radioactive sources present at each spectrum acquisition station; however, there were some instances of misidentifications. For instance, at spectrum acquisition station 2, analysis results for one acquired spectrum failed to indicate K-40, and at station 3, analysis results for one spectrum reported medical isotopes that were not actually present.
- The IdentiFinder-R400 NGH has an internal G-M detector that provides the capability to measure gamma radiation levels of up to 1 rem/h. Evaluator feedback on this capability was mixed: some evaluators considered it advantageous to be able to measure a high radiation level, while others did not think this was an important capability because they were trained to turn back upon encountering much lower gamma radiation levels.
- Spectrum files can be transferred to a personal computer via a commercial, off-the-shelf (COTS) USB cable or to a smart phone using the same cable connection, or through a

wireless Bluetooth link. The evaluators considered the capability to export spectrum files via smart phone to be an excellent option for transmitting data to a reachback resource when a potential threat was identified while in the field.

4.1.3 Deployability

The R400-NGH received a Deployability score of 4.2. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The R400-NGH's relatively small size and light weight allow it to be comfortably held and operated with one hand.
- The R400-NGH's operating temperature range and ingress protection (IP) rating (see Appendix C) for water and dust resistance met evaluator expectations for field deployability; however, the rubber plug used to seal the micro-USB socket on the instrument's body is not anchored to the instrument's body, and so can be easily lost.
- The operating time on fully charged batteries was considered to be sufficient for field operations. See the Maintainability section below for related evaluator feedback on ease of battery change-out and operability on COTS batteries.

4.1.4 Maintainability

The R400-NGH received a Maintainability score of 3.9. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The R400-NGH operates on COTS AA alkaline or rechargeable nickel metal-hydride batteries that can be quickly replaced without using any tools. The evaluators stated that in their experience it was not unusual to begin a field deployment with an instrument with depleted batteries, therefore the ability to replace depleted batteries with batteries that can be readily obtained locally is a positive feature.
- The evaluators judged that most external surfaces of the R400-NGH can be easily decontaminated; however, the narrow slot on the instrument body where the micro-USB port is situated was considered to be an area that might be problematic to decontaminate.
- FLIR Systems does not offer a trade-in option (i.e., a discount on the price of new instruments in exchange for the return of older instruments). Evaluators had mixed opinions about this; some considered the availability of a trade-in option to be a positive feature that would enable their organizations to better afford the cost of acquiring new equipment, while others stated that the availability of a trade-in option would not be a factor in their organizations' equipment acquisition decisions.

4.1.5 Usability

The R400-NGH received a Usability score of 4.3. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators found the R400-NGH's operating software intuitive to use. The layout of control buttons on the instrument body is well-suited for one-handed operation and corresponds in a clear way with the menu options presented on the display screen. Buttons were easily activated even when wearing firefighting gloves.

- The display screen can be clearly read in all lighting conditions. Evaluators noted that the display screen is smaller than those of other RIDs with which they were familiar, but data is generally displayed in font sizes that are easily read. One evaluator, however, suggested that spectrum file numbers should be displayed in a larger font size to make them easier to read.
- Visible, audible and vibration alarms are adequate to alert users when measured gamma or neutron radiation levels exceed alarm thresholds.
- The IdentiFinder R400-NGH's operating software provides two ways of exporting spectrum files to a personal computer. In mass storage mode, the R400-NGH functions like an attached thumb drive, allowing spectrum files to be transferred by a simple drag and drop. The R400-NGH can also act as a web server with a file transfer interface that is accessed using the recipient computer's internet browser. Evaluators found both file transfer procedures to be easy to carry out.

4.2 ThermoFisher Scientific RIIDEye X-GN

Figure 4-2 RIIDEye X-GN

The RIIDEye X-GN received an overall assessment score of 3.9. It is equipped with a 2-×-2-inch-NaI(Tl) gamma ray detector for acquiring gamma-ray spectra, and a lithium-6 (Li-6) neutron detector. It does not contain a G-M detector or other device for measuring high gamma radiation levels; however, it can measure gamma radiation exposure rates of up to 30 millirem/hour (mrem/h) using its NaI(Tl) detector.

