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Unmanned Vehicles Systems; Unmanned Vehicle Tactical Memorandum (TM 3-22-5-SW): Report of Findings and Recommendation

31 January 2007

by

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Prepared for: Naval Postgraduate School, Monterey, California 93943

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Abstract

In response to a request by NWDC, the Naval Postgraduate School agreed to research and revise the current Maritime Tactical Memorandum (TACMEMO) TM 3-22-5-SW for unmanned vehicles systems (UVS). The CRUDES fleet would immediately benefit by the removal of Captain's gigs/second RHIB in favor of a unmanned surface vehicle (USV) in order to increase warfighting capabilities. An analysis of N86 CRUDES ROC/POEs revealed no impact to primary or secondary warfighting missions by removing the gig/second RHIB. In today's capabilities-based warfighting, this replacement better supports the global concept of operations. The research was limited to sparsely deployed platforms, developmental project results, and test procedures as delineated in various UV concepts of operations. It was found that the preponderance of UVs remain largely experimental and not integrated into organizational Navy (SMD/FMD) or Marine Corps (TO&E) manpower management documents. The research found that unmanned vehicles are actually part of larger UV systems (which require human operators) and that simply adding UVs does not result in manpower cost savings. Some advantages of UVs are persistent on station time and removal of the human operator from potentially harmful and fatiguing environments. Research indicates that, though still in their infancy, Navy UV's are being employed by naval personnel but closely supported by contractors while operating on Naval platforms and in Naval units. Additionally, the majority of existing UV tactics and training address ISR and undersea missions with no definitive operational doctrine for unmanned combat vehicles (UCV). The report includes an UV acronym list (Appendix B) extracted from publications (Appendix C), a notional launch-and-recovery procedure and a notional estimate of USV manpower requirements and watch organization. Significant consideration must be made in the design and acquisition process as to who will operate these systems. The responsibility and spatial acumen required to operate UVs must be delineated prior to the acquisition phase so as to include key performance parameters (KPP) in unmanned vehicle design. An UV's size, tier of operational employment and payload

play a critical role in determining level of operator autonomy, responsibility (i.e., paygrade) and supervision.

Keywords: UV Manpower, UV Training, USV, UAV, UAS, UUV, UV Tactics, UVS, TACMEMO

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I. Introduction

In response to a request by Naval Warfare Development Command (NWDC) to update the maritime unmanned vehicle (UV) Tactical Memorandum (TM 3-22-5 SW), NWDC commissioned the Naval Postgraduate School (NPS) to review and incorporate recent UV innovations into the TACMEMO. This review first established a baseline of Naval UV projects. The baseline analyzed the literature listed in the reference list and established e-mail exchanges with platforms and activities conducting UV operations. Additionally, research was conducted through Naval Postgraduate School theses; students interviewed activities conducting UV operations that included UAVs operating in combat environments. The lack of actual operational maturity of combat unmanned vehicles significantly impacted the ability to conduct a more in-depth analysis for development and recommendations of proven fleet combat tactics. Unmanned vehicle systems (UVS) fall into four broad categories: unmanned aerial vehicles (UAV), unmanned surface vehicles (USV), unmanned undersea vehicles (UUV), and unmanned ground vehicles (UGV).

Unmanned vehicles systems (UVS) are viewed as a key component of efforts to transform US military forces.[1] Recent US military operations have highlighted the potential of UVS to significantly improve and reshape US military capabilities. Perhaps uniquely among the military departments, the Department of the Navy (DON), which includes the Marine Corps, may eventually acquire a large variety of UVs, including unmanned air vehicles (UAVs), unmanned air combat vehicles (UCAVs—UAVs armed with weapons), unmanned surface vehicles (USVs), unmanned underwater vehicles (UUVs), and unmanned ground vehicles (UGVs).[2]

The GWOT continues to place emphasis on the importance of UAVs. The Fiscal Year 2006 Budget request reflects the commitment to a focused array of UAVs

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[1] Ronald O'Rourke, *Defense Transformation: Background and Oversight Issues for Congress,* CRS report RL 32238 (Washington, DC: Library of Congress, DATE).

[2] Ibid.

that will support and enhance both surveillance and strike missions with persistent, distributed, netted sensors.[3]

The Department of the Navy's plans calls for acquiring UAVs and UCAVs for three primary mission areas: (1) long-dwell, persistent, standoff ISR operations; (2) penetrating surveillance/suppression of enemy air defense (SEAD)/strike operations; and (3) tactical surveillance and targeting operations.[4] These mission areas support primary and secondary missions assigned to Navy platforms required operational capability and projected operational environments (ROC/POE) and doctrine to be executed by Marine Corps units.

An USV is a remotely controlled or autonomous craft that operates on the surface of the water. In the past and currently, carrier and expeditionary strike groups (CSG/ESG) have deployed with Spartan Scout and Seafox USVs under operational and tactical tests.[5] The US Navy has been operating USVs for some time, primarily as surface targets for gunnery exercises such as the QST-33 and QST-35/35A SEPTAR targets, high-speed maneuverable seaborne target (HSMST), and RoboSki.[6] However, these USVs pale in comparison to the new breed of USVs the US Navy is currently testing.

USVs are an integral part of the Navy's transformation to a more agile and networked force. Navy planners foresee USVs operating in littoral areas and protecting the fleet from asymmetric threats, such as terrorists, without subjecting operators to direct harm. USV missions include surveillance and reconnaissance,

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[3] House Armed Services Committee statement, FY2006 Navy/Marine Corps Navy R & D in the support of the GWOT and Future Naval Capabilities, March 2005.

[4] Ibid.

[5] Wayne Gayle, **"**Analysis of Operational Manning Requirements and Deployment Procedures for Unmanned Surface Vehicles aboard US Navy Ships," Working Paper (Monterey, CA: Naval Postgraduate School, March 2006).

[6] Moire Incorporated, "The Growing US Market for USVs," Accessed; Available from http://www.moireinc.com/USVmarketMoire.pdf, 9 July 2003.

force protection, mine detections, and special operations. Undersea warfare (USW) and intelligence collection are some of the possible USV missions.

The USS Pinckney deployed in 2005 with the Navy's AN/WLD-1 remote mine hunting system (RMS), a semi-submerged USV designed to detect submerged mines.[7] The first littoral combat ship (LCS) scheduled to be delivered to the Navy in 2006 is being designed to be able deploy UAVs, USVs and UUVs.[8] The same can be said about the new destroyer DD(X) and cruiser CG(X). Although definitive USV acquisition plans do not exist, the Navy is pursuing several USV developmental programs. The Navy will develop an USV to perform intelligence, surveillance and reconnaissance (ISR) to be deployed from older combatant ships. The ISR USV will possibly replace the standard Navy rigid hull inflated boat (RHIB). It will carry EO/IR sensors, a targeting device, a radar, and line-of-sight (LOS) and over-the-horizon (OTH) communication links. A larger multi-mission version is likely to operate from LCS, DD(X) and CG(X), incorporating technologies developed from Spartan Scout operational testing.

The successful implementation of USVs into the Navy surface fleet will depend on the early and accurate determination of manpower and subsequent personnel assignments. During operational testing of Spartan Scout by USS Gettysburg in 2003, a Personnel man second class was selected as the remote operator because he was the best video game player on board the ship.[9] It is imperative that while development and testing is being conducted on the USV concept, the operational techniques and procedures required for safe and effective operations must be developed as well.

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[7] Robert M. Byron, "Sea Power: Bristling with new gear, USS Pinckney," Accessed; Available from http://www.findarticles.com/p/articles/mi_qa3738.

[8] Littoral Combat Ship Flight 0 Preliminary Design Interim Requirements Document.

[9] LT Matthew Richter, USS Gettysburg. "Spartan Scout Fleet Testing," 2003.

