

**DEEP SUBMERGENCE SCIENCE COMMITTEE**  
**Annual Planning Meeting**  
**Thursday - November 9, 2006**  
**Seattle Aquarium**  
**1483 Alaskan Way**  
**Seattle, WA 98101**

**Meeting Minutes**

**Executive Summary**

The Deep Submergence Science Committee (DESSC) met on November 9, 2006 at Seattle Aquarium in Seattle, WA. The meeting was chaired by Debbie Kelley and began with presentations by the Principal Investigators who used submergence vehicles in 2006. Funding agency representatives provided budget information as well as agency priorities. A variety of reports were made by the National Deep Submergence Facility (NDSF) operator to summarize facility operations, planned activities, and system upgrades. Reports on the status of design, development, and construction of the AUV *Sentry*, the replacement HOV and the hybrid ROV were provided. DESSC activities, future plans and issues were reported including discussions on long-range planning, public outreach and educational activities.

**Summary of Action Items**

1. **NDSF Vehicle Debrief Interviews** – In order to better track the status of vehicle and system performance, DESSC will conduct debrief interviews of PIs who use *Jason2*, *Alvin*, and *ABE/Sentry*. Agendas for future meetings will include summary reports of these debriefs. Participants in the debriefs will include the DESSC interviewers (*Jason2* – Bill Chadwick, *Alvin* – Michael Tryon, *ABE/Sentry* – Hedy Edmonds) the science user, and the NDSF operator (Chris German). DESSC will compile a list of items that have been identified as problems, then track them. A set of debrief questions has been drafted by Hedy Edmonds. Finalization of the questions and process is needed. Debriefs will begin prior to the spring 2007 DESSC meeting.
2. **Science Outfitting and Sensors for Replacement HOV** – A community on-line survey for scientific sensors for the RHOV has been drafted. Annette will add tools and other instrumentation to the survey with input from Bob Brown. Buttons will link to websites with “additional information”. A deadline for submitting the survey will be specified. The draft survey will be reviewed at the spring 2007 DESSC meeting. The results of the survey will be available to the community over the summer and a summary of responses to the survey will be provided at the fall 2007 DESSC meeting. (DeSilva/Brown/DESSC).
3. **DESSC Membership** – Annette and Deb will contact DESSC members with terms ending in 2007 about staggering term lengths. They will present a recommendation at the next meeting. (Kelley/DeSilva)
4. **Prioritization of the key issues identified in Bill Chadwick’s letter regarding *Jason2* operations** – Bill Chadwick and Chris German will provide a recommendation on

prioritization of the issues raised in Bill's 2006 letter and present it at the spring DESSC meeting.

5. **Shore-side Data Management** – DESSC recommends that shipboard personnel conduct daily quality checks of cruise navigation data (as opposed to shore-side checks). Deb Kelley will send a recommendation to WHOI.
6. **Science Training Opportunities for Pilots** - DESSC will formulate a recommendation to offer a workshop/training session to inform pilots about scientific objectives for a given mission. The session will demonstrate the importance of data obtained from dives with the undersea vehicles and how this information is used in different research disciplines. DESSC recommends that training be conducted in appropriate locales such as Hawaii (Pacific realm) or Iceland (Atlantic regime). (Kelley)
7. **R2K Lectureship program** – DESSC recommends that the R2K Lectureship program include an *Alvin* or ROV pilot as a distinguished lecturer. (Kelley)
8. **Career Advancement /Learning Opportunities for Pilots** – DESSC recommends that WHOI Management promote formal learning opportunities and career advancement opportunities for pilots. (Kelley)
9. **Ocean Observatory ROV Workshop** – Organize an ROV workshop for technology exchange and to define future needs of undersea vehicle support for ocean observatories. Participation should include principal investigators and ROV operators/engineers from WHOI, MBARI, and *ROPOS*. Commercial entities might also be considered. The workshop would be supported through UNOLS. DESSC, in collaboration with the agencies and UNOLS, will formulate the workshop description, objectives, and invitation list. (Kelley/DeSilva)

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### **Meeting Summary:**

**Introductory Remarks, Meeting Logistics, and Introductions** - Debbie Kelley, DEep Submergence Science Committee (DESSC) Chair, called the meeting to order at 0830 on Thursday, November 9, 2006. The meeting was held at the Seattle Aquarium in Seattle, WA. Deb introduced the DESSC membership (*Appendix I. A*). The agenda for the meeting is included as *Appendix I.B*. The items of the agenda were addressed in the order reported below. The list of attendees is included as *Appendix II*.

The minutes of the June 2006 DESSC Meeting <[200605desmi.pdf](#)> were accepted as written.

**2006 Principal Investigator Reports** – Principal Investigators (PIs) who used the NDSF vehicles over the past year reported on what they learned during their cruises. Deb Kelley moderated the session.