The user interface consists of a seven-key touch pad and an organic light-emitting diode (OLED) 3.5-inch diagonal color display screen. Acquired spectrum files can be exported to a personal computer via a proprietary data cable or a removable Compact Flash (CF) card. Spectrum files can also be exported via a cable connection to a satellite phone; this data transfer method was not assessed in hands-on fashion because satellite phones were not available during the assessment.

The following sections summarize the assessment results for the five SAVER categories.

4.2.1 Affordability

The RIIDEye X-GN received an Affordability score of 4.0. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators indicated that the RIIDEye X-GN's features generally met or exceeded their expectations, and so they considered it to be a good value at its relatively low manufacturer's list price.
- The RIIDEye X-GN is listed on the GSA price schedule. Evaluators indicated that this is beneficial because many state and local responder organizations seek to purchase equipment at reduced cost through GSA schedule contracts.

4.2.2 Capability

The RIIDEye X-GN received a Capability score of 3.9. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators were generally able to correctly identify the radioactive sources present at each spectrum acquisition station; however, there were some instances of misidentifications. Analysis results for one spectrum acquired from the shielded depleted uranium source at spectrum acquisition station 1 failed to report any isotope. Analysis of a spectrum acquired from the plutonium source at spectrum acquisition station 3 correctly identified plutonium, but also reported medical isotopes that were not present at this station.
- Spectrum files can be transferred to a computer using the removable CF card that serves as the storage device for all measurement data acquired with the RIIDEye X-GN. An external USB card reader is supplied with the RIIDEye X-GN for use with computers lacking a CF card reader slot. The RIIDEye X-GN operator's manual cautions against using CF cards from other RIIDEye X-GN instruments because the CF cards are optimized for the specific instrument they are shipped with. Spectrum files can also be transferred to a personal computer using a proprietary data transfer cable available from ThermoFisher. While data transfer using the CF card worked well, evaluators expressed concern that the CF card was instrument-specific and so cannot be quickly replaced with a COTS CF card; this concern was also raised about the data transfer cable, which is non-COTS item. Evaluators noted that the RIIDEye X-GN lacked the ability to export spectrum files via smart phone and recommended that future versions of the RIIDEye X-GN be designed to provide this capability.
- The RIIDEye X-GN can measure gamma radiation levels of up to 30 mrem/h using its NaI(Tl) scintillation detector. Some evaluators felt that this was a sufficient upper limit for their needs, while others stated that a capability to measure higher gamma radiation levels was desirable.

4.2.3 Deployability

The RIIDEye X-GN received a Deployability score of 3.8. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators perceived the RIIDEye X-GN to be relatively large compared to other RIDs with which they were familiar; however, it had a well-balanced weight distribution and a good handle design, and so they found it suitable for one-handed operation.
- The RIIDEye X-GN's IP rating and operating temperature range met evaluator expectations for field deployability; however, the plugs used to seal the power and headphone ports to attain this IP rating were not easy to properly seat.
- The operating time on fully charged batteries met evaluator expectations. See the Maintainability section below for related evaluator feedback on ease of battery change-out and operability on COTS batteries.

4.2.4 Maintainability

The RIIDEye X-GN received a Maintainability score of 4.1. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The RIIDEye X-GN operates on COTS AA alkaline or rechargeable nickel metal-hydride batteries that can be quickly changed out without using any tools. The evaluators stated that in their experience it was not unusual to begin a field deployment with an instrument with depleted batteries; therefore, the ability to quickly replace depleted batteries with batteries that can be readily obtained locally is a positive feature.
- In the evaluators' judgement, the RIIDEye X-GN's external surfaces can be easily decontaminated. The ability to remove the corner bumpers without using tools was considered to be a good feature from the standpoint of instrument decontamination.
- ThermoFisher Scientific indicated that it offered trade-in options that would reduce the purchase price of new instruments. As discussed for the FLIR Systems IdentiFinder R400-NGH, the evaluators had mixed opinions about the merits of such trade-in options.

