SBX-1 Operational Suitability and Viability Assessment

An Independent Assessment

FINAL REPORT
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Submitted to:

Director
Mission Readiness Task Force
Missile Defense Agency

Submitted by:

Independent Assessment Team

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EXECUTIVE SUMMARY

In preparation for the deployment of SBX-1 to operate in the northern Pacific and Bering Sea MODLOC north of Adak, the Director, Mission Readiness Task Force, MDA ordered the conduct of an independent assessment of the Operational Suitability and Viability (OAV) of the SBX-1 platform.

SBX-1, with the XBR, is a unique and critical National Defense asset and must be treated as such.

SBX-1 is built on a commercial semi-submersible platform, to commercial standards. The vessels manning complies with the minimum level specified by the United States Coast Guard (USCG) Certificate of Inspection and the crew members hold security clearances, as well as licenses and merchant mariner documents issued by the USCG.

The OAV panel, with a broad technical and operational background, met with the prime contractor (Boeing), the lead naval architectural firm (The Glosten Associates) and the SBX program leadership. In addition four members of the panel transited in the support ship and transferred to SBX-1 at sea (Sea State 4).

The OVA panel categorized their findings into the area of Crew Readiness, Materiel Readiness and Operational Considerations. In addressing the issues, the recommendations were divided into three time frames: Address before leaving Hawaii; Address before winter operations off of Adak/in the Bering Sea; and Long Term Mission Readiness.

The OAV panel concluded SBX-1 is an inherently rugged and suitable platform for the intended mission however, the panel found that at the current time:

1. Crew Readiness and Materiel Readiness issues indicate that SBX-1 needs additional underway shakedown time and inport time to address crew and material issues in the Hawaiian area, and
2. Operational Considerations identifies issues for which operational commanders and developing commands need a full understanding of associated implications, and

which require resolution prior to departure from Hawaii and operations at the Adak winter MODLOC in the Bering Sea.

The conclusions are focused on ensuring and improving the total platform mission readiness and survivability of this unique National Defense asset and are supported by the panel issue Description, Findings and Recommendations contained in the report.

INTRODUCTION

Background: In preparation for deploying SBX-1, with XBR, from the Hawaiian operating areas to the northern Pacific and the MODLOC area in the Bering Sea north of Adak, the Director, Mission Readiness Task Force in MDA requested an independent assessment of the operational suitability and viability of the SBX-1 platform. The Terms of Reference (Annex B) directed an assessment of the operational suitability, planning and viability of SBX-1 to effectively operate in the environment of the western Bering Sea with a focus on the seaworthiness, operating procedures and structural, mechanical and electrical considerations for SBX-1 in those environments. In addition, the assessment was to include the areas of maritime and sustainment operations while moored in Kuluk Bay off of Adak and while loitering in the open sea. Functions to be assessed included sea-keeping, refueling/reprovisioning, personnel transfer and severe weather operations. Note: the TOR and the panel did not include the XBR GMD mission capability. SBX-1 is built on a commercial semi-submersible platform and operates under a Certificate of Inspection (COI) issued by the US Coast Guard. The vessel is also classed by the American Bureau of Shipping (ABS), who performed the design review and initial inspection on behalf of the US Coast Guard under the Alternate Compliance Program. The vessel has a merchant marine operating crew via a sub-contract from Boeing. The vessel's manning level complies with the minimum level specified on the COI, and all vessel operating crew members have a security clearance and hold licenses and merchant mariner documents issued by the US Coast Guard.

Panel Composition: The panel consisted of retired Navy and Coast Guard Flag officers, retired SES Naval Architects and an off shore semi-submersible industry expert. The experience of the panel covered at sea operation of ships, propulsion examining board experience, vessel safety and regulatory body experience, naval architects with both design and production experience and semi- submersible experience with platforms in a wide range of operating environments. Panel membership and qualifications are located in Annex C.

Assessment: The panel visited the SBX-1 prime contractor, The Boeing Company, and The Glosten Associates – the Naval Architects under contract to Boeing. The panel received presentations from the SBX Program office and from the American Bureau of Shipping, the classification society for the platform. These meetings were also attended by representatives from the Naval Sea Systems Command, the Military Sealift Command and the US Coast Guard (Anchorage). Four members of the panel traveled to Hawaii and transited in the support ship DOVE from Pearl Harbor out to SBX-1 in the Hawaiian operating areas. Embarkation/debarkation at SBX-1 was conducted at sea (Sea State 4) between the support ship DOVE and the SBX-1, using a crane lift with the "Billy Pugh" multi-person lifting ring/net rig. Time on board SBX-1 was spent in conducting a thorough walk-through of the platform, and detailed discussions with the senior members of the operating crew and Boeing personnel. In reviewing the data and the information obtained from the meetings and the SBX-1 and DOVE visits/discussions, the panel focused the observations and recommendations into three categories: Crew Readiness, Materiel Readiness and Operational Considerations. In addition, within each of these areas, the panel assessed the issues identified against three time frames: Address before leaving Hawaii; Address before winter operations off of Adak/in the Bering Sea; and Long Term Mission Readiness. Following each recommendation there is a letter with the panel suggested time frame for addressing the recommendations:

H – Address before leaving Hawaii

A – Address before winter operations off of Adak/in the Bering Sea

L – Long Term Mission Readiness

Annex D provides a matrix listing of the panel's recommendations and the suggested time frames to address the issue.

Conclusions**:** The OAV panel concluded SBX-1 is an inherently rugged and suitable platform for the intended mission, however the panel found that at the current time:

1. Crew Readiness and Materiel Readiness issues indicate that SBX-1 needs additional underway shakedown time and in-port time to address crew and material issues in the Hawaiian area, and
2. Operational Considerations issues identify areas where operational commanders and developing commands need a full understanding of the associated implications, and which require resolution prior to departure from Hawaii for operations at the Adak winter MODLOC in the Bering Sea.

The conclusions are supported by the panel issue description, findings and recommendations contained in the following detailed Crew Readiness, Material Readiness and Operational Considerations sections. Annex E provides a copy of the 5 June 2006 briefing for the Director, MRTF, MDA.

SECTION 1. CREW READINESS

I. ADDITIONAL SHAKEDOWN TIME

Description: New ships are put through a shakedown phase after delivery to get the crew working together as a team with maximum effectiveness before being placed on-line performing real missions. Shakedown training provides a structured method for the crew to attain proficiency in routine operations and in casualty control response. This shakedown period helps to form critical team work, improves crew morale and mission effectiveness while reducing often costly operator errors. The more complex a new ship is and the more important and difficult its mission, the more important adequate shakedown training becomes. The SBX is a perfect example - a unique ship with a complex, developmental payload. SBX is scheduled to operate in a harsh and unforgiving environment performing a critically important national defense mission.

Findings: The SBX is now in its shakedown period but, to date, shakedown training has been limited by interruptions such as casualties, extended shipyard availabilities, and the dry transit from the Gulf of Mexico to Hawaii aboard the Blue Marlin. SBX is scheduled to move north in June. The harsh Arctic winter sets in by late October. Only four months remain available for shakedown training before winter.

Recommendations:

1. Do not rush SBX into service performing real missions before adequate shakedown training has been done. **(H)**
2. Establish operations, casualty control and damage control training criteria and metrics which must be met and maintained to forward deploy SBX. **(H)**
3. Conduct initial shakedown in good weather and good support areas followed by focused shakedown training in preparation for heavy weather and cold weather operations. **(H)**

II. SYSTEMS OPERATIONAL AND CASUALTY CONTROL TRAINING

Description: For critical systems, the operator must not only be trained how to operate the system in normal situations, but also be provided training in how to respond properly when casualties occur. The lack of such training can result in operator errors in the time of crisis immediately after a casualty. Operator errors in casualty situations can compound problems and lead to catastrophe. Computer simulations of complex systems are an ideal training tool. Simulations installed on-board SBX could be used “off-line” for training without interfering with the operations of the real systems. A wide variety of casualties can readily be introduced into a simulated system. The operator actions in response and their effects on the system behavior can be observed and evaluated. The feedback to the operator from such exercises is invaluable for its training benefits.

Findings: It is not apparent that the crew members of SBX who operate critical systems have received adequate training in casualty control. The drills and evaluations conducted to date have generally been concerned with routine operational scenarios. There has not been time for the system operators to use the real systems for training in casualty control. System simulations have not been made available to the operators for training. Additionally, comprehensive operational procedures and detailed casualty control procedures did not appear to be in place.