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II. Unmanned Vehicles and Missions

A. Background

Missions assigned to the Department of the Navy as part of National Military Strategy in support of a greater National Security Strategy are delineated in the required operational capability and projected operational environment (ROC/POE) through design capabilities of platforms, staffs and units. The POE describes how an organization will operate in a given environment and under what conditions to fulfill resource sponsor-prescribed primary and secondary missions. These POE statements are further described by ROC elements that are linked to readiness through status of resources and training systems (SORTS) reporting.

Currently, research could not find any Department of the Navy platforms, staffs or units with the design capability to execute any unmanned vehicle missions. The research found the platforms and missions shown in Table 1 fit existing ROC/POEs mission criteria from Expeditionary Warfare N85, Surface Warfare N86 and Aviation Warfare N88.

Platform	Missions
Global Hawk, Predator, Fire Scout, Pioneer, Dragon Eye	ISR
Predator, Fire Scout	ASUW, FP, Strike, USW, MIW
Spartan Scout, Seafox	ASUW, FP, MIW, USW, MIO
RMS/RMV	USW, MCM, MIW

Table 1. Naval UV Platforms and Missions

Currently, UAVs primarily focus on long-dwell, Persistence, standoff ISR, penetrating surveillance, tactical surveillance, targeting, strike, anti-surface warfare

(ASUW) and force protection (FP) missions. These missions are broadly categorized by sizes and associated platforms (not all inclusive) as shown in Table 2.

UAV greater than 17-ft wingspan greater than 14-ft length	**Global Hawk, Predator, Fire Scout**
Small S-UAV 17-ft wingspan 14-ft length	**Pioneer**
Mini M-UAV 6- to 9-ft wingspan 2- to 4-ft length	**Dragon Eye**
Micro UAV (MAV) 6- to 12-in length & width	**WASP**

Table 2. UAV Categories

B. Unmanned Aerial Vehicles (UAV)

1. Global Hawk

The Air Force RQ-4 Global Hawk is a high-altitude, long-endurance UAV designed to provide wide-area coverage of up to 40,000 nm^2 per day. It successfully completed its Military Utility Assessment, the final phase of its advanced technology concept demonstration (ACTD), in June 2000, and transitioned into engineering and manufacturing development (EMD) in March 2001. It takes off and lands conventionally on a runway and currently carries a 1950-lb payload for up to 32 hours. Global Hawk carries both an EO/IR sensor and a SAR with moving-target-indicator (MTI) capability. A Navy maritime version of Global Hawk is to be delivered soon.

RQ-4 Global Hawk/Northrop Grumman/Air Force

Weight:	26,750 lb
Length:	44.4 ft
Wingspan:	116.2 ft
Payload:	1950 lb
Ceiling:	65,000 ft
Radius:	5400 nm
Endurance:	32 hr

Figure 1. Global Hawk

Source: Office of the Secretary of Defense. 2002. *Unmanned Aerial Vehicles Roadmap 2002-2027*, Department of Defense, Washington, D.C., December.

2. Predator

MQ-9 Predator is a larger, more capable, turboprop-engined version of the Air Force MQ-1B/Predator developed jointly by NASA and General Atomics as high-altitude endurance UAV for science payloads. Its initial flight occurred in February 2001. With the capability to carry up to ten Hellfire missiles, the MQ-9 could serve as the killer portion of a MQ-1/MQ-9 hunter/killer UAV team.[10]

MQ-1 Predator/General Atomics/Air Force

Weight:	2250 lb
Length:	28.7 ft
Wingspan:	48.7 ft
Payload:	450 lb
Ceiling:	25,000 ft
Radius:	400 nm
Endurance:	24+ hr

Figure 2. Preditor

Source: Office of the Secretary of Defense. 2002. Unmanned Aerial Vehicles Roadmap 2002-2027, Department of Defense, Washington, D.C., December.

[10] Ibid.

3. Pioneer

The Navy/Marine RQ-2 Pioneer has served with Navy, Marine, and Army units, deploying aboard ship and ashore since 1986. Initially deployed aboard battleships to provide gunnery spotting, its mission evolved into reconnaissance and surveillance, primarily for amphibious forces. Launched by rocket assist (shipboard), by catapult, or from a runway, it recovers into a net (shipboard) or with arresting gear after flying up to 5 hours with a 75-lb payload. The Navy ceased Pioneer operations at the end of FY02 and transferred their assets to the Marine Corps as of fiscal year 2006 budget.

RQ-2 Pioneer

Weight: 450 lb
Length: 14 ft
Wingspan: 16 ft 10 in
Payload: 75 lb
Ceiling: 15,000 ft
Radius: 185 km
Endurance: 5 hr

Figure 3. PQ-2 Pioneer

Source: www.fas.org/irp/agency/daro/uav95/pioneer.html.

4. Fire Scout

The Fire Scout vertical take-off and landing (VTOL) tactical UAV (VTUAV) program is currently in engineering and manufacturing development (EMD) and low rate initial production (LRIP). Five Air Vehicles and four Ground Control Stations are now in Developmental Testing. A significant number of successful test flights have been accomplished demonstrating autonomous flight, tactical control data link (TCDL) operations, Multi-Mission Payload performance and Ground Control Station operations. Fire Scout Tactical Control System developmental testing is scheduled for mid-FY03. With continuing FY03 EMD testing successes, the Navy has recognized the VTUAV program value for the emerging Landing Craft Support series of surface vessels.[11]

[11] Ibid.

RQ-8 Fire Scout/Northrop Grumman/Navy

Weight: 2650 lb
Length: 22.9 ft
Rotorspan: 27.5 ft
Payload: 300 lb
Ceiling: 19,000 ft
Radius: 150 nm
Endurance: 5+ hr

Figure 4. RQ-8 Fire Scout

Source: Office of the Secretary of Defense. 2002. *Unmanned Aerial Vehicles Roadmap 2002-2027*, Department of Defense, Washington, D.C., December.

5. Dragon Eye

Dragon Eye is a mini-UAV (4-foot wingspan and 5-lb weight) developed as the Marine Corps Warfighting Laboratory's (MCWL) answer to the Navy's over-the-hill reconnaissance initiative and the Marines' interim small unit remote scouting system (I-SURSS) requirement. The potential Navy version is referred to as *Sea ALL.* Dragon Eye fulfills the first tier of the Marine Corps' UAV roadmap by providing the company/platoon/squad level with an organic RSTA capability out to 10 km (5 nm).

Dragon Eye

Weight: 5 lb
Wingspan: 18 cm
Payload: 1 lb
Ceiling: 150 m'
Radius: 10 km
Endurance: 1 hr

Figure 5. Dragon Eye

Source: www.defense-update.com/products/d/dragoneyes.

6. WASP

Efforts to create smaller and smaller UAVs has reached the point where the U.S. Navy and Marine Corps are now field testing the seven ounce Wasp Micro Air Vehicle (MAV). This is a flat, rectangular "flying wing" (13 inch wingspan, about seven inches long) that can stay in the air for about an hour. Once the battery powered propeller is spinning, the operator throws Wasp into the air, and off it goes, usually a 100 feet altitude. You land it by pressing the auto land button after you have entered GPS coordinates of where you want it to return to. The propeller often breaks off when it lands, but the Wasp was designed for that, and you just snap on another one. The MAV is controlled via a hand held device that looks like a Game boy, but has a seven inch color screen and controls laid out for easy use. The Wasp carries a GPS, and microprocessor that keeps it stable in flight. The operator picks a route via GPS coordinates, and can order it to circle an area at any time. Two color video cameras are carried (one looking forward, and one looking to the rear), and then the Wasp is a hundred feet up, you can make out people below, and whether they are armed. The Wasp moves at a speed of 35-75 kilometers an hour (or about 9-19 meters a second). The controller can remain in touch with a Wasp that is up to ten kilometers away, after which the operator losses control, and the video feed.[12]

WASP

Weight: 7 oz
Length: 7 in
Wingspan: 13 in
Payload:
Ceiling: 100 ft
Radius: 10 km
Endurance: 1 hr

Figure 6. WASP

Source: www.defense-update.com/features/du-2-04/mav-darpa.

