

# Replacement HOV Update



## Science Improvements

- Improved fields of view
- Increased depth capability
- Increased bottom time
- Automated position-keeping in all axes
- Improved interior ergonomics
- Increased interior electronics and science payload
- Reduced physical & chemical disturbances to science study areas



## Milestone History

- **31 July 2004 – NSF Cooperative Agreement awarded**
- **1 Oct 2004 – Acquisition consultant retained (Perot Systems Government Services)**
- **May 2005 – Request for Proposal (RFP) from Southwest Research Institute (SwRI) for personnel sphere design approved by NSF**
- **1 November 2005 – Contract with SwRI signed**
- **1 Dec 2005 – Personnel sphere design kick-off meeting**



## Risk Management

To address areas of higher risk the project has been broken into two phases:

- **Phase One**

- Design and forging of personnel sphere
- Feasibility testing for prospective energy system
- Qualification testing for syntactic buoyancy foam

- **Phase Two**

- Completion of personnel sphere
- Design and fabrication of remaining vehicle



# Syntactic Foam Testing and Certification

- Test and fabrication specifications developed
- ABS has approved specifications
- 32 lb/ft<sup>3</sup> foam (single size balloon) developed
- 30 lb/ft<sup>3</sup> foam (DS-30-5000 M) developed
- Continue development of lower density foam w/ 30 lb/ft<sup>3</sup> as target
- Additional manufacturer is starting R&D to produce a 30 lb/ft<sup>3</sup> foam



## Batteries

- Evaluated current designs & efforts (Li polymer & Li ion)

**LTC**

**SKC**

**Kokam**

**GS Battery**

**Ultralife**

**Lithion**

**Electrovaya**

- Scaled battery assemblies for Kokam and LTC
- Baseline and environmental performance testing and safety testing
- Received environmental test results for Bluefin 1.5 kWh Li battery module



# Alternative Solutions to Select ABS Rules

- **Alternative oxygen storage solution**
- **Normal ballast system actuation**
- **External mechanical pressure monitoring**
- **Means for equalizing pressure across hatch**
- **Hand operated hydraulic pump**



## Personnel Sphere Design

### Status

- Preliminary trade studies and analyses completed
- Material (Ti 6 Al-4 V ELI) characterization complete
- Contract let for titanium purchase
- Design reports for Preliminary Design Review (PDR) under review by WHOI, ABS, NAVSEA
- PDR scheduled for early Dec 2006
- Bids for forging and fabrication due at PDR



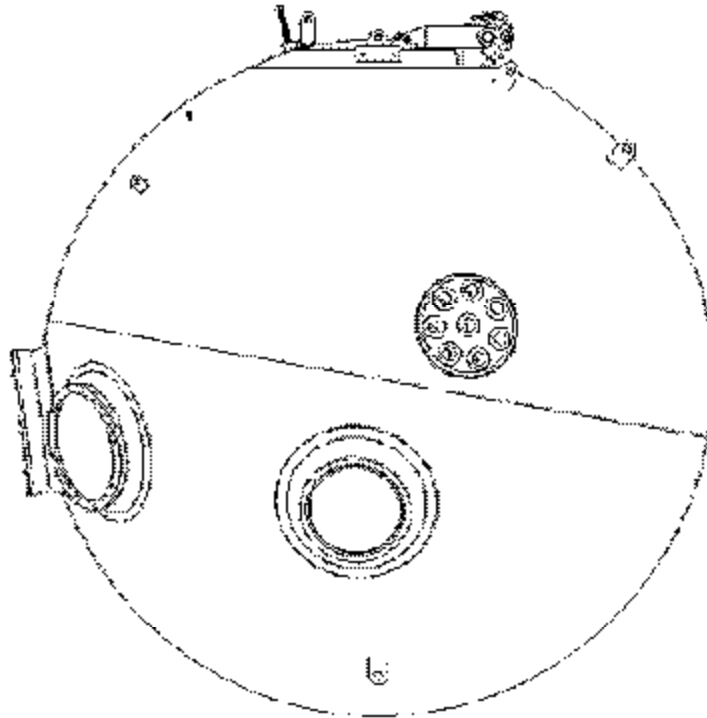


## Preliminary Design Review - Documents

- **Hull Thickness Design Calculation Report**
- **Ingot Material Specification**
- **Forging Production Specification**
- **Hull Thickness Design calculation report**
- **Hull Penetration Design & Analysis Report**
- **EB & GTAW Welding & Qualification Specification**