Recommendations:

1. Develop realistic computer simulations for critical SBX systems. The Ballast Control System, electrical and saltwater systems are noteworthy examples. Ensure that the simulations provide appropriate feedback to the user for training benefits. **(L)**
2. Install the simulations on-board SBX and provide time and incentives for the SBX operators to use the simulations for basic, advanced and refresher training. **(L)**
3. Develop detailed equipment lightoff and securing procedures and detailed equipment casualty control procedures similar to USN Engineering Operational

Sequencing Systems (EOSS) to include Engineering Operating Procedures (EOP) and Engineering Operational Casualty Control (EOCC). **(A)**

4. Ensure the operating crew has up-to-date technical documentation and is provided with job performance aids. **(H)**
5. Convert to Interactive Electronic Technical Manuals (IETM) to improve responsive and correct troubleshooting of equipment casualties. **(L)**

III. CREW QUALIFICATIONS

Description: SBX-1 is a critical national asset, embodied within a complex maritime platform. Sustainment of SBX-1 operations and maintenance is dependent upon the ability to recruit and retain a well-trained, experienced crew of licensed and unlicensed commercial mariners, i.e., better than the "hiring hall" minimum standard of performance and qualification.

Findings:
Crew qualifications should include:

- Basic Coast Guard licensing and documentation requirements
- Excellent character references
- Clean background investigation (security clearance)
- Offshore operations experience
- Journeyman-level skills in assigned position (presumes clear roles and responsibilities)
- Pipeline training for special assignments
- SBX-1-specific on-the-job training in assigned position
- Orientation training for newly assigned personnel.

While the Panel found evidence that crew screening was ongoing, a comprehensive formalized program incorporating all of the above elements for crew qualification did not exist.

There are commercially available training programs for offshore platform personnel readily available.

Recommendations:

1. Develop a SBX-1 crew qualification program which incorporates clear requirements for roles, responsibilities, experience, skills, and training. **(H)**
2. Adequate onboard turnover time must be provided for crew attrition replacements. **(A)**
3. Provide the operating crew with training capability ashore and afloat. **(L)**

IV. MEDICAL PERSON IN CHARGE (MPIC)

Description: SBX-1, with the XBR, is designed to operate at sea for long periods as an independent unit. SBX-1 total embarked crew can be up to 100 men and women. The support ship (DOVE) performs shuttle resupply missions and may or may not be in company with SBX-1. The current MPIC is the Chief Mate who has the most basic medical training and access to "tele-medicine" reach back for advice.

Findings: The MPIC has the qualifications required by the USCG and the embarked crew is medically screened for duty in SBX-1. While SBX-1 is designed to be safe, duty in a seagoing platform with all the systems of SBX-1 has inherent risks and dangers, in addition to the normal illnesses which may occur within the crew. The totally independent nature of SBX-1 operations means that there are long periods when SBX-1 may be out of range of helicopter support for medical evacuation. The support ship does not have better medical support, and may not be in the area. The support ship, which is relatively slow (about 12 kts.) is the alternate means of medical evacuation and embarking a patient is by crane hoist. Initial triage and treatment of injuries or illness will be by the onboard MPIC, with the support and advice of the doctor on the land end of the "tele-medicine" system. The skill level of the MPIC is not sufficient to provide sufficient support to the crew for life threatening illness or injury or to manage the injuries from a major on board casualty.

Recommendations:

1. The MPIC should be upgraded to an individual who has the level of qualifications of a US Navy Independent Duty Corpsman or a licensed Physician's Assistant. **(H)**

V. HELICOPTER SUPPORT

Description: Helicopters provide a valuable capability to SBX, especially before the ship is permanently moored at Adak. Helos can be employed for routine personnel transfers, logistics support, and perhaps most importantly, MEDEVAC.

Findings: The SBX is fitted with a commercial helicopter landing platform, approved by ABS. It is similar to helo decks used on semi-submersibles in the oil industry world-wide. It is suitable only for daylight use in good visibility. There is no refueling capability. The SBX helicopter deck is designed for use by a 12-passenger European EH101 model helicopter, weighing about 32,000 lbs. The USCG HH-60 is significantly lighter than the EH101. The SBX helo deck has not been certified by NAVAIR. Thus Navy helos will not land on the deck; nor will the USCG. A USCG helo could execute a MEDEVAC from SBX by hovering over the deck and hoisting the injured or ill patient up to the helo. The helicopter provides greater operational capability in higher wind and sea states than does the crane/support vessel. There is currently no plan in place to provide commercial helo service to support SBX on call or on station from Adak. Personnel transfers and replenishment are currently planned to be done by ship's single crane and DOVE. The USCG has helos at Kodiak that could be used for emergency MEDEVAC. However, the minimum transit time to Adak is eight (8) hours in good weather, including time for a re-fueling stop. The USCG also has cutters on patrol in the Bering Sea but they could be hundreds of miles away from Adak when a helo is needed. To date, no helo has landed on the SBX helo deck.

Recommendations:

1. Obtain Navy (NAVAIR) and USCG (AS KODIAK) certification of the SBX helo deck. **(H)**

2. Conduct Helo refueling and night operations capability trade-off study. **(L)**
3. Contract with a commercial helo operator to rotate SBX personnel and provide other support, at least during the next 16 months (prior to completion of the SBX mooring off of Adak). **(A)**

VI. CREW ROTATION CYCLE

Description: The SBX and its support ship, DOVE, both have two full crews. The crews alternate on a regular cycle with half of each crew being switched at the mid-point of the cycle. The current cycle is 56 days long with one half of the crew being changed every 28 days. After a crew change, half of the crew has been aboard for 28+ days, while the other half has been ashore and must be brought up to speed. By this means, continuity is preserved and lessons learned effectively transferred between crews.

Findings: The length of the crew rotation cycle is a major factor in crew morale. The SBX and DOVE crews are expected to serve in a very harsh climate and to work long hours each day without days off during the work period to provide breaks in the tedium. The current plan is to use the DOVE and the ship's crane for personnel transfers. This will mean that bad weather will sometimes delay transfers and further extend the crew's work period. Crew rotation is further exacerbated by the extended travel time required for the crew to come from their home to Adak. Morale will be hard to maintain. The SBX and DOVE will be competing with the oil industry for mariners. The oil industry is currently in a boom time and is paying top dollar for crew members on semi-submersibles. In the Gulf of Mexico, the standard rotation cycle is 7 days, in the North Sea it is 14 days and in other areas, e.g., Africa and the Far East, it is no more than 28 days. Considering pay rates, weather, and the planned method of personnel transfer (the oil industry uses helicopters almost exclusively), the 56-day rotation cycle will be one more reason that the SBX and DOVE will likely find it hard to attract and keep top quality crew members.

Recommendations:

1. Consider a 28-day rotation cycle for SBX and DOVE crew members, at least prior to going on the Adak moor. Because of contract modification implications, this issue needs consideration before departing Hawaii. **(H)**

VII. CREW SIZE AND MIX

Description: SBX-1 is a large vessel with an important mission. It's very design, systems, and roles require assurance that operations can be carried out properly, safely, on a 24/7 basis for long periods of time, in a harsh weather environment, at sea or in a remote moored site. There is a substantial preventive and corrective maintenance workload that must be addressed on a continuing basis. Damage control and fire fighting can require substantial amounts of trained manpower at any moment. This vessel has numerous display and automated control stations for operating vital systems such as the electrical plant, ballast system, and propulsion which will require trouble shooting and maintenance. In addition, the vessel has the usual numerous auxiliary systems found on a sea going vessel that require attention such as heating and ventilation, water making, refrigeration, galley equipment, fuel, saltwater service, and drainage systems.

Findings: SBX-1 is certified as a "vessel" and is manned in accordance with USCG requirements. Based on systems and apparent workload there may be selected shortfalls in the manning. Skills in the electronics and general electrical areas seem to be inadequate, for example. It is unlikely that the operating crew will be able to stay abreast of the hull, machinery, and electrical maintenance requirements. While some corrective maintenance is to be accomplished with LRUs, there is not a comprehensive workload evaluated maintenance philosophy. As a national defense asset, damage control of onboard emergencies takes on additional importance, and requires more manpower than minimal manning.

Recommendations:

1. Add an additional general electrician and an electronics technician. **(H)**

2. Monitor the maintenance workload with further experience and adjust the crew size and skill sets as appropriate. **(L)**
3. Review damage control functions against onboard manning and train mission crew in basic damage control and firefighting functions to augment core teams. **(L)**

VIII. GALLEY AND SCULLERY

Description: Galley and scullery are essentially collocated off the mess deck. Galley food preparation is in close proximity to scullery and garbage handling.

