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System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, contact the SAVER Program Support Office.

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Summary

Electronic Personal Dosimeters

(AEL reference number 07RD-01-EPD)

In order to provide emergency responders with information on currently available electronic personal dosimeters (EPDs), National Security Technologies, LLC (NSTec), conducted a comparative assessment of EPDs for the System Assessment and Validation for Emergency Responders (SAVER) Program in February 2010. Detailed findings are provided in the Electronic Personal Dosimeters Assessment Report, which is available by request at <https://www.rkb.us/saver>.

Background

EPDs are compact devices that measure the radiation dose rate levels that an emergency responder may receive during an operational period. EPDs provide immediate feedback to responders and, potentially, their command post. If a responder enters a high-level radiation area or spends too much time in a low-level radiation area, the EPD will alert the responder to the dose rate and/or accumulated dose rate with an audible alarm, vibration, or both. EPDs are designed to be clipped to response gear, a belt, or other garment.

Assessment Methodology

Prior to the assessment, nine emergency responders were chosen from various jurisdictions to participate in a focus group. Participants possessed strong backgrounds in law enforcement, fire service, hazardous materials, and radiological emergency response. The group's primary objectives were to recommend evaluation criteria, product selection criteria, products and/or vendors, and possible scenarios for the assessment.

Based on the focus group recommendations, market research, and equipment availability, the following EPDs were assessed:

- UltraRadiac-Plus Personal Radiation Monitor, CANBERRA;
- PD-10i, Science Applications International Corporation (SAIC);
- PM1610, Polimaster;
- PM1621M, Polimaster;
- RADOS RAD-60, SE International Inc.;
- Model 25, Ludlum Measurements Inc.;
- PM1603A, Polimaster;
- Radiation Alert Sentry, SE International Inc.;
- PM1208M, Polimaster;
- PM1203M, Polimaster;
- DMC 2000S, Mirion Technologies;
- 4084 Canary IV, Far West Technology Inc.;
- 4083 Canary III, Far West Technology Inc.;
- 4080 Canary II, Far West Technology Inc.;
- DOSE-GARD DG01, General Atomics Electronic Systems; and
- Self-Indicating Cumulative Dosimeter, General Atomics Electronic Systems.

Twelve responders served as evaluators for this assessment. All evaluators had at least 5 years of hazardous materials or law enforcement experience.

Evaluators assessed EPDs in two phases. During phase I, evaluators assessed equipment against vendor provided specifications. Hands-on experience with EPDs during two scenarios served as the basis for assessment during phase II. The indoor scenario involved unaccounted for workers during a fire at a facility that produces gamma-emitting radiation sources. The outdoor scenario involved construction site workers trapped near an open radiography source.

Assessment Results

Evaluators rated the EPDs based on the evaluation criteria established by the focus group. Each criterion was assigned to one of the five SAVER categories, and then assigned a weight for its level of importance. Once the criteria were weighted, the five SAVER categories were assigned a percentage value to

SAVER Category Definitions

Affordability: This category groups criteria related to life-cycle costs of a piece of equipment or system.

Capability: This category groups criteria related to the power, capacity, or features available for a piece of equipment or system to perform or assist the responder in performing one or more relevant tasks.

Deployability: This category groups criteria related to the movement, installation, or implementation of a piece of equipment or system by responders at the site of its intended use.

Maintainability: This category groups criteria related to the maintenance and restoration of a piece of equipment or system to operational conditions by responders.

Usability: This category groups criteria related to the quality of the responders' experience with the operational employment of a piece of equipment or system. This includes the relative ease of use, efficiency, and overall satisfaction of the responders with the equipment or system.

Table 1. Electronic Personal Dosimeter Assessment Results¹

Product	Composite Score	Affordability (15% Weighting)	Capability (23% Weighting)	Deployability (17% Weighting)	Maintainability (20% Weighting)	Usability (25% Weighting)
UltraRadiac-Plus Personal Radiation Monitor	82	74	88	86	76	88
PD-10i	76	70	80	78	70	78
PM1610	74	68	74	72	70	82
PM1621M	74	68	76	72	72	80
RADOS RAD-60	70	64	72	74	68	72
Model 25	68	68	68	66	70	72
PM1603A	62	66	62	62	72	54
Radiation Alert Sentry	62	68	62	62	64	58
PM1208M	60	66	60	68	66	50
PM1203M	60	68	54	58	68	58
DMC 2000S	54	52	54	54	58	54
4084 Canary IV	54	58	44	52	64	50
4083 Canary III	52	60	42	56	60	52
4080 Canary II	52	58	40	56	62	48
DOSE-GARD DG01	52	50	52	56	56	48
Self-Indicating Cumulative Dosimeter	44	50	36	46	48	40

Note:

¹ Scores contained in the assessment report may be displayed differently. For the purposes of the SAVER Summary, all SAVER category scores are normalized using a 100-point scale.

represent the level of each category’s importance relative to the other categories.

