USCG

ROV Tactics, Techniques and Procedures Development

Program Review and Recommended Guidelines

Presented to: Kenneth McDaniel (G-OPD)

Presented by: Bob Christ, SeaTrepid

Appendix I – USCG ROV After Action Report dated December 2004

2333 Jones Road
Pottstown, PA 19465 USA
Phone/Fax: (610)469-1730

January 10, 2005

Kenneth McDaniel
USCG G-OPD
2100 Second Street, S.W.
Washington DC 20593-0001
Phone: (202)267-4083

Subject: Review of ROV TTP Development Program and Recommended Guidelines

Mr. McDaniel:

SeaTrepid has recently completed procedural testing of ROV systems at MSSTs 91101 and 91103. Attached please find a summary of those operations as well as some recommendations for incorporating the ROV-based inspection/security systems for the USCG.

The report is divided into 2 basic components:

1) Summary of the ROV TTP development program to-date
2) Some specification guidelines as to what can reasonably be expected from a USCG ROV-based security system

This report is from the contractor's point of view without access to internal USCG documentation. The views expressed within this report are those of the author's and SeaTrepid ONLY. This report is produced as a courtesy provided by SeaTrepid outside of the terms of the contract during TTP development operations. The report [as well as the accompanying video presentation] is the property of SeaTrepid with all rights reserved.

Sincerely,

Robert D. Christ

Attachment

EXECUTIVE SUMMARY

The purpose of this report is to summarize the development program for the USCG's ROV Tactics, Techniques and Procedures Manual for inclusion into the USCG's Port Security Manual. Along with this report is a summary of the author's estimation of reasonable expectations from ROVs used for underwater port security tasks.

At the termination of SeaTrepid's implementation task for the USCG's VideoRay ROV program, a report was written dated December 10, 2003 addressed to Mr. Bill Nagy of G-OPD. In that report were some recommendations to further the implementation of Unmanned Underwater Vehicles (specifically manufacturer non-specific ROVs) into the USCG's Underwater Port Security Tasks. One of those recommendations was the development of Standard Operating Procedures for accomplishing a basket of tasks in furtherance of the USCG's mission. In July, 2004, a proposal was generated by SeaTrepid to develop such SOPs that were then tested during a 2-week period at MSST San Pedro and MSST Seattle in December, 2004.

The product of this program is the development of a manufacturer non-specific manual for ROV deployment as well as SOPs, training materials and PQSs for qualifying personnel on this equipment.

A requirement of underwater port security is the delivery of a set of human eyes into an underwater location so as to make final identification of items of interest. With an ROV system, these eyes may be placed into a remote location so as to minimize the risk of personnel placed in hazardous environments (i.e. remote from the hazards of temperature, hyperbarics, moving machinery and other underwater hazards).

As with any new class of vehicle, the deployment of ROV systems involves certain tactics, techniques and procedures in order to fully utilize the equipment and bring back results for the end customer. Although this is a powerful tool, it is still a machine subject to operator experience, equipment capabilities and environmental factors that could limit its usefulness. The vehicles are a compromise of cost, size and power. A larger ROV system will accomplish many more tasks than would a smaller system due to its ability to muscle to a location [through currents, distance offset and around obstructions] with the attached camera. But a larger vehicle may not fit aboard the vessel of opportunity (ex. a 25' Response Boat or other small deployment platform). A very small ROV system may not pull its own tether to the inspection site. Low water visibility will vastly increase the level of time and difficulty of completion of the inspection task.

As an integral part of this report is an accompanying DVD with edited clips of the tests conducted demonstrating from the submersible's view the concepts put forth in this report. In the later sections of this report, a matrix is developed so as to guide operational tasking personnel as to what can reasonably be expected from different classes of ROV systems as well as operator experience requirements and approximate times to complete a list of mission tasks.

Appendix I – USCG ROV After Action Report dated December 2004

I. Review of This Project

A. Previous After Action Review

The USCG purchased a total of 4 VideoRay ROV systems along with certain acoustic positioning accessories in 2002/2003 for delivery to MSSTs 91101, 91102, 91103 and 91104. SeaTrepid was tasked with training the local personnel for usage of the equipment. During the training and implementation of those systems, personnel were trained only on the functions of the system. It quickly became apparent that each location had to make up procedures to accomplish their mission task(s).

