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**Report Conclusions – General Observations****Research Objective:**

In July 2006, the Center for Domestic Preparedness (CDP) conducted a comparative assessment of six multi-sensor meter (MSM) chemical detectors. Because technology advances since that time have allowed for the development of additional MSM detectors, the System Assessment and Validation for Emergency Responders (SAVER) Program elected to conduct an additional comparative assessment in May 2008 to include new, currently available MSM chemical detectors. Additionally, the RAE Systems MultiRAE Plus was scored the highest by the 2006 assessment evaluators and was therefore included with three additional MSM detectors for the 2008 assessment. The following four MSM detectors were included in the 2008 assessment:

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

The assessment was conducted using a scenario selected from the Homeland Security Council (HCS) National Planning Scenarios and response activities recommended by the June 2006 MSM focus group held at the CDP. Eight emergency responders were selected to serve as evaluators. Each MSM was evaluated in the same manner, and operational conditions were controlled to make the evaluation of each system as similar as possible. Detailed evaluator comments were captured during the assessment activities, and these comments have been included in the full assessment report.

**Research Summary/Conclusions:**

Evaluators scored the MSM based on evaluation criteria established by the 2006 MSM focus group and prioritized within the five SAVER categories (capability, usability, affordability, deployability, and maintainability). The scoring system was based on a 100-point scale and utilized the evaluation criteria and weighting factors established by the focus group. Higher scores indicate better MSM performance. [Table 1 \[p. ii\]](#) illustrates the respective equipment scores.

There were significant differences noted by the evaluators among the four assessed MSM. The evaluators preferred MSM that were intuitively designed, user-friendly with easy-to understand menus and operator buttons, ergonomic, and lightweight. [Table 2 \[p. iv\]](#) provides a synopsis of the advantages and disadvantages of the assessed MSM as noted by the evaluators.

Key References	MSM fall under the AEL equipment category Multi-sensor Meter Point Chemical Detector, reference number 07CD-01-DPMG. Federal Acquisition Regulation (FAR), specifically Section 10	<input type="checkbox"/> N
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Detectors addressed	Mine Safety Appliances (MSA) Sirius® Multigas Detector (Sirius), RAE Systems MultiRAE Plus Monitor (MultiRAE Plus), Scott Health & Safety Scout® Multi Gas Monitoring System (Scout), Draeger Safety X-am 7000 Multi-Gas Detector (X-am 7000)
Related Reports	NA
External Supporting/Refuting Information	NA
<b>Technical Approach- Dissemination</b>	
Vapor Spike Parameters	NA
Aerosol Spike Parameters	NA
Liquid Spike Parameters	NA
Spike Level(s)	NA
Surfaces Spiked	NA
Surface-Specific Interferences Reported	NA
Environmental Conditions During & after Dissemination	NA
Weathering period prior to/after collection	NA
<b>Technical Approach- Collection</b>	
Interference Background	NA
Collectors Used	NA
Collection Time	NA
Percent Collected	NA
Collection Delay	NA
<b>Technical Approach- Sample Preparation</b>	
Percent Recovery	NA
Percent Retention	NA
Method/Process Metrics	NA
Concentration/Method Losses	NA
Method Interferences	NA
Matrix Interferences	NA
Sample Archive	NA
<b>Technical Approach- Analytical Information</b>	
Instrumental Methods/Parameters	NA
Percent Match/Similarity	NA
Confirmation	NA
Negative Controls	NA
Positive Controls	NA
Detection Limits	NA
Unusual Skills, Equipment, etc...	Evaluators with at least four years of HAZMAT and/or fire service experience and trained to the OSHA operations level or higher, have previous experience with MSM detectors, be willing to sign a non-disclosure agreement/conflict of interest statement, have not participated in a SAVER focus group or assessment within the last twelve months, and physically able to complete the required tasks while wearing National Fire Protection Association (NFPA) 1991 vapor-protective ensemble (Level A) PPE.
Instrument Model(s)	NA
Instrument Performance Standards	NA
<b>Personal Protection/Decontamination</b>	
Equipment Type	NA
Protection Duration	NA

