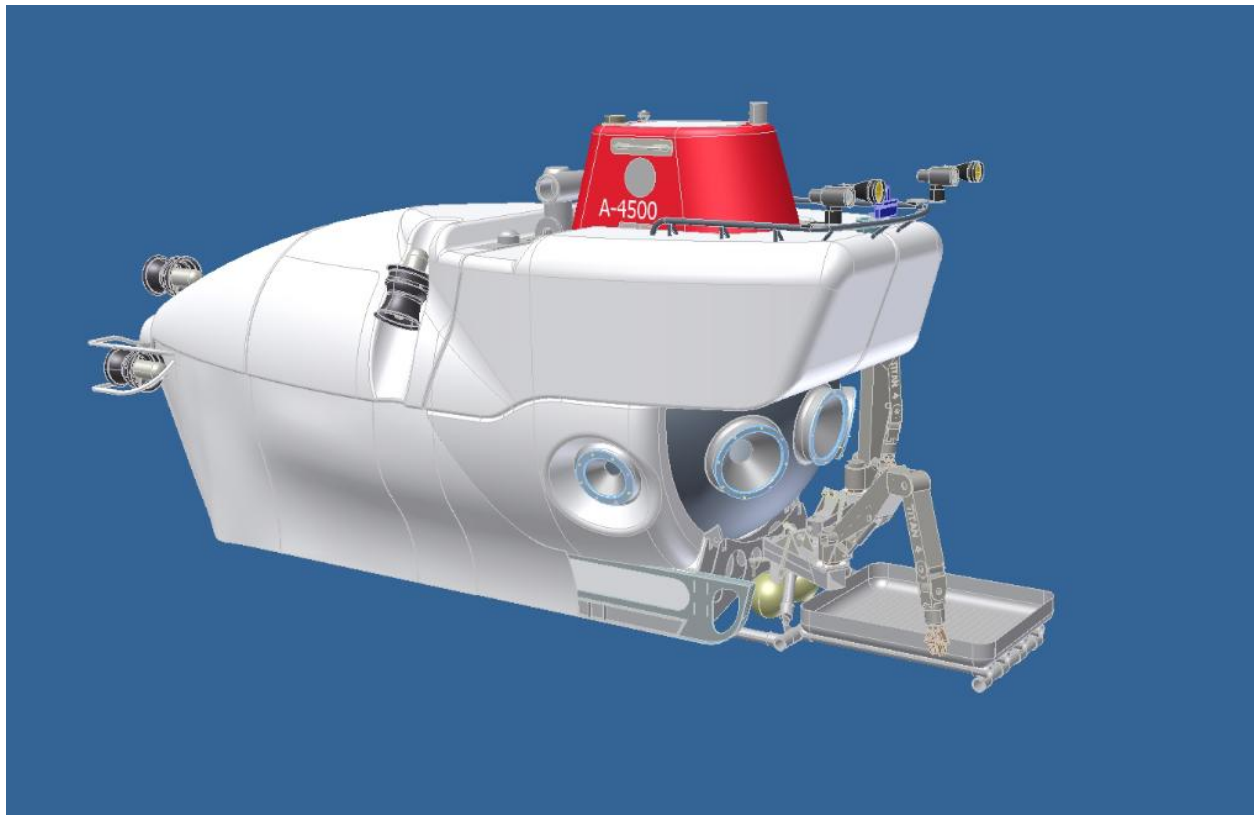


6500m HOV Project

Stage 1: A-4500 HOV

Configuration Management Plan

Document Control No.: 0000000
29-October-2009



Document Control Sheet

Date	Originator	Description
08-21-09	R. Chandler	Initial Outline
08-21-09	R. Chandler	First Draft
09-03-09	R. Chandler, J. Leadmon	Second Draft
10-28-09	R. Chandler	Third Draft

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1.0 Introduction

The purpose of this *Configuration Management Plan* (CMP) is to set forth the methodology to be used for the control of configuration items associated with the A-4500 HOV Project. The CMP is the formal means for approval of design documentation and deliverables, including drawings, and subsequent changes. It is WHOI's responsibility to ensure that the configuration is managed and controlled in a fashion that is relative to the project stages, is well documented, and is communicated to affected functional areas in a timely manner.