[12] www.strategypage.com/dls/articles/20054172340

C. Unmanned Surface Vehicles (USV)

Unmanned Surface Vehicles are broadly categorized by size as listed in Table 3. The notional handling, launch and recovery procedure found in Appendix B was generalized using USS Pearl Harbor's SEAFOX working documents. These procedures have been adapted for a notional RHIB USV and must first be tailored to each platform's USV (such as Spartan Scout) and associated specific davit system. The USS Pearl Harbor's procedure was used as a notional basis for the manpower requirements assessment.

Unmanned Surface Vehicle (USV) 24-ft RHIB	**Spartan Scout**
Unmanned Surface Vehicle Small (USV-S) 16-ft RHIB	**Seafox**

Table 3. USV Categories

1. Spartan Scout

Spartan Scout is an evolving unmanned integrated sensor and weapon system (Figure 7) designed to be a primary force leveler against asymmetric threats by enabling the battleforce commander to match inexpensive threats with an appropriate response. As a low-cost force multiplier, Spartan provides increased sensor coverage in a netcentric environment, thus enabling the possibility of establishing battlespace dominance.[13]

Spartan is a remotely controlled, semi-autonomous, modular, multi-mission USV centered on the ability to deploy sensors and weapons which provide warfighters with a remote, offensive and defensive barrier in the littorals. The expanded battlespace coverage afforded by off-board sensors can provide an additional layer of defense in the early warning/intercept capability. As a result,

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[13] Naval Undersea Warfare Command, "SPARTAN SCOUT Advance Concept Technology Demonstration (ACTD) Management Plan Rev 1" (Executive level, living document that is intended to outline the basic strategies necessary to execute the SPARTAN ACTD, 14 March 2003) 1.

Spartan is designed to provide protection for surface combatants, noncombatants, and other national and strategic assets. As a node in the battlespace network, Spartan's extended ISR capability facilitates the development of an accurate tactical picture to ensure information superiority.[14]

Spartan Scout

Weight: 4000 lbs
Length: 24 ft
Displacement: 5000 lbs
Radius: LOS
Max speed: 40 kts
Endurance: 48 hrs

Figure 7. Spartan Scout

Source: www.military-training-technology.com/article.

2. Sea Fox

The Sea Fox is a semi-autonomous, reconfigurable, high-speed, unmanned surface vehicle-small (USV-S) (Figure 8). It provides two-way communications with intruders, determination of intent of intruders, and intelligence collection of the situations at safe standoff distances for manned small patrol boats and Visit, Board, Search, and Seizure (VBSS) Teams. The system consists of a Sea Fox USV, the Remote Operator Station (ROS) and Mobile Remote Operator Station (MROS). Through wireless RF relays, the Sea Fox can engage in two-way voice communications and transmit real-time video and infrared imagery to the ROS, thus allowing for standoff engagement of potential threats and increased situational awareness during Enhanced Maritime Interdiction Operations (EMIO) and VBSS missions.

[14] "SPARTAN SCOUT Advance Concept Technology Demonstration Management Plan Rev 1."

Sea Fox is designed to provide force protection with more flexibility in EMIO(small boat against small boat scenarios) and safer Intelligence, Surveillance, and Reconnaissance (ISR) gathering to aid in threat assessment, decision-making, and situational awareness, prior to escalation to lethal actions.[15]Initially, Sea Fox will serve as an extension of the eyes and ears of the VBSS/MIO team, allowing close observation of COI while team personnel remain outside effective small arms range.

Seafox

Weight: lbs
Length: 16 ft
Displacement: 2250 lbs
Radius: LOS
Max speed: 45 kts
Endurance: 12 hrs

Figure 8. Seafox

Source: www.military-training-technology.com/article.

D. Unmanned Undersea Vehicles

The Navy's unmanned undersea vehicle development is quite extensive and comprehensive.[16] The remote minehunting system (RMS) program has exercised a series of developmental prototypes in a fleet environment enroute to a fully supported operational system. The RMS (V)1 variant was launched pier-side and operated from USS John Young (DD 973) during Kernel Blitz '95 table 4. A later variant with shipboard launch and recovery capabilities was installed and deployed on the USS Cushing (DD 985) and successfully demonstrated during SHAREM 119. The final RMS variant, AN/WLD- 1(V)1, is now installed and deployed aboard DDGs 91-97.[17]

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[15] NAVSEA Warfare Center Norfolk "SEAF0X Concept of Operations (CONOPS)." Draft. June 2005.

[16] Ibid.

[17] Gayle, Wayne. "ANALYSIS OF OPERATIONAL MANNING REQUIREMENTS AND DEPLOYMENT PROCEDURES FOR UNMANNED SURFACE VEHICLES ABOARD US NAVY SHIPS," Thesis, March 2006.

Unmanned Undersea Vehicles (UUV)	Remote Minehunting System (RMS) Remote Minehunting Vehicle (RMV)

Table 4. Naval Unmanned Undersea Vehicles (UUV)

The AN/WLD-1(V)1 remote minehunting system (RMS) is an off-board system that is organic to the Battle Group. It has been designed to meet Fleet demand for beyond line-of-sight mine reconnaissance against bottom and moored mines in deep and shallow water regions of anticipated operating areas. The semi-autonomous system will detect, classify, and identify mines and record their precise location for avoidance and/or subsequent removal. The system has been designed to be integral to forces deployed anywhere in the world, providing a mine countermeasures capability to surface combatant forces in the absence of dedicated mine countermeasure forces. The remote minhunting system and its component remote minehunting vehicle are shown in figure 9.

Remote Minehunting System (RMS) and Remote Minehunting vehicle (RMV)

Depth: 10-200 ft+
Range: LOS/OTH via link
Deployment: over the side
Endurance: 20 hrs
Speed: 8-15 kts

Figure 9. Remote Minehunting System

Source: AN/WLD-1(V)1 Remote Minehunting System Specification, February, 2003.

III. Manpower, Personnel, Training and Education Requirements

A. Background

Too frequently resource sponsors do not adequately evaluate newly developed systems for critical ROC/POE impacts. Adequate assessment of platform and unit capabilities has fallen short in the past. This deficiency is due to a lack of understanding of manpower, personnel, training and education (MPTE) policy. Strict adherence to the early development of Navy training systems plans (NTSP) is critical to MPTE planning. In an ideal world trained personnel, equipment installation and logistics for new and improved capabilities would arrive simultaneously. This way trained personnel can oversee installation and operational testing. It seems far too often properly trained personnel arrive after equipment is installed. A thorough understanding of the MPTE process would lead to more informed program objective memorandum (POM) decisions, schoolhouse planning, manpower personnel Navy (MPN) individual account (IA) student resourcing and execution Manpower, Personnel, Training and Education Requirements.

Common to all UVS is the lack of formal MPTE analysis and subsequent published documents specifically stating the quantitative and qualitative manpower requirements. As with any new system the MPTE associated lifecycle costs must be considered up front. The identification of these requirements provides projections for the sailors and marines needed to employ and maintain unmanned vehicle systems throughout these systems' existence. To accomplish this end, the following remains to be formally conducted:

- Perform a formal needs analysis to establish UV requirements by platform and system.
- Convert the needs analysis into requirements and delineate them in manpower management documents.

- Determine if the current personnel inventory possesses adequate KSAs to support UV operations.
- Develop schoolhouse curriculum to support manpower and personnel requirements.
- Mandate a system-specific Navy training systems plan (NTSP) be generated as part of the acquisition phase for each platform and system.

B. Manpower and Personnel

Spartan Scout was ISR configured while assigned to Gettysburg. Eighteen personnel consisting of Boatswain's Mates (BM) and Seamen (SN) were used in the launch and recovery of both Spartan Scout and the ship's RHIB. A minimum of four personnel were required to operate Spartan Scout: one to operate the ROS as driver; C2 operator to monitor sensor displays; RC operator to control Spartan Scout during launch and recovery; and a Coxswain for manned operations.[18] USS Gettysburg's USV team assignments are shown in Table 5.