***Alvin* PI Reports** – Slides are included in *Appendix IIIa*.

June 14-June 17: Michael Tryon reported on **David Hilton**'s *Atlantis/Alvin* cruise on June 14-17 to the Costa Rico Ridge. The title of the project was "Collaborative research: towards quantifying elemental fluxes and fluid origins from margins using novel submarine instrumentation." All cruise objectives were accomplished. Over the past two years, they had nine days on site with nine dives. Over 1/2 km<sup>2</sup> was surveyed. Eight instruments were deployed and recovered. More than 100 push cores were collected for chemistry, biology, and sediment studies. Clams, mussels, crabs, tubeworms, and rocks were collected and 12 heat flow measurements were made.

June 18 – July 7: Marv Lilley reported on **Karen Von Damm**'s *Atlantis/Alvin* cruise (see slides), which was a response cruise to the April 2006 eruption site at R2K East Pacific Rise (EPR) 9°N Integrated Study Site (ISS). Bottom images obtained at the M vent showed that there has been lava flow at the site. New lava surrounds and buries (by ~1 meter) the base of an old inactive chimney. The question was asked, "What does the temperature recorder look like?" Marv replied that the recorder survived the eruption.

July 10 – 20 and September 26 – October 13: Ray Lee reported on **Lisa Levin's** and **Vicki Orphan's** *Atlantis/Alvin* cruises in the summer and fall (see slides) to the Eel River, Northern California, and Oregon Coast area. Their projects were: "Examination of Diverse Anaerobic CH<sub>4</sub> -Oxidizing Archaea and Associated Syntrophic Relationships Using High Resolution Molecular and Isotopic Methods" and "Metazoan Life at Extreme Sulfide Concentrations: The Ecology and Evolution of Dorvilleidae at Methane Seeps." During these cruises there were 18 dives, 110 tube cores, 85 CTD casts, 25 scoops, multiple rocks, 8 short-term/20 long-term sulfide experiments, 18 wood and rock colonization experiments, and over 40 multicore drops. Dorvilleidae polychaetes (small worm) were investigated to study the evolution and ecology of metazoan life at extreme sulfide concentrations. Many of the dorvilleidae species are not closely related to shallow living species and they are living in extreme conditions. The colonization experiments, which involved tray recoveries, proved to be difficult and very time consuming. The elevators had some problems handling the trays. The *Alvin* group was very patient and supportive, but Ray's impression was that the elevators probably weren't designed for these sorts of operations. It was difficult getting the weights on the elevator.

August 3 – August 20: **Ken Smith** could not be present and there was no report. He had an *Atlantis/Alvin* cruise off southern California titled, "An autonomous bottom-transecting instrument for making long time-series measurements of phytoplankton fluorescence and acoustically detectable sediment structure to abyssal depths."

August 25 – September 11: **Deb Kelley** reported on her *Atlantis/Alvin* cruise at Juan de Fuca (JdF) titled, "Determining the Limits to Life in Submarine Hydrothermal Systems: Active Sulfide Deposits as Natural Laboratories" (see slides). All of the planned dives were accomplished. In 2006, two incubators were recovered after a 1-year deployment period and both instruments recorded data for the full year. This cruise was the first time since 2000 that fluids were sampled in all five fields. There is evidence that organisms exist in the 150 – 200 degree temperature range. During the cruise several poor-man incubators were deployed for another year. Several students dove in *Alvin* for the first time.

A few issues were identified during the cruise. There is a recurring problem of pre-cruise meeting information not being communicated to the *Alvin* pilots. There are the historical problems of poor images with the still cameras. Imagenex was used to map the field. The navigation data quality must be confirmed by someone on shore or on the ship.

Jeff Karson asked how they kept the chambers sterile. Deb said that keeping the chambers sterile was an issue, but they came up with a technique for maintaining a sterile environment. Jeff Karson also asked if any acoustic measurements (to determine seismic activity). Deb replied that they did not, but the area is known to be seismically active.

August 25 – September 11: Marv Lilley reported on his *Atlantis/Alvin* cruise with **Karl Booksh** and **Brian Marquardt** at the JdF Endeavour site (see slides). Smart sensors for In-Situ monitoring of hydrothermal vent systems were tested. The probes are installed into the chimneys and measure parameter changes over time. Graphs of temperature and resistivity at Sully site were presented. Marv showed a picture of an instrument probe that was buried in a chimney. A 12-inch chimney grew around the probe. It is a risky place to deploy equipment for long periods and sometimes skates or octopi raze the probes. Marv also reported on tests with a Roman Spectrometer, which uses nanotechnology. This instrument recorded data during the whole cruise.

Marv noted that the *Alvin*'s inverter never functioned properly and had to be powered with laptop batteries. Fortunately this problem did not impact the success of the cruise.

September 16 –September 21: **Keir Becker** had an *Atlantis/Alvin* cruise titled, “The Hydrogeologic Architecture of Basaltic Oceanic Crust: CORK Experiments for the Initial IODP Expedition to the Flank of the Juan de Fuca Ridge.” A 2-leg program was planned. On the first leg holes would be drilled and cores inserted into the holes. On the next leg, tracers would be installed in the holes. During previous operations at the study site one of the critical holes was not sealed properly. The purpose of Keir's *Alvin* cruise was to reseal that hole using cement so that the tracer experiment could be conducted. Pouring cement to the seafloor before it settles was a challenge. A picture of the cement mixer on the ship's deck and the transporter was shown (see slides). Unfortunately, during Keir's cruise, the cement hardened before reaching the bottom.