Findings: The close proximity of food preparation to scullery and garbage presents a potential health hazard. Additionally the maceratator is reported not to have adequate capacity. There is no provision for a trash compactor to facilitate onboard storage of retrograde trash.

Recommendation:

1. Have independent review of galley operations by Navy food service team. **(H)**

IX. PERSONAL COMMUNICATIONS AND ENTERTAINMENT

Description: Personal communications and entertainment systems provide increased morale and personal real time communications with family and friends while off duty or in times of family emergencies or need. These systems can also be used for crew educational uses. The platform and the mission crews will expect to be provided commercial communications and entertainment systems that they most frequently use when ashore.

Findings: The current recreational room with a combined use as a site for movies and a library does not provide adequate environment for personal communications. Staterooms are not equipped with personal entertainment and communication drops.

Recommendations:

1. Provide individual stateroom drops for a TV with DVD/VHS player, and an internet access drop. **(L)**
2. Provide a private location on board where the crew can call into the commercial phone system for personal communications ashore. **(L)**

X. ACCOMMODATIONS

Description: SBX-1 is provided with accommodations for 100 people. The accommodations consist of a mix of single and two person staterooms. The crew is comprised of merchant mariners and high tech mission systems personnel.

Findings: Stateroom arrangements on SBX-1 required two person assignments in most cases for the mission crew and the platform crew. The highly technical personnel for the mission crew may not be accustomed to sharing accommodations. Spare staterooms for increased or surge manning requirements are minimal (current manning is 86 and this report recommends adding 6 billets to the onboard count, reducing onboard excess berthing to 8). In many ships with commercial crews, single staterooms are the norm – a morale and recruiting issue. Many operational spaces seem to have excessive volume assigned. Modular staterooms that are pre-fabricated and outfitted are commonly installed on vessels in the commercial world and might be a way to improve the quality of life on SBX.

Recommendations:

1. Review the allocation of space on SBX-1 and determine if additional staterooms could be installed without impacting key mission or platform functions. **(L)**

SECTION 2. MATERIEL READINESS

I. BALLAST SYSTEM

Description: Ballast control is a critical function on any semi-submersible platform. Control system malfunction or operator error can quickly lead to dangerous trim or list with possibly catastrophic results. Highly trained and experienced operators on watch at all times are required in order to respond to casualties or adverse weather in a speedy and correct manner. Industry practice is to have the ballast control position manned 24/7 by a dedicated person.

Findings: The SBX Ballast System is critical for both platform survivability and operations. There is no dedicated system manager or operator. The system is monitored and centrally controlled by the mate on watch on the bridge, who has other duties assigned. The secondary centralized Ballast Control station is located in the Engineering Control Station (ECS). There are local Ballast Control Stations at the top of each SBX corner column. The ballast system in the corresponding quadrant of the ship can be controlled from these control stations but not the entire system. Effective and timely communications and coordination between the actions of the four stations is critical. In case of a bridge casualty, system control would pass to the ECS. There is no on-board simulation of the ballast control system to enable the necessary ballast control expertise to be developed and sustained. There is no evidence that numerous ballast control drills have been performed to date where casualties are simulated and operator responses evaluated. We find it to be critical that control for the ballast system be exercised from only one watch station at a time. The "LODIC" stability model does not reflect actual vessel trim and list. Ballast system has recently incurred a major casualty and needle valves were installed to control valve opening times. The panel believes an independent analysis of the ballast system and recent casualty root cause is required to ensure reliable system functioning.

Recommendations:

1. Conduct an independent engineering analysis of the whole ballast system to include a focus on the root cause of the recent casualty and validity of the implemented fix. Analysis should take advantage of current offshore industry standards and previous industrial ballast system casualty investigations. Include in the analysis of the Ballast System consideration of thermal expansion of piping runs and the need to accommodate expansion and contraction. **(H)**
2. Identify, train, certify and assign dedicated Ballast Control System operators to provide continuous watch-standing. Only certified individuals operating under the direction of licensed officers should operate the system. Ensure operating procedures provide for ballast system control authority and shifting o f control to alternate sites. **(H)**
3. Exercise alternate and remote ballast control stations periodically. **(H)**
4. Install a commercially available Ballast Control System simulator that can be used on-board SBX for operator training in both routine and casualty response scenarios to include stability considerations and limitations. Until simulators are on-board, consider utilizing off-shore industry training facilities. **(A)**
5. Make Ballast Team Operations a mandatory drill as part of crew rotations. **(H)**
6. Resolve “LODIC” Ballast model problems in reflecting actual SBX-1 condition. **(H)**

II. RESCUE BOAT

Description: A rescue boat is a small, light, fast boat capable of being launched quickly to rescue personnel in the water. Many commercial ships of various types and services are routinely fitted with a rescue boat, usually launched from its own davits. SBX will operate independently in harsh environments.

Findings: SBX is currently deployed without a rescue boat. The CONOPS for man overboard is to use a 50-person lifeboat. The current lifeboats are large, slow, and cumbersome. The lifeboat configuration does not lend itself to recovery of a survivor from the water. Recovery of the 50-person lifeboat is a cumbersome and potentially dangerous operation. Crews will be rotated at sea using transfer methods that have some risk of man overboard.

Recommendations:

1. Provide a dedicated, quick-launch rescue boat suitable for service in the Northern Pacific and Bering Sea. Consider the crew's recommendations in assessing the best boat type/model and location on SBX. **(H)**

III. SHIP'S CRANE

Description: The SBX is fitted with a single hydraulically-operated crane on the starboard side. It is not a typical, proven semi-submersible ship crane. The ship's crane is used for transferring personnel, provisions, repair parts, and other material. It is also used for refueling from the support ship DOVE.

Findings: The current crane is critical to sustaining SBX at sea for long periods of time and has generally served well to date. The crane lacks the quick response to match Dove deck motions. SBX does not have spares onboard for all the necessary crane computer circuit boards. The SBX crane is a single point of failure and could adversely impact operations. If the crane fails and cannot be repaired in situ by the ship's force, crew rotations and MEDEVACS may be delayed along with planned replenishment evolutions. Winds impact crane effectiveness and it is standard practice to use the SBX topsides to provide a lee when the crane is in use. When SBX is loitering, a lee behind the topsides can readily be created by changing the SBX heading as necessary. When SBX is permanently moored the crane must be positioned on the lee side from predicted winds. Strong winds on the SBX starboard side will effectively prevent crane use. Alternatives considered include:

- A duplicate of the existing crane to gain the advantages of standardization.
- A more responsive crane to avoid the deck strikes that often occur with the current crane as an object is being lifted off the DOVE's deck.

- A smaller, less capable man-rated portable/mobile backup crane that could be permanently mounted or bolted/strapped down and used, should the current crane be out of commission or unusable.

Recommendations:

1. Provide a quick response, man rated second deck crane for SBX. **(H)**
2. Ensure electronic circuit board spares for existing crane are procured and placed on-board at the earliest opportunity. **(H)**

IV. ELECTRICAL POWER AND MAIN PROPULSION

Description: SBX is outfitted with six of the eight possible SSDGs (split three in each engine room) and four thrusters capable of providing about 10 knots at transit draft and about 4 knots at operational/survivability draft in calm water.

Findings: When operating the currently populated radar at full power and supporting the rest of the SBX electrical requirements, thrusters cannot meet 95% Maximum Continuous Rating (MCR). In this situation, with all six generators on line, SBX can reach 91% MCR. With five generators on the line, MCR drops to 64% and with four generators to only 37%. In excess of 50+ knots of wind SBX will not be able to make headway, even if at 95% MCR. The loss of an engine room or more than one generator places SBX in electrical extremis. SBX operates with four azimuthing thrusters which are always immersed in salt water. The loss of a thruster reduces already minimal propulsion capability (refer to Glosten Associates P6-01-003 of 30 May 2006). Thruster repair can only be accomplished with the installation of large cofferdams or a dry docking.

Recommendations:

1. Add two additional SSDGs. **(L)**
2. Add two additional thrusters. Consider fixed axial thrusters on inboard side of pontoons. **(L)**

V. ONBOARD LOGISTICS

Description: SBX-1 is a relatively new, complex vessel which has major dependency on automated systems. The current operating history of the vessel has not developed reliable parts usage range and depth data. The general repair philosophy is to repair failed systems with a Line Replaceable Unit (LRU), vice component trouble shooting.