[18] Ibid.

Position	Rate
Command and Control (C2)	Officer
Remote Operating Station (ROS)	Officer
Radio Control (RC)	PN3
Coxswain	BM2
Electronic Repair	ET3
Mechanical Repair	EN2
Launch and Recovery	Various BMs/Deck Seamen
Launch and Recovery	Various BMs/Deck Seamen

Table 5. USS Gettysburg's USV team

Onboard USS Gettysburg (CG-64), Surface Warfare qualified (designator 1110) officers supervised command and control operations in order to abide by rules of the road and to ensure safe navigation of Spartan Scout. A Personnelman Third Class (PN3) served as remote control operator from above-decks once the Spartan Scout was within 200 yards of the host ship. The Coxswain provided manual control in case of loss of radio control frequency link between Spartan Scout and the host ship. After approximately one month of operating with Spartan Scout, CG-64 demonstrated both night- and day-unmanned operations. Additionally, a senior officer in CIC (such as the Operations Officer) served as mission supervisor relaying pertinent information to the ship's Commanding Officer.[19]

[19] Ibid.

C. Training and Education requirements

The Navy does not currently have an established training pipeline for unmanned vehicle systems (UVS) in general. The notional unmanned aerial vehicle training requirements in Table 6 were derived from actual training developed for unmanned undersea vehicles' (UUV) remote minehunting system (RMS).

SAILOR	CIN	COURSE TITLE	NEC	LOCATION	TYPE	LENGTH (DAYS)	PRE-REQ'S
GM1	J-041-0103	AMMO ADMIN	N/A	FCTCLANT, DAM NECK	F1	5	N/A
E-7 & Above	A-2G-2760	UAV Planning Officer	N/A	Ingleside, Texas	F2	10	N\A
E-7 & Above	A-2G-0089	UAV OPS Officer Course	N/A	Ingleside, Texas	TBD	5	N\A
E-6 & Above	A-121-0007	MEDAL Supervisor	N/A	Ingleside, Texas	TBD	10	GCCS-M
FC1	TBD	Payload Operator	TBD	TBD	TBD	5	N/A
OS1	K-221-2503	ASW/ASUW Tactical Air Controller	0324	CSCS San Diego/ Norfolk	C1	TBD	E-5 & Above
E-6 & Above	J-221-2311	GCCS-M Operator	0342	CSCS San Diego/ Damneck, Va	C1	TBD	N/A
STG	TBD	UAV Maintenance (Manufacturer Training)	0525	TBD	TBD	TBD	TBD

Table 6. UAV Notional Training

1. Remote Minehunting System (RMS) Training Requirements

Currently, personnel working with RMS attend training provided by the Navy and the system manufacturer. Existing "A and C" schools provides some rate-specific training. Other courses are under development or provided by the manufacturer. The current and projected training for RMS operators in the MIW mission area is illustrated in Table 7.

SAILOR	CIN	COURSE TITLE	NEC	LOCATION	TYPE	LENGTH (DAYS)	PRE-REQ'S
STG1	J-041-0103	AMMO ADMIN	N/A	FCTCLANT, DAM NECK	F1	5	N/A
All	A-2G-2758	MIW Core	N/A	Ingleside, Texas	D2	10	E-6 & ABOVE
E-7 & Above	A-2G-2760	MCM Planning Officer	N/A	Ingleside, Texas	F2	10	MIW Core
E-7 & Above	A-2G-0089	MIW OPS Officer Course	N/A	Ingleside, Texas	TBD	5	MIW Core MCM Planning Officer
E-6 & Above	A-121-0007	MEDAL Supervisor	N/A	Ingleside, Texas	TBD	10	GCCS-M
STG	TBD	SNUITT–Side Scan SONAR Recognition	TBD	Ingleside, Texas	TBD	5	SONAR Operator
OS/TBD STG	K-221-2503	ASW/ASUW Tactical Air Controller	0324	CSCS San Diego/ Norfolk	C1	TBD	E-5 & Above
E-6 & Above	J-221-2311	GCCS-M Operator	0342	CSCS San Diego/ Damneck, Va	C1	TBD	N/A
All	A-647-0009	AN/WLD-1 (V)1 RMS Operator (Manufacturer Training)	N/A	NSWC Panama City FL, LOCMAR Syracuse NY	TBD	10	N/A
STG	A-130-XXXX	STG C School AN/SQQ-89A (V)-15 Maintenance (Manufacturer Training)	0525	Chesapeake, Va	C1	TBD	STG "A" School Advanced Electronics Training
STG	TBD	MP Computing Environment Maintenance	TBD	NSWC Panama City FL	TBD	TBD	N/A

Table 7. RMS Training

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IV. Handling Procedures

A. Notional Handling Procedure

The handling procedures found in Appendix A were derived from USS Pearl Harbor, LSD-52 and are included as a strawman for platforms to tailor their launch-and-recovery procedures for assigned USVs. It is included in this research as a generic starting place for future USV operations and for the development of occupational standards for manpower documents.

These procedures are intended to provide guidance to personnel engaged in the launch and recovery of the SEAFOX USV. Conditions and situations that may pose a hazard to personnel or equipment have been identified and evaluated. This procedure has been written to mitigate those conditions and situations.

In one instance, the USV actually had personnel on board while in operation as a precaution to loss of command and control. The launch of a manned chase boat prior to launching the USV was found to be a common practice. An in depth description of RMS handling can be found in AN/WLD-1(V)1 RMS specification, 26 February 2003, PEO Mine Warfare. Notional USV evolution requirements for SMD section III watchstations is shown in Table 8.

Position	Rate
Command and Control (C2)	Officer
Remote Operating Station (ROS)	Officer
Radio Control (RC)	OS2
Electronic Repair	ET3
Mechanical Repair	EN2
Launch and Recovery	BM3
Launch and Recovery	SN
Launch and Recovery	SN

Table 8. Notional USV Evolution Requirements

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V. Tactics, Weapons and Ordinance

A. Tactics

The study resulted in the addition of two UV tactics—the first involving solely the use of an UAV and the second involving both an UAV and USV in combination. The UAV tactic is to be used in Force Protection (FP) against and in prosecution of small-craft attack against a high-value unit (HVU). The second is for protection of a HVU during a straits transit. The straits transit tactic can also be used for choke-point and archipelagic transits.

Other changes made to the original TACMEMO (TM 3-22-5-SW) included clarification of space deconfliction, a new section addressing armed patrol as a technique for unmanned combat vehicles (UCV) and the introduction of ingress-point placement in planning the search of an area of interest.

B. Weapons/Ordnance

USVs offer a wide variety of remotely operated crew-served weapon systems performing an array of Required Operating Capability (ROC)/Projected Operating Environment (POE) elements and statements. "USVs can employ a variety of modulated Hellfire, Stinger, 25-mm chain gun, 7.62-Gatling gun, dual or single .50 caliber machine guns, 40-mm grenade launchers, and a variety of non-lethal weapons."[20] Figure 5 is a "7 meter Intelligence, Surveillance, and Reconnaissance (ISR), Force Protection (FP) USV with an articulating weapons mount, a .50 caliber machine gun and an integrated Javelin missile that participated in the first successful "Live Fire" technical demonstration at the Aberdeen Test Center."[21] However, as weapon systems alternatives increase, the associated manpower requirements may follow too.

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[20] Ricci, Vic. (2002), Spartan Scout Unmanned Surface Vehicle CONOPS, NUWC, July 2002.
[21] Marvin, Ernest and Wasilewski, Mark. (2004), Unmanned Surface Vehicle Mission Module Development and Demonstrations, NUWC.