**Jason2/DSL120 PI Reports:** Presentations are included as *Appendix IIIb*.

January 1 – January 10: Joe Resling reported on **Rachel Haymon**'s cruise on *Thompson* titled, “Hydrothermal Systems Response to Magma Supply and Crustal Thickness Gradients along the Galapagos Spreading Center.” The *DSL-120a* and *Medea* systems were used. The nested survey strategy worked well and they created *DSL-120* maps. The first black smoker in the area was discovered. The expedition was considered a great success and they were able to investigate the nature of hydrothermal venting, hydrothermal biota, and geologic behavior of the ridge crest.

One problem reported was that the lack of a protective cage for *Medea* resulted in frustratingly slow tow speeds. Also, *Medea*'s dynamic positioning navigation, when controlled from the *Jason* van, caused bow thrusters problems.

April 18-May 13: The NOAA Ocean Exploration cruise will be discussed during the NOAA report.

July 21-September 1: Dana Yoerger reported on the vehicle operations and coordination of *ABE* with *Jason* during the **Wolfgang Bach** and **Maurice Tivey** cruise on *Revelle*. The project was titled: “Hydrothermal Systems in the Eastern Manus basin; Fluid Chemistry and Magnetic Structure as Guides to Subseafloor Processes” (see slides). The NSF grant that supported this cruise was supplemented with commercial funding. The primary objective of the cruise was to map in detail and sample fluids, sulfide and rock samples from hydrothermal vent systems located within the Manus Basin. A total of 30 ROV *Jason* dives, 18 *ABE* dives and 26 CTD casts were completed. There were daily deployments of ROV *Jason* interspersed with *ABE* and CTD deployments.

During the cruise *ABE* and *Jason2* were often in the water simultaneously. *ABE* would anchor on the seafloor at the end of its dive, and wouldn't interrupt the *Jason2* dive. Dana showed a real-time *ABE* map. *Jason2* would operate using the newly made *ABE* mapping results. Dana's role during the cruise was to produce a bathymetric map. He accomplished this task within a day of collecting the data. The model of generating real-time maps using the AUV and then using these maps for ROV operations is one that WHOI would like to use in the future.

Dolly commented that there are established procedures that must be followed when working with industry. Industry must pay the full cost of the operation. UNOLS ships should not be competing with industry.

September 5 to October 2 – Chris German reported that **Chuck Fisher** and **Colleen Cavanaugh** had a cruise on *Melville* titled, “Evaluations and background Studies of Interactions among Fluid Chemistry, Physiology, and Community Ecology for RIDGE 2000 Lau Basin Studies.” *Jason2* operations, dredging, and SeaBeam surveys were conducted. The science objectives of the cruise were met.

**Other Facility User Reports** – There were no reports.

### ***Mid Morning Break***

### **Agency and UNOLS Reports**

**National Science Foundation (NSF)** - Dolly Dieter (NSF) reported that the agency is working under a continuing resolution, but NSF was able to fund navigation improvements for UNOLS vessels. NSF has many facility renewal projects underway. Ship acquisition and conversion efforts are progressing, including the Alaska Region Research Vessel (ARRV), the Regional Class, and the R/V *Marcus Langseth*.

Larry Clark (NSF) noted that Mike Reeve retired at the end of October 2006. He encouraged anyone interested in the position to contact NSF.

**National Oceanic and Atmospheric Administration (NOAA)** – Craig Russel provided the report for NOAA. His slides are included as **Appendix IV**. Craig reviewed the NOAA National Undersea Research Program (NURP) and Ocean Exploration (OE) program missions and showed a chart that illustrated past NOAA’s National Deep Submergence Facility (NDSF) funding levels. In FY2006, NOAA’s funding level for NDSF was \$2.3M. Because of the continuing resolution, \$0.5M is currently available for FY2007. NOAA’s portion of support for the *Alvin* overhaul & certification costs was 20% of the total cost in FY2006.

In FY2006 there were three NDSF programs. Chuck Fisher had an *Atlantis/Alvin* cruise to the Gulf of Mexico titled, "Expedition to the Deep Slope." The objective was systematic exploration of hydrocarbon seep communities deeper than 1000 m. Another program that NOAA participated in was the Galapagos Expedition on R/V *Thompson* using *DSL-120* and *Medea*. The objective was to explore a section of the Galapagos Spreading Center located above the mantle plume. Bob Embley had a Submarine Ring of Fire cruise on *Melville* using *Jason2* for intensive explorations, mapping and sampling at 6 to 8 sites in the Western Pacific.