Findings: There is a backlog of spare parts (approximately $350k+) that has not been ordered or placed on board SBX-1. As systems age, the use of mechanical and electronics parts will increase. There are systems, which while basically adequate for the envisioned service, do not have a total margin that supports components being out of commission for a long time. Routine resupply is by the support vessel, with a potential for a helicopter lift of high priority parts, if within range of available helicopter support. The nature of SBX-1 is to operate independently at sea for long periods supporting the national defense mission of the XBR.

Recommendations:

1. Immediately order and place on board the parts identified and not ordered. **(H)**
2. Ensure that four cylinder heads for the Ships Service Diesel Generators (SSDGs) are on board SBX to support timely crew casualty repair of these vital units. **(H)**
3. Ensure that full electronics spares are included onboard to support the maintenance of the single installed crane and other electronic control systems. **(H)**
4. Ensure highly accurate inventory control of onboard spares. **(H)**
5. Consider onboard 2M repair capability. **(H)**

VI. TEMPORARY EMERGENCY RADOME PRESSURIZATION SYSTEM (TERPS)

Description: The TERPS system is designed to provide an emergency electrical power source to the radar dome pressurization system, and is in addition to the vessel main and emergency diesel generator electrical power systems.

Findings: The existing TERPS system is a bolted down generator, installed on the weather deck, outside the radar base ring. The TERPS is manually started on the loss of vessel electrical power. The generator is not rigged or protected for operations at sea or for automatic start. The harsh operating environment that will be experienced in the area where SBX-1 is likely to operate will rapidly degrade the reliability of this vital backup system.

Recommendations:

1. Prior to leaving the Hawaiian area and encountering the harsher climates of the Adak MODLOC area, the TERPS systems should be made a permanent installation, protected from the weather. **(H)**
2. The TERPS system should be equipped with an automatic starting system in order to ensure the minimal loss of time and dome pressure in the event of a loss of the vessel main electrical power. **(H)**

VII. ONBOARD MAINTENANCE MANAGEMENT SYSTEM

Description: SBX and DOVE require a sailor friendly onboard maintenance management system suited for minimum manning concept.

Findings: The SBX maintenance recording, scheduling, and planning system (Boeing CIMMS) is not currently populated or effective. The system proposed was not primarily designed for shipboard maintenance. ABS and Merchant Mariners are experienced in numerous onboard maintenance management systems at sea which are designed for a maritime environment. DOVE has an effective maintenance management system provided by the owner. Pace of DOVE operations may be building a maintenance backlog.

Recommendations:

1. Choose a straightforward maintenance management system. The system should be proven in maritime applications, record maintenance, manpower, and parts usage. In addition the system should schedule and predict future maintenance. Install in SBX at the earliest time. **(H)**
2. Ensure adequate maintenance time for DOVE. **(H)**

VIII. DEPOT LEVEL LIFE CYCLE MAINTENANCE AND REACH BACK SUPPORT

Description: Complex platforms such as SBX require depot maintenance and modernization in order to obtain a 20 year life cycle. Reliable and viable operations of complex systems require access to a wide range of technical talent. In addition there needs to be a long term technical support base that provides in-depth engineering and modernization and depot availability planning.

Findings: At present, despite the intention of providing some Alaskan support and port engineer(s), there is no "planning yard" with in depth staff, documentation, and plans for upkeep and upgrades of the vessel. ABS has identified several structural joints that will fatigue in less than 20 years and require more frequent structural surveys. While there are some indications of the use of technical reach back, there was no evidence of a detailed support plan.

Recommendations:

1. Establish relationship with a commercial shipyard to track SBX configuration, plan depot maintenance, do advance design/prefabrication, and facilitate subcontract for availabilities. **(L)**
2. Document and exercise technical reach back plan for key systems. **(H)**
3. Task the depot planning yard to track structural joint fatigue inspections and status. **(L)**

IX. TOWING CAPABILITY

Description: SBX is configured with a single towing bridle forward for deployment to DOVE or a towing vessel. The bridle is attached to the forward end of the pontoons which in wave heights in excess of 2.4m (Sea State 4) will be well underwater. SBX is anticipated to operate in a harsh environment.

Findings: SBX will have limited ability to make headway in high winds and seas. Due to electrical power and propulsion limitations, it is essential that SBX can be taken in tow expeditiously when adverse weather and position near land dictates. Deployment of the towing bridle to the towing vessel is a complex operation requiring careful coordination. Hooking up for tow is a critical capability and, in higher sea states (above Sea State 4), will be problematic. TAGOS hulls (similar to the DOVE) were frequently relieved in Northern Pacific missions based on sea conditions.

Recommendations:

1. Include in the CONOPS the concept of early tow to avoid hooking up in bad weather. **(H)**
2. Exercise towing capability at sea periodically. **(H)**
3. Consider second towing bridle on aft end of SBX. **(H)**
4. Consider viability of DOVE sea keeping in heavy weather. **(A)**

X. AS-DESIGNED/AS-BUILT AND DETECTION OF SINGLE POINT FAILURES

Description: Any conversion of an existing vessel is a complex undertaking which includes modifying numerous systems and the associated technical documentation. Design specifications and drawings must translate into production and installation of systems by different activities. The resulting as-built configuration must be checked against the as-designed documentation to ensure compliance, particularly concerning the survivability of the vessel.

Findings: Recent experience with the SBX ballast system indicates that critical needle valves were not installed and were not identified as missing by at least three activities (shipyard, ABS/USCG and owner). In addition to the ballast system, SBX is highly dependent upon electrical power generation and distribution, fuel, propulsion and saltwater systems. The unfunded requirements/gaps list contains additional items.

Recommendations:

1. Conduct as-designed/as-built validation as soon as possible of primary SBX systems, such as the electrical generation and distribution to major systems, fuel, propulsion, saltwater and ballast systems, to include a failure mode analysis of these primary systems in order to identify any possible single-point failures. **(A)**
2. Conduct a similar ADAB validation and single-point failure analysis of secondary systems over the long term maintenance and repair of the SBX. **(L)**

XI. SBX IS A NATIONAL DEFENSE VESSEL

Description:

- SBX started as a test platform.
- The operating areas were defined and acquisition strategy was established
- SBX is a converted commercial offshore semi-submersible platform certified by ABS and the USCG to commercial design and construction standards.
- SBX is a vital National defense vessel with a critical defense mission.

Findings:

- The USCG documented and certificated SBX as a cargo and miscellaneous vessel. ABS classed SBX as a MODU, and employed equivalent compliance in many areas. The vessel is certified under the Alternate Compliance Program (ACP) of the USCG.
- SBX is transitioning to a fully operational and test asset.

- This new mission and its corresponding operational requirements increase the importance of risk mitigation and the need to determine specifically where military standards should be applied to reduce operational risks.

Recommendations:

1. Conduct an operational requirements review between the COCOM and the developing agent to ensure a documented agreement on the SBX capabilities and limitations. **(A)**
2. Identify, prioritize, and fund gaps or shortfalls to ensure platform reliability and survivability as a National defense operational vessel. **(L)**

XII. SBX ADAK MOORING PLAN

Description: SBX is planned to operate for significant periods from a fixed mooring site off of Adak. Throughout the year, SBX will be required to get underway. Weather in Adak can be severe and can increase quickly in intensity. The mooring system must be able to maintain SBX in position through a wide range of weather conditions, adjust on short notice and be designed to facilitate periodic underway operations.

Findings: The Adak mooring system envisioned for SBX is currently in design and procurement. Consulting with offshore design experts indicates an active tensioning capability may be a significant feature in order to ensure a safe moor of SBX throughout a range of weather conditions. The envisioned system does not appear to provide for balancing the load on various mooring legs as the weather changes. Installation of windlasses for active tensioning will require major shipyard support. Hookup and unhooking may be unnecessarily time consuming with the currently envisioned system.

Recommendations:

1. Engage a company experienced in designing and installing turnkey mooring systems for semi-submersible platforms offshore to conduct an independent

analysis of the current design to include a specific look at the requirement for active tensioning. **(H)**

2. Ensure final mooring design is ABS classed. **(L)**

XIII. EMERGENCY HF COMMUNICATIONS

Description: SBX-1 depends on satellite communications for long haul mission and administrative communications requirements.