## Baseline Penetrator Tradeoff Study



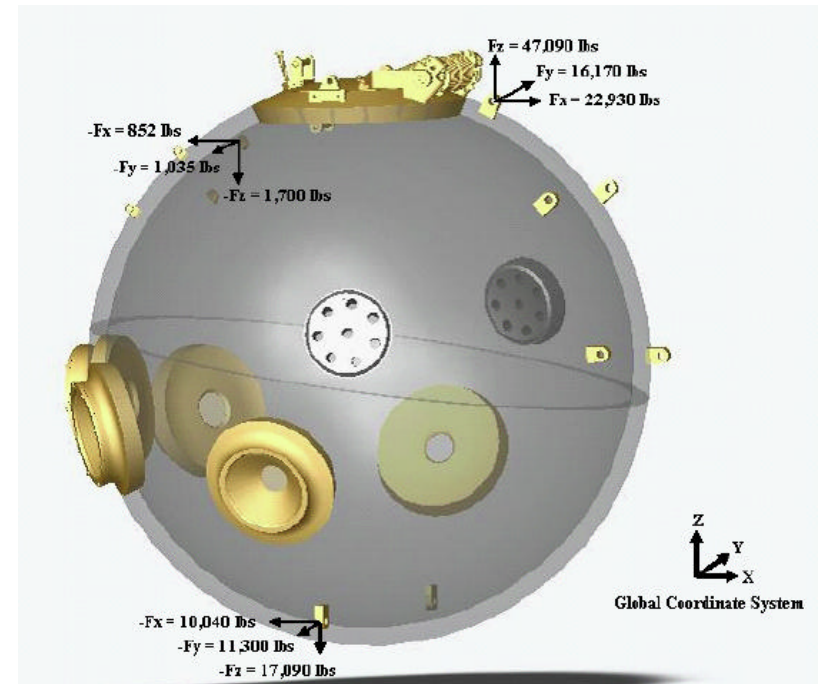
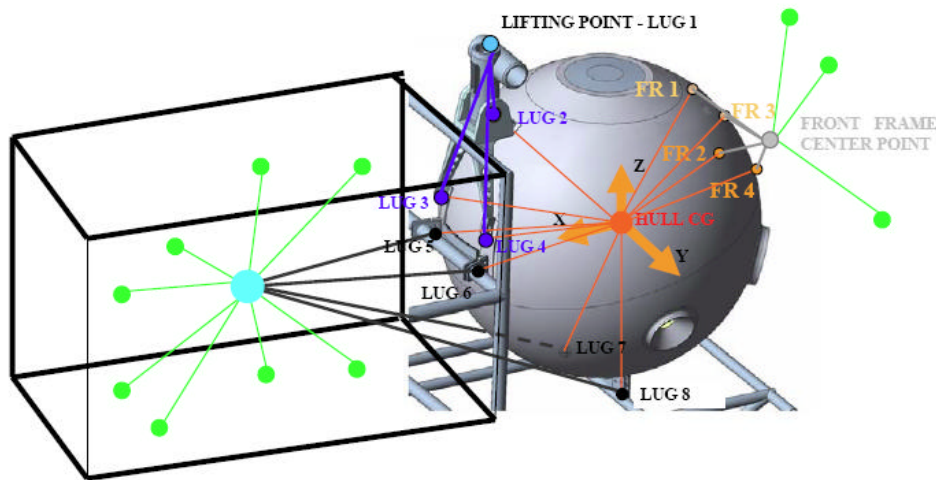
### 16 Penetrations