NOAA conducted six additional cruises in FY2006 that deployed other deep submergence vehicles. These assets included the use of HBOI’s *Johnson Sea-Link*, MBARI’s *Tiburón*, *ROPOS*, *SeaBED*, *Thetis*, *ABE*, *Quest*, *Argus*, and *Hercules*. The PIs on these cruises and the geographic research area were:

- Bob Carney in the Gulf of Mexico
- Andrew DeVogelaere at the Davidson Seamount
- Ed Bowlby at the Olympic Coast NMS
- Brendan Foley in Greek national waters
- Chris German at the Southern Mid-Atlantic Ridge, and
- Bob Ballard at the Aegean, Black and Eastern Mediterranean Seas

There were also Ocean Exploration and Research cruises aboard KOK using the NURP HOV submersibles, *Pisces IV* and *V* for a total of 60 dive days in the Hawaiian Archipelago. NOAA also used the autonomous underwater vehicle, *Eagle Ray* in sea trials. The maximum operational depth of this AUV is 2,200 m and its capabilities include high-resolution multibeam, conductivity/temperature sensors, and an expandable science payload capacity.

A chart showing the NURP and OE budgets in 2005, 2006, and 2007 was presented. In 2006, the budget was drastically reduced from \$45.8M in 2005 to \$23.5M in 2006). The 2007 budget level is unknown.

Planned NOAA NDSF use in FY2007 includes Chuck Fisher's *Jason (Ron Brown)* cruise to the Gulf of Mexico, "Expedition to the Deep Slope."

Lastly, Craig reviewed the status of NOAA's OE ship, *Okeanos Explorer*. This ship is a T-AGOS vessel that was acquired from the Navy in 2004. The vessel is undergoing conversion at Todd Pacific Shipyard in Seattle.

- Phase I: Major vessel infrastructure modifications and select mission systems (Oct 06-Jul 07)
- Phase II: Most science/mission systems (Sep 07 – Apr 08)
- Phase III: Additional science/mission systems, auxiliary vessel systems (TBD)

The ship is expected to begin operations in spring 2008. Its capabilities will include mapping, an ROV, and telepresence. The ROV will be a Phoenix system, similar to *Hercules*. It will be built next year and have a 6000 m depth rating. The ROV should be ready in mid 2007. It will be dedicated to the ship.

Discussion followed:

- Question: Once the OE ship is on line, will NOAA continue to support science on other vessels?
- Reply: NOAA plans to continue to use UNOLS vessels.
- Questions: What are the ship's cruise plans? Where will it operate? Where will it be homeported?
- Reply: OE will be the primary focus of the science and ship planning. Operations will be coordinated with the NURP centers.

**University-National Oceanographic Laboratory System (UNOLS)** – Annette DeSilva (UNOLS) gave the UNOLS report. Her slides are included as *Appendix V*. At the UNOLS Annual meeting in October, Council elections were held and Marcia McNutt (MBARI) became the Chair and Vernon Asper (USM) was elected to the Chair-Elect position. UNOLS issues, activities, and accomplishments in 2006 included:

- Briefed the Naval Research Advisory Council on "What is UNOLS";
- Provided input to the FOFC Fleet Renewal Plan;
- Created Marcus Langseth Science Oversight Committee;
- Produced UNOLS Informational Brochure;
- Initiated discussion on Codes of Conduct - The Impact of Scientific Studies on the Environment;
- Established Procedures for Recommending Non-operational periods in the UNOLS Fleet.

The effort to establishing procedures for recommending non-operational periods in the UNOLS Fleet was a major activity. A subcommittee was formed to develop a process for making recommendations. Their findings were:

- The shortfall in funding for the UNOLS fleet is not a short-term issue.
- The under funded situation of the UNOLS fleet is unlikely to be rectified in the near future.
- While NSF support for the fleet has, until recently, supported a nearly constant number of operating days, Navy and NOAA support has been gradually declining.
- The under-funded situation for the UNOLS fleet could potentially become worse as new, more costly larger ships replace intermediate and regional ships.
- Cold lay-ups (lay-ups with little or no crew support and minimal maintenance costs for vessels with no plan for replacement) and early retirements (for vessels that have a plan for replacement) preserve the most funding for science field programs. Bringing a vessel out of cold lay-up or retirement is likely to be an expensive proposition and should be planned carefully.
- While the Ocean Observatory Initiative (OOI) has funding for installing ocean observatories that is over and above the funds currently budgeted to support UNOLS vessel operations, much of those dollars will be needed for special purpose vessels for cable laying, launching large moorings, etc. However, some of that funding might come to the UNOLS Global Class vessels. There is no “new” money yet identified for OOI science operations and maintenance after the installation phase, but that may indeed materialize (hence another good argument for not retiring any global ships early).

The subcommittee established values to be considered when making recommendations on non-operational periods for ships. These values include meeting the science needs, geographic availability, costs of operation, quality of operation, sharing the pain and maintaining diversity of operators. The subcommittee also decided that the recommendations for non operational periods for ships should be made by agency (NSF, ONR, and NOAA) program managers working with ship schedulers based on their respective agency budgetary constraints. The agency recommendations on non operational periods would be formally reviewed by a subcommittee of the UNOLS Council with input from ship operators, Council members and others. They would provide feedback to the agencies and the community regarding these recommendations and provide suggestions for alternate solutions as appropriate. During the October UNOLS Council meeting, the agency representatives endorsed the subcommittee approach and asked that UNOLS give this process a trial run for 2007 operations. For additional details about the criteria and process for recommending non-operational periods of ships in the UNOLS Fleet, go to [http://www.unols.org/publications/reports/budget\\_impacts/NonOp\\_Process\\_Recmd.pdf](http://www.unols.org/publications/reports/budget_impacts/NonOp_Process_Recmd.pdf).