Findings: While satellite communications are capable of reliable and high data rate communications, they depend on a system of systems to ensure their reliability. The SBX-1 operating profile will have the vessel at sea operating independently for long periods. HF communications has the ability to provide emergency long haul communications capability and is independent of satellite support requirements.

Recommendation:

1. Equip SBX-1 with a basic emergency HF communications transceiver capability before beginning operations in the Adak MODLOC area. **(A)**

XIV. SHIP SERVICE LOW PRESSURE AIR COMPRESSOR (LPAC)

Description: Low pressure air is provided from a single compressor to various services throughout SBX-1. The back up for the single LPAC is the air compressors designed and dedicated to supplying the air pressure required to start the SSDGs.

Findings: The low pressure air system is an important secondary vessel operating system. The single LPAC will require routine down time for maintenance and may suffer a casualty. Loss of low pressure air would mandate the use of the back up systems – the SSDG starting air compressors. Use of the SSDG starting air compressors for other than the intended services in a short term may not be harmful, but in the long term will degrade this primary capability to start additional

SSDGs. SBX-1 will operate at sea independently for long periods and quick supply support/repair support for the LPAC can not be assured.

Recommendation:

1. Provide a second Ship Service LPAC to allow for routine maintenance and back up to the existing LPAC. **(L)**

XV. WEATHER DECK COATING

Description: The weather decks on SBX-1 are coated with an epoxy system to ensure preservation of the base metal of the deck and to provide a non-skid surface for personnel safety.

Finding: The installed epoxy deck coating system is beginning to fail. This failing condition will only accelerate as the sea conditions and winter weather environment worsens. High traffic areas will see accelerated wear of the system. The failed system will increase the hazard to personal safety for crew members working topside in worsening conditions and will also contribute to accelerated deterioration of SBX-1 topside decks. The more advanced the corrosion and system failure, the more expensive the restoration costs.

Recommendations:

1. Provide SBX-1 with a vacuum grit blast machine and the supplies to enable the crew to undertake some limited weather deck preservation. **(A)**

XVI. COMMERCIAL GPS RELIABILITY AND PRECISION

Description: The SBX-1, with XBR embarked, is a national defense asset and is outfitted with commercial GPS to support vessel safe navigation and position keeping when operating at sea.

Findings: The commercial GPS does not have the reliable accuracy required for SBX operations and in times of emergency, the access to commercial GPS could be denied. As a key national defense asset and part of the national missile defense capability, SBX-1 should be outfitted with the military defense GPS capability to ensure reliability and improved accuracy. In order to ensure long term reliability and in the event of a loss of satellite link for GPS, SBX-1 should have some reliable back up to ensure safe navigation and adequate position keeping capability. Inertial Measurement Units (IMU) are available in Navy systems and are also available in the commercial market.

Recommendations:

1. Shift SBX-1 GPS from the commercial capability to the military defense GPS system. **(L)**
2. Research the required accuracy and life cycle support provided by a USN IMU or a commercial IMU and provide SBX-1 with an IMU. **(L)**

SECTION 3. OPERATIONAL CONSIDERATIONS

I. COMMAND AND CONTROL

Description: The onboard presence of a licensed Master, a Mission Director, and a Security Officer, coupled with the multiple "owners" or operators of SBX-1 (e.g., MDA, COCOM, Boeing), creates an operating environment ripe for confusion about "who's in charge". This situation is compounded by the legal and regulatory framework which governs a documented and certificated vessel with licensed merchant marine operators. This governance includes federal laws and regulations enforced by the USCG and other federal agencies as well as state laws and regulations enforced by the various state agencies. When adding the limitations in electrical power and propulsion, this potential source of command and control confusion may manifest itself when balancing platform operations (such as heavy weather operations, training and maintenance) with externally directed mission payload operations.

Findings: By law, the Master is legally responsible for the operation and navigation of his vessel. The Master is licensed by the USCG and subject to a system of criminal and administrative sanctions which may be applied to his actions in command. The Mission Director is the Combatant Commander's (COCOM's) representative onboard and, as such, will be focused on mission performance. The Security Officer is responsible for the protection of this national asset and its personnel. It would not be difficult to envision situations where all three of these leaders may have differing opinions about the appropriate course of action, e.g., during mission operations in degrading weather conditions. A similar situation may exist among the "owners" and operators of the SBX-1 ashore. By experience, the optimal manner to handle these situations is to play them out ahead of time, through tabletop exercises or joint working groups, and document them in a clear, concise manner. A common understanding of the associated roles, responsibilities, and standard operating procedures/rules of engagement is critical for all key onboard leaders.

Recommendations:

1. Deconflict and document onboard authorities among the licensed Master, Mission Director, and Security Officer, and their relationships to off-board authorities in order to ensure clarity of command and courses of action. **(H)**

II. LIMITING SEA STATE FOR TRANSIT DRAFT OPERATIONS

Description: SBX operations at the transit draft (not ballasted) are limited to significant wave heights less than 2.4 meters (near the top of sea state 4). If the SBX is in transit or loitering in the open ocean and severe weather threatens, the first line of defense is its inherent platform seaworthiness and systems reliability and second, its somewhat limited mobility. While every effort must be made to avoid the storm by transiting out of the area at the best possible speed, this may not be sufficient or possible given SBX mission requirements, existing power limitations, and large sail area/wind resistance. At the transit draft, SBX can make about 10 knots in calm water while at the Operational Draft, SBX top speed is reduced to about 4 knots at best. It should be noted that the transition from transit draft to Operational Draft requires 12+ hours. The limiting wave height for the transit mode is a critical SBX constraint.

Three criteria impose sea state restrictions on transit draft operations. Two are regulatory body (ABS) criteria:

- Slamming on lower cross braces between P/S columns (braces 4m above calm water surface at transit draft - limiting significant wave ht. about 4.1m, i.e., low end of sea state 6)
- Structural fatigue at critical pontoon-column brackets (limiting significant wave ht. about 3.3m, i.e., mid-sea state 5)

The third criterion is set by the XBR design which is susceptible to damage from two failure modes induced by platform motions. They are: (1) acceleration-induced structural damage to the array elements (horizontal and vertical acceleration limits), and (2) corner lift-off (lift-off from the track of the pairs of wheels at a corner of the DPCS). The horizontal-plane acceleration component is significantly more limiting than the vertical component and slightly more limiting than the corner lift-off limits. The limiting significant wave height varies with ship heading; the limit is 2.4m in beam seas and rises to greater than 5m in head and bow seas (also in stern and stern quartering seas). However, with no means provided to directly measure the XBR accelerations, wave period, or relative wave heading, the decision was made to write the Operations Manual to instruct the ship's Master to ballast down when the significant wave height (estimated by the Master from the bridge) exceeds 2.4m, regardless of heading. The 2.4m sig. wave height is close to the top end of sea state 4.

The following table summarizes the limiting sea states detailed above:

Limiting Sea States for Transit Draft Operations

Criterion	Limiting Sig. Wave Ht.	Equivalent Sea State
XBR Structural Design	2.4m	Near top of Sea State 4
Structural fatigue at critical pontoon-column brackets	3.3m	Mid-Sea State 5
Slamming on lower cross braces	4.1m	Low end of Sea State 6

Findings:

- Anything that can be done to increase the 2.4m limit, however slightly, will improve the SBX transit operability, including its ability to escape a serious storm.
- It is not practical to try to improve SBX operability at the transit draft by:
    - Radar re-design to raise the sea state limits imposed by platform motions effects on XBR accelerations and corner lift-off.
    - Platform structural modifications to raise the ABS sea state limits,
- The sea state limits for SBX operations at transit draft are specified as simple wave height limits for all vessel speeds and headings. This form of specification requires the operator to estimate by "eye-ball" the wave height of the prevailing ocean waves. Eye-ball estimates combined with absolute wave height limitations do not provide the operator with the intelligence needed to maximize the transit

operations heading-sea state envelope while avoiding the specific conditions that could cause damage to the platform and/or payload. Safe Operating Envelopes (SOEs) can provide this intelligence to the operator to avoid specific unsafe conditions.