Please refer to SeaTrepid's December 10, 2003 memo addressed to G-OPD's Bill Nagy. In that memo, SeaTrepid recommended developing a task list of underwater port security missions then testing each to develop suggested procedures most likely to produce the desired results. This program is a furtherance of those recommendations.

B. Concepts of this program

Within the mandate for this project were protocols demanding all TTPs be manufacturer non-specific so that the USCG would not be tied to any single manufacturer of ROV equipment. In the proposal, SeaTrepid suggested testing all techniques on a variety of ROV systems in the small "Observation Class" category so as to gain confidence as to these procedures' applicability through a range of ROV sizes and capabilities. A total of 6 small ROV systems were tested during this project. These 6 systems are:

1. Outland 1000
2. Indel GNOM
3. VideoRay Pro II (owned by the USCG)
4. Benthos StingRay Mark II
5. Seabotix LBV150S
6. Inuktun Seamor

The systems fell into 3 general "observation class" categories based upon size and thrust: Small, Medium and Large. The manufacturer-supplied specifics of these systems are as follows:

System and Parameter	Outland 1000	Indel GNOM	VideoRay Pro II	Benthos StingRay	SeaBotix LBV150S	Inuktun Seamor
Depth Rating:	500 ft.	330 ft.	500 ft.	1150 ft.	500 ft.	1000 ft.
Length:	24 in.	10 in.	14 in.	39 in.	21 in.	18.6 in
Width:	15 in.	7 in.	9 in.	18 in.	9.65 in.	14 in
Height:	10 in.	6 in.	8 in.	18 in.	10 in.	14 in
Weight in air:	39 lbs.	4 lbs.	8 lbs.	70 lbs.	24 lbs.	40 lb
Number of Thrusters	4	3	3	4	4	4
Lateral Thruster	Yes	No	No	Yes	Yes	No**
Approx. Bollard Thrust	25 lbs.	2 lbs.	5 lbs.	23 lbs.	9 lbs.	12 lbs.
Tether Diameter	.52 in.	.12 in.	.44 in.	.65 in.	.30 in	.35 in.
Rear Camera (as tested)	No	No	Yes	No	No	No
Side Camera (as tested)	No	No	No	Yes	No	No
Generator Requirements	3 kW	1 kW	1 kW	3 kW	1 kW	3 kW

** - Seamor possesses lateral thrusting capabilities due to offset of vertical thrusters

The systems divided into their respective sizes based upon the submersible weight and thruster output available to deliver the individual submersibles to their desired work locations. The size assignments were arbitrary based upon systems tested:

Small – submersible weight less than 30 pounds with thruster output less than 10 pounds.
Medium – submersible weight between 30 and 50 pounds with thruster output 10 to 20 pounds.
Large – submersible weight above 50 pounds and/or with thruster output greater than 20 pounds.

The systems tested fell into these categories as follows:
Small – Indel GNOM, VideoRay Pro II and Sebotix LBV150S
Medium – Inuktun Seamor
Large – Outland 1000 and Benthos StingRay

Systems Tested

	
VideoRay Pro II (Owned by USCG)	Seabotix LBV150S
	
Inuktun Seamor	Outland 1000
	
Benthos StingRay Mark II	Indel GNOM

C. General Operating Characteristics of ROV Size Categories

The overall size of the system somewhat determines the payload capacity and ability to carry larger [more powerful] thrusters. Thruster output determines the vehicle's capability to deliver the submersible to a place where it can capture a useful picture while fighting through currents and pulling its [drag-producing] tether in order to get there. Generally, the larger the submersible, the more powerful are the thrusters available to the system. There are other control, drag and stability considerations such as hydrodynamics of the thruster placement [effecting laminar/turbulent flow through thruster housings], vehicle stability at higher speeds and diameter of tether [circular shapes being the highest drag coefficient shape] being pulled behind the vehicle.

To summarize, vehicle size category determines the physical capability to maneuver into a place to accomplish the task. The viewing from that point is a function of camera coverage (angular view/sight around the vehicle) and distance from the item being inspected (example is water clarity of 5' requires distance of no more than 5'). The larger is the standoff from the work area, the larger is the thrust necessary to pull the tether to that work place. The higher is the current, the larger is the thrust requirement in order to overcome the parasitic drag created from the vehicle plus the drag of the tether.