Another area of major focus is UNOLS Fleet renewal, which includes acquisition of Regional Class ships, the ARRV, Ocean Class, and the *Marcus Langseth* conversion. The Fleet Improvement Committee (FIC) is working to update the Global Science Mission Requirements (SMRs). A community on-line survey is available on the UNOLS website and science users are asked to provide input. The FIC continues work on their Fleet Improvement Plan. Annette presented a slide showing a comparison of the current fleet with the projected fleet of 2020. In 2020 there will be fewer ships available to support oceanographic research.

A subcommittee has been formed to establish Americans with Disabilities Act (ADA) Guidelines for Research Vessels. NSF indicated the need for new ship construction and ship conversion



efforts to address ADA requirements. Terry Whitledge (UAF) chairs the subcommittee whose membership includes sea-going scientists with and without disabilities, a ship captain, RVTEC rep, and marine superintendent. On September 18-19 an ADA workshop was convened at WHOI and included a visit to the R/V *Knorr* to learn the challenges faced by disabled persons who wish to conduct oceanographic research at sea..

Annette reviewed the activities of the UNOLS Standing Committees (*Appendix V*). A new Standing Committee, the Marcus Langseth Science Oversight Committee, has been formed and is Chaired by W. Steven Holbrook, U Wyoming.

### **National Facility Operators Report:**

**Personnel Changes in the *Alvin* Group** – Bob Detrick reported that Dudley Foster retired at the end of August 2006 and Barrie Walden retired after 35 years at the end of November 2006 (*Appendix VI*). A search process is currently underway to fill both positions. Vicki Ferrini left WHOI in the fall 2006 to take a position at LDEO. There have been two promotions. Bruce Strickrott is now an *Alvin* Expedition Leader and A.D. Colburn is the new *Atlantis* Master. Captain Gary Chiljean is stepping down to the relief captain position.

**NDSF Vehicle Operations Summary** - Rick Chandler summarized *Alvin* operations in 2006 and showed the schedule and cruise track. His slides are included as *Appendix VII*. The overhaul of the ship was completed and 239 operating days and ten science cruises were conducted. There have been 96 dives so far with 130 planned. Eleven dives were lost this year; 9 to weather, one medical emergency, and one mechanical. The average dive time was 7.3 hours, with a total of 413 hours on bottom. The average bottom time was 4.9 hours. The average depth of operations was 1,964 meters. The operating budget was \$1.8M.

The NDSF ROV and towed vehicle operations were all in the Pacific this year. Rick showed the schedule and cruise track. There was a total of 154 operating days with 73 lowerings. There are four science cruises with one in progress. The vehicles used included *Jason2*, *DSL-120*, and *Medea* with a total bottom time of 1,567 hours. A highlight was the longest *Jason* dive ever, of 42 hours. There was a single *DSL-120* dive of 150 hours.

Other highlights include:

- The Multi-chamber suction sampler is operational;
- A new forward-looking sonar is installed;
- The science video monitor in the control van has been replaced;
- A new forward-looking sonar has been installed
- New control vans for *Jason2* are at WHOI and ready for outfitting.

**NDSF Support Ships** – The vessel operators have been very helpful in accommodating the NDSF operation team (*Appendix VII*). Over the past year, NDSF operations included work on *Thompson*, *Melville*, and *Kilo Moana*. The new DP systems on *Melville* (and *Knorr*) perform very well and general training/familiarity continues to improve. *Melville* lab space is very tight. There is limited space for the *Jason* ops team to setup interior equipment.

**NDSF Data Manager Report and Archiving** - Vicki Ferrini provided the data manager's report. Her slides are included as *Appendix VIII*. She reviewed the data management structure at WHOI and covered five main data topics:

1. Video and imaging systems;
2. Real-time data logging and display;
3. Pre-cruise/post-cruise coordination;
4. At-sea/near real-time processing and Quality Control (QC) for core systems;
5. New software development and transition to NDSF.

Video and imaging systems include: video and still cameras, real-time display and control, quality control, logging hardware and media, video overlay, video duplication and editing capabilities, and documentation.

Included under real-time data logging and display are:

1. Hardware
2. Logging and management of native data formats for vehicle sensors
3. Digital event loggers
4. At sea digital metadata generation
5. Virtual van / frame grabber and beyond
6. Real-time display
7. Documentation.

Pre-cruise/post-cruise coordination includes an on-shore point of contact for data issues such as pre-cruise planning, science liaison, advice on data capabilities, acquisition protocols and products, and on-shore liaison to handle/direct at-sea data issues as they arise. Other items covered under pre- and post-cruise coordination are:

- Documentation of standard and archived data products
- Order/inventory media for at-sea data backup/archival/deliverables
- Inventory and deliver data to archive
- Gather and post appropriate documentation. The documentation includes: survey design, data acquisition, data products, and web site content.

