Homeland Security
Science and Technology

Summary

Remotely Operated Underwater Vehicle Systems

(AEL reference number 03OE-07-RPVS)

Remotely operated underwater vehicle (ROV) systems equipped with underwater imaging technology can be used in conjunction with or in place of a dive team. In many cases, a system can perform an operation more quickly than a dive team. These systems—consisting of a submersible ROV, umbilical, and control console—can support both sonar and video technologies for side-by-side visual and acoustic display. Applications for ROV systems may include:

- Inspecting ship hulls, pier pilings, and bridges;
- Directing divers to an area of interest;
- Recovering evidence that was discarded in a body of water; and
- Inspecting an object or area of interest before deploying divers.

In order to provide emergency responders with information on currently available ROV systems, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic conducted a comparative assessment of ROV systems for the System Assessment and Validation for Emergency Responders (SAVER) Program in August 2010. Detailed findings are provided in revision A of the *Remotely Operated Underwater Vehicle Systems Assessment Report*, which is available to registered responders by request at https://www.rkb.us/saver.

Background

This summary is for revision A of the *Remotely Operated Underwater Vehicle Systems Assessment Report*, (February 2012). The original January 2011 report has been revised due to inconsistencies found after publication of the report. Due to these inconsistencies, the assessment results for the affordability category are not included in the assessment report or this summary. In addition, errors regarding the actual model numbers and options assessed were corrected; descriptions of the systems, as assessed, can be found in the assessment report. Vendors should be contacted for current information on models, accessories, options, prices, warranties, and support.

Assessment Methodology

Prior to the assessment, eight emergency responders were chosen from various jurisdictions to participate in a focus group. Participants possessed strong backgrounds in marine patrol or underwater search and rescue. The group recommended product selection criteria, vendors, and possible scenarios for the assessment; however, their primary objective was to identify evaluation criteria.

After identifying evaluation criteria, the focus group assigned each criterion 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 represent the level of each category's importance relative to the other categories.

Based on focus group recommendations, market research, and equipment availability, the following systems were selected for assessment:

- LBV300-5, SeaBotix Inc.;
- Pro 4PS 300SE, VideoRay® LLC;
- Seamor 300F, Seamor Marine Ltd.; and
- Outland 1000, Outland Technology Inc.

Five emergency responders served as evaluators for this assessment. All evaluators had at least 16 years of experience in law enforcement, fire service, emergency services, or underwater search and rescue operations.

SAVER Category Definitions
Affordability groups criteria related to life-cycle costs of a piece of equipment or system.
Capability 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 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 groups criteria related to the maintenance and restoration of a piece of equipment or system to operational condition by responders.
Usability 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.

During the assessment, evaluators rated the ROV systems based on the evaluation criteria established by the focus group. The assessment was separated into two phases: the specification assessment and the operational assessment. Evaluators assessed the systems based on vendor-provided information during the specification assessment. Hands-on experience setting up and configuring the systems for use, operating the systems in controlled and uncontrolled environments, restoring the systems to pre-deployment condition, and repackaging the systems for storage served as the basis for the operational assessment.

Assessment Results

All four ROV systems scored favorably overall. Table 1 displays the composite assessment scores as well as the category scores for each system. Higher scores indicate a higher rating by evaluators. The advantages and disadvantages of each system, as identified by evaluators, are listed in table 2. To view how each ROV system scored against the evaluation criteria assigned to the SAVER categories, see table 3.

Throughout the assessment, the evaluators stated that, most importantly, an ROV system should be easy to put into service, be easy to maneuver, and have a user interface that is easy to use. Evaluators also made the following common observations regarding the assessed ROV systems:

- The depth ratings of the four ROV systems were considered more than adequate for most applications.
- Maintenance training would be required in order to perform field upgrades to the assessed ROV systems. All four vendors offer maintenance training at an additional cost; evaluators felt this training should be included in the initial cost of an ROV system.
- All four vendors offer customer-site training; evaluators considered this beneficial and important to agencies with large dive teams.

Emergency responder agencies that may be considering the purchase of an ROV system should review the detailed findings provided in revision A of the *Remotely Operated Underwater Vehicle Systems Assessment Report* and carefully consider each system's overall capabilities and limitations in relation to their jurisdiction's operational needs.