- 5 Electrical
- 5 Fiber Optic
- 6 Expansion





## Notional Frame to Hull Lug Reaction Analysis



## Finite Element Structural Analysis of *Sea Cliff*

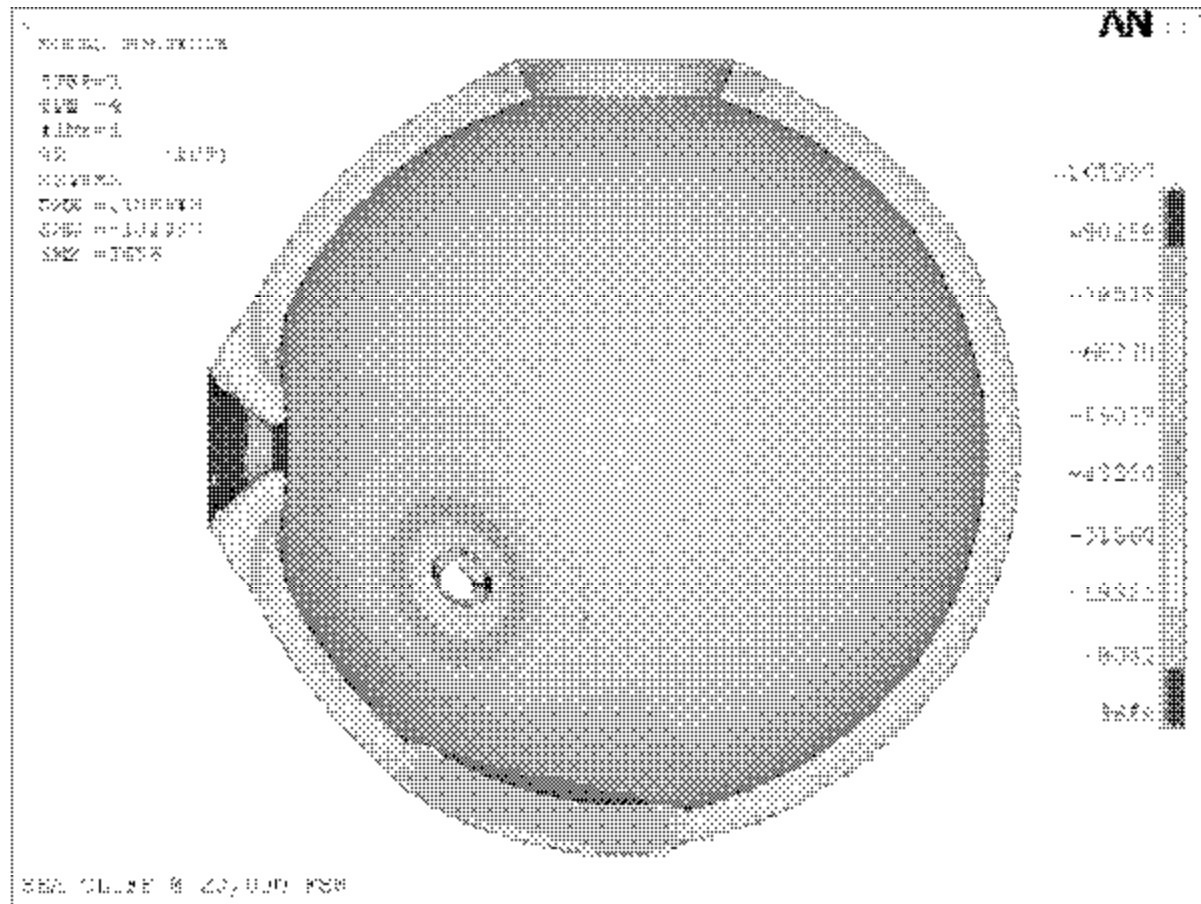


Figure 18 – Longitudinal Stress ( $SZ=S\phi$ )