4.2.5 Usability

The RIIDEye X-GN received a Usability score of 3.8. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators found the RIIDEye X-GN's operating software intuitive to use. The touchpad keys were well situated for one-handed operation and could be easily activated, even when wearing firefighter gloves.
- Display screen visibility was good in all lighting conditions. Several evaluators commented, however, that the font size of some displayed information was too small to easily read.
- Visible, audible and vibration alarms are adequate to alert the user that gamma or neutron radiation levels exceed alarm thresholds; however, some evaluators suggested that the visual display of neutron and gamma alarms be made more distinct from one another.
- Spectrum files can be transferred from the RIIDEye X-GN to a personal computer using a CF card or a proprietary data transfer cable. File transfer using the CF card was simple and intuitive to perform, no different than transferring any kind of data files between devices using a thumb drive. No software needs to be installed on the personal computer to transfer spectrum files via the data cable; instead, the file transfer process is effectuated using menu options in the RIIDEye X-GN's operating software. A problem was noted in that spectrum files transferred to the personal computer lost their original date and time stamp information, making it unclear which particular spectrum acquisition event the spectrum files corresponded to.

4.3 Smiths Detection RadSeeker CS

The RadSeeker CS received an overall assessment score of 3.5. It is equipped with a 2-×-2-inch NaI(Tl) detector and a He-3 neutron detector. The RadSeeker CS does not have a G-M detector or other device for measuring high gamma levels; however, gamma dose-equivalent rates of up to 12 mrem/h can be measured using the NaI(Tl) detector used to acquire gamma-ray spectra.

Figure 4-3 RadSeeker CS

The RadSeeker CS's user interface consists of three control buttons mounted on the instrument's handle and a 3.5-inch diagonal LCD color display screen. Data can be exported to a personal computer via a USB cable or to a USB thumb drive. Spectrum files can also be exported via cable to a satellite phone; this data transfer method was not assessed in hands-on fashion because satellite phones were not available during the assessment.

The following sections summarize the assessment results for each SAVER category.

4.3.1 Affordability

The RadSeeker CS received an Affordability ability score of 3.2. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators indicated that the RadSeeker CS's features generally met their expectations, but at a relatively high manufacturer's list price compared to the other assessed RIDs.
- The RadSeeker CS is listed on the GSA price schedule. Evaluators indicated that this is beneficial because many state and local responder organizations seek to purchase equipment at reduced cost through GSA schedule contracts.

4.3.2 Capability

The RadSeeker CS received a Capability score of 3.6. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators were generally able to correctly identify the radioactive sources present at each spectrum acquisition station; however, there were some instances of misidentifications. For instance, analysis results for one spectrum acquired from the enriched uranium source at spectrum acquisition station 3 correctly identified U-235 but also reported a medical isotope that was not present. At spectrum acquisition station 4, analysis results for one acquired spectrum indicated Pu-239, which was not present. The RadSeeker CS did not display confidence levels for isotopes indicated by spectrum analysis results, which several evaluators considered to be a deficiency.
- Spectrum files can be transferred from the RadSeeker CS to a USB thumb drive from which they can be transferred to any personal computer. Spectrum files can also be directly exported to a personal computer connected to the RadSeeker CS via a COTS USB cable. Evaluators noted that the RadSeeker CS lacked the ability to export data to a smart phone, which they considered to be an excellent way of transmitting collected spectrum data when operating in the field.

- The RadSeeker CS can measure gamma radiation levels of up to 12 mrem/h using its internal NaI(Tl) scintillation detector. Some evaluators felt that this was a sufficient upper limit for their needs, while others indicated a capability to measure higher gamma radiation levels was preferable.

4.3.3 Deployability

The RadSeeker CS received a Deployability score of 4.2. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators commented favorably on the balanced weight distribution of the RadSeeker CS, with several indicating that it was the easiest of the four assessed RIDs to carry and operate with one hand.
- The RadSeeker CS's IP rating and operating temperature range exceeded evaluator expectations for field deployability.
- The operating time on fully charged batteries is sufficient for field operations. See the Maintainability section below for related evaluator feedback on ease of battery change-out and operability on COTS batteries.

4.3.4 Maintainability

The RadSeeker CS received a Maintainability score of 2.5. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The RadSeeker CS operates on a proprietary rechargeable battery pack that can be quickly swapped out without the use of tools. While a spare battery pack is provided with newly-purchased instruments, the evaluators stated that in their experience it was not unusual to begin a field deployment with an instrument with depleted batteries, and so they considered the inability to operate the RadSeeker CS on a readily obtainable COTS battery type to potentially limit its field maintainability.
- In the evaluators' judgment, the RadSeeker CS's external surfaces can be easily decontaminated; however, the need to use a screwdriver to remove the bumpers at the bottom corners of the instrument was considered a drawback.
- Smiths Detection does not offer a trade-in option (i.e., a discount on the price of new instruments in exchange for the return of older instruments). As discussed for the FLIR Systems IdentiFinder R400-NGH, the evaluators expressed mixed opinions about this.