D. Underwater Port Security Needs

For the purposes of this report, underwater port security tasks fall under 2 broad categories:
1) Search and Identification of underwater items of interest, and
2) Deterrence of placement of threats within the security area

Deterrence is outside the purview of this report. Search and identification of underwater items is accomplished through 4 basic steps:
1) Research to define the area of interest (intelligence, witness interview/last seen point, survey data, etc.)
2) Wide area search with instruments (imaging and profiling acoustics, magnetic anomaly detection equipment, radiological and chemical instrumentation, etc.)
3) Narrow area search with slow-speed instruments (acoustics, magnetics, optical equipment, etc.)
4) Final identification, discrimination and disposition of item (human eyes mounted on delivery platform – i.e. diver or remote camera propelled to the inspection site by some means)

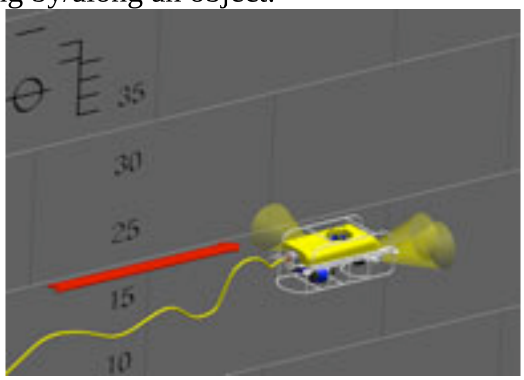
The ROV as a productive and cost-effective means of final item identification, discrimination and disposition is analyzed in this report.

E. ROV as a technology

Underwater vehicle categories break down generally into "Manned" and "Unmanned". Unmanned Underwater Vehicles (UUV) breaks down into Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV) based upon the presence/absence of a tether to control the operation (ROV being tether operated). ROVs break down into Observation Class (OCROV) and Working Class (WCROV) based upon the horsepower of the system (Working Class ROVs are typified by large hydraulic/electrical motors and heavy industrial applications).

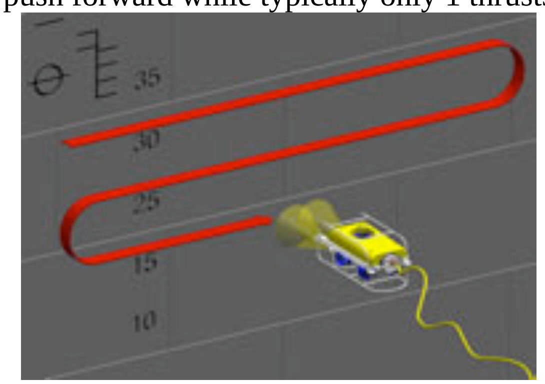
Due to the inability of radio frequency waves to penetrate water more than a few wavelengths, in order to obtain video feedback [under current technologies] a hard-wire is required for real-time video signal and vehicle control. In close quarters (such as with hull inspections, pier/mooring/anchor inspections and the like), ROVs appear to be suited for the USCG's remote-inspection Underwater Homeland Security tasks.

Generally, a video signal is generated from a panning and/or tilting camera located on the front of the submersible. The wider the angle of the camera, the higher the area of coverage with the offset of image distortion for very wide angle lenses. A rear camera is helpful in order to determine the orderly lay of the tether behind the vehicle. A side or top-facing camera is also useful in further imaging objects while the vehicle is swimming by/along an object.



ROV swimming a hull with side-facing camera (Graphic by Benthos, Inc.)

Lateral thrusters are also useful for viewing walls while thrusting with the caveat that lateral thrusting presents a much higher drag profile with less thrust capability (normally 2 thrusters push forward while typically only 1 thrusts laterally).



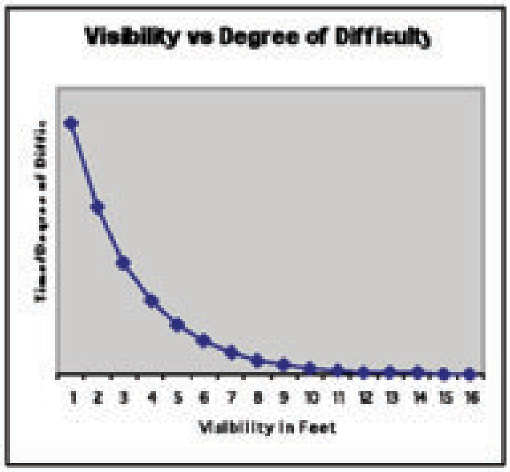
ROV swimming laterally along a hull (Graphic by Benthos, Inc.)