## Pre-production Material Characterization Test Report

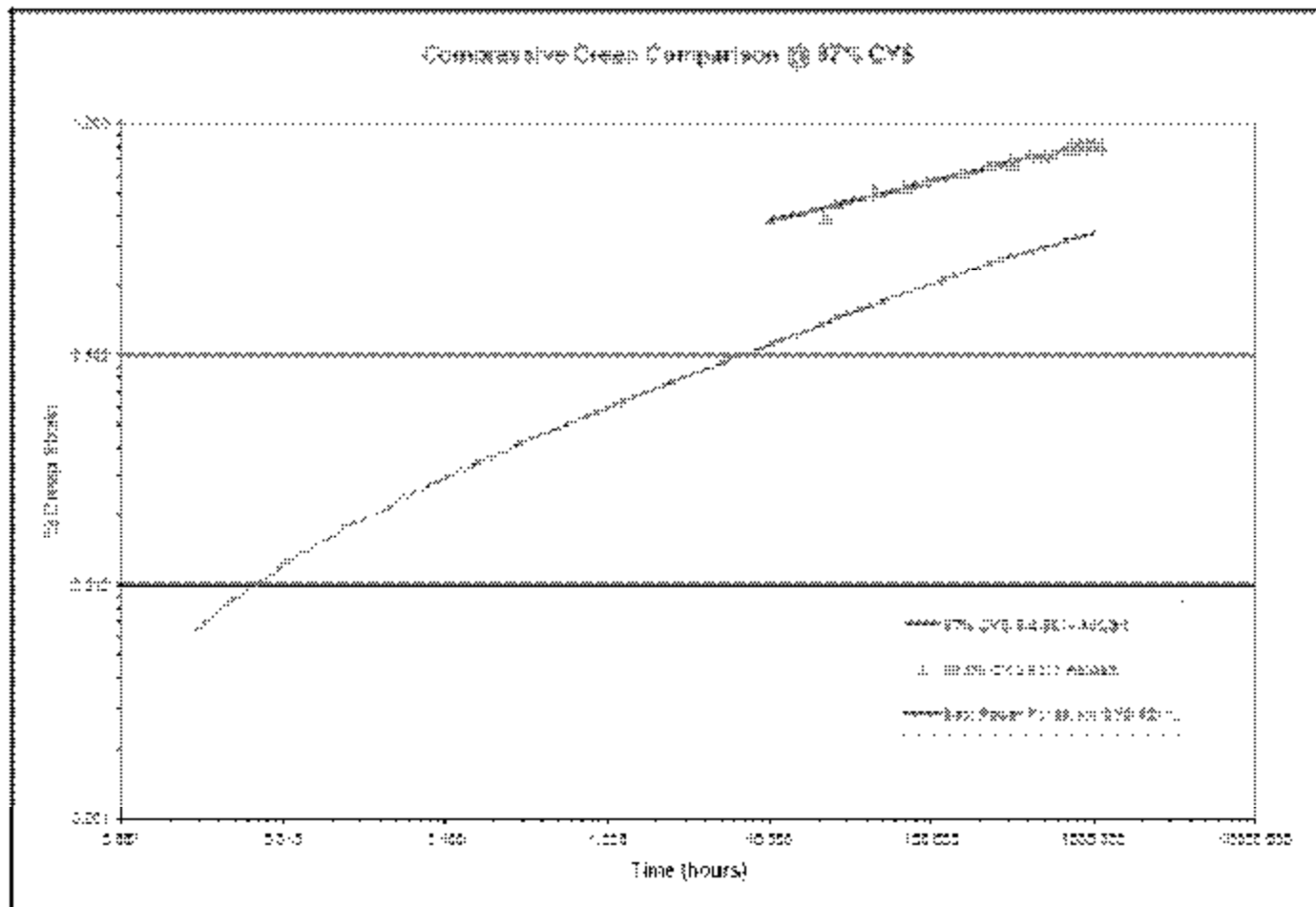
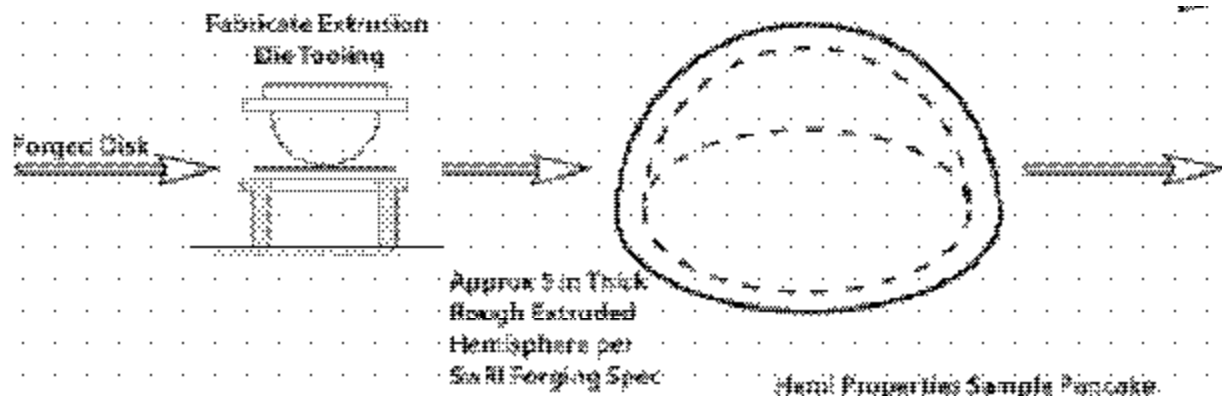
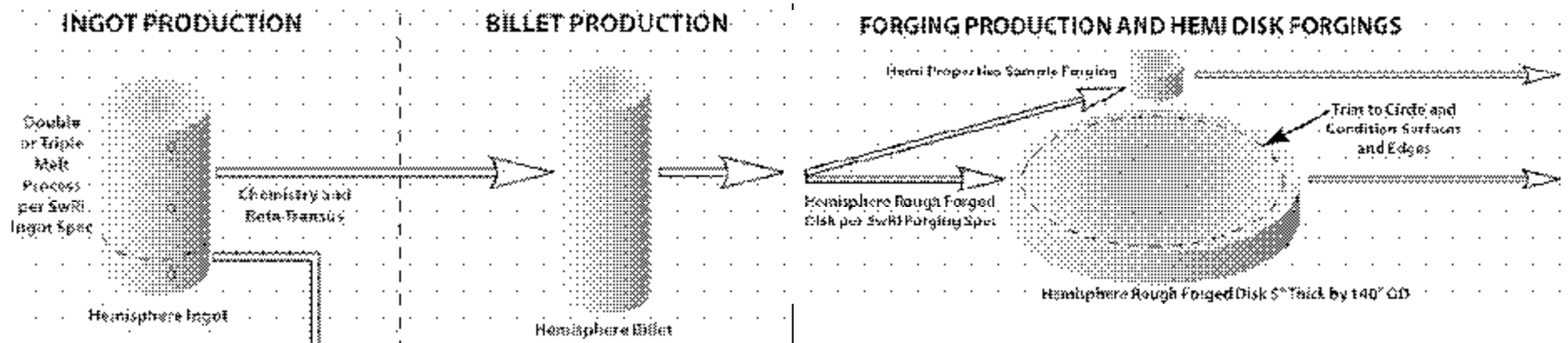