Table 1 displays the composite assessment scores as well as the category scores for each product. Higher scores indicate a higher rating by evaluators. To view how each EPD scored against each of the evaluation criteria assigned to the SAVER categories, see table 2. For equipment specifications, see table 3.

The following paragraphs provide a brief summary of evaluator comments and feedback on each EPD used during the assessment. The EPDs are listed from highest to lowest composite score. The complete assessment report includes a breakdown of evaluator comments by SAVER category.

UltraRadiac-Plus Personal Radiation Monitor

The UltraRadiac-Plus Personal Radiation Monitor received a composite score of 82. The evaluators found it well constructed and appropriate for use in the conditions encountered by emergency responders. They also noted that the unit includes an easy-to-read screen, has strong vibration and warning alarms, is fairly priced, and the batteries are easy to change.

Evaluators noted that the batteries need frequent replacement and could cause the unit to overheat if inserted incorrectly. They also felt the requirement for annual recalibration was too frequent.

	 Pros	<ul style="list-style-type: none"> • Rugged unit • Easy to read • Reasonable price • Distinctive, loud alarm • Batteries easy to change
	 Cons	<ul style="list-style-type: none"> • Poor battery performance • Incorrect battery placement overheats device • Flimsy carrying case
UltraRadiac-Plus Personal Radiation Monitor	Composite Assessment Score: 82	

PD-10i

The PD-10i received a composite score of 76. Evaluators found it to be sturdy with user-friendly software. Other advantages noted were the loud alarm, the maintenance requirements, and the ease of battery changing.

Evaluators expressed a dislike for the amount of button-pressing needed to change the settings. They

noted that the unit has a weak vibration alarm and a small display screen.

	 Pros	<ul style="list-style-type: none"> • Rugged unit • Easy to read • Distinctive, loud alarm • Batteries easy to change
	 Cons	<ul style="list-style-type: none"> • Screw-on battery cover may weaken over time • Too much button-pressing to change the settings • Small display • Weak vibration alarm
PD-10i	Composite Assessment Score: 76	

PM1610

The PM1610 received a composite score of 74. Evaluators found it well constructed and appropriate for use by emergency responders. They liked the alarms and display options as well as the reasonable software and maintenance costs.

Evaluators expressed considerable concern regarding the built-in rechargeable battery setup that would require leaving the field to charge the unit. Also, they did not like the small display and the fragile clip used to attach the unit to personnel.

	 Pros	<ul style="list-style-type: none"> • Rugged unit • Good alarm and vibration • Good backlight
	 Cons	<ul style="list-style-type: none"> • Built-in rechargeable batteries • Small display • Small buttons • Poor attachment to user
PM1610	Composite Assessment Score: 74	

PM1621M

The PM1621M received a composite score of 74. Evaluators found it to be rugged and useful for emergency responders. They identified the simple-to-operate controls, reasonable maintenance requirements, and excellent computer interface as advantages.

Some disadvantages noted were the small screen size, the relatively high cost, and the data transmission mechanism. The evaluators were also concerned that the screw-type battery cover might weaken over time.

	↑ Pros	<ul style="list-style-type: none"> Rugged unit Distinctive, loud alarm Excellent computer interface Batteries easy to change
	↓ Cons	<ul style="list-style-type: none"> Small display Screw-type battery cover may weaken over time High cost
PM1621M	Composite Assessment Score: 74	

RADOS RAD-60

The RADOS RAD-60 received a composite score of 70. Evaluators found that it was user-friendly and had an easy-to-read display. Also favorably noted were the good user interface and the audible alarm.

Evaluators did not feel the unit was rugged enough to withstand emergency responder work. Other disadvantages identified were the lack of a vibrating alarm and concerns about the durability of the clip used to attach the device to personnel.