F. Basics of Environment of Underwater Ports

The underwater environment of ports within the USA (and the remainder of the world) varies greatly in temperature, water clarity, operating currents and vessel traffic. The environment in Seattle, WA (cold deep water, good visibility, moderate currents, moderate vessel traffic) varies greatly from the Port of New Orleans (warm deep water on the Mississippi River, very poor visibility, very high currents, moderate vessel traffic), the Port of Galveston (warm shallow water, very poor visibility, low currents, low vessel traffic) and New York Harbor (cold shallow water, poor visibility, high currents, high vessel traffic).

The environmental factors determining the difficulty of completing an underwater port security task with an ROV system are as follows:

- **<u>Currents</u>** – determine the ability of the submersible to successfully swim to and station-keep near a fixed object while countering these currents.
- **<u>Water Depth</u>** – determines the offset from the deployment [water insertion] point to the bottom for bottom clearance searches as well as proximity of bottom to vessels/moorings/anchors/piers.
- **<u>Vessel Traffic</u>** – determines the relative security of the inspection operation (a more secure location produces an easier inspection task).
- **<u>Water Temperature</u>** – determines the “reluctance” of a dive team to enter that environment.
- **<u>Water Clarity</u>** – determines the degree of difficulty in completing the underwater task as well as the time to fully image the items of interest.



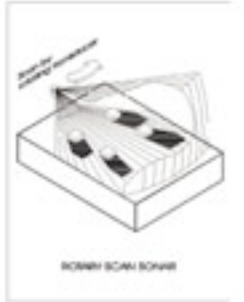
Degree of Difficulty and Time Requires versus Water Clarity

G. Navigation Accessories Available for Underwater Port Security Tasks

There are several technologies available for achieving underwater positioning and target acquisition for further investigation. This author is most familiar with acoustical methods – which will be discussed here.

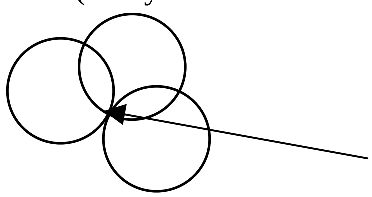
Most common ROV-mounted acoustical systems involve imaging sonar and acoustic positioning.

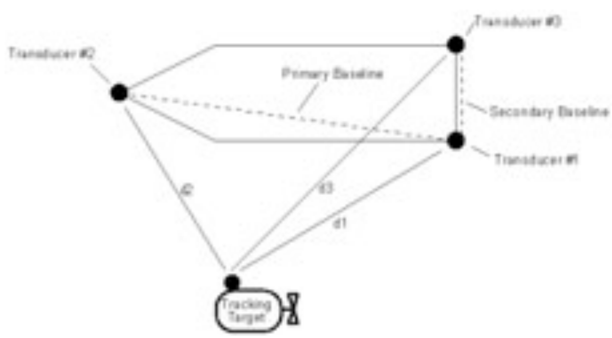
<u>Imaging Sonar</u> – Imaging sonar is useful in underwater port security tasks in identifying items of interest by producing a sonar reflection or a blockage [which produces a sonar shadow]. Imaging sonar manufacturers have been able to miniaturize the sonar unit to fit aboard practically all sizes of ROV systems. In order to get a high-resolution image of a small target at a nominal range of, for instance, 50 feet, most manufacturers use a high-frequency sonar with a fan beam in the 600 to 800 kHz range. This allows most suspicious items on the bottom underneath vessels to be imaged on sonar if they protrude off of the bottom.