4.3.5 Usability

The RadSeeker CS received a Usability score of 3.7. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators found the RadSeeker CS's operating software intuitive to use. The layout of control buttons is well-suited for one-handed operation and corresponds in a clear way with menu options presented on the display screen. Most evaluators found the control buttons to be easily activated while wearing duty gloves; however, one evaluator reported some difficulty activating the control buttons while wearing firefighter gloves.

- The display screen can be clearly read in all lighting conditions; however, some information was displayed in a small font size that was difficult to read.
- Visible and audible alarms were adequate to alert users when measured gamma or neutron radiation levels exceed alarm thresholds. Some evaluators indicated that the vibration alarm was not sufficiently noticeable.
- Spectrum files can be transferred from the RadSeeker CS to a USB thumb drive, from which they can be transferred to any personal computer. Spectrum file transfer to the USB thumb drive is carried out using a menu option in the RadSeeker CS's operating software; evaluators found this process to be easy to accomplish. Spectrum files can also be directly transferred to a personal computer that is connected to the RadSeeker CS via a COTS USB cable. Proprietary Smiths Detection file transfer software must be installed on the personal computer to transfer spectrum files in this way. Evaluators found this software easy to use, but several of them indicated that they preferred to use file transfer methods that did not require the use of any proprietary software.

4.4 Mirion Technologies SPiR-ID NaI-LT

The SPiR-ID NaI-LT received an overall assessment score of 2.9. It is equipped with a 2-×-2-inch NaI(Tl) gamma-radiation detector and a Li-6 neutron detector. It is equipped with a G-M detector capable of measuring gamma dose-equivalent rates of up to 1 rem/h.

Figure 4-4 SPiR-ID NaI-LT

The SPiR-ID NaI-LT's user interface consists of four control buttons, a 3.5-inch diagonal color LCD display screen, and six LED lights indicating instrument status and the type of radionuclide identified (e.g., medical, industrial, SNM or naturally occurring). Acquired spectrum files can be exported to a personal computer via a USB cable or wirelessly to a smartphone serving as a WiFi hotspot.

The following sections summarize the assessment results for each SAVER category.

4.4.1 Affordability

The SPiR-ID NaI-LT received an Affordability score of 2.7. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators commented that the SPiR-ID NaI-LT relatively high initial cost did not come with superior features and capabilities compared to other assessed RIDs.
- The SPiR-ID NaI-LT is not listed on the GSA price schedule. Evaluators indicated that this was a disadvantage because many state and local responder organizations seek to purchase equipment at reduced cost through GSA schedule contracts available through the GSA Cooperative Purchasing Program.

4.4.2 Capability

The SPiR-ID NaI-LT received a Capability score of 3.8. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Evaluators were generally able to correctly identify the radioactive sources present at each spectrum acquisition station; however, there were some instances of misidentifications. For instance, at spectrum acquisition station 2, one spectrum analysis failed to indicate K-40, while at spectrum acquisition stations 3 and 4 analysis results incorrectly indicated the presence of Thorium-232, a naturally-produced isotope, although at a low confidence level.
- Spectrum files can be transferred to a personal computer via a COTS mini-USB to USB cable connection or they can be transferred wirelessly to a smartphone acting as a WiFi hotspot. Evaluators indicated that the latter method was particularly well-suited for field use and would allow them to quickly and easily send spectrum files to a reachback resource when a potential threat was identified while in the field.
- The SPiR-ID NaI-LT has an internal G-M detector that provides the capability to measure gamma radiation levels of up to 1 rem/h. Evaluator feedback on this capability was mixed: some evaluators considered it advantageous to be able to measure to such a radiation level, while others did not think this was an important capability because they were trained to turn back upon encountering much lower gamma radiation levels.

