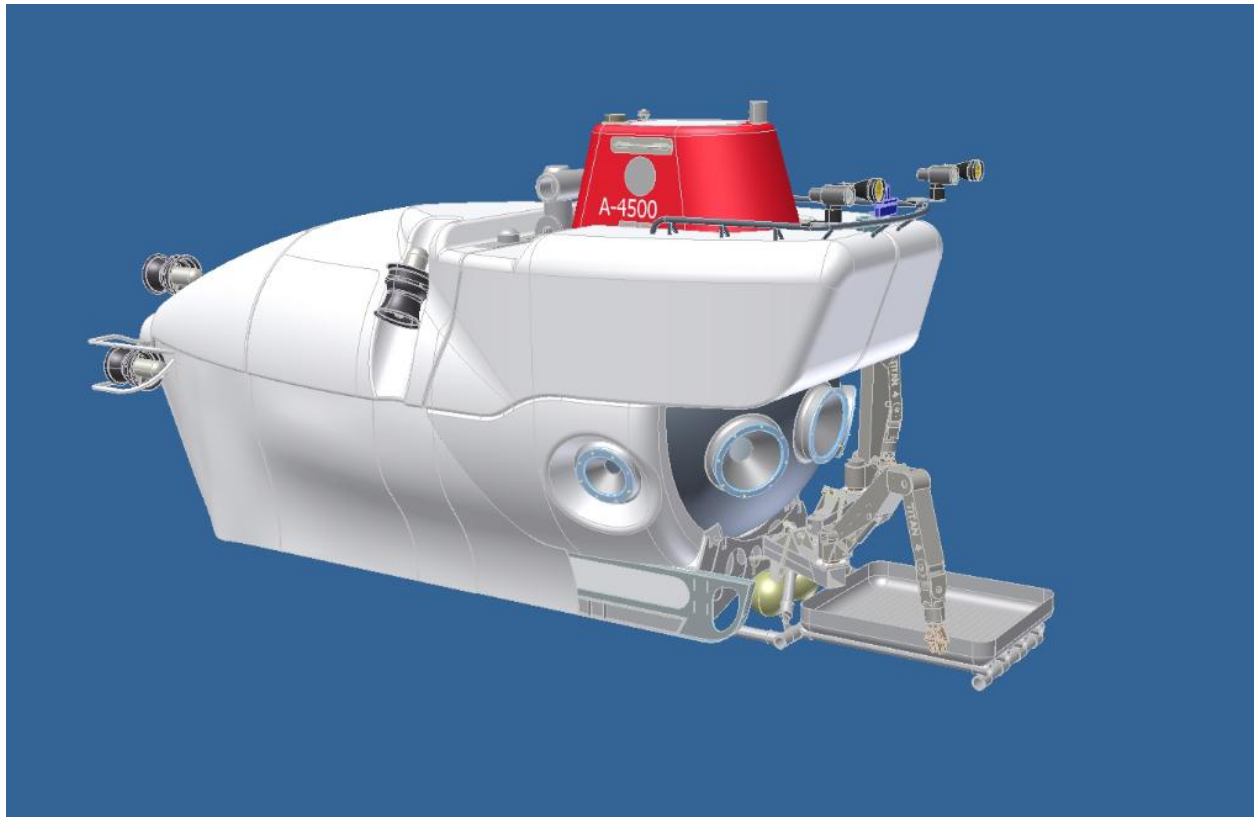


6500m HOV Project Stage 1: A-4500 HOV

ABS Classification Plan

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1.0 Introduction

The Woods Hole Oceanographic Institution (WHOI) is building a deep diving submersible that will ultimately be capable of operating at depths of 6500 meters of seawater. The 6500 Meter Human Occupied Vehicle (6500M HOV) project will be executed in two stages in accordance with the *ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, 2002* (UWVS). The vehicle will be classified by the American Bureau of Shipping. The project is funded by the National Science Foundation (NSF) under Cooperative Agreement number OCE-0433409 effective August 1, 2004. This document will serve as the classification plan for Stage One of the project.