Also significant is the performance/certification to handle and employ ordnance in support of UCV. The following weapon systems and ordnance are just a few that have been proposed or demonstrated in support of UCV missions:

- **Predator**
  1. Hellfire
- **Fire Scout**
  1. .50 Cal
  2. 2.75 rocket
  3. Cartridge Actuated Devices (CAD)
  4. Smokes
- **Spartan Scout**[22]
  1. ROSAM
  2. .50 Cal Machine Gun
  3. Sea-Javelin
  4. Hellfire Missile
  5. GAU-17A 7.62 Gatlin gun
  6. Stinger
  7. 40mm Grenade Launcher
  8. 25mm Chain Gun

[22] Marvin, Ernest and Wasilewski, Mark. (2004), Unmanned Surface Vehicle Mission Module Development and Demonstrations, NUWC.

Figure 5. Spartan Scout with .50 Cal and Javelin mount.[23]

1. Remotely Operated Small Arms Mount (ROSAM)

The ROSAM is currently being evaluated for use on the Spartan Scout USV as well as the U.S. Army's Theater Support Vessel (TSV).[24] The ROSAM is the key component that provides Spartan Scout USV the capability to employ a variety of different weapon systems. The ROSAM's sighting system is comprised of both Forward Looking Infrared (FLIR) and an off-mount electro optical device. Its aiming system is made up of an optical, ring and post laser designator and laser range finder making it an effective fire control system for USV weapons modules.[25] The ROSAM's advertised maritime target detection range is rated at 4,400 yards.[26] As proven at Aberdeen, the ROSAM is a robust system that utilizes an optical target tracker, built-in fire control, and two-axis weapons correction stabilization in order to provide highly

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[23] Marvin, Ernest and Wasilewski, Mark. (2004), Unmanned Surface Vehicle Mission Module Development and Demonstrations, NUWC.

[24] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.

[25] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.

[26] General Dynamics. MK49 MOD0. [retrieved June 27, 2006] available from world wide web @http://www.gdatp.com/products/weapons_systems/ROSAM/MK49.htm.

accurate maritime firepower.[27] The overall manpower implication to naval personnel is that the USV's ROSAM must be supported by shipboard personnel. Although the ROSAM has been issued the type classification MK49 MOD0 Gun Weapon System, no official NEC has been established for maintenance and support.

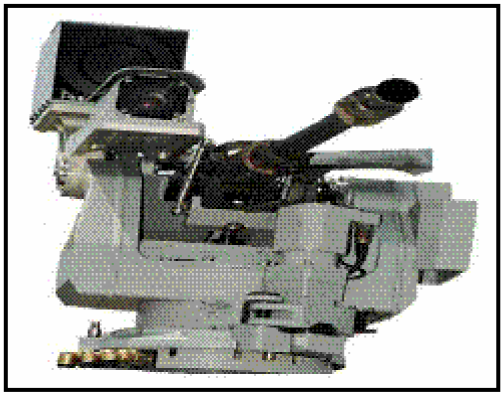

Figure 6. MK49 MOD0/ROSAM with M2HB Bushmaster .50 caliber machine gun[28]

2. .50 Cal Machine Gun

The .50 caliber entered military service in 1921 and has been a proven combat weapon since WWII. It is still used by every branch of the U.S. military and scores of foreign militaries. Its simple yet effective design is the crux of its staying power. At 550 rounds per minute the M2HB Bushmaster .50 caliber will provide USV C2/Sensor operators with substantial fire power. A USV with a remotely operated .50 caliber weapons module will be a formidable addition to any Commanding Officers layered – defense architecture. However, the real benefit may be that adding the .50 caliber to the USV arsenal will not require additional manpower to support the weapon.

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[27] General Dynamics. U.S. Navy Type Classifies MK49 MOD0 Gun Weapon System. Dec 19, 2005. [retrieved June 27, 2006] available from world wide web @http:// www.gdatp.com/news/NR-019.htm.
[28] Vic Ricci, (2006), Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

3. Sea-Javelin

The Javelin anti-tank missile was developed by the U.S. Army. It is a shoulder launched, fire and forget missile, with an imaging infrared (I2R) guidance system. "The Javelin consists of a missile in a disposable launch tube and a reusable Command Launch Unit (CLU) with a trigger mechanism and the integrated day/night sighting device for surveillance, and target acquisition and built-in test capabilities and associated electronics. The CLU, powered by a disposable battery, provides the capability for battlefield surveillance, target acquisition, missile launch, and damage assessment. The Javelin night vision sight (NVS) is a passive I2R system."[29] It also has an advertised effective range of approximately 2000 meters or about 2200 yards.

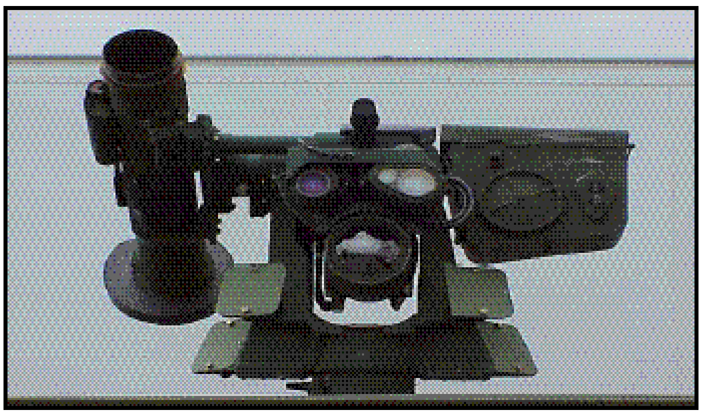

Figure 9. USV ROSAM Javelin/.50 cal mount[30]

Although the range of Javelin is limited, it is still a viable alternative for USVs. A USV equipped with Javelin will be a lethal weapon at sea, capable of ASUW, ATFP, and perhaps Anti Air Warfare (AAW) for low slow-flying aircraft. The sea borne application of the imaging infrared (I2R) guidance system is a good fit because the ocean provides a steady constant temperature to contrast a maritime target. Javelin

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[29] Javelin Anti-tank Missile. [retrieved May 5, 2006] article available on world wide web @http://www.fas.org/man/dod-101/sys/land/javelin.htm.

[30] Vic Ricci, Spartan Scout ACTD USV Overview and Status, NUWC, 10 March 2006.

is a fire and forget weapon, whereby USV C2 operators can launch the weapon and quickly maneuver to a safe position outside the target vessels weapons release range. However, at Aberdeen the Javelin Live-Fire testing was called off due poor platform stability issues.

4. Hellfire Missile

The Hellfire missile is a semi-active laser guided, subsonic anti-tank missile. The Hellfire has an effective range of over 6nm. Hellfire missiles are commonly used by Navy SH-60/HH-60 helicopters for ASUW operations. Originally designed as an air-to surface missile, the Hellfire has evolved into a quality air-to-air weapon used to engage helicopters or slow moving fixed wing aircraft. The Hellfire can be guided to its target by a laser provided by either the helicopter or a shipboard MK80 Illuminator.[31] USV's armed with Hellfire missiles would be a formidable asset capable of effective ASUW or ATFP operations. In addition, USVs with Hellfire would provide a quality buffer for a HVU during a strait transit scenario.

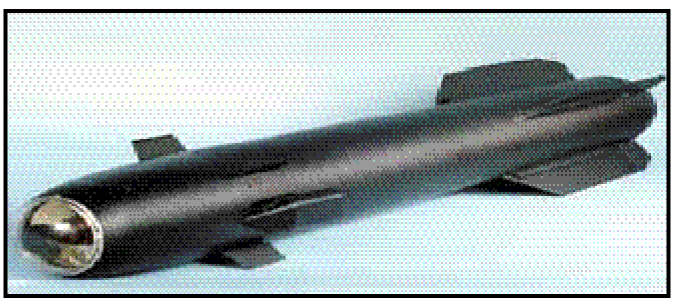

Figure 14. HELLFIRE MISSILE (AGM-114A) [32]

When SH-60/HH-60 Helicopter Detachments deploy with ships, they bring the Hellfire with them. The Aviation Ordnance men (AO) assigned to the Helo Detachments for the maintenance, loading and unloading of all air launched

[31] U.S. Navy Official Website. FACT FILE. [Retrieved May 31, 2006] available on world wide web @http://www.navy.mil/navydata/fact_display.asp.