At-sea/near real-time processing and QC for core systems include:

- Data processing pipeline (At-sea renav ingestion)
- Develop, test, and implement QC tools
- Transmission of QC reports to shore via HiSeasNet every dive (Navigation, standard sensors)
- At-sea/near real-time processing and QC for core systems documentation

After Vicki leaves WHOI, she would likely continue efforts to develop new software and transition them into the NDSF.

Next Vicki reported on 2006 highlights:

1. Video and imaging systems – Improvements include new video overlay software, video duplication and editing capabilities, and documentation;

2. Real time data logging and display – Improvements include Fledermaus with RT navigation display in *Jason* control van, Lowering ID ingestion, and evaluation of new digital event loggers;
3. Pre and post cruise coordination – Improvements include ongoing development of a new NDSF website. Launch is expected in early 2007;
4. At-sea/near real-time processing and QC for core systems – Improvements include at-sea navigation processing and 2006 virtual van updates. Future upgrades include renav ingestion into the frame grabber, improved *Alvin* digital event logging, and interface with 3D visualization tools;
5. New software tool development and transition to NDSF items include sonar processing tools and image processing.

Lastly, Vicki discussed the NDSF Archive Policy, which is posted on the NDSF website. The data archive inventories include vehicle data, cruise data, at-risk digital data, and hardware for reading media. Vicki discussed the standardization of metadata and at-sea digital generation of metadata.

**NDSF use by Non-supporting agencies** – Bob Detrick reported that from time to time WHOI receives requests for use of NDSF vehicles by non-supporting agencies (e.g., foreign countries; other State or Federal agencies; industry,). His slides are included as *Appendix IX*. They have established a policy for this type of use. The policy is to ensure that NDSF usage meets the requirements of the Memorandum of Agreement established by NSF, NOAA, and Navy. All users must be treated the same with regard to charge days and costs. The policy describes the requirements and costs associated with use of NDSF vehicles by non-supporting agencies. The costs to non-supporting agencies cannot be less than costs charged to supporting agencies for the same service. Bob reviewed policy details including terms of use, operating day definitions, and charges. He also discussed the procedures for obtaining approval to use the NDSF.

### **Upgrades to National Deep Submergence Facility**

**AUV *ABE* and *Sentry* Update** – Dana Yoerger provided an update on *Sentry* (*Appendix X*). DESSC recommended the addition of *ABE* to NDSF in 2006. Over the past year there were two *ABE* cruises. The vehicle was used at the Southern Mid Atlantic Ridge in conjunction with the ROV *Quest*. The vehicles were operated one at a time (in other words that were not in the water at the same time). *ABE* mapping results were used within hours by the *Quest* team.

*ABE* was also used in a cruise with *Jason*. These vehicles were often in the water at the same time. The mapping results obtained with *ABE* were used with real-time display by the *Jason* team.

AUV *Sentry* will replace *ABE* in 2008. During deep water trials, *Sentry* has demonstrated improved control system performance and improved speed and endurance as compared to *ABE*. Upgrades funded by NSF and the WHOI Foundation include:

- Improved mapping sonar (Reson 7125);
- INS (Phins) installation and testing;
- Improved batteries -Nereus packs;
- Magnetic gradiometry;
- And a digital still camera.

Examples of *Sentry's* data and projected performance were presented (see slides). *Sentry's* lead-acid batteries will be replaced with Nereus packs (~10 kwhr). The present *ABE* packs are 5.5 kwhr. By using the Nereus packs, the *Sentry's* air weight will be reduced by more than 1,300 lbs and will open a large amount of space in the lower half of the vehicle. *Sentry's* science payload will exceed 300 lbs. *Sentry's* addition of the Inertial Navigation System (INS) will decrease reliance on Long Baseline (LBL) transponder navigation.

Jess Adkins asked if there would be Doppler navigation. Dana replied, "Yes." WHOI is concerned about being totally dependent on the ultra short baseline (USBL).

**Status of Navigation Upgrades** - Barrie Walden provided the status of the NDSF navigation upgrades (*Appendix XI*). He explained that presently the surface ship does the navigating and sends the information to the sub. The *Alvin* group still uses the Benthos 455 as the back-up. A year ago Benthos indicated that they are no longer going to build the Benthos 455 and asked if WHOI wanted to buy all of their spare parts. WHOI bought the parts. Navigating the vehicle to within a meter is an issue. WHOI has gone down two different tracks to solve this problem, but neither option met their navigation requirements. The original designer of the ASP has come to work for WHOI.