1.1 Stage One – the A-4500 HOV

The scope of the 6500M HOV Stage One project (referred to as the A-4500 HOV) will include the design, construction and commissioning of an ABS classed “research submersible” vehicle. The A-4500 HOV will carry three persons, one pilot and two scientific observers, and have an operating depth of 4500 meters of seawater. The vehicle will make use of several 4500 meter components but, within project cost limitations, new components will be designed and built to 6500 meter specifications. In all such instances, any report or documentation that is submitted for ABS review will be clearly marked with the intended operational depth rating.

1.2 Stage Two – the A-6500 HOV

The scope of the 6500M HOV Stage Two project (referred to as the A-6500 HOV) will include making all required modifications to the A-4500 HOV under ABS Survey to increase the operational depth to 6500 meters. Execution of the A-6500 HOV project is optimistically planned to coincide with the vehicle’s first Special Periodical Survey period. Stage Two modifications will be managed under a separate classification plan.

2.0 Scope of Classification

The US Naval Sea Systems Command, 07Q4, SS800-AG-MAN-010/P-9290 *System Certification Procedures and Criteria Manual for Deep Submergence Systems* (NAVSEA-9290) states that the scope of certification of a deep submersible vehicle is “comprised of those systems, subsystems and components and the associated maintenance and operational procedures required to provide maximum reasonable assurance that DSS personnel are not imperiled during system operations”.

WHOI will collaborate with ABS to develop a comprehensive Scope of Classification (SOC) document for the A-4500 HOV that identifies all critical systems and components of the vehicle according to the UWVS rules. Those items identified by the SOC will comply with the classification plan outlined in this document.

3.0 Submission Reports

All items identified in the vehicle SOC will be categorized into one or more of the following submission groups:

1. Existing Equipment
2. General Group
3. Mechanical Equipment Group
4. Pressure Hull Group
5. Pressure Vessel Group
6. Ballast Group
7. Electrical Installations Group
8. Emergency Systems Group
9. Propulsion Group
10. Launch and Recovery System (LARS) Group
11. Life Support Systems Group
12. Procedures & Test Group
13. Manuals Group

The *Submission Tracking* spreadsheet in Appendix A lists the submission reports that WHOI will generate. This tracking sheet provides the required insight to ensure that those engineering documents generated as part of the design process are approved by ABS in a timely manner. The submission tracking spreadsheet also provides the required insight to ensure that hardware components are accepted/approved by ABS in a time frame that supports the vehicle construction plan. These documents will be drafted and submitted during the Detailed Design Phase of the project once an approved vehicle design has been determined.

For each submission report, a responsible engineer will be designated to manage the ABS requirements throughout the design and build process. This individual will ensure that all applicable rules specified by UWVS section 1/7 “Submissions of Plans, Calculations, Data and Test Results” are met, and will generate the required detailed submission report. A breakdown of the rules that apply to each submission report is supplied in the *Rule Matrix for Submission Groups* in Appendix B. All submission reports are stand-alone documents that will be generated

and submitted independently as they become available. Groups 12 and 13 will be assembled from multiple sections. Each section may be submitted individually or combined as deemed appropriate by the ABS Classification Lead (see Section 4).

4.0 Review and Submission Process

When a submission report is assembled, the A-4500 HOV Technical Director and project engineers will review it for content and completeness. Once approved internally, the document will be forwarded to the ABS Engineering group and the ABS Survey group by the designated A-4500 HOV Classification Lead. The Classification Lead is the single point of contact between WHOI and ABS and is responsible for submitting and tracking all official documents and correspondence. WHOI will engage a naval architect firm familiar with ABS classing to assist the Classification Lead and ensure that certification occurs successfully.

Attention: Construction of any component within the Scope of Classification **CANNOT** begin until the applicable report containing design, manufacturing and survey plans has been reviewed, and WHOI has received documented approval from both the ABS Engineering group and the ABS Survey group.