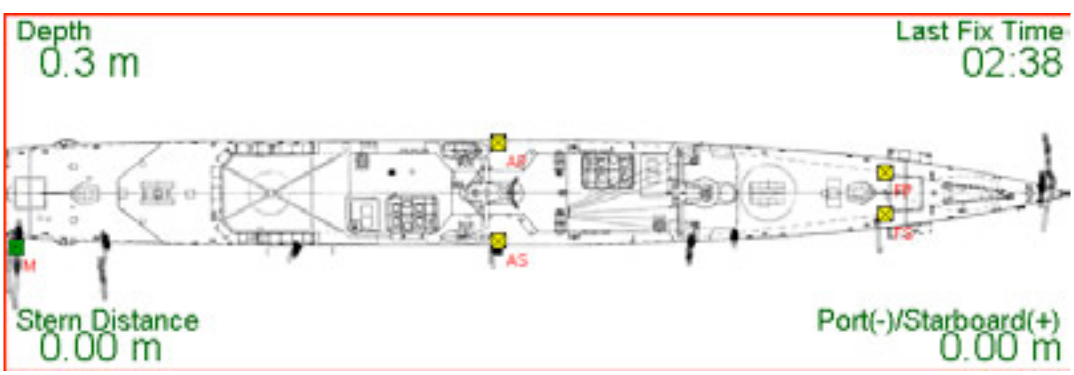
Rotating Sonar Head Images Items on Bottom (graphic by Imagenex Technology Corp.)

Acoustical Positioning – This type of positioning system calculates range away from a submersible-mounted transducer to other transducers at known locations with know spacing. This allows for accurate range calculation (with adjustment for water temperature/salinity/density) by computing round-trip timing. Bearing is resolved through triangulation of the timing differences across the transducer array (i.e. merging point of the separate lines-of-position). In order to resolve relative bearing to magnetic bearing, a magnetic transducer array orientation needs to be determined (easily done in software with a flux-gate compass outputting standardized data streams). In order to resolve relative location to geo-referenced location, an accurate lat/long must be determined (easily done with GPS outputting standardized data streams).





Short Baseline Positioning Setup as Implemented on RB-HS (graphic by Desert Star LLC)



Ship Hull Files as Implemented with MSSTs (graphic by Desert Star LLC)

The vessel-referenced acoustical positioning system is similar to the geo-referenced short baseline system except that the transducer array is placed on a measured drawing of the target vessel with all transducer placements calculated based upon that scaled drawing.

Difficulties Involved with Sonar and Acoustical Positioning – The major issue involved with ROV-mounted imaging sonar is image interpretation. A basic "hole in the water" can either be identified by acoustic reflection or by acoustic shadow. Unfortunately, image interpretation is in most cases counter-intuitive and requires instruction into sonar theory and application. Further difficulties are peculiar to very small ROV systems due to the vehicle movement during image generation. This is the so-called "Image Smear" from moving the vehicle/sonar platform before the full image is allowed to generate.

Acoustical Positioning within a port environment is problematic. A port, by its location and function, is a very noisy acoustical environment. Broadband noises bounce around the water space causing false narrow-band reception reducing the signal to noise ratio of the primary positioning signal. Multi-path errors also cause difficulty (a narrow band sound bouncing between a hull and a pier wall can spoil round-trip sound calculations due to false reception).

With all of the difficulties associated with these technologies, these remain powerful tools to accomplish port security tasks with proper training and implementation.

H. ROV Techniques for Accomplishing Underwater Port Security Tasks

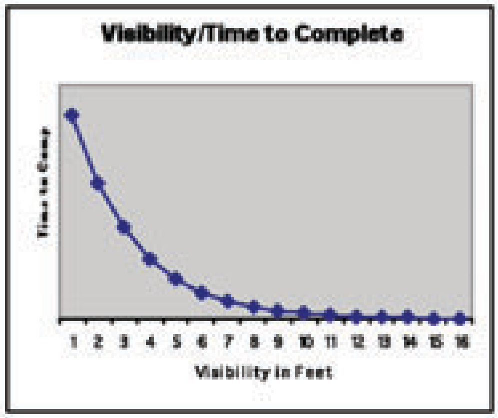
ROV-based Underwater Port Security tasks involve 2 broad categories of inspections:

- Identification of items trapped/located by other means, and
- Imaging areas so as to clear the inspection area of "suspicious items".

It is possible to "luck upon" an item of interest while making random searches of an area of interest. However, it has been found to be of decreasing marginal return to do unstructured searches of suspect areas. As water visibility decreases, a high degree of certainty that an area of interest has been cleared [with all suspicious items discovered] becomes increasingly difficult, as does positive navigation through the search area. In order to construct a maximum risk/benefit model of search time covering the high-risk exposure, a combination of tools and techniques must be used to achieve best results.