2.0 Reference Documents

- *A-4500 HOV ABS Classification Plan*
- *A-4500 HOV Environmental Health & Safety Plan*
- *A-4500 HOV Procurement Plan*
- *A-4500 HOV Engineering Design Plan*
- *A-4500 HOV Project Execution Plan*
- *A-4500 HOV Project Management Plan*
- *A-4500 HOV Quality Management Plan*
- *A-4500 HOV Risk Management Plan*
- *A-4500 HOV Sphere Construction Plan*
- *A-4500 HOV Systems Engineering, Integration & Testing Plan*
- *A-4500 HOV Transition to Operations Plan*
- *A-4500 HOV Vehicle Construction Plan*
- *A-4500 HOV Work Breakdown Structure & Dictionary*

3.0 Configuration Management

Starting with the accepted design at the Preliminary Design Review, the design and capability, cost and schedule control accounts will be set. In this document, these accepted parameters will be referred to as the Accepted Control Account (ACA). WHOI will use the Configuration Management Process described in this plan to: 1) ensure there is a disciplined process that involves both management and technical direction to design and build the A-4500 HOV in accordance with the ACA; and 2) manage changes to the ACA within established guidelines as noted herein. A sound configuration management plan is an essential WHOI tool for managing the scope, cost and schedule parameters of the A-4500 HOV Project and to keep the NSF informed of any breaches in scope, cost and schedule.

3.1 Establishment of Configuration

Formal configuration management will begin at the completion of a successful Preliminary Design Review and the establishment of the ACA. Configuration management will serve as a primary WHOI management tool and continue until the finished vehicle is formally transitioned to an operational status, at which point the vehicle configuration will be managed using traditional operations procedures.

3.2 Configuration Control Process

The management element of the configuration control process includes the preparation, justification, evaluation, coordination, disposition, and implementation of proposed engineering configuration items or program technical data changes and/or deviation from the requirements. The systematic change management process is progressive and evolves with the maturity and complexity of the program.

3.2.1 Control Accounts

An ACA will be established as described above. External advisors will participate in control account reviews/updates and provide assessments and advice on the A-4500 HOV Project design, capability, cost, and schedule (including any associated risks).

3.2.2 Change Classes

All changes (e.g. engineering, policy, statement of work, controlled program/design documents, etc.) to the ACA shall be categorized as Class 1 or Class 2 as defined below. Both Class 1 and Class 2 changes may be included on the same Change Control Request (CCR) form. However, should this be the case, each document identified by the CCR must identify the appropriate Class as 1 or 2.

3.2.2.1 Class 1 Changes

A change shall be classified as Class 1 when the change is to a controlled design document, controlled policy/plan document, statement of work or contract **and** one or more of the following statements apply:

- a) Affects any physical or functional requirement in approved configuration documentation (form, fit and function as related to a requirement):
 1. Technical requirements and specifications that affect reliability, maintainability, availability, form, fit, function or interface characteristics

2. Interchangeability, substitutability, or replaceability as applied to configuration items and to all sub-assemblies and parts of repairable configuration items.
- b) Affects any approved functional, allocated or product configuration documentation, cost, warranties, or contract milestones:
1. Cost to the A-4500 HOV Project in excess of \$25,000 per control account, singular and cumulative per control account
 2. Schedule to the A-4500 HOV Project in excess of four weeks increase in work package schedule, singular and cumulative per control account.
- c) Affects approved product configuration documentation **and** one or more of the following:
1. Safety, correction of a hazard or conformance to applicable design standards
 2. Compatibility, interoperability, interfaces, or logistic support
 3. Interchangeability, substitutability, or replaceability of any item down to non-repairable subassemblies
 4. Sources on a source control drawing.
- d) Affects system configuration to the extent that retrofit (replacement of components) action would be taken on a formally tested or commissioned component.

3.2.2.2 Class 2 Changes

A change shall be categorized as Class 2 if it is a proposed change to a controlled design document, controlled policy/plan document, statement of work, or contract **and** is not categorized as a Class 1 change. Such changes may:

- a) Be minor in nature, such that the cost of processing the change request may equal or exceed the cost of performing the work
- b) Not exceed any single difference of 10% of the control account baseline budget or \$25,000 between a control account estimate to complete and the baseline budget to complete, whichever is lower
- c) Be EVM items, task level or lower
- d) Be a correction of typographical errors, dimensions, graphical or pictorial representation.