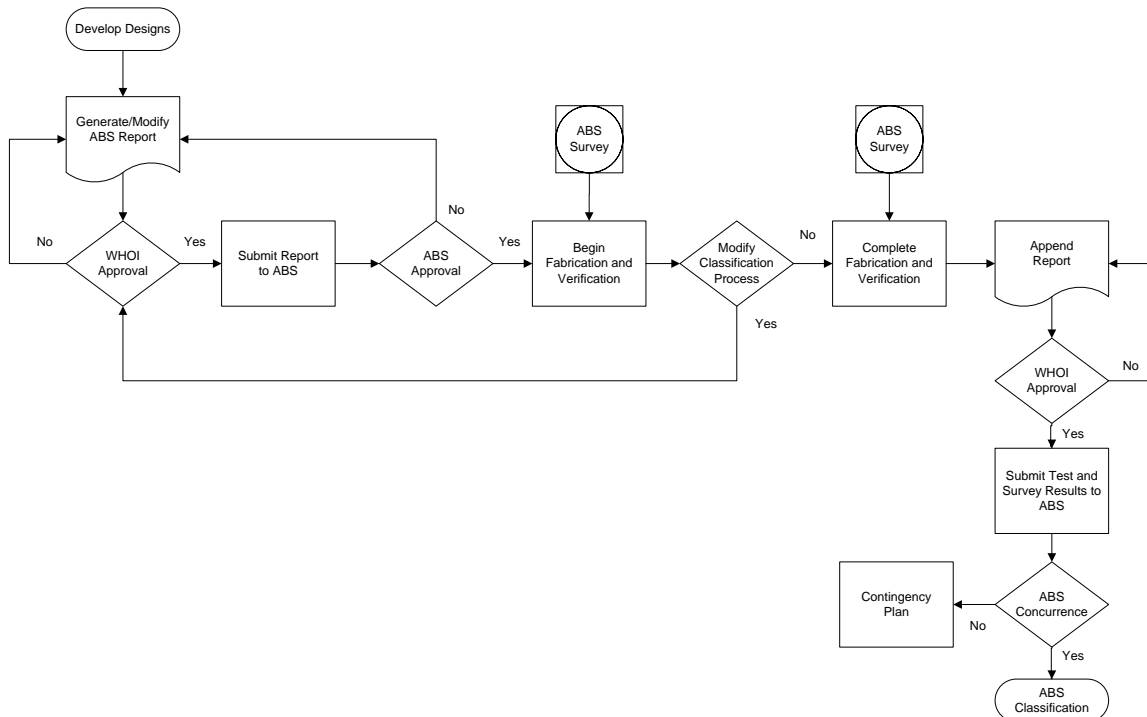


Figure 1. WHOI Document Review and Submittal Process

When a report has been approved by ABS, construction of the system and/or components may begin. When the results of all in-process surveys and testing for a component or system, as defined by the approved manufacturing plan, are available, the applicable submission group report will be appended to include this objective quality evidence (OQE) as needed. The appended report will be reviewed by WHOI and resubmitted to the ABS Engineering group and the ABS Survey group for final classification.

During construction and validation of a classed system or component, any proposed deviations from approved designs and plans must be reviewed by the A-4500 HOV Technical Director, the Change Control Board, the ABS Engineering group and the ABS Survey group. Any proposed changes must receive official approval by the ABS Engineering group and the ABS Survey group before they can be executed. The *Submission Tracking* spreadsheet in Appendix A will be used to track ongoing submittals and approvals throughout the classification process.

5.0 Alternate Arrangements

Because of this vehicle's extreme operating conditions, WHOI has identified several instances where UWVS rules cannot be met for either safety or technical reasons. In these cases, WHOI has or will submit requests to ABS for alternate arrangements that meet the intent of the rule in question. Requests for alternate arrangements must be justified by practical engineering data and/or operational experience and must be approved by ABS before any aspect can be incorporated into the vehicle's design.

The complete details of a design that incorporates any aspect of an approved alternate arrangement must be submitted to the ABS Engineering Department and Survey Department as part of a submission report for a full review before it can be approved for fabrication. Appendix C provides a list of the alternate arrangements that have been or will be submitted to ABS.