Figure 10b – Compressive Creep at 87% CYS of Ti-6Al-4V ELI and Ti-6211



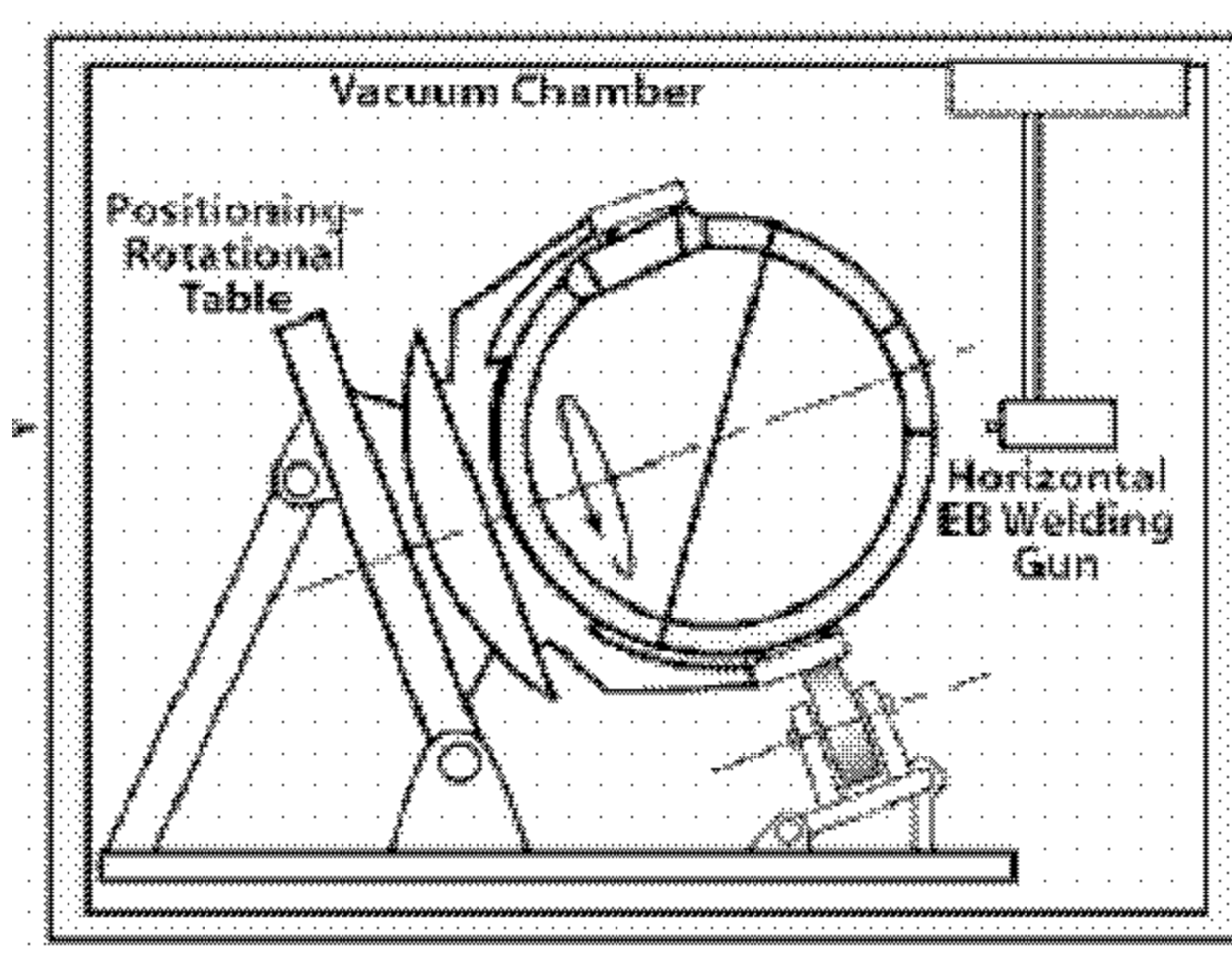


## Manufacturing Assembly Plan





## Manufacturing Assembly Plan



# Replacement HOV Update

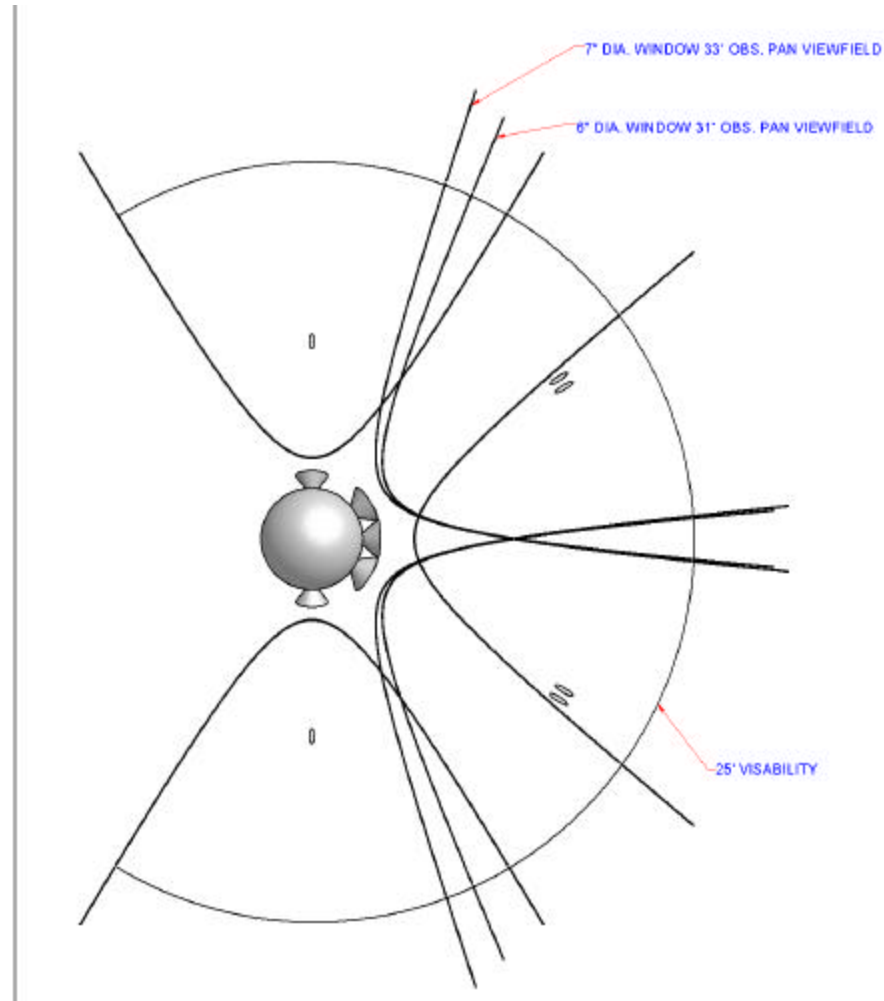