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Hazard Types	NA
Decon Volume Applied	NA
Threat Mass	NA
Decon Reaction Time	NA
Decon Efficacy	NA
<b>Algorithms &amp; Statistical Information</b>	
Algorithms Used	See <a href="#">Appendix A</a> for the Evaluator Debriefing Questions. See <a href="#">Appendix B</a> for the scoring methodology and the composite score formula. See <a href="#">Appendix C</a> for the MSM scoring tabulations. See <a href="#">Part E</a> . Assessment Scoring <a href="#">[p. 9]</a> for a description of the Sample Spider Chart in <a href="#">Figure 2.1</a> .
Precision & Accuracy	NA
Software Required	Pre-loaded software
Statistical Method(s)	NA

**Key Figures & Tables (Copy & Paste):**  
**Chemical Equations, Reactions, Stability Curves, Etc...**





Tables and Figures were copied from original document.

**Table 1 MSM Assessment Results**

MSM	Capability Score Maximum: 30	Usability Score Maximum: 25	Affordability Score Maximum: 20	Deployability Score Maximum: 10	Maintainability Score Maximum: 15	Composite Score Maximum: 100
Sirius®	23.3	20.0	15.0	8.2	10.7	77.2
MultiRAE Plus	23.6	18.4	15.0	8.5	11.2	76.7
Scout®	21.8	18.1	14.7	8.2	10.8	73.6
X-am 7000	19.4	15.5	12.9	6.4	9.2	63.4

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**Table 2 Evaluator-Identified Advantages and Disadvantages**

MSM	Advantages	Disadvantages
 <p><b>Sirius®</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Easy-to-see red protective boot</li> <li>• Large, easy-to-read screen</li> <li>• Simple, easy-to-scroll menu</li> <li>• Quick reference guide affixed in case lid</li> <li>• Necessary components easily fit in single case</li> <li>• Ergonomic design</li> <li>• Good visual and audible alarms</li> <li>• Wrist strap</li> <li>• Tubing has secure locking mechanism</li> <li>• Required tools are included in kit</li> </ul>	<ul style="list-style-type: none"> <li>• Insecure case locking mechanism</li> <li>• Display screen easily covered by hand</li> <li>• User manual only on compact disc (CD)</li> <li>• Battery removal exposes electronics board</li> <li>• Battery charger light indicator not easily seen</li> </ul>
 <p><b>MultiRAE Plus</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Easy-to-see yellow protective boot</li> <li>• Small, compact design</li> <li>• Strong power pump</li> <li>• User-friendly manual</li> <li>• Easy filter change</li> <li>• Tool pack included with kit</li> <li>• Easy calibration</li> <li>• Necessary components easily fit in case</li> </ul>	<ul style="list-style-type: none"> <li>• Lengthy battery connection cord</li> <li>• Loud power pump</li> <li>• Short wrist strap</li> <li>• Control buttons too close to rubber boot edge</li> <li>• Small display screen</li> <li>• Alarm not loud enough in noisy environment</li> </ul>
 <p><b>Scout®</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Battery pack easy to change</li> <li>• Raised control buttons easy to feel through gloves</li> <li>• User-friendly user's guide and quick reference guide</li> <li>• Easy to calibrate</li> <li>• Necessary components easily fit in case</li> </ul>	<ul style="list-style-type: none"> <li>• Small display sensor labels text</li> <li>• Protective case material causes glare on display screen</li> <li>• Becomes heavy when used with one hand</li> <li>• Short-term backlight illumination</li> <li>• Carbon monoxide (CO) and hydrogen sulfide (H<sub>2</sub>S) readings flash alternately in same place on screen</li> </ul>
 <p><b>X-am 7000</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Pump automatically turns on when sampling plate is attached</li> <li>• Loud chirp alarm</li> <li>• Easy-to-see visual alarm</li> <li>• Good display screen and sensor position</li> <li>• Slightly raised control buttons easy to feel through gloves</li> </ul>	<ul style="list-style-type: none"> <li>• Long warm-up time</li> <li>• Small carry case does not hold all necessary components</li> <li>• Components must be ordered separately</li> <li>• Difficult to follow manual</li> <li>• Display menus are not intuitive to follow</li> </ul>