6.0 Components Not Constructed Under ABS Survey

The A-4500 HOV will be designed and constructed by WHOI in its Woods Hole, MA, facility under ABS survey. WHOI intends to incorporate existing hardware that will be "cross-decked" from the current Deep Submergence Vehicle *Alvin*. These systems or components were designed, constructed and operated under NAVSEA-9290 standards. Such components are considered to have been designed, built, and operated under the survey of a "Recognized Flag State" and are considered to be acceptable for use within the ABS classified design. WHOI has

discussed the incorporation of NAVSEA-certified equipment into the A-4500 HOV with ABS. They have determined that systems of this nature will be identified and documented in accordance with UWVS in the applicable submission report, and they will be evaluated by ABS on a case-by-case basis.

7. Pressure Hull

The A-4500 HOV will use a titanium pressure hull that has been designed and constructed by the Southwest Research Institute (SwRI) under ABS survey for 6500 meter operations in accordance with UWVS rules. All submissions regarding the classification of the hull are being generated and submitted by SwRI in accordance with their separate and independent classification program. SwRI sphere documentation submission schedules are tracked by the WHOI project management team and *Perot Systems Government Services* representatives (who provide technical liaison to SwRI for WHOI) during weekly management telecoms. When applicable, reports are reviewed by the appropriate WHOI engineering staff prior to their submission to ABS.

8. Launch and Recovery System (LARS)

The A-4500 HOV will be operated from the R/V *Atlantis* which is outfitted with an A-Frame launch and recovery system that was designed and built under ABS survey by Caley Hydraulics Ltd. The LARS was not classified with ABS, but has been certified and operated under NAVSEA-9290 since its original commissioning on board R/V *Atlantis II* in 1985. ABS classification of the LARS is not required by UWVS. Hence, WHOI will continue to certify and operate the system under NAVSEA-9290 certification.

Appendix A: Submission Tracking

Document #	Submission Group Report	Description	RO	WHOI First Submission Date	ABS Reviewer & Response Date	WHOI Final Submission Date	ABS Approval Date	Approval Need Date
TBD-1	Existing Equipment	DSV-2 Alvin components that will be reused or recycled in the new vehicle design. One or possibly several submittals that address the issues specified in section 1.3.5 "New and Existing Underwater Units or Systems Not Built Under Survey".	WHOI					Sep-10
TBD-2	General Group	General vehicle operating parameters.	WHOI					Sep-10
TBD-3	Mechanical Equipment Group	Vehicle general arrangement and stability analysis including frame details and analysis.	WHOI					Mar-10
TBD-4	Pressure Hull Group	Not applicable to the vehicle project. All sphere documentation will be submitted by Southwest Research Institute under separate project.	SwRI					May-11
TBD-5	Pressure Vessel Group, Power Bottle	Dimensional details, design criteria, fatigue analysis and testing plans for the "Power Bottle" pressure vessel. Test results for multiple units of this single design will be submitted together.	WHOI					Sep-10
TBD-6	Pressure Vessel Group, Data Bottle	Dimensional details, design criteria, fatigue analysis and testing plans for the "Data Bottle" pressure vessel. Test results for multiple units of this single design will be submitted together.	WHOI					Sep-10
TBD-7	Pressure Vessel Group, Motor Controller Bottle	Dimensional details, design criteria, fatigue analysis and testing plans for the "Motor Controller Bottle" pressure vessel. Test results for multiple units of this single design will be submitted together.	WHOI					Sep-10
TBD-8	Pressure Vessel Group, Implodable Volumes	Manufacturers details and design criteria for purchased critical implodable volumes (ID > 6 inches)	WHOI					Sep-10
TBD-9	Ballast Group, Variable Ballast System	Variable ballast system submission.	WHOI					Mar-10
TBD-10	Ballast Group, Main Ballast System	Main ballast system submission.	WHOI					Mar-10
TBD-11	Ballast Group, Syntactic Foam	Syntactic foam submission.	WHOI					Mar-10
TBD-12	Electrical Installations Group	Electrical system architecture and top level schematics for vehicle with main battery system energy analysis. To include ground detection and leak detection systems.	WHOI					Mar-10
TBD-13	Emergency Systems Group	Emergency system architecture and schematics with emergency battery system energy analysis. To include emergency release system.	WHOI					Sep-10
TBD-14	Propulsion Group	Propulsion system submission.	WHOI					N/A
TBD-15	LARS Group	A-Frame launch and recovery system classification documentation (to be submitted by outside contractor if necessary).	Glosten					N/A
TBD-16	Life Support Systems Group	Life support system specifications and habitability calculations.	WHOI					Sep-10
TBD-17	Procedures & Test Group	Multiple submissions for process and procedures to be developed independently of specific designs (i.e.: weld procedures, hydro test procedures, etc.)	WHOI					Sep-10
TBD-18	Manuals Group	Multiple submissions including Operating Manual, Maintenance Manual and Rescue Plan.	WHOI					Sep-10

