Homeland Security
Science and Technology

Summary

U.S. Department of Homeland Security
SAVER
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 operational tests 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?"

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Multi-sensor Meter (MSM) Chemical Detectors

In order to provide emergency responders with information on currently available multi-sensor meter (MSM) chemical detector capabilities, limitations, and usability, the Center for Domestic Preparedness (CDP) conducted a comparative assessment of six MSM chemical detectors for the SAVER Program in July 2006. Because technology advances since that time have allowed for the development of new MSM detectors, the CDP conducted an additional assessment of four MSM chemical detectors in May 2008. Detailed findings of the latest assessment are provided in the complete Assessment Report on Multi-Sensor Meter Chemical Detectors*, which is available by request at https://www.rkb.us/saver.*

Background

As opposed to single gas chemical detection equipment which monitors for one specific agent, MSM technology allows for the simultaneous detection of more than one gas. Detection capabilities include recognition of oxygen-deficient or oxygen-rich atmospheres, combustible gas levels, certain combustible vapors, and a wide selection of toxic gases detected by specialized sensors. Some MSM chemical detectors have a photo-ionization detection (PID) capability which will detect volatile organic compounds (VOC).

MSM chemical detector configurations include combinations of sensors, battery options, sampling methods (i.e., diffusion, motorized sampling pump), data logging with or without software, and confined space kit options. Various types of alarms are also available, including short-term exposure limit (STEL) and time-weighted average (TWA) readings, and low battery. There are multiple types of indicators as well, to include audio, visual, vibrating, or a combination of each.

Accessories may include probe filters, probe attachments, rubber or leather instrument jackets, a chest harness for hands free operation, extension hoses and connectors, and calibration kits. Many MSM chemical detectors come equipped with protective covers or housing that make them intrinsically safe. Power supplies include rechargeable batteries such as lithium ion, nickel-cadmium, or nickel metal hydride batteries. Non-rechargeable alkaline batteries are also available. MSM detectors are usually available for a base price plus additional costs for each sensor and other specific options.

Assessment

A focus group of eight emergency response practitioners from various regions of the country met in June 2006 to identify equipment selection criteria, evaluation criteria, and assessment scenarios. The SAVER Program elected not to hold a second MSM chemical detector focus group for this assessment in order to evaluate the additional MSM detectors with the same criteria used during the July 2006 assessment. The recommended selection criteria

included standard detection capabilities, varying sizes, capability options, and delivery possibilities. Based on focus group recommendations and market survey research, the CDP selected the following four models for assessment:

- Mine Safety Appliances (MSA) Sirius® Multigas Detector
- RAE Systems MultiRAE Plus Monitor
- Scott Health & Safety Scout® Multi Gas Monitoring System
- Draeger Safety X-am 7000 Multi-Gas Detector.

Eight emergency response practitioners served as assessment evaluators. Four assigned CDP class and training rooms were utilized for the assessment activities. Three of the four rooms contained a simulant that activated the MSM chemical detectors and the fourth room had no products or simulants present. During each rotation, the evaluators monitored each of the four designated rooms with an assigned MSM detector while wearing Level A personal protective equipment (PPE) and a self-contained breathing apparatus (SCBA). The teams moved in a round-robin fashion through the four designated rooms until they had successfully monitored each room. The MSM chemical detector assignment during each rotation allowed each model to be used by every evaluator during the assessment.

Assessment Results

Evaluators rated the MSM chemical detectors based on the evaluation criteria established by the 2006 focus group. Each original criterion was assigned to one of the five SAVER categories, and each SAVER category was assigned a weighting factor to indicate its impact on the total composite score. The SAVER category and composite scores are shown in table 1. Higher scores indicate better MSM performance. To see how each MSM chemical detector scored within the specific evaluation criteria assigned to the SAVER Program categories, see table 2 (on page 6).

The following sections provide a brief summary of the evaluator comments and feedback on each MSM chemical detector. The sections present the systems from the highest to lowest composite score. For the purposes of this SAVER Summary, the category scores are normalized and rounded to the nearest

SAVER Program 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 responder-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. MSM Chemical Detectors Assessment Results[1]

MSM Chemical Detector	Composite Score	Affordability (20% Weighting)	Capability (30% Weighting)	Deployability (10% Weighting)	Maintainability (15% Weighting)	Usability (25% Weighting)
Sirius	**77**	75	78	82	71	80
MultiRAE Plus	**77**	75	79	85	75	74
Scout	**74**	74	73	82	72	72
X-am 7000	**63**	65	65	64	61	62

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 and rounded to the nearest whole number.

whole number. The complete assessment report includes a breakdown of evaluator comments by individual criterion.