## U.S. Navy Involvement

### *Review of:*

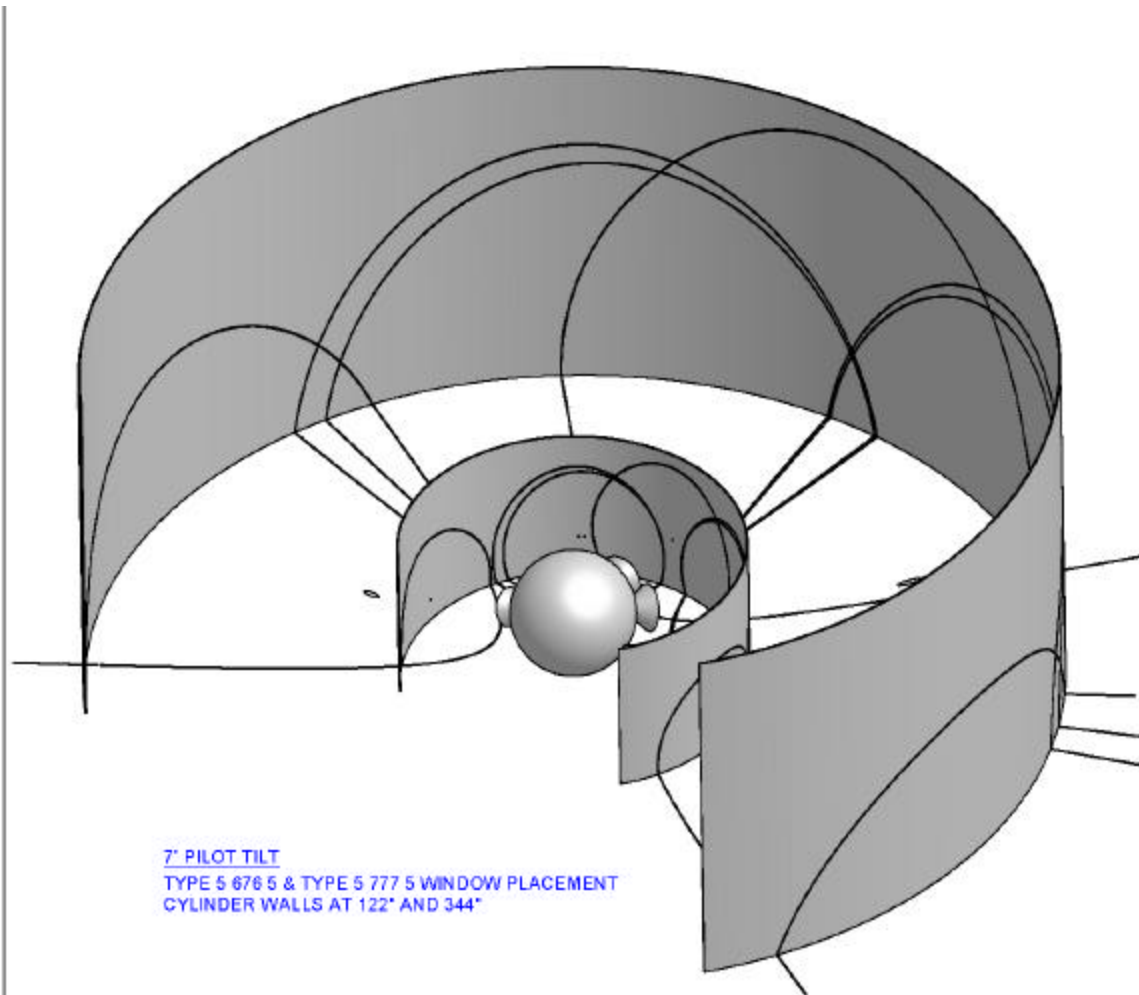
- **Material characteristic test results**
- **FEA of the replacement HOV and *Sea Cliff***
- **Proof test and strain gage plan**
- **Establishment of the hull creep stress design criteria**