3.2.3 Review Authority

Authority	Class 1 Change	Class 2 Change
NSF	Review and approve CCRs affecting A-4500 HOV Project Accepted Control Accounts for cost, schedule or scope implications	Not Reviewed
A-4500 HOV Change Control Board	Review and disposition	Review and disposition

3.2.4 NSF Program Manager Review

The NSF Program Manager will review, in person or via technology as required by the needs of the project, any Class 1 CCRs that require adjustment to the ACA. The Chair of the Change Control Board (CCB) will provide advance notification to the NSF Program Manager of any in-process critical CCRs as soon as practicable to ensure prompt scheduling of the review and processing of the request.

3.2.5 Deviations

A deviation is a specific written authorization to move away from a particular requirement for a specified period of time. A deviation is not intended for changes to configuration documents. Deviation requests within the A-4500 HOV Project have limited utility.

3.3 Configuration Change Process

All requested changes must be evaluated for risk and impact on design/capability, schedule, and cost. Changes in the A-4500 HOV Project are controlled through a formal approval process.

3.3.1 Requests for Changes

Changes are generated by a need to increase or decrease scope, change deliverables, schedule and/or cost.

Whenever any party determines that some aspect of the ACA should be changed, then that party must submit a Change Control Request Form to the A-4500 HOV Project CCB.

3.3.2 Change Control Request (CCR)

The Change Control Request:

1. Identifies the WBS element in question
2. Describes the aspect of the WBS element to be changed as part of the request
3. Includes a description of the cost, schedule and scope impact of leaving the control account as is versus incorporating the suggested change. This provides the CCB with a better understanding of why the change is being proposed and what importance it has from the perspective of the submitting party.
4. Identifies the source of funds for the requested change (i.e. re-budgeting funds within control accounts, contingency).

Each CCR must conform to the following minimum requirements:

- a) The CCR must be clear, unambiguous, and describe in detail the change in the description, purpose, reason or category. In addition, the actual change must be identified in the body of the CCR by either a pictorial representation of the change, e.g. “Original/Previous” or “Requested/Proposed” scheme, or a detailed written description of the change.
- b) Identify whether a retrofit is required. Should a retrofit be required, the CCR must identify each system that is affected by the change.

The change control request form is attached to this plan as Appendix A.

3.3.3 Assessing the Impact of Requested Changes

Once a CCR has been submitted, the change is circulated to the Program Management Team and those parties that the CCB identifies may be impacted by the change. These parties are responsible for producing an estimate of the effects of implementing the proposed change. Proposed changes should account for:

1. Additional management effort to revise the schedule and notify affected parties
2. Impact on control account attributes
3. Impact on control account design documents
4. Impact on quality of the system
5. The risk of increased cost of changes at later stages of the project (exponential factor).

In the interest of efficiency, a CCB may process a series of change proposals as a group, depending upon the frequency and importance of the change proposals.

3.3.4 Change Control Documentation

A formal document management system will be used for both the processing of proposed changes and their documentation. Each request for change, whether ultimately approved or rejected, will be documented in the system and thus available to all A-4500 HOV Project team members.

In addition, all approved changes must be reflected in the Earned Value Management System (EVMS), particularly in the Cost of Work Scheduled. All approved changes will also be reflected in a revised Integrated Master Schedule (IMS).

3.3.5 Funding for Changes

Funds required for change implementation must be identified from one of two sources:

- (1) re-allocated funds within the respective WBS account which is the subject of the change, or
- (2) the contingency budget

3.4 Change Control Board

The A-4500 HOV Project CCB will consist at a minimum of the Project Management Team, with the chairperson approving additional members and guests as needed to adequately address the change requested.

Chairperson:	Principal Investigator
Members:	Project Manager
	Assistant Project Manager
	Technical Director
	Business Manager
	Operations Liaison/Safety Manager

The CCB's roles and responsibilities include:

1. Track, review, evaluate and document all requested changes and board actions
2. Ensure requested change is beneficial to the system
3. Evaluate alternatives that would achieve the same results
4. Evaluate all impacts and their effect on scope, cost, and schedule
5. Approve or reject requests for change
6. Document the approved change, and communicate decisions to all stakeholders
7. Ensure the EVMS and IMS systems are appropriately updated when a change has been approved.