Sirius

The Sirius was scored the highest overall by the evaluators, and highest in the usability category. It tied for highest score in the affordability category. The detector was user-friendly, the display screen was easy to read, and it was easy for evaluators to hold with one hand.

The Sirius was equipped with both a wrist strap and an adjustable shoulder/neck strap. Both the Sirius rubber boot casing and the carrying case were bright red, making them easy to quickly identify. Evaluators commented that the menus displayed on the screen were easy to navigate. The display screen and text size were large enough to be easily read by the evaluators while wearing PPE. The carrying case was large and accommodated all components, and a full storage and reference guide was affixed to the inside lid.

Conversely, evaluators commented that the screen's location on the device made it easy to inadvertently cover it with their hand during operation. When evaluators opened the MSM detector cover to remove the battery pack, the sensor electronics were exposed within the battery compartment. This exposure confirmed the evaluators' opinion that any maintenance should be performed in the cold zone so as not to expose the sensor electronics to a compromised environment. The evaluators noted that the inner case foam could possibly tear with repeated use and the case's plastic latches did not appear to be durable.

Pros

- Quick warm-up time
- Easy-to-see red protective boot
- Large, easy-to-read screen
- Simple, easy-to-scroll menu
- Quick reference guide affixed in case lid
- Necessary components easily fit in single case
- Ergonomic design
- Good visual and audible alarms
- Wrist strap
- Secure locking mechanism with tubing
- Required tools included with kit

Cons

- Unsecure case locking mechanism
- Display screen easily covered by hand
- User manual only on compact disc
- Electronic board exposed by battery removal
- Battery charger light indicator not easily seen

Sirius — **Composite Assessment Score: 77**

MultiRAE Plus

The MultiRAE Plus scored highest by evaluators in the capability, deployability, and maintainability categories. It tied for the highest score in the affordability category.

The MultiRAE Plus was housed in a bright yellow rubber boot, which made it clearly identifiable. Its compact design allowed it to be comfortable to hold and easy to calibrate. Evaluators stated the MultiRAE Plus had a strong power pump and the pump cleared out quickly after a response. In addition, the audible and visual alarms were easily identified. The MultiRAE Plus carrying case appeared to be durable and held all necessary components, including a tool kit.

Evaluators stated that the battery connection cord was lengthy. They also noted that the wrist strap was too short to be compatible with PPE. The audible alarm was loud enough in a quiet atmosphere, but it would need to be louder for a noisy environment.

The screen displayed small text and the screen could be unintentionally covered by the user's hand while in operation. The control buttons were too close to the protective rubber boot edge, making them difficult to push while wearing PPE gloves.

Pros

- Quick warm-up time
- Easy-to-see yellow protective boot
- Small, compact design
- Strong power pump
- User-friendly manual
- Easy filter change
- Tool pack included with kit
- Easy calibration
- Necessary components fit easily into case

Cons

- Lengthy battery connection cord
- Short wrist strap
- Control buttons too close to rubber boot
- Small display screen
- Alarm not loud enough in noisy environment

MultiRAE Plus — **Composite Assessment Score: 77**

Scout

Evaluators scored the Scout second highest in the maintainability category. A quick reference guide and complete instruction manual were easy to understand. The carrying case had sturdy foam and could house the necessary MSM detector components. Evaluators stated the Scout was easy to calibrate and the battery pack was easy to change. They noted that the arrow prompts made it easy for the user to scroll through the menus. The raised buttons were easy to find and manipulate while wearing gloves.

The Scout was heavy and not as comfortable to carry with one hand as the Sirius and MultiRAE Plus. Strap hooks were only available on the leather boot—not on the MSM detector itself—making the Scout difficult to use without the boot. The boot's plastic display cover flap caused a glare when the evaluators attempted to read the screen. The Scout display screen text was small and the backlight faded out toward the screen edges. Also, carbon monoxide (CO) and hydrogen sulfide (H_2S) readings alternately flashed in the same place on the display screen throughout the assessment.

	**Pros**	• Quick warm-up time • Battery pack easy to change • Raised control buttons easy to feel through gloves • User-friendly user's guide and quick reference guide • Easy to calibrate • Necessary components fit easily into case
	Cons	• Small display screen text • Protective case material causes glare on display screen • Becomes heavy when used with one hand • Short-term backlight illumination • CO and H_2S readings flash alternately in same place on screen
Scout	**Composite Assessment Score: 74**	

X-am 7000

The X-am 7000 received the lowest evaluator scores in all five SAVER categories. Evaluators agreed that the X-am 7000 is a very capable tool. The screen backlight was easily seen, and the menus became easier to navigate with repeated use. In addition, the visual and audible alarms were clearly seen and heard.