**Table 2.1 Selected MSM**

<b>MSM</b>	<b>Manufacturer</b>
 <p><b>Sirius® Multigas Detector</b> <i>Photo courtesy of CDP</i></p>	<p><b>MSA</b> P.O. Box 426 Pittsburgh, PA 15230 866.672.1001 <a href="http://www.msanet.com">http://www.msanet.com</a></p>
 <p><b>MultiRAE Plus Monitor</b> <i>Photo courtesy of CDP</i></p>	<p><b>RAE Systems</b> 3775 North First Street San Jose, CA 95134 408.952.8200 1.877.723.2878 <a href="http://www.raesystems.com">http://www.raesystems.com</a></p>
 <p><b>Scout® Multi Gas Monitoring System</b> <i>Photo courtesy of CDP</i></p>	<p><b>Scott Health &amp; Safety</b> P.O. Box 569 Monroe, NC 28111 704.291.8300 1.800.247.7257 <a href="http://www.scotthealthsafety.com">http://www.scotthealthsafety.com</a></p>
 <p><b>X-am 7000 Multi-Gas Detector</b> <i>Photo courtesy of CDP</i></p>	<p><b>Draeger Safety</b> 101 Technology Drive Pittsburgh, PA 15275 412.787.8383 1.800.858.1737 <a href="http://www.draeger.com">http://www.draeger.com</a></p>

**Table 3.1 MSM Assessment Results**

<b>MSM</b>	<b>Capability Score</b> Maximum: 30	<b>Usability Score</b> Maximum: 25	<b>Affordability Score</b> Maximum: 20	<b>Deployability Score</b> Maximum: 10	<b>Maintainability Score</b> Maximum: 15	<b>Composite Score</b> Maximum: 100
<b>Sirius®</b>	23.3	20.0	15.0	8.2	10.7	77.2
<b>MultiRAE Plus</b>	23.6	18.4	15.0	8.5	11.2	76.7
<b>Scout®</b>	21.8	18.1	14.7	8.2	10.8	73.6
<b>X-am 7000</b>	19.4	15.5	12.9	6.4	9.2	63.4