The CCB shall provide rapid response to proposed changes as required to maintain the program schedule and minimize cost impacts. Attendance may be through physical attendance, phone, computer, or other electronic means. Delegation of representation to another member of the project team must be reviewed for approval by the chairperson prior to the session. Other project staff or non-collaboration members may attend CCB meetings with the approval of the chairperson.

3.4.1 Consensus and Resolution

The CCB will by consensus approve, reject, or defer each CCR, noting any dissenting opinions. Dissenting members should provide a signed written statement detailing the reason(s) for discord for the meeting record. In the case where the CCB cannot reach a majority consensus, the chairperson shall request input from the advisory resources maintained by the project. The CCB chairperson, after consultation with the advisory resources, may provide binding direction to the CCB and approve or disapprove the CCR.

3.4.2 Promulgation of Approved Changes

Once a change has been approved by the CCB, it will be promulgated to all A-4500 HOV participants and placed in the document control process described herein. An Approved Change (AC) will be executed as directed by the CCB unless otherwise directed by the Principal Investigator and the NSF.

3.4.3 Timing of Meetings

The CCB shall meet at least monthly, but may be convened more frequently at the chairperson's discretion and according to the needs of the project. The CCB chairperson has discretion to cancel or postpone a meeting based on mitigating circumstances and in the best interest of the project.

3.4.4 Records of Meetings

Minutes of CCB meetings shall be maintained and include (at a minimum):

- Attendees
- Change Requests reviewed
- Actions
- Change Request outcomes (approved, denied, deferred, closed, etc.)

4.0 Document Management

In accordance with the *A-4500 HOV System Engineering, Integration and Testing Plan*, WHOI will establish the A-4500 HOV design requirements based on desired missions, science objectives, and improvements to the current *Alvin* needed to facilitate future missions and science. Design requirements will also be based on engineering improvements that allow science flexibility and improved reliability relative to the current *Alvin*. Using the system engineering approach, WHOI will create documents (drawings, calculation sheets, system diagrams, procurement specifications etc., as further noted below) that will define the A-4500 HOV in sufficient detail to allow construction and operation of the submersible. Management of these

documents in a manner that ensures traceability and consistency is essential for a successful project.

The following sections describe the majority of documents that will be created by WHOI during the course of the design development and the manner in which they will be controlled. WHOI will employ the Synergis Adept documentation management system, which provides control over drawings, specifications, process instructions, and maintenance, operating, and emergency procedures and all changes thereto.

4.1 Document and Information Types

4.1.1 Models and Drawings

Part and assembly models and/or drawings shall be developed for each module, hardware assembly or subassembly that is to be documented, manufactured or purchased. Drawings shall clearly state the revision number of the assembly, subassembly or part they represent.

4.1.2 Hardware and Software Documentation

Hardware documentation is that generated for the purpose of defining the design, manufacture, installation and service of hardware. Hardware documentation can include requirements, specifications, engineering analysis and decision reports, assembly procedures, and installation/test procedures.

Documentation generated for the purposes of describing the functionality, interfaces and use of software elements of the A-4500 HOV Project may also be created. Software documentation can include code and build information.

4.1.3 Procurement Documentation

Procurement documents support the purchase or manufacture of required system elements. The complexity of the documentation may range from a simple vendor's part number and description to a detailed specification with performance criteria.

4.1.4 Specifications

A specification is a standard that is referenced by a contract or procurement document. It provides the necessary details about the specific requirements required for procurement of an item.

Specifications are used when the needed items must be defined "from scratch" to support vendor selection. The specification establishes the complete set of detailed characteristics of the item to be delivered.

4.1.5 Parts Lists and Bills of Materials

Each hardware assembly drawing shall contain a Parts List that describes all of the materials and components that are required to build an assembly or subassembly, including quantity, part/model number (as appropriate), description, material (as appropriate) and vendor (as appropriate). The Parts List may be a stand-alone document or included as part of the assembly drawing.