	**Pros**	• Pump automatically turns on when sampling plate is attached • Loud chip alarm • Easy-to-see visual alarm • Good display screen and sensor position • Slightly raised control buttons easy to feel through gloves
	Cons	• Long warm-up time • Small carry case does not hold all necessary components • Components must be ordered separately • Difficult to follow manual • Display menus are not intuitive to follow
X-am 7000	**Composite Assessment Score: 63**	

Evaluators commented that the X-am 7000 is not as user-friendly as the other assessed models, and operators would require more training and familiarization in order to use it proficiently. The X-am 7000 was bulky and difficult for evaluators to hold while wearing gloves. Some commented that the display screen text was easy to see and read, but others did not agree.

Evaluators stated that the detection alarms were difficult to clear from the X-am 7000. There was no diagram indicating battery positioning, so it was possible for them to be inserted in the X-am 7000 incorrectly. Evaluators noted that the carrying case was only large enough for the X-am 7000 itself and that ancillary equipment (e.g., sampling wand) had to be ordered separately.

Conclusion

The purpose of this comparative assessment was to evaluate the effectiveness of selected MSM used in emergency response operations. The assessment was based on setting up the MSM chemical detectors, carrying out scenario-driven exercises simulating environments that would require the use of the detectors, and reviewing manufacturer specifications.

Evaluators were able to successfully complete the assessment tasks using each of the selected MSM. An analysis of evaluator comments and scores revealed these common observations concerning the assessed portal monitors:

- Evaluators felt that MSM chemical detectors should include a manual that is easy to read and follow with clear, understandable instructions.

- Evaluators stated that MSM detectors should have intuitive designs, making them simple and easy to use with little or no prior training.
- Quick and easy bump tests and calibration were preferred, as was multiple alarms and simultaneous display readouts.
- Evaluators valued user-friendly MSM detectors with clearly understandable display menus and operator buttons.
- Evaluators agreed that the display screen should be easy to see and read in different levels of light. They also preferred MSM detectors with larger display screens and text, as well as menu screens that were easy to scroll through and change.
- Evaluators preferred the MSM chemical detectors that were lightweight, ergonomically designed, and easy for one person to hold and use.

QuickLook Snapshot[2]

Notes:

[2] The SAVER QuickLook, available on the SAVER Web site, allows users to select the SAVER categories that are most important to their department and view results according to their specific needs.

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

All reports in this series as well as reports on other technologies are available by request at https://www.rkb.us/saver.

Table 2. SAVER Category and Criteria Scores

KEY Least Favorable → Most Favorable				
○ ◔ ◑ ◕ ●	Sirius	MultiRAE Plus	Scout	X-am 7000
Assessment Criteria				
Affordability				
Durable/rugged	●	●	●	●
Calibration supply cost	◕	●	●	◕
Basic warranty	◕	◕	◕	◑
Life expectancy of sensor/sensor cost	◕	◕	●	◕
Battery/power supply cost	◕	◕	◕	◕
Standard vs. opt'l accessories and tools	◕	◕	◕	◔
Capability				
Multiple alarms	●	●	◕	◕
Multiple readouts on single display	●	●	◕	◕
Number of available sensors	◕	●	◕	◕
User-calibration vs mfg calibration	●	●	●	◑
"Quick calibrated" or "bump tested"	●	●	◕	◑
User-changeable sensors	◕	◕	◕	◕
Pump options	◕	◕	◕	◑
Data logging/downloading	◑	◕	◑	◔
Power source flexibility	◕	◕	◕	◕
Decontamination capabilities	◕	◕	◑	◑
Deployability				
Warm-up time	●	●	●	●
Transit case	◕	●	◕	◕
Maintainability				
Return to service	◕	◕	◕	◑
Out-of-service time for required mtnc	●	●	●	◕
Calibration schedule	◕	●	●	◕
Availability of calibration supplies	◕	◕	◕	◕
Shelf life of calibration supplies	◕	◕	◕	◕
Usability				
Ease of calibration	●	●	●	◑
Size of display readout text	●	◕	◕	◕
Size of display screen	●	◕	◕	◕
Simultaneous readout	●	◕	◕	◕
Display illumination	◕	◕	◕	◕
Controllable display	◕	◕	◕	◑
Alarm reset time	◕	◑	◕	◔
Easy to manipulate controls	◕	◑	◕	◑
User-friendly buttons	◕	◕	◑	◑
User-friendly menu	◕	◕	◕	◑
Multiple alarm recognition	◕	◑	◑	◕
Easy to carry	◕	◕	◕	◑
Manageable size/ergonomic	◕	◕	◕	◑
Easy sensor change	◕	◕	◕	◑
Easy power source change	●	◕	●	◕
User-friendly manual	◕	◕	◕	◔