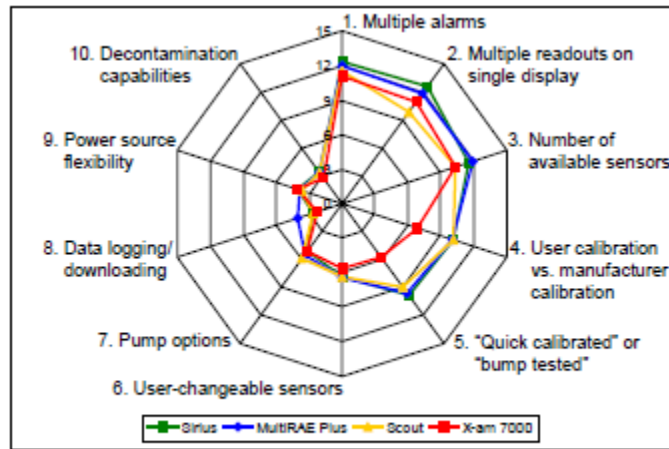


Figure 3.1 Capability Criteria Scores

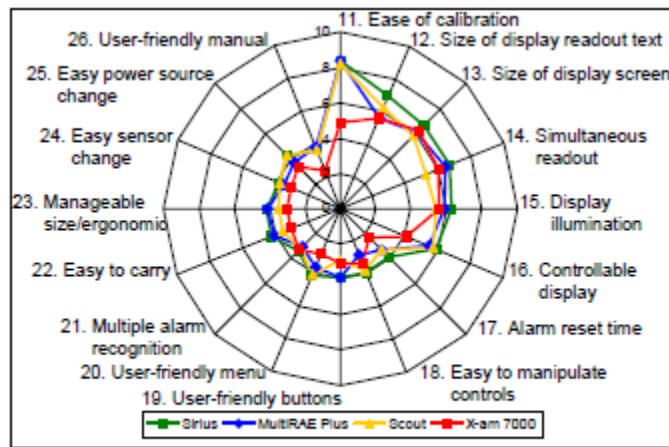


Figure 3.2 Usability Criteria Scores

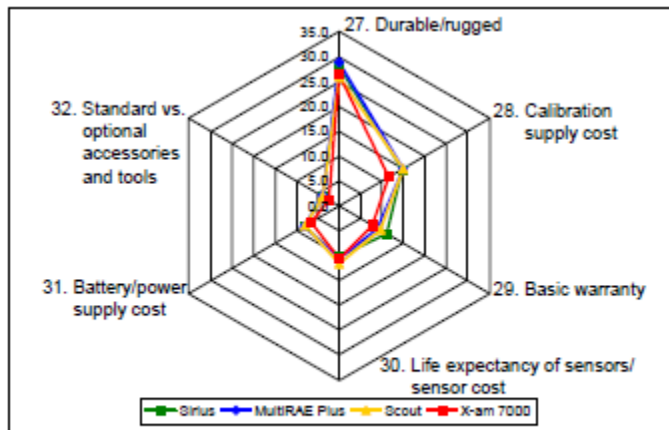


Figure 3.3 Affordability Criteria Scores

Table 3.2 MSM Detector and Accessory Cost

MSM	Total Cost	Sensors					Calibration Kit	Rechargeable Batteries	Battery Charger	Alkaline Battery Pack	Sampling Wand and Tubing	Carry Case
		LEL	PID	CO	O <sub>2</sub>	H <sub>2</sub> S						
MSA Sirius® Multigas Detector (AL111C0133R104)	\$4,387	\$180	\$250	\$190	\$170	\$190	\$575	\$240 (Price includes Li-Ion battery pack, battery charger, and alkaline battery pack)			\$121	\$199
RAE Systems MultiRAE Plus Monitor (009-3121-014)	\$4,185	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scott Health & Safety Scout® Multi Gas Monitoring System (096-2561-43)	\$4,888	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Draeger Safety X-am 7000 Multi-Gas Detector (4552282)	\$6,768	\$395	\$1,025	\$290	\$199	\$290	\$520	✓	✓	\$400	\$39 (probe only)	\$85

\* The checkmark (✓) indicates that the components are included in the kit.