The ASP hardware has been purchased and WHOI plans to test the hardware and prototype software this year. During a cruise of opportunity, the prototype hardware was tested and WHOI was unable to hear the transponders. They suspected a problem with the DSL Straza transducer and testing ashore revealed hardware issues with one board. WHOI has successfully retested the system in the laboratory tank using a Reson transducer. The software interface has been developed. Tests are planned on *Kilo Moana* on November 11-21, 2006. Presuming success of the *KM* tests, plans are to continue with the phased implementation plan and replace the Benthos 455 acoustic receivers. The next steps will be to finalize the hardware and integrate into vehicle systems. WHOI will move to a common acoustic navigation system for all NDSF vehicles.

**Response to Bill Chadwick's comments on *Jason2* operations** - Chris German reported on WHOI's response to the comments from Bill Chadwick on *Jason2* operations. Bill Chadwick's letter addressed 9 key issues with *Jason2* operations:

- Long Baseline Navigation
- Video Imaging
- Digital Still Imaging
- Audio Recording
- Suction Sampling
- Virtual Van
- Payload
- *Medea* Maneuverability
- Control Van Layout/Ergonomics

WHOI solicits DESSC's prioritization of these issues to provide guidance for WHOI's 2007 NDSF proposal. Chris elaborated on the status of each issues (*Appendix XII*).

Deb Kelley asked if there are any plans of operating *Jason2* without *Medea*. Chris replied that there are not.

**Lunch Break**

**Navigation – Comparison of Jason2 and ROPOS** – Bill Chadwick (DESSC Member) provided a comparison of the *Jason* and *ROPOS* navigation systems. His slides are contained in **Appendix XIII**. When using *Jason*, the LBL and Doppler data are currently delivered as separate files. *ROPOS* uses USBL & Doppler. The data are merged in real-time via a Kalman filter. Two images showing *Jason2*'s Doppler navigation at Rota and NW Eifuku were presented. Another image showing the *ROPOS* merged USBL and Doppler navigation at Axial Volcano was presented. The *ROPOS* IXSEA Gaps USBL system doesn't require calibration. All of the sensors are within the transducer head.

Bill gave the pros and cons of each vehicle navigation system. The *Jason2* LBL pros are its depth range and accuracy, but the time required for processing is about 12 hours. The *ROPOS* (cageless system for <2500 m) USBL only requires about 30 minutes for processing, but doesn't have the depth range and accuracy of *Jason2*'s LBL system. Bill provided a bathymetric image obtained with *ROPOS*' USBL and Imagenex system. Another bathymetric image was presented that had been obtained using *Jason2*'s LBL and SM2000 systems.

Lastly, Bill showed a movie clip of *ROPOS*. The vehicle has a heavy-lift capability and comes with a heavy lift crane.

Barrie Walden commented that *Alvin* continues to use LBL, but *Atlantis* has USBL. *Alvin* is self-navigating.

**Ocean Observatory ROV Workshop** – Deb Kelley reported that plans to hold an ROV Workshop are postponed. Stay tuned.

**Deep Submergence Scheduling: 2007 and Beyond** - Liz Caporelli reported on deep submergence scheduling for 2007 and beyond. Her slides are included as **Appendix XIV**. The tentative 2007 *Alvin* schedule starts the year at the East Pacific Rise (EPR). EPR operations will be followed by a maintenance period before resuming operations off California. Work will continue at Juan de Fuca before ending the year at the EPR. The *Atlantis* schedule is strong at 292 days (NSF = 273, NOAA = 18, ONR = 1) with 176 *Alvin* days, 71 *Jason* days, and 38 non-*Alvin* days. The estimated number of dives is 106. Liz showed the *Atlantis* cruise line. *Jason* 2007 operating areas include the MAR, EPR, Gulf of Mexico, JDF, and off Hawaii with a total of 194 days (NSF = 112, NOAA = 55, and German = 27).

Liz provided a summary of ship time demand (a total of 109 days) for *Alvin* and the ROVs for 2008. There are:

- 51 funded *Alvin*, and *Alvin* or *Jason2*;
- 58 pending *Alvin*, and *Alvin* or *Jason2*.
- 

STRs that requested just the ROV include 24 days funded and 160 days pending for a total of 184 days.

For 2009 thru 2011, there are 91 day funded, which includes 60 days for RHOV testing. An additional 138 days are pending. Liz showed the maps of the geographic research areas.

**Support Ships in 2007:** In 2007, support ships for the NDSF include *Maria S. Merian*, *Atlantis*, *Ron Brown*, and *Kilo Moana* (see **Appendix XV**). Some issues associated with these operations were reported. Science berthing on *Kilo Moana* is 26 total. Normal 24-hour operations with

*Jason* requires a team of 10 people; leaving just 16 berths for science. Another issue is that entry documentation for equipment is becoming more complex and not all operators are prepared to support U.S. and foreign customs requirements.

*Atlantis* improvements planned for 2007 include installation of a Kongsberg dynamic positioning system. The ship's two main engines will be overhauled. The full list of improvements is included in *Appendix XV*. Also included in the appendix is a list of items requested in the December 2006 Shipboard Scientific Support Equipment proposal for *Atlantis*.