Table A-1: WHOI Tracking Matrix for A-4500 HOV Submissions to ABS

Appendix B: Rule Matrix for Submission Groups

Group	Name	Section	Description
		1	Scope and Conditions of Classification
1	Existing Equipment	1.3.5	New and Existing Underwater Units or Systems Not Built Under Survey
		1.3.5	Welding procedures (WPS) and performance qualifications records (PQR)
		1.3.5	NDT records
		1.3.5	Material mill test Reports
		1.3.5	All other certificates of past surveys and tests results conducted by the original certifying agency, insofar as such documentation is available and valid
		1.3.5	Written test procedures for the tests and trials required to be performed for classification
		1.3.5	HOVs will only be accepted with proof of fabrication under survey of International Association of Classifying Agencies (IACS) or recognized flag State.
		1.3.5	Prior to classification acrylic windows for PVHO must be replaced with new certified windows
		1.7	Submissions of Plans, Calculations, Data and Test
		1.7.3	Documentation to be Submitted (2002)
2	General Group	1.7.3.1	Design and Operational Parameters (2007)
		1.7.3.1	Design pressures and depths
		1.7.3.1	Design temperatures
		1.7.3.1	Hydrostatic test pressures
		1.7.3.1	Design sea state conditions
		1.7.3.1	Maximum operating depth
		1.7.3.1	Maximum mission time
		1.7.3.1	Maximum number of occupants (passengers and crew) in each unit and/or system
		1.7.3.1	Maximum weight of units including occupants, contents, entrapped water, etc.
		1.7.3.1	Maximum towing speed/towing line tension
1.7.3.1	Maximum speed while surfaced and submerged		
3	Mechanical Equipment Group	1.7.3.2	General
		1.7.3.2	General arrangement
		1.7.3.2	Cross-section assembly
4	Pressure Hull Group	1.7.3.2	Outboard profile
		1.7.3.2	Dimensional details of pressure hull, pressure vessel(s) and scantlings
5	Pressure Vessel Group	1.7.3.2	Material specifications and grades, including tensile and impact values, for all pressure retaining or load bearing items
6	Ballast Group	1.7.3.2	Weld details of pressure hull, pressure vessel(s) and scantlings
		1.7.3.2	Welding procedures to include base and filler materials, pre and post weld heat treatment, tensile and impact values, extent of nondestructive testing.
		1.7.3.2	Out-of-roundness tolerances
		1.7.3.2	Fabrication tolerances
		1.7.3.2	Dimensional details of penetrators, hatch rings, hatch details, lugs and any other internal or external connection to the hull
		1.7.3.2	Penetrator sealing arrangements
		1.7.3.2	Hatch sealing arrangements
		1.7.3.2	Nameplate, including nameplate material and method of attachment
		1.7.3.2	Plan showing all hull valves, fittings and penetrations
		1.7.3.2	Exostructure details
		1.7.3.2	Dimensional details of viewport components
		1.7.3.2	Hard ballast tanks design details
		1.7.3.2	Soft ballast tanks design details
7	Electrical Installations Group	1.7.3.2	Piping systems including pump capacities and pressure relief devices
		1.7.3.2	Ballast piping systems
		1.7.3.2	Layout of control stands
		1.7.3.2	Equipment foundation and support arrangements with details where such foundations and supports increase stresses in the pressure hull or experience significant stress due to the operating loads encountered
		1.7.3.2	Release devices and arrangement for jettisonable weights and equipment
8	Emergency Systems Group	1.7.3.2	Propeller details including shafting, bearings and seals
		1.7.3.2	Propulsion motors, thrusters and wiring diagram
9	Propulsion Group	1.7.3.2	Steering control system
		1.7.3.2	Electrical distribution system
		1.7.3.2	Battery capacity, arrangement and main feeder scheme
		1.7.3.2	