Each system shall be accompanied by a Bill of Materials (BOM) generated from the manufacturing process and intended for use as a system parts lists and modular BOM. The BOM shall be hierarchical in nature with the top level representing the sub-systems and provide incorporation or a link to the Parts Lists. The BOM must include, as available, part/model number, quantity, material, supplier and estimate price, and may include actual pricing and receipt history. The BOM is not intended to be an asset tracking system.

4.1.6 Vendor Documents

Vendor documentation may include engineering, design, manufacture, installation and test documents.

4.1.7 Manuals/Procedures

Examples of in-house manuals and/or procedures that may be archived include those covering management, operations, maintenance, systems, user, quality control and training.

4.1.8 Correspondence

Correspondence generated by a project will be numbered and archived. Email messages, faxes and paper transmittals may be either directly archived or digitized first.

4.1.9 Classification Documents

Documents relating to classification of the vehicle will be identified as such and segregated from the general document population, and will have more stringent and limited access availability.

4.2 Formats and Applications

Electronic documents will be created and stored in common formats to facilitate editing and viewing. Several software packages have been identified for generation of digital drawings and documents. Autodesk Inventor is the preferred 3D mechanical modeling software. Cadence OrCAD Capture is preferred for electrical drawings, and Microsoft Word should be used for text documents. Measurements will be in English units.

4.3 Document Numbering System

4.3.1 Introduction

Because the A-4500 HOV will be operated as part of the National Deep Submergence Facility (NDSF), WHOI will utilize the NDSF Document Numbering System, established to identify, name and provide traceability for all components of NDSF vehicles. This system has been used for over twenty years, and will aid transition of the new vehicle to operational status. A document number will be indicated on all Project documents.

4.3.2 Maintenance

The numbering system will be maintained by the A-4500 HOV Project Management Team.

4.3.3 Document Number

A document number will be comprised of at least seven distinct fields in three sections separated by hyphens for readability. There shall be a maximum of 20 characters in each number. The seventh or Designator field may have either two or three characters; all other fields must contain the requisite number of characters and will be padded with zeroes as required for uniformity. The eighth (Serial) field is optional.

The pattern for a document number is as follows. The eight fields are defined in subsequent sections.

<u>Vehicle</u>	<u>System</u>	<u>Subsys</u>	<u>Assy</u>	<u>Subassy</u>	<u>Part</u>	<u>Designator</u>	<u>Serial</u>
XX	nn	nn	- nn	nn	- nnn	XXX	nn

Example document number: AL0204-0201-001ECA01

4.3.3.1 Vehicle Field

The Vehicle field identifies the vehicle or group. It is comprised of two upper case alpha characters. This is a restricted field and only the following values will be permitted.

AR	A-4500 HOV (until further notice)
AL	<i>Alvin</i>
JA	<i>Jason</i>
SE	<i>Sentry</i>
AB	ABE

4.3.3.2 System Field

The System field identifies the vehicle or group top level system category. It is comprised of two numeric characters. For each vehicle there is a fixed list of System values. For HOV *Alvin* and the A-4500 HOV, this is a restricted field and only the following values will be permitted.

00	Master Indexes & Procedures
02	Sphere & Attachments
04	Frame, Structural Components & Foundations
06	Fixed Buoyancy Assemblies
08	Skins, Fairings & Sail
10	Battery Systems
12	Power Control & Distribution
14	Main Ballast System
16	Variable Ballast System
18	Propulsion System
20	Main Hydraulic System
22	Mercury Trim System
24	Life Support & Habitability
26	Compensation Systems
28	Releases
30	Manipulators
32	Operational Instrumentation & Equipment
34	Science Instrumentation & Equipment

- 50 General Support Equipment
- 52 Launch & Recovery System
- 54 Navigation, Communications & Tracking Systems
- 60 Special Science Equipment & Instrumentation
- 90 Documentation

4.3.3.3 Subsystem Field

The Subsystem field identifies a vehicle or group subsystem within a system. It is comprised of two numeric characters. For the A-4500 HOV, the subsystem field will be aligned with current *Alvin* subsystems where possible. Use Subsystem 90 for documentation.