4.4.3 Deployability

The SPiR-ID NaI-LT received a Deployability score of 3.0. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The evaluators indicated that the SPiR-ID NaI-LT's size, weight and front-heavy weight distribution were less than optimal for one-handed operation.
- The SPiR-ID NaI-LT's operating temperature range and IP rating for water and dust resistance met evaluator expectations for field deployment of this type of instrument. Covers for power and communication ports remained attached to the instrument body when removed from their ports.
- The operating time on a fully charged internal battery met evaluator expectations for field deployment. See the Maintainability section below for related evaluator feedback on ease of battery change-out and operability on COTS batteries.

4.4.4 Maintainability

The SPiR-ID NaI-LT received a Maintainability score of 1.6. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- The SPiR-ID NaI-LT's internal rechargeable battery is not designed to be swapped out in the field. The evaluators stated that in their experience it was commonplace to begin a field deployment with an instrument whose batteries were depleted, and so the inability to replace the battery while in the field was considered to be a significant limitation on the SPiR-ID NaI-LT's field maintainability.
- The evaluators judged that most external surfaces of the SPiR-ID NaI-LT could be easily decontaminated; however, the three external antenna ports were considered to be problematic to decontaminate.

- Mirion does not offer a trade-in option to customers owning older instruments. As discussed for the FLIR Systems IdentiFinder R400-NGH, the evaluators had mixed views on trade-in option availability.

4.4.5 Usability

The SPiR-ID NaI-LT received a Usability score of 3.1. Evaluator feedback relating to evaluation criteria in this category is summarized below.

- Several evaluators indicated that the SPiR-ID NaI-LT operating software was not as easy to use as those of other RID models with which they were familiar. One evaluator reported that there was not enough clearance between the handle and the instrument body to comfortably operate the SPiR-ID NaI-LT while wearing firefighting gloves.
- Several evaluators reported that the display screen was difficult to read when brightly illuminated, and that some information is presented in small font sizes that were difficult to read.
- Visible and vibration alarms were adequate to alert users when measured gamma or neutron radiation levels exceed alarm thresholds. The regular audible alarm tone could be clearly heard, but the optional voice alarm feature did not consistently sound or was too weak to hear.
- Spectrum files can be exported from the SPiR-ID NaI-LT via cable connection to a personal computer running Microsoft Active Sync or Windows Mobile Device Center software. When the cable connection to the recipient computer is made, the SPiR-ID NaI-LT's internal memory appears as an external data storage device from which spectrum files can be transferred as from a USB thumb drive. Evaluators found this to be an intuitive way of exporting data from the instrument.

5.0 SUMMARY

Handheld RIDs are the primary tools that first responders use to identify the radionuclides present in radioactive material they encounter so that appropriate action can be taken when a threat is identified. The assessed RIDs generally performed well in this core function; however, some radionuclide misidentifications were noted when each RID was used at the spectrum acquisition stations.

Some key advantages and disadvantages identified by the evaluators are summarized in Table 5-1. There were significant differences in evaluation criteria ratings for price, ease of one-handed operation, battery power options, and spectrum export capability among the four assessed RIDs. Evaluators expressed a preference for RIDs that can be operated on COTS batteries, which can be readily replaced if necessary while in the field. Similarly, there was a preference that peripheral components such as data cables be COTS products. The ability of some of the assessed RIDs to export acquired spectrum files to a smartphone was considered to be an excellent feature as this was considered to be the most effective way to transmit data to a reachback resource when a potential threat was identified while using the RID during a field deployment.

Emergency responder agencies that are planning to purchase handheld RIDs should carefully research each product's overall capabilities and limitations in relation to its operational needs.

Table 5-1 Product Advantages and Disadvantages

Product		Advantages	Disadvantages
	FLIR Systems IdentiFinder R400-NGH **Overall Score: 4.1**	• Comfortable one-handed operation • Operates on COTS batteries • Quick battery change-out • Spectrum files can be transmitted via smart phone when in the field • Low cost	• USB port cover can be easily lost, reducing water/dust resistance • No trade-in option
	ThermoFisher Scientific RIIDEye X-GN **Overall Score: 3.9**	• Comfortable one-handed operation • Operates on COTS batteries • Quick battery change-out • Trade-in option for old instruments • Low cost	• Lacks ability to export spectrum files to a smart phone • Power and data port covers are difficult to seal
	Smiths Detection RadSeeker CS **Overall Score: 3.5**	• Comfortable one-handed operation • Quick battery change-out	• Lacks ability to export spectrum files via smart phone • Does not operate on COTS batteries • Relatively high list price • No trade-in option