[32] Google.com. HELLFIRE Image. [retrieved May 31 2006] available from world wide web @http://en.wikipedia.org/wiki/Image:Hellfire_AGM-114A_missile.jpg.

weapons, including the Hellfire. However, GMs also have experience in handling Hellfire missiles on ships. If Hellfire is to become a USV weapons module, the fleet must decide if the AO and/or GM ratings will provide the manpower to support it. Currently, the Aviation Ordnance NEC AO-6801 is dedicated to performing fleet intermediate maintenance ashore and at sea for all air launched weapons.

5. GAU-17A, 7.62 mm Gatling Gun

The GAU-17A Gatling Gun is an effective combat weapon that is typically mounted to aircraft. It is "air-cooled, multi-barreled and electrically powered with a firing rate up to 3,000 rounds per minute."28 A USV with a GUA-17A ROSAM mount would be an effective ATFP platform. Like the .50 caliber, the benefit of adding the GAU-17A to the USV arsenal is that it will not require additional manpower to support the weapon because it is a crew served weapon on surface combatants. If the Navy uses the GAU-17A as a USV weapons module it will have no significant manpower implications with regards to maintenance, loading/unloading and delivery.

Figure 16. GAU-17A fired from CG29[33]

[33] WIKIPEDIA Online Encyclopedia. Minigun Image from USS Philippine Sea. [retrieved June 11, 2006] available form world wide web http://en.wikipedia.org/wiki/Image:Gau_17_7.62mm_minigun.jpg .

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VI. Summary, Conclusions and Recommendations

A. Summary

The mission remains to bring the fight to the enemy. The nation will continue to execute the GWOT while transforming for the future fight. There will be a need for Naval forces to continue to refine operational concepts and appropriate technology investments to deliver the kind of dominant military power from the sea envisioned by sea power 21. There will be a continued need to pursue operational concepts for seabasing persistent combat power as we invest in technology and systems to enable Naval vessels to deliver decisive, effects-based combat power in every tactical and operational dimension.[34]

Manpower requirements for unmanned vehicle system operations on board cruiser and destroyer (CRUDES) platforms are not quantified and qualified in either operational manning or watchstation sections of ship-class manpower management documents. Such identification supports the total force manpower concept and strength planning for unmanned vehicle systems in the Navy and could easily be included in LCS and DD (X) preliminarily ship manpower document (PSMD) development and Navy training systems plans (NTSP). Similar finding where found for Marine Corps manpower management in the tables of organization and equipment (TO&E).

Through discussions with commands operating various unmanned vehicle platforms none were found to be programs of record. It can only be assumed that the lack of a total force manpower planning process for unmanned systems is due to the majority of these systems not being programs of record.

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[34] House Armed Services Committee statement, FY2006 Navy/Marine Corps Navy R & D in the support of the GWOT and Future Naval Capabilities, March 2005.

Naval combat unmanned vehicle employment, for the most part, remains in the research and development stage and not readily available as a CSG/ESG-force capability (of which contractors currently play a significant role). Additionally, it is recognized that unmanned vehicles compete for air- and water-space management along with manned platforms—further complicating already complex warfighting issues.

B. Conclusions

Unmanned vehicles are anything but unmanned. The inclusion of these platforms must be viewed as the inclusion of operational capabilities of deploying ESG/CSGs in today's Navy. Any notion of cost savings using unmanned vehicles is predominately false. Simply adding UVs does not result in manpower cost savings, but does allow persistent on-station time and generally removes the operator from harm.

Some roadblocks remain in order to fully integrate unmanned vehicles into the force. The more minor roadblocks are cultural or organizational. These take the form of who is most qualified (officer or enlisted) to operate the flight controls and payloads. Other concerns are the use of unmanned vehicles in U.S and international air space. How other countries and international law perceive unmanned vehicles.

The inclusion of key performance parameters (KPP) is critical to UV acquisition. Early integration of the human's role in UV operations facilitates force planning and allocation of already limited resources. Navy training systems plans (NTSP) analysis is critical in the developmental testing phase of have unmanned vehicles. The timely development of manpower, personnel and training requirements is critical to supporting the notion of the right person at the right place at the right time with the right KSAs before UVs are delivered to the fleet as a force capability. This practice will best manage the Navy's capital investments and better realize its Human Capital return on investment.

The CRUDES fleet would immediately benefit by the removal of Captain's gigs/second RHIB in favor of an USV. This simple change would immediately enhance mission capabilities. An analysis of N85 and N86 CRUDES ROC/POEs revealed no impact to primary or secondary warfighting missions by removing the gig and, in today's capabilities-based warfighting supports a global concept of operations.

Operator knowledge, skills and abilities must be a KPP in UV design. This research was limited primarily to operational UCV experimentations. Current tactics are too immature to establish valid doctrine on their use. Of particular concern is UV Naval weapons release authority and weapons safety issues.

C. Recommendations

1. Research suggests the following:

a. Increase warfighting capabilities by replacing all Captains' gigs on CRUDES and appropriate expeditionary warfare platforms with unmanned surface vessels to increase platform capabilities.

b. Add USV launch and recovery manpower requirements to appropriate ship class SMDs. Add USV requirements (in addition to current the RHIB requirements) as appropriate, mandate this be part of the Navy training systems plan (NTSP) review and preliminary ship manpower documents.

c. Ensure the acquisition process includes key performance parameters along with explicit Navy training systems plan for the incorporation of unmanned vehicle systems.

d. Disseminate existing UV TACMEMO to fleet for operational validation of tactics, provide feed back to Naval Warfare Development Command and continue development of the unmanned vehicle tactical memorandum to include a dedicated expansion of the tactics and use of unmanned combat vehicle systems.

e. Commission a study to review the manpower, personnel, training and education force structure issues and costs.

f. Those systems that have been operating for an extended period should be made programs of record in order to facilitate the systems integration approach to total force capabilities and Manpower, personnel, training and education tooth to tail concept.

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Appendix A. Notional USV Launch and Recovery Procedures

DEFINITION: For the purpose of these procedures, sea state 3 is defined as significant (average of one-third highest) wave heights up to 5 feet, average wave period 8 seconds, sustained winds up to 16 knots.

NOTE: THESE PROCEDURES WERE DEVELOPED FOR LAUNCH AND RECOVERY OF NAVY RHIBS IN CONDITIONS UP TO AND INCLUDING SEA STATE 3 WHILE TRAVELING AT 3 TO 5 KNOTS INTO QUARTERING SEAS WITH A LEE ON THE STARBOARD SIDE. ANY CONDITIONS OUTSIDE OF THIS OPERATING WINDOW LISTED MAY REDUCE THE SAFETY OF THE LAUNCH/RECOVERY EVOLUTIONS AND MUST BE APPROVED BY THE OFFICER IN CHARGE.

For ready reference, these procedures have been separated into the following categories:

1. EQUIPMENT LIST
2. PERSONNEL CHECKLIST
3. PRE-LAUNCH AND RECOVERY CHECKS
4. USV LAUNCHING
5. USV RECOVERY

1. **EQUIPMENT LIST**

a) Cargo crane
b) USV lifting pendant and lifting hook
c) USV lifting sling w/shackles
d) 2 steadying line leader lines w/ snap hooks (attached to fore and aft pad eyes on USV)
e) 1 sea painter leader line w/ snap hooks (attached to forward pad eye of USV)
f) Steadying lines
g) 1 lifting sling leader w/ snap hook (attached to lifting sling ring)
h) Ship's capstans, bollards and cleats
i) 1 boat hook (on board chase boat)
j) USV cradle with associated tie downs

2. PERSONNEL CHECKLIST

a) Officer in Charge (OIC) shall supervise the entire boat handling operation.
b) Safety Officer
c) Line handlers
d) Crane Operator
e) Chase boat crew (Coxswain, Boat Hook and Aft line handler, USV operations personnel)

3. PRE-LAUNCH AND RECOVERY CHECKS:

NOTE: THE CHASE BOAT SHALL BE LAUNCHED PRIOR TO LAUNCHING THE RHIB. THE CHASE BOAT WILL STAND OFF ON THE STARBOARD SIDE OF THE SHIP UNTIL INSTRUCTED TO PROCEED TO A POINT BETWEEN THE STARBOARD SIDE OF THE SHIP AND THE INBOARD SIDE OF THE USV AFTER THE USV BECOMES WATERBORNE.

a. Muster the OIC, the chase boat crew, line handlers, and the crane operator. Ensure that all crewmembers are wearing proper personnel safety equipment (i.e., Lifejackets, hard hats and safety shoes) and have been briefed on and understand their duties.
b. Perform any pre-operational checks required on the USV RHIB communication equipment.
c. Launch the chase boat.
d. Establish communications with the chase boat crew.
e. Inspect the operating area to ensure there are no foreign objects that might interfere with operation. Ensure the USV securing tie downs are removed and stowed clear of the handling area.
f. Ensure the USV lifting sling is properly installed and ready for use. Verify that the sling will not foul any USV antennas or other gear during launch.