## Window Fields of View



## Vehicle Design



7° PILOT TILT  
TYPE 5 676 5 & TYPE 5 777 5 WINDOW PLACEMENT  
CYLINDER WALLS AT 122° AND 344°



## Window Size and Number Comparison

Window Size & Number	5-6-7-6-5	6-7-6	5-7-7-7-5	7-7-7
<b>Viewport System Total Cost (\$)</b>	\$758k - \$1012k	\$485 - \$643k ✂ \$273k less to \$369k less	\$764k - \$1000k ✂ \$6k more to \$12k less	\$466k - \$624k ✂ \$292 less to \$388k less
<b>Total Weight (Viewport System &amp; Syntactic Foam) (lbs) *</b>	348	222 ✂ 126 less	366 ✂ 18 more	318 ✂ 30 less
<b>Syntactic Volume (ft<sup>3</sup>)</b>	10.9	6.9 ✂ 4 less	11.4 ✂ 0.5 more	9.9 ✂ 1 less
<b>Summary</b>	Specified in contract	Minimum weight	Most viewing area	Least expensive



\* Syntactic foam required to compensate for viewport system weight assumes a 32 lb/ft<sup>3</sup> density.



## Side Window Evaluation

### Pros

- Increased area for observation
- More effective search
- Increased area for sampling
- Closer view of seafloor/ sediment
- Allows for monitoring proximity to hazards on side of vehicle

### Cons

- Increased exposure to hazards on side of vehicle
- Questionable actual usage
- Manipulator mount complexity and weight



## Three 7" Windows Evaluation

### Pros

- Small increase in field of view
- Increased ease of use
- Simpler logistics (one size vs. two)

### Cons

- Small increase in vehicle weight
- Small increase in vehicle volume
- Small increase in fabrication complexity



## Vehicle Design

- Request for Information (RFI) released April 2006
- Responses (Statement of Interest) received from:
  - General Dynamics
  - Oceaneering
  - Northrop Grumman
  - Lockheed Martin
  - Battelle Memorial Institute
  - Oceanworks (& ISE)
- Industry Day held on *Atlantis* 1 Aug 2006
- Request for Proposals (RFP) issued 2 Nov 2006
- Responses due 4 Jan 2007