Hull Searches – The highest risk sections of commercial and military sea-going vessel hulls are isolated to a limited set of landmarks located on the hull of these vessels. Those can be actively located in a relatively short period of time thereby quickly eliminating the high-risk areas. Thereafter, a search pattern can be implemented to image and cover a set percentage of the hull area.

One hundred percent visual hull coverage is exceedingly difficult to achieve due to navigational considerations as well as environmental factors with the time-requirement line turning nearly vertical as the water visibility nears zero. It has been this author's experience that the 80/20 rule applies in hull inspection cases whereby 80% of the hull can be inspected in 20% of the time it would take to achieve full hull coverage. The last 20% of hull coverage is the most tedious, time-consuming and requires the remaining 80% of the total time needed to achieve full coverage.



Visibility versus Time to Complete Inspection Task

<u>Under-Vessel Bottom Searches</u> – Achieving bottom clearance beneath berthing of large vessels is quite time-consuming without the usage of imaging sonar to identify items of interest. Bottom visibility conditions become difficult due to bottom stirring from vessel traffic, ROV submersible thrusters as well as silt movement from tidal flows. The time/benefit results could be enhanced by discrimination of items to isolate “items of interest” (with imaging sonar, magnetometer and other instruments) then positively identifying same (with ROV-mounted camera) thereby eliminating these as threats.

<u>Pier/Mooring/Anchor Searches</u> – Identification of the threat could aid in lowering the time spent searching Pier/Mooring/Anchor areas. The further away from the high-value asset the item to be inspected resides, the lower is the likelihood a threat will be placed in that location. Planning of the operation could take into consideration these factors and limit the time inspecting these lower-risk areas to either cursory or ignored status.

II. Review of This Project

A. Objectives of Operation in San Pedro and Seattle

Mandated from this project was the development of a series of “best practices” involving a series of underwater port security tasks then testing of it over a range of ROV equipment.

The mandated tasks culled down to the following major areas:

- Ship Hull Searches (Pier-side and at Anchor)
- Pier Searches
- Bottom Searches to Include Directly Under Vessels
- Day and Night Operations
- Inclement Weather Operations
- Launch/Recovery Operations
- Tether Entanglements

During procedures testing, it was quickly noted that the size/power of the individual systems translated into capabilities that fell into the 3 general size categories (small/medium/large as stated earlier in this report).

Distance Offsets with Larger ROV Systems and Launching Issues

Size Comparison Between ROV Systems Tested

The large ROV systems demonstrated their abilities to complete difficult tasks. Some tasks required power to muscle through long offsets as well as strong wind/current combinations causing the smaller systems to fail.

The larger systems, however, were difficult to fit aboard the RB causing difficulty in movement for the crew while underway.

Outland 1000 aboard RB showing excess green tether

<u>Tasks Tested and Performed:</u>
Ship Hull Inspections (Moored/Anchored)
Pier Inspections
Simulated HAZMAT Spills
Simulated Potable Water Environment

Results of Procedures Testing by Sizes:

The power of large systems countered the lack of experience with the operators. The smaller systems took a higher degree of operator proficiency, task planning and tether handler coordination than did the larger systems to accomplish similar tasks. The smaller systems faired better in untangling their tether and in functioning in confined spaces. The results of the tests broke down into a series of what were termed degrees of difficulty:

E – Easy
D – Difficult
VD – Very Difficult
NR – Not Recommended

Example Task Assumes 50' of Tether Offset to Item of Interest

Prevailing Current	***0 kt.***	***.5 kt.***	***1.0 kt.***	***1.5 kt.***	***2.0 kt.***	***2.5 kt.***	***3+ kt.***
Small System	E	D	VD	NR	NR	NR	NR
Medium System	E	E	D	VD	VD	NR	NR
Large System	E	E	E	D	VD	VD	VD

Note: The current and offset decides whether the system can accomplish the task. Visibility decides the time to accomplish this task.

B. Reasonable Expectations from ROVs in Underwater Port Security Tasks

Currently, the USCG operates the VideoRay ROV [which is classed as a small system for this report]. This system may not be able to accomplish all tasks needed during tasking of operations within the field. Below is a list of tasks by size category along with reasonable expectations of completion based upon an average benchmark proficient operator. Benchmarks operators observed were ET1 Jacob Smith at MSST 91103 and MK2 Jon Myer at MSST 91101.