Table B-1: ABS Rule Matrix Spread for A-4500 HOV Submissions

Group	Name	Section	Description
10	LARS Group	1.7.3.2	Lifting and handling system
		1.7.3.2	Depth indicating systems
		1.7.3.2	Emergency systems
		1.7.3.2	Fire fighting system
		1.7.3.2	Details for permanently installed pressure vessels
		1.7.3.2	Documentation for portable pressure vessels including standards of construction and design calculations for external pressure if units may at any time be subject to this condition.
		1.7.3.2	List and location of implodable volumes
		1.7.3.2	Materials and dimensions of umbilicals including cross-sectional details
		1.7.3.2	Any additional system deemed necessary to the intended operations (FOAM?)
11	Life Support Systems Group	1.7.3.3	Life support system details, both normal and emergency
		1.7.3.3	Life support system capacities, fluids contained and supply arrangement
		1.7.3.3	Specifications for environmental control systems and equipment including heating, gas analysis (CO ₂ , CO, CH ₄ , O ₂ , etc), absorption, circulation, temperature control, humidity
		1.7.3.3	Component list including manufacturer, model, design specifications and test documentation for all equipment used in the life support system
		1.7.3.3	For gas analyzers: specifications of type of gas to be detected, principle of detection, range of pressures under which the instrument may be used
		1.7.3.3	Lodging facilities and drainage systems in hyperbaric chambers
		1.7.3.4	Procedures
12	Procedures & Test Group	1.7.3.4	Procedures for out-of-roundness and sphericity measurements
		1.7.3.4	Cleaning procedures for breathing gas systems
		1.7.3.4	Inclining experiment procedures
		1.7.3.4	Functional test procedures
		1.7.3.4	Sea trial procedures for normal and emergency conditions
		1.7.5	Calculations
		1.7.5	Pressure vessel stress analysis in compliance with Section 6
		1.7.5	Foundation stress analysis
		1.7.5	Pressure hull support reaction analysis
		1.7.5	Analysis of lifting load and stresses induced in the hull
		1.7.5	Window calculations in compliance with Section 7
		1.7.5	Life support system analysis
		1.7.5	Heat/cooling consumption for the hyperbaric chamber or underwater vehicle under the design conditions and the expected environmental temperatures
		1.7.5	Electrical load analysis and loss of power, power sources; power demands
		1.7.5	Short circuit current calculations
		1.7.5	Coordination of short circuit protection devices (coordination study)
		1.7.5	Calculation for the center of gravity and center of buoyancy
		1.7.5	Intact stability analysis
		1.7.5	Damage stability analysis
		1.7.5	Hydrodynamic ascent calculations under normal and emergency conditions
		1.7.7	Operational Data
		1.7.7	Description of operations
		1.7.7	Description of units and intended service
		1.7.9	Test Results
		1.7.9	Tests are to be performed to the satisfaction of the surveyor (possibly in the presence of)
		1.7.9	Material tests
		1.7.9	Procedure and welder qualification test results
		1.7.9	Out-of-roundness measurements before and after hydrostatic test
		1.7.9	Hydrostatic tests
		1.7.9	Strain gauge tests, as applicable
		1.7.9	Electrical system insulation tests
		1.7.9	Life support tests
1.7.9	Functional test of completed unit or chamber		
1.7.9	Test dive of completed underwater unit at rated depth (to include deadweight survey and inclining experiment)		