NOTE: THE USV LIFTING PENDANT, WHEN INSTALLED ON THE CRANE AUXILIARY HOIST HOOK, ASSISTS IN PROTECTING PERSONNEL IN THE CHASE BOAT AND PREVENTS DAMAGE TO THE USV BY KEEPING THE CRANE AUXILIARY HOISTING HOOK CLEAR OF THE USV.

g. Rig the USV lifting pendant to the crane auxiliary hoist hook.
h. Ensure the crane auxiliary hoist hook throat is moused closed to secure the USV lifting pendant into the hook.
i. Ensure the boat bilges are dry, and the bilge plugs are in place, and the USV is ready to launch (fuel and oil levels are correct).
j. Attach the forward and aft steadying lines to their respective leader lines on the USV.

k. Ensure the sea painter is properly attached to the sea painter leader line on the USV.
l. Ensure all non-operating personnel are clear of the area.
m. Notify the chase boat coxswain that the USV is ready to launch.
n. Confirm with the crane operator that the crane is ready to operate.
o. Confirm the line handlers are ready for launch/recovery.
p. Establish communication with the bridge, and advise that preparations for USV launch/recovery are completed and the USV is ready to be launched/recovered.

WARNING: ALL REPORTED SAFETY AND OPERATING DEFICIENCIES MUST BE CORRECTED PRIOR TO START OF HANDLING OPERATIONS.

4. <u>USV LAUNCHING:</u>

a. Ensure pre-operational checks were conducted and are satisfactory. The OIC and safety observer will observe the entire USV handling evolution and stop the handling operation immediately if abnormal or unusual conditions arise.
b. Ensure all handling personnel are familiar with the planned evolution and their responsibilities. Instruct the USV handling crew and crane operator to immediately report any abnormal or unusual conditions observed during launch operations.
c. Assign the USV handling crew and crane operator to their stations.
d. Advise the Bridge that the USV is ready to launch. On authorization from the bridge, begin handling operation.
e. Lower the crane auxiliary hoist hook and attach the USV lifting pendant. Position the USV lifting pendant over the USV lifting point.

WARNING: ENSURE THE USV SLING RING IS PROPERLY SEATED IN THE THROAT OF THE QUICK RELEASE HOOK AND ENSURE THE HOOK IS SECURELY LATCHED.

f. Lower the USV lifting pendant, and attach the USV sling ring to the lifting hook of the pendant. Ensure the USV sling ring is securely latched in the lifting hook of the USV lifting pendant.
g. Hoist the USV high enough to clear the stowage cradle and life rails.

NOTE: THE LAUNCH POSITION OF THE SEAFOX SHOULD BE FAR ENOUGH OUTBOARD SO AS TO HAVE ENOUGH ROOM TO SAFELY MANEUVER THE CHASE BOAT BETWEEN THE STARBOARD SIDE OF THE SHIP AND THE PORT SIDE OF THE USV.

h. Slew the USV into launch position.
i. Lower the USV to the water. Use the steadying lines to tend the USV during its descent. Once waterborne, the sea painter should become

taut as the USV is taken in tow. The USV operator shall start the engine.

j. Maneuver the chase boat alongside the port side of the USV and maintain this station.

NOTE: A BOAT HOOK FROM THE CHASE BOAT MAY BE NEEDED TO REACH THE RELEASE LANYARD, STEADYING LINES, AND SEA PAINTER LEADER LINE.

CAUTION: THE FOLLOWING SEQUENCE OF RELEASING THE USV STEADYING LINES, HOIST HOOK, AND SEA PAINTER IS IMPORTANT TO ATTAIN A SAFE LAUNCH OF THE USV WHILE THE SHIP IS UNDERWAY.

k. The aft steadying line handler will slack the aft steadying line until the chase boat crew can reach it. The chase boat crewmember will unhook the aft steadying line from the aft leader line at the leader line release hook.

l. The aft line handler will retrieve the aft steadying line.

m. The chase boat crewmember shall hook the aft leader line to the USV grab bar.

n. The fwd steadying line handler will slack the fwd steadying line until the chase boat crew can reach it. The chase boat crewmember will unhook the fwd steadying line from the fwd leader line at the leader line release hook.

o. The fwd line handler will retrieve the fwd steadying line.

p. The chase boat crewmember shall hook the fwd leader line to the USV grab bar.

q. Using the release lanyard on the USV lifting hook, the chase boat crewmember shall release the lifting hook. The chase boat crew shall signal to the OIC that it is safe to raise the crane auxiliary hoist hook. Upon receipt of authorization from the OIC, the crane operator shall raise the crane auxiliary hoist hook.

r. The sling ring of the USV shall be hooked to the USV grab bar using the sling ring leader line.

s. The USV operator shall increase the speed of the USV in order to create slack in the sea painter. The chase boat shall match this speed increase.

t. The chase boat crew will then release the sea painter from the USV sea painter leader line using the sea painter quick release hook.

u. The chase boat crewmember will hook the sea painter leader line to the USV grab bar.

v. The USV operator will maneuver the USV away from the ship and commence with the planned operation.

w. The chase boat will also maneuver away from the ship and commence operations.

x. All shipboard handling gear shall be stowed until the USV is to be recovered. The crane will be returned to the stowed position.

5. USV RECOVERY:

a. Ensure all applicable pre-operational checks in paragraph 3 have been accomplished and are satisfactory.
b. Ensure all handling personnel are familiar with the planned evolution and their responsibilities. Instruct the USV handling crew and crane operator to immediately report any abnormal or unusual conditions observed during recovery operations.
c. Assign the line handlers and crane operator to their stations
d. Advise the Bridge that the USV is ready to recover. Upon authorization from the Bridge, begin the USV recovery operation.

NOTE: ISSUE CLEAR AND SUFFICIENT ADVANCE WARNING THAT BOAT HANDLING OPERATIONS ARE COMMENCING.

e. Using the cargo crane, lower the hoisting hook and attach the USV lifting pendant. Ensure the crane auxiliary hoist hook throat is moused closed to secure the pendant into the crane auxiliary hoist hook.
f. Position the lifting hook of the USV lifting pendant approximately 15 feet off of the water at the pickup point of the USV.
g. Maneuver the USV to a position 5 to 6 feet forward of the USV lifting pendant.
h. Maneuver the chase boat to a position alongside the USV between the ship and the USV.