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

Table 1. ROV System Assessment Results

System	Composite Score	Capability (32.5% Weighting)	Deployability (15% Weighting)	Maintainability (12.5% Weighting)	Usability (40% Weighting)
LBV300-5	**3.9**	4.0	3.7	3.7	3.9
Pro 4PS 300SE	**3.4**	3.3	4.0	3.0	3.3
Seamor 300F	**3.3**	3.5	2.9	3.0	3.4
Outland 1000	**3.1**	3.4	3.1	3.1	3.0

Table 2. ROV System Advantages and Disadvantages

System	Advantages	Disadvantages
LBV300-5 Composite Score: 3.9	- Easy to maneuver the submersible ROV - Auto heading worked well - System size and weight - Control console layout and weather resistance - Display readable in direct sunlight 24/7 technical support at no cost - Comprehensive technical manuals and maintenance kit	- Changing/replacing the center thruster is labor intensive - Thruster power low for use in strong currents - No still image capture
Pro 4PS 300SE Composite Score: 3.4	- System size and weight - Easy to maneuver the submersible ROV - Operating temperature range - Easy to record and capture still images - Reserve power capacity - Image quality	- Umbilical connector strength - Technical support - Field maintenance requires training - Graphical user interface (GUI) uses overlapping windows - Auto heading did not perform well - No lateral thrusters - Manipulator arm/grabber
Seamor 300F Composite Score: 3.3	- Layout of controls - Easy to maneuver the submersible ROV - Automatic and manual zoom and focus - Thruster power - Manipulator arm/grabber rotates - Optional altimeter	- Bend radius and tensile strength of the umbilical - Difficult to connect the umbilical to the submersible ROV - Durability of Teflon® studs and float - Weather resistance - No split-screen capability - Manipulator arm/grabber mounting interferes with camera rotation
Outland 1000 Composite Score: 3.1	- Durable, open frame with easy access for performing maintenance - Interchangeable thrusters with magnetically coupled propellers - Comprehensive digital video recorder (DVR) with character generator	- Control console weather resistance - System size, weight, and portability - Display visibility - No still image capture - Manipulator arm/grabber mounting position interferes with camera

Table 3. ROV System Criteria Ratings[1]

Criteria	LBV300-5	Pro 4PS 300SE	Seamor 300F	Outland 1000
Capability				
Thrusters	◕ ◕	◑ ◕	● ◕	◑ ◕
Basic instrumentation	◕ ◕	◑ ◕	◕ ◕	◑ ◕
Depth rating	◕ ◕	◕ ◕	◕ ◕	◕ ◕
Umbilical characteristics	● ◕	●	◔ ◔	◕ ◕
Camera	◕ ◕	◑ ◕	◕ ◕	◑ ◕
Video output	◕ ◕	◕ ◕	◕ ◕	◕ ◕
Expandability	◕ ◕	◕ ◕	◕ ◕	◕ ◕
Advanced instrumentation	◕ ◕	◑ ◕	◑	◔ ◔
Deployability				
Power	◑ ◕	● ◕	◑ ◕	◑ ◕
Portability	◕ ◕	● ◕	◕ ◕	◑ ◕
Submersible ROV launch and recovery	◕ ◕	●	◑ ◕	◑ ◕
Size	◕ ◕	◕ ◕	◑ ◕	◑ ◕
Weather resistant	● ◕	●	◔ ◔	◑ ◕
Easy to assemble	◕ ◕	●	◔ ◔	◑ ◕
Pre-dive procedure	◕ ◕	● ◕	●	◔ ◔
Operating temperature	◑ ◕	◕ ◕	◑ ◕	◑ ◕
Maintainability				
Technical support	●	◔ ◔	◑ ◕	◑ ◕
Technical manual	◕ ◕	◕ ◕	◕ ◕	◑ ◕
Field upgradable	◑ ◕	◑ ◕	◑ ◕	◑ ◕
Maintenance kit	◕ ◕	◑ ◕	◑	◔ ◔
Time to change/replace	◔	◔	◔ ◔	◕ ◕
Storage temperature	◑ ◕	◕ ◕	◑ ◕	◕ ◕
Decontamination	◕ ◕	◕ ◕	◑ ◕	◕ ◕
Usability ◕				
Maneuverability	◕ ◕	◕ ◕	◑ ◕	◑ ◕
Training	◕ ◕	◕ ◕	◑ ◕	◑ ◕
Intuitive controls	◕ ◕	◑ ◕	◕ ●	◕ ◕
User guide	◕ ◕	◑ ◕	◕ ◕	◕ ◕
Portable topside control	◕ ◕	◕ ◕	◑ ◕	◑ ◕
Auto altimeter	◔	◑ ◕	◑ ◕	◑ ◕
Auto depth	◕ ◕	◕ ◕	◕ ◕	◑ ◕
Auto heading	● ◕	○ ◔	◑	◔ ◔
Display	● ◕	◕ ◕	◕ ◕	◑ ◕
Video recording	◕ ◕	◕ ◕	◕ ◕	◕ ●
Video overlay	● ◕	◑ ◕	◑	◔ ◔
Video/photo settings	◕ ◕	◑ ◕	◕	◔ ◔
Positioning technology	◑ ◕	◑ ◕	◑ ◕	◑ ◕
Intuitive software	◕ ◕	◑ ◕	◑ ◕	◑ ◕
Reel type	◕	◔ ◔	◕ ◕	◑ ◕

Note:

[1]   Averaged criteria ratings for each assessed product are graphically represented by colored and shaded circles. Highest ratings are represented by full green circles.