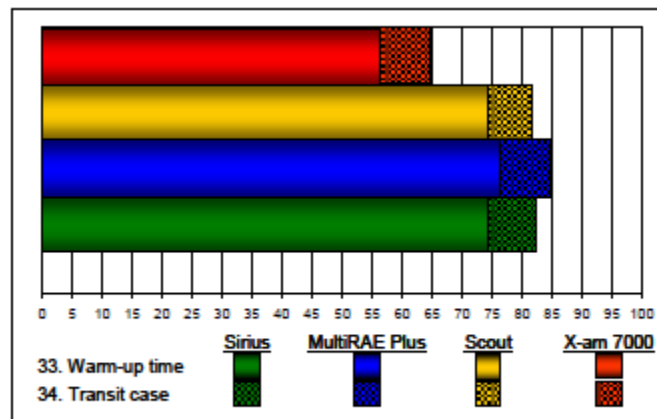


Figure 3.4 Deployability Criteria Scores

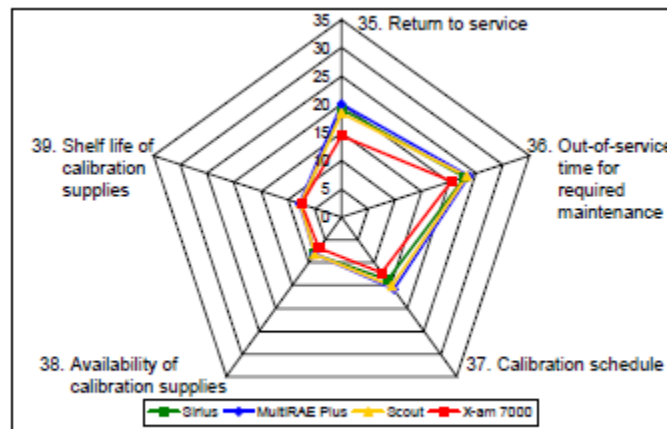





Figure 3.5 Maintainability Criteria Scores




**Table 4.1 Evaluator-Identified Advantages and Disadvantages**

MSM	Advantages	Disadvantages
 <p><b>Sirius®</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Easy-to-see red protective boot</li> <li>• Large, easy-to-read screen</li> <li>• Simple, easy-to-scroll menu</li> <li>• Quick reference guide affixed in case lid</li> <li>• Necessary components easily fit in single case</li> <li>• Ergonomic design</li> <li>• Good visual and audible alarms</li> <li>• Wrist strap</li> <li>• Tubing has secure locking mechanism</li> <li>• Required tools are included in kit</li> </ul>	<ul style="list-style-type: none"> <li>• Insecure case locking mechanism</li> <li>• Display screen easily covered by hand</li> <li>• User manual only on CD</li> <li>• Battery removal exposes electronics board</li> <li>• Battery charger light indicator not easily seen</li> </ul>
 <p><b>MultiRAE Plus</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Easy-to-see yellow protective boot</li> <li>• Small, compact design</li> <li>• Strong power pump</li> <li>• User-friendly manual</li> <li>• Easy filter change</li> <li>• Tool pack included with kit</li> <li>• Easy calibration</li> <li>• Necessary components easily fit in case</li> </ul>	<ul style="list-style-type: none"> <li>• Lengthy battery connection cord</li> <li>• Loud power pump</li> <li>• Short wrist strap</li> <li>• Control buttons too close to rubber boot edge</li> <li>• Small display screen</li> <li>• Alarm not loud enough in noisy environment</li> </ul>
 <p><b>Scout®</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Quick warm-up time</li> <li>• Battery pack easy to change</li> <li>• Raised control buttons easy to feel through gloves</li> <li>• User-friendly user's guide and quick reference guide</li> <li>• Easy to calibrate</li> <li>• Necessary components easily fit in case</li> </ul>	<ul style="list-style-type: none"> <li>• Small display sensor labels text</li> <li>• Protective case material causes glare on display screen</li> <li>• Becomes heavy when used with one hand</li> <li>• Short-term backlight illumination</li> <li>• CO and H<sub>2</sub>S readings flash alternately in same place on screen</li> </ul>

Continued...

**Table 4.1 Evaluator-Identified Advantages and Disadvantages (Continued)**

MSM	Advantages	Disadvantages
 <p><b>X-am 7000</b> Photo courtesy of CDP</p>	<ul style="list-style-type: none"> <li>• Pump automatically turns on when sampling plate is attached</li> <li>• Loud chirp alarm</li> <li>• Easy-to-see visual alarm</li> <li>• Good display screen and sensor position</li> <li>• Slightly raised control buttons easy to feel through gloves</li> </ul>	<ul style="list-style-type: none"> <li>• Long warm-up time</li> <li>• Small carry case does not hold all necessary components</li> <li>• Components must be ordered separately</li> <li>• Difficult to follow manual</li> <li>• Display menus are not intuitive to follow</li> </ul>

## Chemicals Tested

### Simulants

Isobutylene for calibrating the photoionization (PID) sensor