CAUTION: THE FOLLOWING SEQUENCE OF ATTACHING THE USV SEAPAINTER, STEADYING LINES AND LIFTING HOOK IS IMPORTANT TO ATTAIN A SAFE RECOVERY OF THE USV WHILE THE SHIP IS UNDERWAY.

i. Once the chase boat is alongside the USV, lower the sea painter to the chase boat. Detach the sea painter leader line hook from the USV grab bar, and attach the sea painter to the sea painter leader line.
j. Reduce the speed of the USV so that the sea painter is allowed to deploy to its pre-determined full length. Follow this maneuver with the chase boat.
k. Lower the forward steadying line to the chase boat. Detach the forward steadying line leader line from the USV grab bar, and attach it to the forward steadying line.
l. Lower the aft steadying line to the chase boat. Detach the aft steadying line leader line from the USV grab bar, and attach it to aft steadying line.
m. Lower the USV lifting hook pendant to the outboard edge of the chase boat at a point amidships of the USV. Detach the USV sling ring leader line from the grab bar, and secure the sling ring into the lifting hook of the USV lifting pendant.

n. Signal the crane operator that it is safe to take any slack out of the USV lifting pendant.
o. Maneuver the chase boat to a stand-off position away from the ship.
p. Upon command from the OIC, hoist the USV from the water. Shut down the USV engine as it comes out of the water.
q. Tend the steadying lines to control the motion of the USV during hoist operations.
r. Place the USV in its stowage cradle.
s. Secure the USV in its stowage using the tie-downs. Once the USV is secure, release the lifting hook of the USV lifting pendant from the USV lifting sling. Stow steadying lines and any other gear used in the recovery process.
t. Remove the USV lifting pendant from the crane auxiliary hoist hook and stow it in a secure area.
u. Recover and stow the chase boat.
v. Return the crane to its stowed position.

Appendix B: Acronym List

Acronym	Definition
AAW	Anti-Air Warfare
ACTD	Advanced Concept Technology Demonstration
ADC	Air Defense Commander
AMRDEC	Aviation and Missile Research, Development, and Engineering Command
AO	Area of Operations
AOI	Area of Interest
AOR	Area of Responsibility
AOU	Area of Uncertainty
ARG	Amphibious Readiness Group
AREC	Air Resource Element Coordinator
ASR	Armed Surface Reconnaissance
ASUW	Anti-Surface Warfare
ASUWC	Anti-Surface Warfare Coordinator
AUV	Autonomous Underwater Vehicle
USW	Antisubmarine Warfare
AT	Antiterrorism
ATG	Afloat Training Group
ATO	Air Tasking Order
BDA	Battle Damage Assessment
BLOS	Beyond Line-Of-Sight (ranges from 10-100nm)
BM	Boatswain's Mate
C2	Command and Control
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CAS	Close Air Support
CCIR	Commander's Critical Information Requirements
CCOI	Critical Contact of Interest
CDC	Combat Direction Center
CDP	Cumulative Detection Probability
COE	Critical Operations Effectiveness
CIC	Combat Information Center
COI	Critical Operational Issue
CPA	Closest Point of Approach
CONOPS	Concept of Operations
COP	Common Tactical Picture
COTS	Commercial Off-The-Shelf
CSAR	Combat Search and Rescue
CSG	Carrier Strike Group
CWC	Composite Warfare Commander

Acronym	Definition
D3M	Deterrence, Detection, Defense, and Mitigation
DIW	Dead In the Water
ECM	Electronic Countermeasure
EMI	Electro Magnetic Interference
EMIO	Enhanced Maritime Interdiction Operations
EN	Engineman
EO	Electro-Optic
EO/IR	Electro-Optical/Infrared
ES	Electronic Support
ESG	Expeditionary Strike Group
ES/SIGINT	Electronic Support/Signals Intelligence
ET	Electronics Technician
FOV	Field of View
FP	Force Protection
GCS	Global Command Station
GCCS-M	Global Command and Control System Maritime
GEOSIT	Geographical Situation
GM	Gunner's Mate
GOTS	Government Off-The-Shelf
GPS	Global Positioning System
HM	Hospital Corpsman
HVA	High-Value Assets
HVU	High-Value Unit
ID	Identification
IAP	Integrated Assessment Plan
IFF	Identification, Friend or Foe
ILS	Integrated Logistics Support
IMINT	Imagery Intelligence
IMPI	Integrated Maritime Platforms International
INU	Inertial Navigation Unit
IPB	Intelligence Preparation of the Battlespace
IR	Infrared
ISB	Intermediate Staging Base
ISR	Intelligence, Surveillance, and Reconnaissance
ISR&T	Intelligence, Surveillance, Reconnaissance, and Targeting
ISMA	In-Stride Mine Avoidance
IT	Information Systems Technician
I&W	Indications and Warning
JFMCC	Joint Force Maritime Component Commander
JLOTS	Joint Logistics Over the Shore
JTF	Joint Task Force
J-UCAS	Joint USAF-Navy Unmanned Combat Air System
KSA	Knowledge, Skills, and Ability

Acronym	Definition
L&R	Launch and Retrieval
LAMPS	Light Airborne Multipurpose Platform
LCS	Littoral Combat Ship
LEC	LAMPS Element Coordinator
LFA	Lead Federal Agency
LMRS	Long-Term Mine Reconnaissance System
LOS	Line-of-Sight (ranges from 0-10 nm)
LRIP	Low Rate Initial Production
MEDEVAC	Medical Evacuations
METOC	Meteorological and Oceanographic
METT-T	Mission, Enemy, Terrain & Weather, Troops & Support Available, & Time Available
MIO	Maritime Interdiction Operation
MIW	Mine Warfare
MIUW	Mobile Inshore Undersea Warfare
MNS	Mission Needs Statement
MODLOC	Miscellaneous Operations Detail Local
MOE	Measure of Effectiveness
MOP	Measure of Performance
MROS	Mobile Remote Operator Station
MUA	Military Utility Assessment
MUAV	Micro-UAV
MUVAM	Maritime UV Assignment Model
NAI	Named Area of Interest
NEO	Non-Combatant Evacuation Operation
NLW	Non-Lethal Weapon
NVD	Night Vision Device
NVG	Night Vision Goggles
OJT	On the Job Training
OM	Operational Manager
OMI	Operator-Machine Interface
OPCON	Operational Control
ORM	Organizational Risk Management
OTC	Officer in Tactical Command
OTH	Over-The-Horizon (ranges greater than 100nm)
PE	Precision Engagement
PIC	Payload Interface Controller
PID	Positive Identification
PIR	Priority Intelligence Requirements
PS	Precision Strike
PTZ	Pan/Tilt Zoom
R/C	Remote Control
RHIB	Rigid Hull Inflatable Boat

Acronym	Definition
RF	Radio Frequency
RFI	Radio Frequency Interference
RMP	Recognized Maritime Picture
RPM	Revolutions Per Minute
ROE	Rules of Engagement
ROS	Remote Operator Station
RSN	Royal Singapore Navy
SAG	Surface Action Group
SAR	Synthetic Aperture Radar
SCC	Sea Combat Commander
SD	Search and Detection
SDHSS	Shallow Draft High Speed Sealift
SENSO	Sensor Operator
SIGINT	Signal Intelligence
SK	Storekeeper
SOCA	Submarine Operations Coordinating Authority
SOF	Special Operations Force
SS	Sea State
SSC	Surface, Search and Control
SUAV	Small UAV
SUW	Surface Warfare
SUW C&R	SUW Coordination & Reporting
SWC	Strike Warfare Commander/Coordinator
TACON	Tactical Control
TACSUP	Tactical Supervisor
TAO	Tactical Action Officer
TAWS	Target Acquisition Weapons System software
TCS	Tactical Control System
TFCC	Tactical Flag Command Center
TOE	Table of Organization and Equipment
TOS	Time on Station
TRADOC	Training and Doctrine Command
TSV	Theater Support Vessel
TTP	Tactics, Techniques and Procedures
TUAV	Tactical Unmanned Aerial Vehicle
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
UHF	Ultra High Frequency
USV	Unmanned Surface Vehicle
USV-S	Unmanned Surface Vehicle-Small
USW	Undersea Warfare
UVEC	UV element coordinator

Acronym	Definition
UUV	Unmanned Undersea Vehicle
VAC	Vital Area Center
VAL/VER	Validation/Verification
VBSS	Vertical Board Search & Seizure
VHF	Very High Frequency
VID	Visual Identification
VTOL	Vertical Take Off Landing
VTUAV	Vertical Takeoff UAV

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