Product		Advantages	Disadvantages
	Mirion Technologies SPiR-ID NaI-LT **Overall Score: 2.9**	• Spectrum files can be transmitted via smart phone when in the field	• Less comfortable for one-handed operation due to size and weight • Display screen hard to read in bright light • Cannot operate on COTS batteries • Internal battery cannot be changed out in the field • Relatively high list price • No trade-in option

Appendix A. ASSESSMENT SCORING FORMULAS

The overall score for each product was calculated using the product's averaged criterion ratings and category scores. An average rating for each criterion was calculated by summing the evaluators' ratings and dividing the sum by the number of responses. Category scores for each product were calculated by multiplying the average criterion rating by the weight assigned to the criterion by the focus group, resulting in a weighted criterion score. The sum of the weighted criterion scores was then be divided by the sum of the weights for each criterion in the category as seen in the formula and example below.

Category Score Formula

$$\frac{\sum\left(\textit{Average Criterion Rating} \times \textit{Criterion Weight}\right)}{\sum\left(\textit{Criterion Weights}\right)} = \textit{Category Score}$$

Category Score Example[ii]

$$\frac{(4.3 \times 4) + (5 \times 4) + (4 \times 3) + (4.5 \times 3) + (4.5 \times 3)}{4 + 4 + 3 + 3 + 3} = 4.5$$

To determine the overall assessment score for each product, each category score was multiplied by the percentage assigned to the category by the focus group. The resulting weighted category scores were summed to determine an overall assessment score as seen in the formula and example below.

Overall Assessment Score Formula

$$\sum\left(\textit{Category Score} \times \textit{Category Percentage}\right) = \textit{Overall Assessment Score}$$

Overall Assessment Score Example

$$\underbrace{(4.0 \times 33\%)}_{\textit{Capability}} + \underbrace{(4.2 \times 27\%)}_{\textit{Usability}} + \underbrace{(4.2 \times 20\%)}_{\textit{Affordability}} + \underbrace{(3.8 \times 13\%)}_{\textit{Maintainability}} + \underbrace{(4.5 \times 7\%)}_{\textit{Deployability}} = 4.1$$

[ii] Examples are for illustration purposes only. Formulas vary depending on the number of criteria and categories assessed and the criteria and category weights.

Appendix B. EVALUATION CRITERIA DEFINITIONS

The 45 evaluation criteria identified by the radionuclide identification devices (RIDs) focus group are defined below, grouped by the SAVER assessment categories to which they were assigned by the focus group.

Affordability criteria are related to the total cost of ownership over the life of the product. The evaluation criteria in this category are:

- Initial Cost: The cost to purchase the RID.
- GSA Schedule: Refers to whether the RID is listed on the General Services Administration (GSA) price schedule.
- Mean Time between Failure: Refers to how long the RID will operate properly without normal scheduled maintenance or repair (this does not refer to simple redetermination of energy calibration).
- Cost of Calibration/Repair: The cost of refurbishing/recalibration. There is the possibility for price competition on this kind of work (e.g., such work can be done by a third party or by a technically competent user).
- Software Updates: The cost of updates to RID operating software and spectrum libraries.
- Training Options: Terms under which the manufacturer provides training. What does instrument-specific training provided by the manufacturer cost and where is it offered (e.g., at the user's location, at the manufacturer's facility).

Capability criteria are related to product features or functions needed to perform one or more responder-relevant tasks. The evaluation criteria in this category are:

- High Energy Gamma: The ability to identify radionuclides whose gamma-ray spectra include high energy gamma-ray peaks (e.g., Cobalt-60).
- Isotope Identification: The RID correctly identifies sources containing more than one gamma ray emitting radionuclide and lists confidence levels.
- Isotope Library: The RID's isotope library contains all radionuclides required by relevant national standards.
- Data Transfer (Hardware): Hardware options for data transfer are well suited for sending acquired data off-site (e.g., for Reachback analysis) when in the field.
- Dose Rate Accuracy: Gamma-ray exposure rate measurements are energy independent.
- Non-Volatile Memory: Acquired data are not lost when batteries are removed.
- Energy Resolution: The energy resolution of acquired gamma-ray spectra (Note: This is typically stated in terms of the full width at half maximum of gamma-ray spectrum peaks at specific energies).
- Over-range Indication: Whether the instrument indicates that radiation levels exceed the maximum level it is capable of measuring.
- N42 Compliant Data Format: Acquired data are saved in file formats compliant with ANSI N42.42 specifications.
- Neutron Sensitivity: The detection sensitivity for neutrons meets or exceeds relevant national standards.