	↑ Pros	<ul style="list-style-type: none"> Good user interface Display easy to read Batteries easy to change
	↓ Cons	<ul style="list-style-type: none"> Not rugged in construction Weak clip attachment High software costs No vibrating alarm
RADOS RAD-60	Composite Assessment Score: 70	

Model 25

The Model 25 received a composite score of 68. Evaluators felt it was well constructed and user-friendly. Evaluators also appreciated the straight forward startup procedure, maintenance procedures, and the cost.

	↑ Pros	<ul style="list-style-type: none"> Rugged unit User-friendly unit Reasonable price Distinctive, loud alarm
	↓ Cons	<ul style="list-style-type: none"> Watch-type batteries Small buttons No user lockout No vibrating alarm
Model 25	Composite Assessment Score: 68	

Evaluators determined that the unit includes buttons that are too small, lacks a vibrating alarm, uses batteries that are difficult to change, and lacks a lockout function.

PM1603A

The PM1603A received a composite score of 62. Evaluators liked the excellent backlight and it received high marks in thermal and water resistance. They also felt the unit had low maintenance requirements, reasonable maintenance costs, and was easy to startup.

Evaluators were concerned about the unit's fragile design and difficult-to-navigate menus, and felt a wrist attachment was not ideal for monitoring the radiation dose to emergency responders. Evaluators were also concerned about the lack of vibrating alarms and felt the purchase price was too high.

	↑ Pros	<ul style="list-style-type: none"> Excellent backlight
	↓ Cons	<ul style="list-style-type: none"> High cost Fragile unit Wrist attachment Small buttons and menus No vibrating alarm
PM1603A	Composite Assessment Score: 62	

Radiation Alert Sentry

The Radiation Alert Sentry received a composite score of 62. Evaluators determined that it had adequate alarm and vibration strength, and that new responders could be quickly trained to use the device. It also received high marks for easy startup and reasonable pricing.

	↑ Pros	<ul style="list-style-type: none"> Strong vibration alert Minimal training required Reasonable price
	↓ Cons	<ul style="list-style-type: none"> No display Difficult to operate switches when gloved Difficult to connect to computer Not durable
Radiation Alert Sentry	Composite Assessment Score: 62	

The unit received low scores in the area of usability because of the small switches and the lack of display. Evaluators felt it was difficult to change the alarms and the unit was too fragile for regular use.

PM1208M

The PM1208M received a composite score of 60. Evaluators were pleased by its dose rate range. They also remarked that the unit was easy to set up, the data recording options were simple, and the maintenance costs were acceptable.

Evaluators felt the unit was too expensive given its capabilities and features, and that it would be better suited to laboratory use than emergency responder use. They also felt the controls were difficult to operate, and the quiet alarms and lack of vibration were unacceptable for emergency responder use.

	 Pros	<ul style="list-style-type: none"> • Easy to set up • Constant dose display
	 Cons	<ul style="list-style-type: none"> • Wrist attachment • Lack of vibration • Watch hands interfere with display
PM1208M	Composite Assessment Score: 60	

PM1203M

The PM1203M received a composite score of 60. Evaluators felt it was readily usable in the field in terms of ease of startup, and they ranked the maintenance costs as affordable.

Evaluators felt the unit was not suitable for emergency use due to its fragile battery cover and low-volume alarm. They were frustrated by the low backlight and lack of vibration. They also found the unit's buttons

	 Pros	<ul style="list-style-type: none"> • Low maintenance cost • Easy to start up in the field
	 Cons	<ul style="list-style-type: none"> • Brittle design • Fragile battery cover • Fragile belt clip • No backlight • Quiet alarm • No vibration feature
PM1203M	Composite Assessment Score: 60	

were too small and poorly placed for operating while wearing gloves.

DMC 2000S

The DMC 2000S received a composite score of 54. Evaluators commented that it was lightweight and maintained a constant dose display. They were satisfied with the lockout feature and the ability to download data.

Evaluators commented that the EPD's display size is too small and there is no backlight. They felt the unit was difficult to operate, that it would break easily if dropped, and the purchase and maintenance costs are too high.

	 Pros	<ul style="list-style-type: none"> • Lightweight • Constant dose display • Data download capability
	 Cons	<ul style="list-style-type: none"> • Fragile design • Small display • Small buttons • Difficult to open battery compartment • No backlight • No vibrating alarm
DMC 2000S	Composite Assessment Score: 54	

4084 Canary IV

The 4084 Canary IV received a composite score of 54. The EPD was judged rugged enough for emergency responder use, and evaluators were comfortable with the maintenance requirements and costs listed for the unit.