Inherent in these tasking expectations is the clear need to develop a coherent "Threat Definition" so as to avoid wasting time on items that are not significant security risks. Tasking questions include: "Is it necessary to do a full hull inspection or can we limit our search to running gear/sea chests? Are we looking for a 1-pound pipe bomb or a 55-gallon drum filled with toxic substances?" The answers to these questions will dictate the use of the below tasking matrix. This threat definition is not within the purview of this report.

Table of Task Expectations:

P – Possible with Average Proficient Operator
D – Difficult with Average Proficient Operator (possible but time consuming)
X – Difficult or Not Possible with Average Proficient Operator (positive outcome questionable or doubtful)
NA – Non-Applicable

Table of Size Categories [as described in section B. above]:

S – Small ROV
M – Medium ROV
L – Large ROV

The detailed list of tasks is as follows:

Appendix I – USCG ROV After Action Report dated December 2004

[***Note: All ship hull inspection tasks assume an inspection target of a 600’ ocean-going cargo vessel. Sea conditions assume no current. As the current increases from zero, all ROV systems will trend from their nominal state towards the “X” state.]***

Task	S	M	L
Pier/Mooring/Anchor/Hull Search from RB			
[RB3] Tied off to structure			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	P	P	P
[g]Run anchor chain	D	P	P
[h]Acoustically/visually search bottom under vessel	P	P	P
[RB4] Station-Keeping			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	D	P	P
[g]Run anchor chain	D	P	P
[h]Acoustically/visually search bottom under vessel	P	P	P
[RB5] Tied off to different structure and swimming to object (100-foot offset)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	X	D	P
[c]Inspect sea chest(s)	X	D	P
[d]Inspect thrusters	X	D	P
[e]Inspect through-hull fittings	X	D	P
[f]Inspect bulkhead/pilings	X	D	P
[g]Run anchor chain	X	X	D
[h]Acoustically/visually search bottom under vessel	X	D	P
Visual and acoustic hull inspections from vessel			
[Vessel1] Deployed from vessel with RB handling tether (with and w/o acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[RB6] Deployed from RB with tether handled from vessel (with and w/o acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
Visual and acoustic hull inspections from dock			
[Dock1] Deployed from dock with RB handling tether (with and w/o acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P

[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[RB7] Deployed from RB with tether handled from dock (with and w/o acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[RB8] Stationary deployment from RB			
[a]Sub swimming entire ship from single spot – bow	X	D	P
[b]Sub swimming entire ship from single spot – amidships	D	P	P
[c]Sub swimming entire ship from single spot – stern	X	D	P
[RB9] Minimal tether in water from RB			
[a]Station keeping with RB moving along with sub	X	D	P
[b]Move RB from stationary point to point then deploy	D	P	P
[RB10] Longitudinal/Lateral searches from RB			
[a]Longitudinal search from bow	X	D	D
[b]Longitudinal search from stern	X	D	D
[c]Lateral search	P	P	P
[RB11] Section searches (quarter/halve vessel) versus landmark/high-exposure searches			
[a]Obtain "As Built" drawings and perform landmark/high-exposure searches	P	P	P
[b]Full coverage search	NA	NA	NA
[c]Convenience of breaking vessel down into sections versus full ship	NA	NA	NA
[RB13] Adrift versus tied to vessel for hull search			
[a]Drift in current from bow to stern while conducting hull scan	P	P	P
[b]Tie off to bow then do drift scan with sub facing down-current	D	D	D
[c]Tie off to stern in current and do up-current search	X	D	P

Pier/Mooring/Anchor/Hull Search from both shore and vessel

[Dock4] Shore to structure/vessel			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	P	P	P
[g]Run anchor chain	NA	NA	NA
[h]Acoustically/visually search bottom under vessel	P	P	P
[Vessel4] Vessel to Same Vessel			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	P	P	P
[g]Run anchor chain	NA	NA	NA
[h]Acoustically/visually search bottom under vessel	P	P	P
[Vessel5] From vessel swimming to other vessel (100-foot offset)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	X	D	P
[c]Inspect sea chest(s)	X	D	P
[d]Inspect thrusters	X	D	P
[e]Inspect through-hull fittings	X	D	P