- Operability of the platform at transit draft would be improved significantly by installing wave and acceleration monitoring systems. A wave monitoring system would provide accurate wave height, period and heading information to the Master to allow operations in sea states above 2.4m sig. wave height at headings away from beam seas. In head to bow seas and in stern to stern quartering seas, the ABS structural fatigue limit of 3.3m sig. wave height would then become governing.
- An acceleration monitoring system would be used to directly measure the critical XBR acceleration limits and would likely increase the 2.4m wave height limit in beam seas that is influenced by necessarily conservative assumptions made in the Glosten analysis.
- The significant wave height is less than the 2.4m limit about 61% of the time in the Adak Loiter Area (year-round avg.) and about 48% of the time (year-round avg.) in the transit region (central and eastern Pacific Ocean north of Hawaii). If the significant wave height limit could be raised to 3.3m, the corresponding percentages increased to about 88% and 72%, respectively. Thus, significant gains in transit operability can be achieved by modest gains in the limiting wave height.
- The Operations Manual does not state what draft the SBX should be ballasted to when the limiting sea state for transit draft operations is exceeded (operational, survival, other draft?).

Recommendations:

1. Provide enhanced operator guidance to optimize the SBX-1 transit envelope. Develop and provide an on-board simulator integrating weather forecasts, wave and acceleration monitoring devices, and simulations of the SBX seakeeping performance as a function of draft, heading, speed, and sea state. Present

results as Safe Operating Envelopes (SOEs) for the platform and payload. Also, use the simulations for crew training both ashore and aboard ship. **(A)**

2. Install wave height sensors so that the ship's Master has firmer knowledge of the actual sea state being experienced at any time (wave height, period and heading). **(H)**
3. Install an acceleration monitoring system to directly measure XBR acceleration limits. This will likely increase the 2.4m significant wave height limit based on the XBR design. **(H)**
4. Determine the effects of exceeding the 3.3m ABS structural fatigue limit. If the consequence is a somewhat reduced fatigue life rather than catastrophic failure, this might be an acceptable course of action for a limited amount of time in order to escape a major storm at transit draft speed. **(A)**

III. SURVIVAL DRAFT OPERATIONS IN EXTREME SEAS

Description: If the SBX is underway at the transit draft or is loitering in the open ocean at the operations draft when a severe storm threatens, an attempt will likely be made to avoid the storm by making the best possible speed at the transit draft away from the storm's track. When the storm cannot be avoided, SBX will ballast to the survival draft and use its excellent seaworthiness to weather the storm.

The SBX Platform will spend the majority of its operating life at the 23.5m Operations Draft, where the platform motions, accelerations, wind loads, and wave loads are minimized. However, at the Operations Draft, the air gap (clearance between the waterline and the wet deck - underside of the cross structure) is also at a minimum (14.65m, 48.1 ft). In waves of the sizes expected in the severest weather conditions, semi-submersibles de-ballast to a Survival Draft (for SBX 2.5 hours from Operations Draft to Survival Draft) to increase the air gap and reduce the occurrence of wet deck slamming. Deck clearance in severe seas is a critical design driver for semi-submersible platforms.

At the Survival Draft (21.5m), the SBX structural integrity and inherent stability are more than adequate to withstand any conceivable storms in the open ocean and the propulsors can be used to select a favorable orientation to the wind and seas. However, in a severe storm, it is possible that the SBX will not be able to maintain station over the ground, i.e., she will drift slowly downwind, influenced as well by the local seaway and currents. Available propulsion power can be used to minimize the drift rate.

Given the Adak Bering Sea MODLOC, if all or significant thruster power is lost, the drift rate would then be significantly greater and, depending on the directions of the wind, seas, and local current, as well as distance to the lee shore, drifting far enough to reach land becomes a possibility unless taken in tow.

Taking SBX-1 in tow in sea states greater than about Sea State 4 is a risky evolution.

Findings:

- For varying wind and sea conditions, Glosten (as provided in Glosten Report P6-01-003 dated 30 May 2006) has estimated SBX capability to make headway and hold position while performing a mission in December in the Adak loiter area at operations draft with 6, 5 and 4 SSDG sets in operation. The XBR is radiating and there is a full hotel load. An example of the results follows for a 50 knot wind and 10m significant wave height in head seas:

Number of Generators On-line	Approximate Speed Made Good*
6 (91% MCR)	0.5 knots
5 (64% MCR)	0.2 knots
4 (37% MCR)	Drifting downwind

the above results do not include current effect

- In the same Glosten Report an estimate was made for SBX-1 free drift rate without propulsion power at the operations draft for a range of wind and wave conditions in December in the Adak Loiter Area. The estimates assume the platform is oriented to head seas and wind. As an example of the results, for a 50 knot wind and 10m significant wave height a drift rate of about 3.4 knots is estimated. This estimate does not include current effect which could be additive.

- In the above Glosten Report, an estimate was also made of DOVE's ability to hold SBX-1 in position against a range of wind and wave forces. Assuming that:
    i. SBX-1 loses all propulsion power at Operations Draft
    ii. SBX-1 is oriented to head seas and wind
    iii. DOVE can operate in the full range of wind and wave conditions
    iv. Tow gear can be connected,

  the report conclusion is that DOVE has sufficient thrust to hold SBX-1 in position in winds up to 55-60 knots.

- The DOVE may not be able to take the SBX under tow in sea states above Sea State 4 and the two anchors on-board SBX are not designed to hold the SBX in the open ocean against the forces of a severe storm. The SBX anchors could be used to reduce the drift rate of SBX once she got into waters shallow enough for anchoring.
- Definitive guidance to the operator as to when to de-ballast from the operations draft up to the Survival Draft could not be found. In addition, the expected Propulsion and Station-keeping performance characteristics at Survival Draft in the severest weather conditions could not be found.
- Section 3, Issue II identifies the need for comprehensive Safe Operating Envelopes (SOEs) at the Transit Draft to assist the operator. Similar definitive operator guidance in the form of SOEs for the worst-case extreme survival conditions would also be worthwhile.

Recommendations:

1. Provide the operational commanders, ship's master and deck officers with more definitive ship propulsive performance predictions for worst-case extreme survival conditions:
    - Characterize propulsive performance at the Survival and Operations Drafts with full, partial and no propulsion power for a range of wind velocities, wave

heights and relative headings for the most severe weather conditions; where power is insufficient to maintain headway, estimate drift rates for these conditions. **(A)**

2. Include a section on loss of propulsion power in the SBX Heavy Weather Plan, to include training and exercises. **(H)**
3. With the aid of tests and trials, explore means to enable the DOVE to take SBX under tow in sea states above Sea State 4, and characterize the expected performance of the OSV in these extreme survival weather conditions. **(L)**
4. Identify alternative towing resources and put contracts in place. **(A)**
5. Review the recent offshore industry significant change to use survival conditions with a 1000 year return period as a design check. **(A)**
6. Provide guidance on when to de-ballast from the Operations Draft to Survival Draft. Review new offshore design criteria for air gap as an information source. **(A)**

IV. HEAVY WEATHER / COLD WEATHER PLAN

Description: SBX-1 is a critical national asset, which was originally conceived as a test platform in benign ocean service. The SBX Concept has evolved to include operations in the unforgiving waters of the Northern Pacific Ocean and the Bering Sea in all seasons. While SBX-1's structure is designed to sustain the associated loads at various operating drafts, its propulsion and electrical power distribution systems limit its mobility and seakeeping ability, particularly in heavy weather. For instance, SBX-1, with its significant sail area, has limited ability to make way in high headwinds (50+ knots), normally encountered in this operating area for a significant portion of the year. High winds, heavy seas, low temperatures, fog, snow, hail, and icing conditions are routinely encountered. The Aleutian Islands and Alaska Coast are both rocky and pristine, unforgiving and environmentally sensitive. Consequently, weather forecasts are vital to SBX-1 and mission system performance and operations. It is prudent for any vessel operating in these conditions to have a Heavy Weather/Cold Weather Plan both for vessel and personnel safety, as well as mission effectiveness. This Plan must address all anticipated and worst case scenarios (e.g., loss of propulsion, need for additional towing capability) and include clear advice to the Master and crew on expectations and alternatives, to enable them to make timely decisions and take expeditious actions.

Findings:

- No adequate Heavy Weather/Cold Weather Plan or CONOPS guidance currently exists.
- The Heavy Weather Cold Weather Plan should consider de-icing measures (sea chests, top-side, etc…), additional sounding and security watches, provisions of an emergency sea-going tug, and top-side controls must be operable with cold weather clothing on. The plan should be written in sailor language.
- There is no evidence that the crew has trained and exercised for heavy weather or cold weather operations, to include testing of de-icing capabilities and heating system.
- Given the environmental sensitivities and prevailing weather conditions in this region, the Coast Guard 17th District Commander has expressed concerns about SBX-1 operations in the vicinity of the Aleutian Islands.
- There are several authoritative sources of regional weather forecasting; however, there does not appear to be a consistent, directed weather information resource used by the SBX Team.