Table B-1 (cont.): ABS Rule Matrix Spread for A-4500 HOV Submissions

Group	Name	Section	Description
		1.9	Manuals
		1.9.1	Operating Manual (2007)
13	Manuals Group	1.9.1	An operating manual describing normal and emergency operational procedures is to be provided and is to be submitted for review. The manual is to include the following as applicable.
		1.9.1	System description
		1.9.1	Operation check-off lists (list to include equipment requiring operational status verification or inspection prior to each dive/operation and verification of the existence of appropriately updated maintenance schedule – see 1/9.3)
		1.9.1	Operational mission time and depth capabilities
		1.9.1	Sea state capabilities (see Appendix 4, Table 1)
		1.9.1	Geographical dive site limitations (such as maximum current, night/limited visibility operation and list of operational and environmental hazards, if any, to be avoided.) as related to the design parameters addressed in Subsections 1/7 and 12/3
		1.9.1	Special restrictions based on uniqueness of design and operating conditions
		1.9.1	Life support system description including capacities
		1.9.1	Electrical system description
		1.9.1	Launch and recovery operation procedures
		1.9.1	Liaison with support vessel
		1.9.1	Emergency procedures, developed from systems analysis, for situations such as power failure, break in lifting cable, break in umbilical cord, deballasting/jettisoning, loss of communications, life support system malfunction, fire, entanglement, high hydrogen level, high oxygen level, internal and external oxygen leaks, stranded on bottom, minor flooding, and specific emergency conditions characteristic of special types of systems.
		1.9.1	Emergency rescue plan (see 8/11.1 and 8/12)
		1.9.1	Color coding adopted
		1.9.3	Maintenance Manual (2002)
		1.9.3	A maintenance manual containing procedures for periodic inspection and preventive maintenance techniques is to be submitted for review.
		1.9.3	Must contain:
		1.9.3	Expected service life of the pressure hull and of other vital components/equipment (e.g., viewports, batteries, etc.)
		1.9.3	Methods for recharging life support, electrical, propulsion ballast and control systems.
		1.9.3	Specific instructions for the maintenance of items requiring special attention.
		1.9.5	Availability (2007)
		1.9.5	The operating and maintenance manuals together with operational and maintenance records are to be readily available at the operation site and copies are to be made available to the Surveyor upon request.
		1.9.5	Summarized procedures for normal and emergency operations are to be carried onboard the unit.
		1.11	Personnel (2002)
		1.11	Owners and Operators of commercial and non-commercial underwater units are ultimately responsible for, and are to assure themselves of, the competence of those performing activities related to the unit.