- Administrator Controls: Operating software allows an administrator to lock certain settings so that they cannot be altered by other users.
- Gamma Sensitivity: Refers to how efficiently gamma rays emitted by a radioactive source are detected by the RID.
- High Dose Rate Measurements: The RID contains a Geiger-Muller detector or similar device for measuring dose/exposure rates above the level that is measurable with the NaI(Tl) detector used for spectrum acquisition.

Deployability criteria are related to preparation to use the product, including transport, setup, training and operational/deployment restrictions. The evaluation criteria in this category are:

- Weight: The assessor's satisfaction with the weight of the RID for field use.
- Size: The assessor's satisfaction with the size of the RID for field use.
- One-Handed Operation: How easily the RID can be carried and operated using one hand.
- Water/Dust Resistance: The assessor's satisfaction with the RID's water and dust resistance, as indicated by Ingress Protection ratings, military specifications (MILSPEC) ratings, etc.
- Ruggedness (shock/vibration): The assessor's satisfaction with the RID's shock or vibration resistance, as indicated by conformance to Domestic Nuclear Detection Office, MILSPEC, or other standards.
- Form Factor: Refers to suitability of the RID from an ergonomic standpoint (e.g., instrument weight is well-balanced, RID is easy to carry/operate).
- Battery Life: How well the RID's operating time on batteries, as stated in manufacturer's literature, suits first responder needs.
- Temperature Range: How well the RID's operating and storage temperature ranges, as stated in manufacturer's literature, suits first responder needs.
- Intrinsically Safe: The RID is certified for safe operation in atmospheres where concentrations of flammable gases or dust reach hazardous levels.
- Radio Frequency Interference: RID function is not compromised by transmissions from radios or other sources of radio frequency emissions.

Maintainability criteria are related to the routine maintenance and minor repairs performed by responders, as well as included warranty terms, duration, and coverage. The evaluation criteria in this category are:

- Calibration/Optimization Contract: Refers to the options available for calibration and/or refurbishment at the RID manufacturer's facility.
- In-House Calibration/Optimization Capability: The RID can be calibrated and/or refurbished by technically competent users.
- COTS Batteries: The RID can be operated on battery types commonly available at stores (e.g., AA or D batteries).
- Trade-In Options: Refers to the conditions under which a vendor will take back user's RIDs at the end of their life cycle.
- Decontaminability: Whether the RID can be effectively and easily decontaminated (e.g., external surfaces have no crevices).
- Ease of Battery Change-Out: Refers to how easily batteries can be changed out in field use.

Usability criteria are related to ergonomics and the relative ease of use when performing one or more responder-relevant tasks. The evaluation criteria in this category are:

- Ease of Data Transfer (Software): The process for exporting acquired data from the RID is intuitive and easy to perform.
- Intuitive Menus and Screens: RID operating software is easily and intuitively navigated.
- User-Friendly Controls: The layout of the buttons and switches provides convenient/intuitive control of RID operation.
- Screen Visibility (Bright/Dark): Users can easily read the screen in different lighting conditions, e.g., in bright sunlight or at night time.
- Display Screen Size, Resolution and Legibility: Self-evident.
- Ease of Calibration and Calibration Documentation: How easily RID energy calibration can be updated during extended use; also, whether calibration history is saved in memory.
- Visible, Audible and Vibration Alarms: Suitability of visible, audible, and vibration alarms for actual first responder use.
- Computer Configurability: Whether RID settings can be set via a computer rather than via the RID’s user interface.
- Operation with Gloves: Suitability of operating RID while wearing gloves.
- User-Settable Alarm Thresholds: Whether gamma-radiation alarm can be set to alert at 2 mR/hour (this is the threshold responders are typically trained to ‘back off’ to).

Appendix C. INGRESS PROTECTION (IP) RATINGS

A product's International Electrotechnical Commission 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 C-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.