Recommendations:

1. Develop a credible, stand alone Heavy Weather/Cold Weather Plan, which includes the full range of weather and other elements identified above. **(H)**
2. Train and exercise the SBX-1 and M/V DOVE crews on implementing the Heavy Weather/Cold Weather Plan to include evaluating the inventory of required cold weather clothing. **(H)**
3. Maintain planning and communications with the Coast Guard. **(H)**

4. The entire SBX Team should utilize a consistent, directed weather forecasting service (COCOM-accepted). Weather information should include current speed and direction, if available for the operating area. **(H)**

V. DAMAGE STABILITY

Description: When SBX is operating at the transit draft, her pontoons are vulnerable to damage by accidental or deliberate collisions or other threat events. Damage of more than one adjacent compartment might result in the damage stability criteria being exceeded and, depending on the extent of flooding, possible platform capsize or foundering. The ship has a longitudinal bulkhead on centerline running the length of each pontoon. Damage is more likely on the outboard side of this bulkhead. Pre-damage liquid loading instructions might be used to reduce the effects of flooding after damage, especially for the outboard compartments in the pontoon. After damage, the ship's officers need guidance on the preferred ballast control measures for restoring ship stability.

Findings:

- The SBX meets the commercial USCG stability standards which call for the ship to withstand the flooding of any single compartment.
- The only multiple compartment damage cases evaluated were cases where the single compartment dimensions were smaller than the specified damage extents noted above, i.e., small tanks. There are five such cases.
- Damage stability with larger damage extents has not been analyzed because the USCG regulations do not require it. Nor have cases where a small penetration occurs directly on a bulkhead between two large tanks, again because the rules do not require it.
- While the USCG damage stability standards are acceptable for commercial vessels, they are not typically acceptable for national defense assets.

Recommendations:

1. Expand the existing SBX damage stability analysis to consider damage cases that go well beyond the USCG requirements. Evaluate the effects of greater damage lengths at all points along the pontoon (up to 12% of the pontoon length). Consider damage penetrations that flood the long tunnel connecting the forward and after columns. Focus primarily on the transit draft cases, since this is probably where the SBX is most vulnerable to damage effects, but also examine damage of a single corner column at the operating draft. Give primary attention to damage cases outboard in the pontoons, since this is where damage is most likely and the flooding moments are greatest. Specifically, all the combinations of adjacent flooded compartments that cause the stability criteria to be exceeded should be identified. **(H)**
2. Examine in greater detail those flooding cases that exceed to meet the USCG damage stability criteria, but do not cause immediate capsize, to determine whether cost effective physical changes could be made to improve SBX damage stability. **(H)**
3. Review guidance on pre-damage liquid loadings of pontoon tanks to minimize damage effects and incorporate in onboard ship documentation. **(H)**
4. Review guidance on post-damage ballast control measures such as counter-flooding to restore stability to the ship and incorporate in onboard ship documentation. **(H)**
5. Summarize the findings of the expanded damage stability investigation in a form readily understood and usable by the ship's master and deck officers. It is essential that they be fully informed of SBX vulnerabilities and be provided with the best possible guidance regarding pre- and post-damage measures to improve the odds of ship survival in case of damage. **(H)**
6. Make structural subdivision and other ship modifications identified by the studies/analyses of Recommendation 2 in this Section, to improve SBX damage stability. **(L)**

VI. SBX PHYSICAL SECURITY

Description: SBX ability to defend against off board threat (ramming, vessel borne improvised explosive device, boarding) is limited to .50 caliber machine guns and small arms. There is no provision for defense against a surface to surface missile aimed at the Radome or the superstructure. There is a dedicated security force of 16 personnel onboard at all times.

Findings: The present SBX security systems have no effective stopping capability against a motor vessel such as a large fishing trawler which would have the capability to inflict physical damage in an intentional collision.

Recommendations:

1. Operational Commanders review SBX onboard security ATFP capability against current and future potential threats in the Adak Bering Sea area. **(H)**
2. Consider provision of non-lethal technologies to enhance SBX ATFP. **(L)**
3. Consider a longer range stand-off weapon (2000 yards). **(L)**

VII. SUPPORT VESSEL CONOPS

Description: SBX-1 is supported by a single Offshore Supply Vessel (OSV), currently DOVE. The OSV performs a vital role in transferring personnel / MEDEVAC, replenishing stores and fuel, and retrograding material.

Findings: The OSV DOVE is a single point of failure in the SBX system. If DOVE goes down hard, a backup OSV must be available and brought on-site in time to avoid negative impacts on SBX mission capability and survivability. Offshore commercial industry in general ensures that an OSV is always located in the immediate vicinity of the supported platform.

Recommendations:

1. Investigate the timeliness of backup OSV support in the event of DOVE failure. **(H)**

2. Perform a realistic test to assess the contractual commitments made to provide a timely DOVE backup. **(A)**
3. Consider appropriateness of providing a second OSV so as to ensure support ship is in company with SBX at all times. **(L)**

ANNEX A. GLOSSARY.

ABS	American Bureau of Shipping
ADAB	As Designed/As Built (drawings)
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AESS	Antenna Equipment Support Structure
BAFO	Best And Final Offer (contracts)
BMDS	Ballistic Missile Defense System
BOE	Basis of Estimate
BOS	BMDS Operations Schedule
BSG	Beam Steering Generator
CEPOA	Corps of Engineers Pacific Ocean Alaska District
CFR	Code of Federal Regulations
CIMMS	Computerized or Contractor Inventory Maintenance Management System
CM	Corrective Maintenance, Configuration Management
COCOM	Combatant Commander
COE	Corps of Engineers
COI	Certificate of Inspection
CONOPS	Concept of Operations
CONUS	Continental United States
CSDU	Column Stabilized Drilling Unit
DNV	Det Norske Veritas
DPCS	Drive Platform Control System
DPS	Dynamic Positioning System
E^3	Electromagnetic Environmental Effects
EIS	Environmental Impact Statement
EMI	Electromagnetic Interference
EMS	Effective Material Strength
ETR	Extended Test Range
FBX	Forward Based X-Band Radar
FBX-T	Forward Based X-Band – Transportable
FOD	Foreign Object Debris/Damage
FONSI	Finding of No Significant Impact
FPCON	Force Protection Condition
GCN	GMD Communications Network
GECIC	GMD Element Coordination Information Center
GFC/C	GMD Fire Control/Communications
GMD	Ground-Based Midcourse Defense
GOM	Gulf of Mexico
HERP	Hazards of Radiation (RADHAZ) to Personnel
HME	Hull, Mechanical, Electrical
IETMs	Inter Active Electronic Technical Manuals
IDT	IFICS Data Terminal
IFICS	In-Flight Interceptor Communications System
ILS	Instrument Landing System
IMO	International Maritime Organization
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
ISM	International Safety Management
MARPOL	International Convention of the Prevention of Pollution from ships
MCR	Maximum Continuous Rating (Thruster Rating)
MEC	Maintenance Execution Center (Formerly MMC)
MMA	Maritime Medical Access

MMC	Maintenance Management Center (Renamed to MEC on May 12, 2006)
MODU	Mobile Offshore Drilling Unit
MSO	Marine Safety Office (e.g. MSO Anchorage)
NAVSTA	Naval Station
NDT	Non Destructive Test(ing)
NEPA	National Environmental Policy Act
NFESC	Navy Facilities Engineering Services Center
NTE	Not To Exceed
NVIC	Navigation Vessel Inspection Circulars
OFSC	Off-Site Support Center
OPLANS	Operational/Operations Plans
Orange Sheets	SEE "PAC" – Boeing's method of controlling work orders
OSSC	On-Site Support Center
OSV	Offshore Support Vessel
PAC	Positive Access Control (replaced Boeing "Orange Sheets" on May 12, 2006)
PCSS	Prime Contractor Support System
PERPS	Permanent Emergency Radar Pressurization System
PHNSY	Pearl Harbor Naval Ship Yard
PIDS	Prime Item Design Specification
PLI	Pounds per Linear Inch
PM	Preventive Maintenance, Program Manager
PSB	Primary Support Base
PSI	Pounds per Square Inch
QOL	Quality of Life
RADHAZ	Hazard of Radiation
REC	Record of Environmental Consideration
REDCON	Readiness Condition
REX	Receiver Exciter
ROD	Record of Decision
ROE	Rules of Engagement
RSS	Radar Support Structure
SBX	Sea Based X-Band Radar
SBX-1	Column Stabilized Semi Submersible Platform for SBX and Support Systems
SDPE	Signal/Data Processor Equipment
SICO	System Integration and Checkout
SOLAS	International Convention for the Safety of Life at Sea
SOP	Standard Operating Procedure
SSCO	Sub System Checkout
STCW	Standards of Training Certification and Watchkeeping for Seafarers
SUP SHIPS	U.S. Navy Superintendent of Ship Building
TERPS	Temporary Emergency Radar Pressurization System
TIM	Technical Interchange Meeting
UFR	Unfunded Requirement
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
WAM	Weekly Activity Message
WSOPS	Weapon Systems Operations & Support (Boeing Organization)
XBR	X-Band Radar