## *Alvin* Prototyping

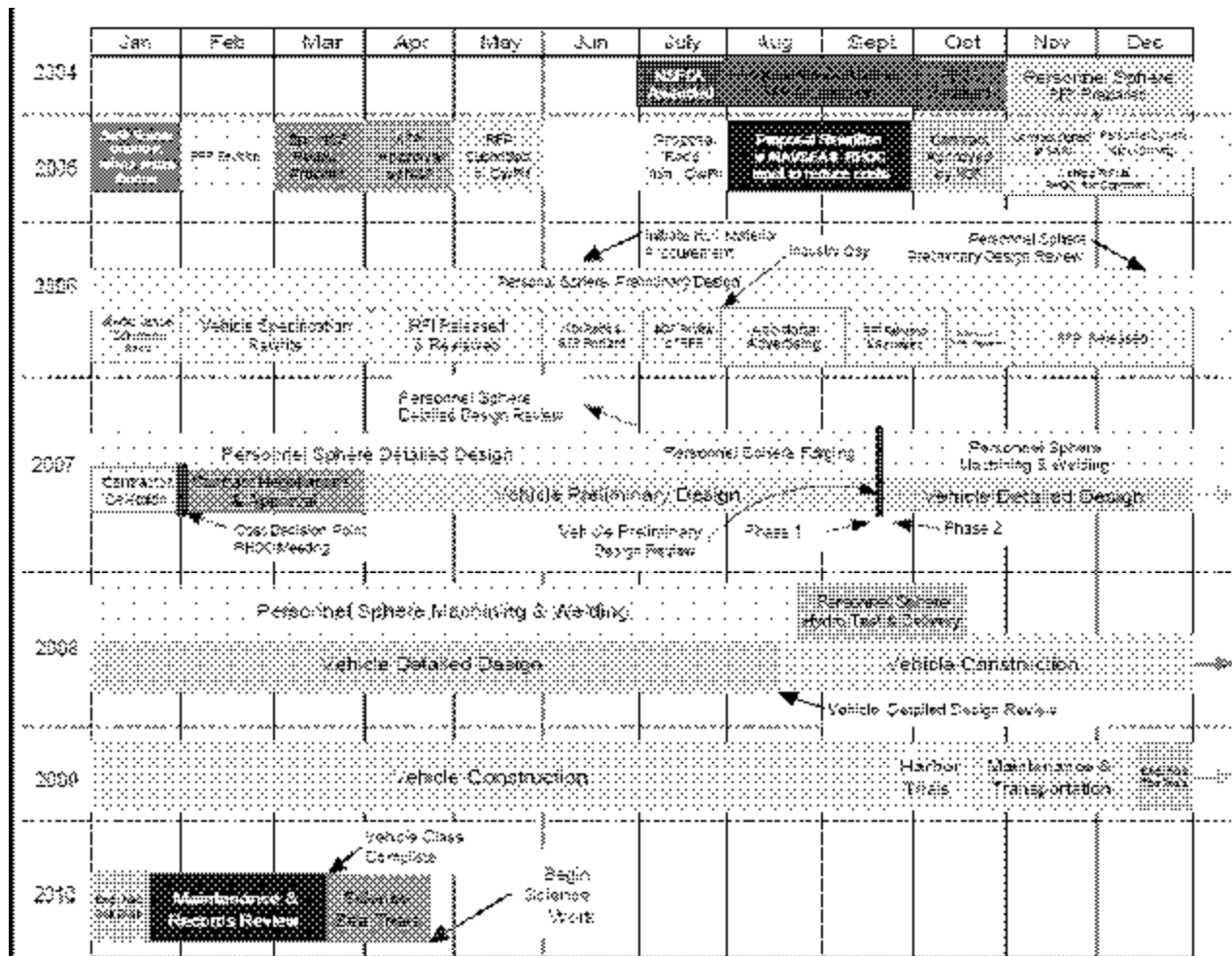
- **Inertial Navigation System**
- **Fiber Optic Penetrator**
- **Shaped Memory Alloy Releases**



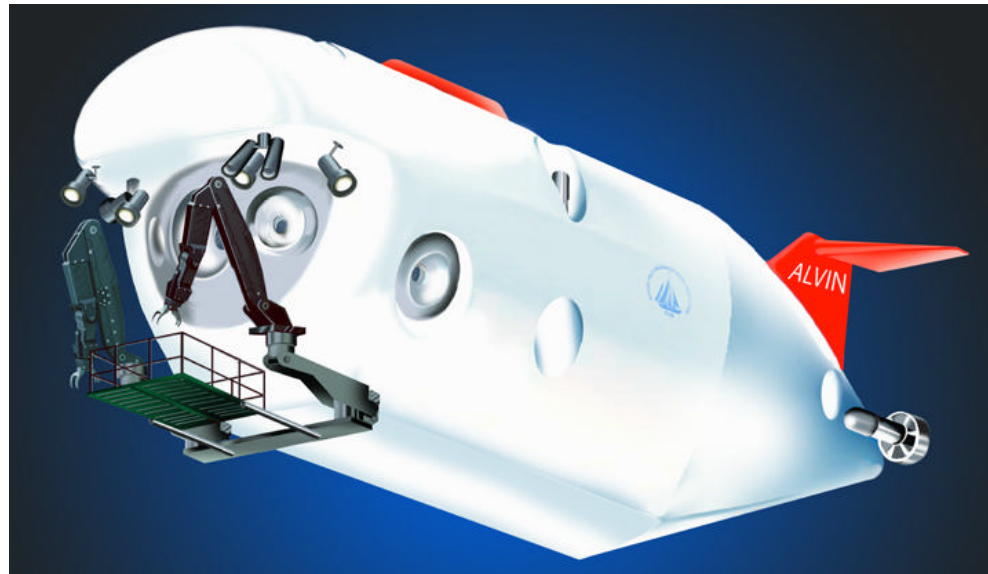
# Replacement HOV Update

DESSC  
November 2006

## Schedule



## *Thank You*



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