The evaluators commented that while the unit had a constant dose display, it was difficult to read. They also noted that the unit was difficult to use due to the small size of the buttons and it lacks vibrating and audio alarms.

	 Pros	<ul style="list-style-type: none"> • Rugged unit • Constant dose display
	 Cons	<ul style="list-style-type: none"> • Too heavy for clip attachment • Fragile clip • No alarms • Drops may affect radiation counts • No backlight
4084 Canary IV	Composite Assessment Score: 54	

4083 Canary III

The 4083 Canary III received a composite score of 52. Evaluators commented favorably on its easy startup, constant dosage display, and the 1-to-5 year maintenance interval.

The evaluators found the unit too fragile and the dose range unacceptable for emergency responder use. They also did not like the button functionality and felt the dosage display was too small and difficult to read. The lack of data logging capability was also a concern to the evaluators.

	 Pros	<ul style="list-style-type: none"> • Long maintenance interval
	 Cons	<ul style="list-style-type: none"> • Fragile design • No data logging • Limited temperature range • Low volume alarms • No vibration • Unacceptable dose range • Unreadable dose display
4083 Canary III	Composite Assessment Score: 52	

4080 Canary II

The 4080 Canary II received a composite score of 52. Evaluators commented that the EPD was easy for them to learn and operate, and that the maintenance interval of 1 to 5 years was acceptable. They also felt it was easy to start up and easy to zero.

The evaluators felt the display was too challenging to read due to its small size and lack of a backlight. They determined that the unit was not acceptable for use in an emergency response environment due to insufficient vibration, audio, and visual alarms. They also felt the purchase, maintenance, and software costs were too expensive.

	 Pros	<ul style="list-style-type: none"> • Long maintenance interval • Constant dose display • Minimal training time
	 Cons	<ul style="list-style-type: none"> • Limited temperature range • No backlight • Quiet alerts of acquired dose • No data logging
4080 Canary II	Composite Assessment Score: 52	

DOSE-GARD DG01

The DOSE-GARD DG01 received a composite score of 52. Evaluators liked its easy startup, constant dose display, and the 3-year service interval.

Evaluators remarked that despite having an audible alarm, the absence of a vibration alarm made the EPD unacceptable for field use. The evaluators stated the unit was difficult to zero and that data logging was challenging. They also felt the initial purchase and software costs were too high and the cost of a battery replacement was too expensive.

	 Pros	<ul style="list-style-type: none"> • Constant dose display • Acceptable service interval
	 Cons	<ul style="list-style-type: none"> • Calibration costs more than new unit • Reportable dose rate begins too high at 10 mR • No vibrating alarm • Small buttons • Unit must be sent to manufacturer for a battery change
DOSE-GARD DG01	Composite Assessment Score: 52	

Self-Indicating Cumulative Dosimeter

The Self-Indicating Cumulative Dosimeter received a composite score of 44. Evaluators noted that the unit was water-resistant. They were able to learn to use the instrument quickly and the purchase cost is low.

The evaluators indicated the unit would not meet their requirements because it lacked audio, visual, and vibration alarms, and they felt the display was difficult to read. They also felt it was not deployable because it

	 Pros	<ul style="list-style-type: none"> • Low unit cost • Minimum training time
	 Cons	<ul style="list-style-type: none"> • No vibration, audible, or visual alarms • Dose rate range begins too high (10 rem) • Inappropriate temperature range
Self-Indicating Cumulative Dosimeter	Composite Assessment Score: 44	

lacks data recording features, and attaches to the wrist, measuring extremity, not core, readings.

Conclusion

Evaluators were able to successfully complete the assessment tasks with all of the EPDs. Analysis of evaluator comments and scores revealed the following common observations concerning the assessed EPDs:

- Evaluators stated that an EPD must have audio, visual, and vibration alarms;
- Evaluators required a rugged design that is impact-resistant and able to withstand water and adverse temperatures;
- Evaluators expressed a need for a strong method of attachment to the user;
- Evaluators placed a high value on larger buttons because the EPD unit is often used by gloved responders;

- Evaluators preferred that the unit be capable of logging accumulated dose and/or dose rate so the data can be retrieved for later examination; and
- Evaluators preferred standard batteries that could be purchased in present bulk quantities; unusual battery options present challenges in purchasing large amounts as well as changing or recharging the batteries.

All reports in this series, as well as reports on other technologies, are available in the SAVER section of the Responder Knowledge Base (RKB) Web site at <https://www.rkb.us/saver>.