[f]Inspect bulkhead/pilings	X	D	P
[g]Run anchor chain	X	D	D
[h]Acoustically/visually search bottom under vessel	X	D	D
Visual and acoustic hull inspections from vessel and shore			
[Vessel6] Deployed from vessel with shore-based handling of tether (with and without acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	P	P	P
[g]Run anchor chain	NA	NA	NA
[h]Acoustically/visually search bottom under vessel	P	P	P
[Dock5] Deployed from shore with tether handled from vessel (with and without acoustics)			
[a]Run bilge keel or keel	X	D	P
[b]Inspect running gear to stuffing block	P	P	P
[c]Inspect sea chest(s)	P	P	P
[d]Inspect thrusters	P	P	P
[e]Inspect through-hull fittings	P	P	P
[f]Inspect bulkhead/pilings	P	P	P
[g]Run anchor chain	NA	NA	NA
[h]Acoustically/visually search bottom under vessel	P	P	P
[Vessel7/Dock6] Stationary deployment on shore and from vessel			
[a]Sub swimming entire ship from single spot – bow	X	D	P
[b]Sub swimming entire ship from single spot – amidships	D	P	P
[c]Sub swimming entire ship from single spot – stern	X	D	P
[Vessel8/Dock7] Minimal tether in water			
[a]Tether handler moving along with sub	P	P	P
[b]Tether handler moving from stationary point to point then deploy	P	P	P
[Vessel9/Dock8] Longitudinal/Lateral searches from vessel and from shore			
[a]Longitudinal search from bow	X	D	P
[b]Longitudinal search from stern	X	D	P
[c]Lateral search	P	P	P
[Vessel10/Dock9] Section searches (quarter/halve vessel) versus landmark/high-exposure searches			
[a]Obtain "As Built" drawings and perform landmark/high-exposure searches	P	P	P
[b]Full coverage search	NA	NA	NA
[c]Convenience of breaking vessel down into sections versus full ship	NA	NA	NA

Please notice the commonality in the above – the smaller the system, the less tether allowed in the water to task failure. Small ROVs are capable of performing a majority of underwater port security tasks. If operational tasking personnel are faced with a need for operations outside of the above parameters, other equipment must be sourced, the feasibility of the task must be reexamined or further time must be allotted to complete the task.

Estimated Time to Complete Task Versus Water Visibility (NR – Not Recommended):

Task	Vis. 1-3	Vis. 3-6	Vis. 6-12	Vis. 12+
Ship Hull Landmark (600' Vessel)	3:00	2:00	1:30	1:00
Ship Hull 80% Coverage	NR	8:00	4:00	1:30
Ship Hull 100% Coverage	NR	NR	10:00	6:00
Pier Sweep (100' x 2 piling deep)	2:00	1:30	1:00	1:00

Bottom Under Vessel (w/sonar)	3:00	1:30	0:45	0:30
Bottom Under Vessel (w/o sonar)	NR	NR	NR	NR

Training Requirements for Implementation

In order to properly implement this capability to the fleet, training and standardization procedures must accompany the equipment into the field. Training comes in 2 basic forms:

Initial Training/Qualification – Initial qualification of personnel on the system

Recurrent Training – Periodic training required to maintain reasonable proficiency

Suggested Table of Training Times for Continued Qualification and Proficiency

Initial Training for Operations, Maintenance and Qualification	3 days
Periodic Recurrent Training in Order to Maintain Basic Proficiency	4 hours/mo.

SUMMARY AND CONCLUSION

ROV technology is allowing the USCG to increase its vigilance of underwater areas within America's ports in a safe, productive and cost-effective manner. Development of "Best Procedures" for deployment of these vehicles will enhance USCG's capabilities, lower its learning curve, and increase its usefulness by allowing for efficient application of personnel resources. Recommended SOPs will be detailed in the upcoming ROV TTP Manual scheduled for March, 2005 publication. Users of this report should gain some insight as to capabilities and limitations of ROV usage in Underwater Port Security Tasks.

Table of Acronyms

ROV	Remotely Operated Vehicle
TTP	Tactics, Techniques and Procedures
MSST	Maritime Safety and Security Team
G-OPD	Director of Operations Policy Defense Operations (USCG)
PQS	Personnel Qualification Standard
RB	Response Boat
USCG	United States Coast Guard
GPS	Global Positioning System
SOP	Standard Operating Procedure
DHS	Department of Homeland Security