4.3.3.4 Assembly Field

The Assembly field identifies a top level assembly within a subsystem. It is comprised of two numeric characters. For the A-4500 HOV, the assembly field will be aligned with current *Alvin* assemblies where possible; otherwise it will be assigned sequentially.

4.3.3.5 Subassembly Field

The Subassembly field identifies a subassembly of an assembly. It is comprised of two numeric characters. For the A-4500 HOV, the subassembly field will be aligned with current *Alvin* subassemblies where possible; otherwise it will be assigned sequentially. Use Subassembly 90 for documentation.

4.3.3.6 Part Field

The Part field identifies individual parts or elements of a system, subsystem, assembly or subassembly. It is comprised of three numeric characters, assigned sequentially. The Part field value should match the item identifier as shown on the Parts List of the next higher level assembly.

4.3.3.7 Designator Field

The Designator suffix of the document number identifies the type of document. It is comprised of either two or three upper case alpha characters. This is a restricted field and only the following values will be permitted:

- BOM Bill of Materials
- COR Correspondence
- ECA Engineering Change Authorization

EDW	Electrical Drawing
FR	Failure Report
IR	Inspection Report
MAN	Manual
MDW	Mechanical Drawing
MM	Mechanical Model
MP	Maintenance Procedure
PHO	Photograph
PO	Purchase Order
PS	Purchase Specification
SCH	Schematic
TM	Technical Manual
VDW	Vendor Drawing
VMP	Vendor Maintenance Procedure
VTM	Vendor Technical Manual

4.3.3.8 Serial Field

The optional Serial field is used to distinguish among documents that have the exact same 18-character document number. The Serial field would be necessary, for example, to uniquely identify the second and subsequent Failure Reports for a particular part. It is comprised of two numeric characters, assigned sequentially.

4.3.4 Document Number Requests

Requests for new document numbers shall be directed to the A-4500 HOV Project Manager or designated representative. The Project Manager (or designated representative) shall maintain the master list of documents and will select and issue new numbers as required.

4.4 Templates

Templates for all document types will be developed and deployed by the Project Manager or their designated representative. Templates shall include appropriate extractable document attributes and/or properties to facilitate population of the Adept document record during the archiving process.

4.5 Document Control

WHOI will employ the Synergis Adept documentation management system, which provides control over drawings, specifications, process instructions, and maintenance, operating, and

emergency procedures and all changes thereto. All changes will be technically justified, accomplished with assurance of quality and safety, economically feasible, and adequately approved and documented.

4.5.1 Change Request Process

Change Control Requests (CCRs) may be initiated by any member of the engineering or operations teams, and then follow a defined sequence to completion as described in Section 3 of this plan. Approved changes to A-4500 HOV documents will be promulgated in accordance with Section 3.4.2.

4.5.2 Review and Approval

Any changes to controlled documents will be reviewed and approved by the CCB Chair prior to revision of the archived document.

4.6 Document Management System (Synergis Adept)

Since NDSF utilizes Synergis Adept document management software to catalog, archive and control digital system documentation, the A-4500 HOV Project will use the same document management software for compatibility with other NDSF systems.

Appendix A. Change Control Request Form

Change Request No.: (Assigned by Configuration Manager)	WBS:	Date:
Control Account Name:	Configuration Manager:	
SECTION TO BE COMPLETED BY PERSON REQUESTING CHANGE:		
Requestor:	Contact Information:	
Request Name (Include document number and revision level):		
Description of Change (include all related systems):		
Reason for Change:		
Benefit to A-4500 HOV Project:		
<i>Assessment of Impact to Control Account:</i>		
Scope:		
Schedule:		
Cost (Include identification of funds: rebudget, contingency):		
SECTION TO BE COMPLETED BY CCB CHAIRPERSON:		
<i>Assessment of Impact to Project:</i>		
Master Schedule:		
Project Cost:		
Deliverables:		
Comments:		
Signature of CCB Chairperson:	Date:	Board Determination: <input type="checkbox"/> Approved <input type="checkbox"/> Rejected
<i>CERTIFICATION OF TECHNICAL DATA PACKAGE AND CONTROL SYSTEM UPDATE:</i>		
Signature of Configuration Manager:	Date:	Project Systems and Documentation Updated: <input type="checkbox"/> Confirmed Complete
Attach supporting technical documentation and or additional comments as needed.		