ANNEX B. TERMS OF REFERENCE

ANNEX C. INDEPENDENT ASSESSMENT PANEL MEMBERS

RADM (Ret) Huchting USN (Team Lead)	*Former Commander Destroyer & Cruiser, Navy PEO*
VADM (Ret) Bien USN	*Former Battle Group CDR; DCINCSPACE*
RADM (Ret) Pluta USCG	*Former Coast Guard Safety Engineer & Operations Expert*
RADM (Ret) Wyatt USN	*Former Navy Engineering Duty Officer & Naval Architect*
Mr. Gale SES (Ret) USN	*Naval Architect & Ship Design Expert*
Mr. Keane SES (Ret) USN	*Naval Architect & Ship Design Expert*
Mr. James Moorehead	*Semi-Submersible Engineer & Platform Operations Expert*

ANNEX D. RECOMMENDATION MATRIX.

Issue No.	Issue Title	Brief Description	Rec. No.	Address before leaving Hawaii (H)	Address before Adak Winter (A)	Long Term Mission(L) Readiness
SECTION 1. CREW READINESS						
I	Add'l Shakedown Time	Adequate Shakedown Time	1	X		
		Training Criteria & Metrics	2	X		
		Initial and focused shakedown in good/bad weather	3	X		
II	Systems Ops & Casualty Ctrl Train.	Computer Simulation	1			X
		Time & Incentives for simulation onboard use	2			X
		Equip. lightoff & Casualty Ctrl. Procedures	3		X	
		Up-to-date Tech. Docs.	4	X		
		Improvement of IETM	5			X
III	Crew Qual.	Crew Qual. Program	1	X		
		Onboard Crew Turnover Time	2		X	
		Training onshore capability	3			X
IV	Medical Person (MPIC)	Upgrade and Licensed	1	X		
V	Helicopter Support	Obtain Navy & USCG Helo deck certification	1	X		
		Helo refuel. & night tradeoff study	2			X

Issue No.	**Issue Title**	**Brief Description**	**Rec. No.**	**Address before leaving Hawaii (H)**	**Address before Adak Winter (A)**	**Long Term Mission(L) Readiness**
SECTION I (Cont.)						
V (cont.)		Contract with Commercial Helo Operator	3		X	
VI	Crew Rot. Cycle	28 Day Rotation Cycle	1	X		
VII	Crew Size & Mix	Addition of gen. Elec. and Elect. Tech.	1	X		
		Adjust. of Crew Size and Skill Set	2			X
		Review Damage Ctrl. & Train Crew in Basic Damage Ctrl.	3			X
VIII	Galley & Scullery	Indep. Review of Galley ops. by Navy Food Svc. Team	1	X		
IX	Personal Comm. & Entertain.	Individual Staterooms	1			X
		Private Location Onboard for Commercial Phone Sys.	2			X
X	Accommod ations	Feasibility of Addition of Add'l Staterooms	1			X
SECTION 2. MATERIEL READINESS						
I	Ballast Sys.	Indep. Engineering Analysis	1	X		
		Identify, Train, Certify Ballast Ctrl. Sys. Operators	2	X		
		Exercise Alt. & Remote Ballast Ctrl. Stations	3	X		
		Install Commercial Ballast Ctrl. Sys.	4		X	

Issue No.	Issue Title	Brief Description	Rec. No.	Address before leaving Hawaii (H)	Address before Adak Winter (A)	Long Term Mission(L) Readiness
		Simulator				
SECTION 2. (Cont.)						
I (cont.)		Drill	5	X		
		LODIC Ballast Model Problems	6	X		
II	Rescue Boat	Quick Launch Rescue Boat	1	X		
III	Ship's Crane	Second Deck Crane	1	X		
		Electronic Circuit Board Spares	2	X		
IV	Elec. Power & Main Propulsion	Generators	1			X
		Thrusters	2			X
V.	Onboard Spare Parts	Identify Parts	1	X		
		Four Heads for Generators	2	X		
		Full Elec. Spares	3	X		
		Inventory Control	4	X		
		Onboard 2M Repair Capability	5	X		
VI	TERPS	Perm. Install TERPS	1	X		
		Equip TERPS w/Auto. Start Sys.	2	X		
VII	Onboard Maint. Mgmt. Sys.	Maint. Mgmt Program	1	X		
		Maint. Time	2	X		
VIII	Depot Lvl Life Cycle Maint. & Reach Back Support	Commercial Shipyard	1			X
		Doc. & Exercise Tech. Reach Back Plans	2	X		

Issue No.	Issue Title	Brief Description	Rec. No.	Address before leaving Hawaii (H)	Address before Adak Winter (A)	Long Term Mission(L) Readiness
		Track Structural Joint Fatigue Inspections	3			X
SECTION 2. (Cont.)						
IX	Towing Capability	CONOPS	1	X		
		Exercise Towing Capability	2	X		
		Second Towing Bridle	3	X		
		DOVE Sea Keeping	4		X	
X	ADAB & Detection of Single Pt. of Failure	Validations	1		X	
		ADAB Validation & Single Point of Failure Analysis	2			X
XI	SBX is a Nat'l Vessel	Ops Reqs Review	1		X	
		Gaps & Shortfalls	2			X
XII	SBX Adak Mooring Plan	Company to Design & Install Turnkey Mooring Sys.	1	X		
		ABS Class Final Mooring Sys.	2			X
XIII	Emergency HF Comms.	Basic Emergency Trans.	1		X	
XIV	Ship Svc. (LPAC)	Second Ship Svc. LPAC	1			X
XV	Weather Deck Coating	Vacuum Grit Blast Machine	1		X	
XVI	Commercial GPS Reliability & Precision	Shift GPS from Commercial to Military	1			X
		Provide SBX-1	2			X

Issue No.	Issue Title	Brief Description	Rec. No.	Address before leaving Hawaii (H)	Address before Adak Winter (A)	Long Term Mission(L) Readiness
		with IMU and Life Cycle Support by USN IMU or Commercial IMU				
SECTION 3. OPERATIONAL CONSIDERATIONS						
I	C2	COCOM	1	X		
II	Limiting Sea State for Transit Draft Ops.	SOEs	1		X	
		Wave Sensors	2	X		
		Accelerations Monitoring Sys.	3	X		
		ABS Structural Fatigue Limit	4		X	
III	Survival Draft Ops. in Extreme Seas	Ship Propulsion Performance Predictions	1		X	
		Loss of Power	2	X		
		Tow	3			X
		Alternate Towing Resource	4		X	
		Survival Conditions	5		X	
		De-ballast Guidance	6		X	
IV	Heavy Weather/Cold Weather Plan	Heavy Weather/Cold Weather Plan	1	X		
		Train	2	X		
		Plan & Comms with USCG	3	X		
		Weather Forecasting Svc.	4	X		
V	Damage Stability	Expand Damage Stability Analysis	1	X		
		Flooding Cases	2	X		
		Pre-Damage Liquid Loading of Pontoon Tanks	3	X		

		Post-Damage Ballast Ctrl. Measures	4	X		
Issue No.	**Issue Title**	**Brief Description**	**Rec. No.**	**Address before leaving Hawaii (H)**	**Address before Adak Winter (A)**	**Long Term Mission(L) Readiness**
SECTION 3. (Cont.)						
V (cont.)		Damage Stability Investigation	5	X		
		Structural Subdivisions & Ship Modifications	6			X
VI	Physical Security	Ops Cmdr. Review	1	X		
		Non-Lethal Tech.	2			X
		Long Range Stand-off Weapon	3			X
VII	Support Vessel CONOPS	Backup OSV	1	X		
		Test DOVE Timely Backup	2		X	
		Second OSV	3			X

ANNEX E. BRIEFING