Table B-1 (cont.): ABS Rule Matrix Spread for A-4500 HOV Submissions

Appendix C: Alternate Arrangements

Topic	UVHS Section	Effected System	Rule Text	WHOI Submission Date	ABS Response Date	ABS Rep	Status	Notes/Requirements
Oxygen Storage	Section 8/7.5.2	Life Support System	The volume of a single internal source is to be limited such that the complete release of its contents will not increase the pressure more than 1 atmosphere nor raise the oxygen level above 23 % by volume.	26-Jul-06	14-Dec-06	R. Tanwar	Accepted	The vehicle may use fewer O2 storage cylinders if: any in-progress dive is terminated in the event of an O2 system failure, there are redundant environment monitoring devices, any failure at pre-dive must be corrected before diving can resume. The unit class certificate will be for a "research vehicle" based on it's alternate degree of compliance per NAVSEA 9290.
Equalizing pressure	Section 8/33	Hatch, Life Support system, Emergency Rescue Plan	Means are to be provided for equalizing pressure on each side of the hatch prior to hatch opening. As an alternative, an absolute pressure indicator with means of adjusting the internal pressure on either side may be provided	9-Aug-06	06-Sep-06	R. Tanwar	Accepted	The vehicle may use an aviation style barometric altimeter internally. WHOI must have a procedure for increasing the oxygen bleed to raise pressure in the personnel sphere prior to opening the hatch. WHOI must have a procedure and design for loosening the hatch securing dogs to relieve excess pressure from the personnel sphere. WHOI must have a design and procedure for jacking open the hatch from the outside to overcome any differential pressure across the hatch if assistance from the vehicle crew is not available.
External Mechanical Pressure Instrument	Section 8/19.3	Life Support System	Internal and external pressure are to be monitored using a mechanical type instrument in addition to any other type of pressure indicating instrument.	7-Aug-06	06-Sep-06	R. Tanwar	Accepted	The latest ABS rule has been changed to reflect the intent of the WHOI alternate arrangement. For deep diving units, special consideration will be given to the equivalent alternate arrangements for external pressure monitoring, such as independent dual electronic sensors, as determined suitable by the bureau.
Hand Operated Hydraulic Backup Plant	Section 10/7.23	Hydraulic System, Emergency Release System	Power driven pumps of hydraulic systems, other than propulsion systems, that are necessary for the operation of the underwater system or hyperbaric facility are to be backed up with at least one hand operated pump.	8-Aug-06	11-Sep-06	R. Tanwar	Accepted	The latest ABS rule has been changed to reflect the intent of the WHOI alternate arrangement. Non-emergency service hydraulic loads (such as manipulators) will not require a hydraulic backup pump. Emergency service hydraulic loads will have a hydraulic backup pump. A hydraulic pump used as a backup for emergency services will have a source of power and electrical distribution that is independent of the normal hydraulic supply.
Normal Ballast System	Section 3/17.1.1	Variable Ballast System, Main Ballast System	Each manned unit is to be fitted with a ballast system capable of providing normal ascent and descent and necessary trim adjustments. Ballast tanks that are subjected to internal or external pressure are to comply with the requirements of Section 6. Two independent means of deballasting are to be provided; one is to be operable with no electric power available	10-Aug-06	16-Nov-06	R. Tanwar	Accepted	The latest ABS rule has been changed to reflect the intent of the WHOI alternate arrangement. The vehicle must have a separate electrical energy source of the necessary capacity for each means of deballasting which uses separate wiring systems (including penetrators/connectors), and separate electrical actuators or motors. The two systems are to include various controls instrumentation and monitoring to ensure that all safety systems are functioning properly.
Rescue Plan	Section 8/11.1	Life Support System, Emergency Rescue Plan	Each submersible or other untethered unit is to have a minimum reserve capacity consistent with the emergency rescue plan but not less than 72 hours.	28-Sep-07	20-Nov-07	Supria Majumder	In Process	Due to the remote geographical location of many dive sites, the physical size of a life support system having minimum reserve capacity that is consistent with an emergency rescue plan is prohibitive. WHOI has requested ABS approval of a reserve life support capacity that is not less than 72 hours. For consideration of this alternate arrangement, WHOI must submit a detailed emergency rescue plan or a risk assessment study.
Hatch Combing Variance	Section 3/17.1.4	Sail, Bathtub	Each unit is to have sufficient intact stability on the surface so that in the worst loading condition, when subjected to a roll expected under the worst conditions listed in Appendix 4, Table 1 for the design sea state, the unit will not take on water through any hatch that may be opened when surfaced. In addition, the distance from the waterline to the top of coamings around hatches that may be opened with the unit afloat is not to be less than 2.5 ft. with the unit upright.	Not Yet Generated				

Table C-1: WHOI Alternate Arrangements for ABS Rules Based on A-4500 M HOV

Appendix D: Abbreviations

WHOI	Woods Hole Oceanographic Institution
6500M HOV	The 6500 Meter Human Occupied Vehicle
UWVS	<i>ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, 2002</i>
NSF	National Science Foundation
A-4500 HOV	6500M HOV Stage One project
A-6500 HOV	6500M HOV Stage Two project
NAVSEA-9290	US Naval Sea Systems Command, 07Q4, SS800-AG-MAN-010/P-9290 System Certification Procedures and Criteria Manual for Deep Submergence Systems
SOC	Scope of Classification
LARS	Launch and Recovery System
OQE	Objective quality evidence
SwRI	Southwest Research Institute