**R2K Database and Visualization Tools** – Vicki Ferrini reported on the R2K Database and visualization tools. Her slides are included as *Appendix XIV*. The goals of this effort were to enable Ridge2000 and Margins communities to find data that have been collected, enable broader community access to the data, preserve data for future use, and facilitate visualization and exploration of data. The system would be required to handle large and diverse datasets (seismic, sonar, geological, fluid, biological, rock, and sediment samples, temperature, photo imagery) and serve a diverse user community (non-specialist and specialist access).

Vicky displayed the Marine Geosciences Data System (MGDS) RIDGE 2000 Data Portal webpage <<http://www.marine-geo.org/ridge2000/>>. From the portal, there are links to:

- Download forms
- Browse data holdings
- Download data
- Links to external sites

Various features of the data portal were presented. Examples of the Metadata Forms, the Digital Event-logging and Metadata Extraction forms, and how to browse data holdings were provided. Direct links to other data resources were displayed. Vicky showed an example of dynamically generated lists to aid ongoing research programs. The GeoMapApp tool was demonstrated. GeoMapApp is a Map-based tool for exploring marine geosciences data <[www.geomapapp.org](http://www.geomapapp.org)>. It features include:

- Dynamically generated bathymetry grids and maps
- PetDB
- Seismicity
- Bottom photos
- Import your own data

Questions or comments concerning the MGDS or any of its tools or data sets can be directed to <[info@marine-geo.org](mailto:info@marine-geo.org)>. Questions or comments specifically concerning the Java application GeoMapApp can be sent to <[info@geomapapp.org](mailto:info@geomapapp.org)>.

**Presentation to Barrie Walden** – A presentation was made to Barrie Walden in recognition of his dedicated service and leadership to the UNOLS community as Operational Scientific Services Manager at the Woods Hole Oceanographic Institution including managing WHOI's shipboard science service group, *Alvin* submersible engineering and operations, and the National Deep Submergence Facility. His 35 years of outstanding service to the oceanographic community has been greatly appreciated. Deb Kelley presented Barrie with a plaque on behalf of UNOLS.

**DESSC Activities and Issues** –

**Criteria for Adding Assets to the NDSF Adopted** - Deb Kelley reported that in 2006 DESSC established criteria for incorporating new assets into the National Deep Submergence Facility (NDSF). NSF requested DESSC to develop the criteria because in the coming years there will be significant demand for new tools to support deep submergence research. There will also be a need for uniform community access to them. The criteria document is available on the UNOLS web page at <[http://www.unols.org/committees/dessc/CRITERIADOCUMENT\\_062206.PDF](http://www.unols.org/committees/dessc/CRITERIADOCUMENT_062206.PDF)>.

**ABE/Sentry incorporated into the NDSF, DSL-120a operation moved to University of Hawaii** - Applying the newly drafted criteria, DESSC reviewed a request to add the Autonomous Underwater Vehicle (AUV) *ABE/Sentry* to the NDSF. DESSC recommended that *ABE/Sentry* be added to the NDSF concurrent with the removal of the two towed vehicles *DSL-120A* and *Argos II*. The Council endorsed DESSC's recommendation in June 2006.

**NDSF Vehicle Debrief Interviews** – Hedy Edmonds reported that in order to better track the status of vehicle and system performance, DESSC will conduct debrief interviews of PIs who use *Jason2*, *Alvin*, and *ABE/Sentry*. Participation in the debriefs will include DESSC, the science user, and the NDSF operator. Future DESSC meetings will include summary reports of these debriefs. The DESSC interviewers are:

- i. *Jason2* – Bill Chadwick
- ii. *Alvin* – Michael Tryon
- iii. *ABE/Sentry* – Hedy Edmonds

**DESSC Recommendations regarding Pilot Training and Advancement** - Deb Kelley reported that during the spring DESSC meeting there was discussion on how to provide training and advancement opportunities to the NDSF pilots. DESSC encourages WHOI Management to promote learning opportunities and career advancement opportunities for pilots. They also recommend that a workshop/training science session be offered for pilots. The session should demonstrate how the data from the vehicles are used for different research disciplines. The training could be offered in an interesting setting such as Hawaii or Iceland. Additionally, DESSC recommends that the RIDGE 2000 Lectureship program include an *Alvin* or ROV pilot as a distinguished lecturer. DESSC will follow-up on these recommendations with WHOI.

**Establishing Safety Standards for the use of Human Occupied Vehicles (HOVs)** - Dan Schwartz provided an update on the efforts to establish Safety Standards for HOVs. Dan's slides are included as **Appendix XVII**. NSF and NOAA tasked DESSC to establish safety standards for HOVs. This task arose because the replacement for *Alvin* will not be inspected and certified by Navy and because of interest in using or operating other human occupied submersibles such as the HURL and HBOI vehicles. Certification of the replacement HOV will be by ABS as is done with several other existing HOVs. A committee was formed to develop these safety standards, which will be modeled after the UNOLS Research Vessel Safety Standards. Dana Wilkes is the Committee Chair. Two in-person meetings and three phone conferences have been held during which the project tasking was defined, current procedures and operating manuals were reviewed, an outline was formulated and writing assignments were reviewed. The HOV Safety Standard chapters include HOV Operations, HOV Support Ship, HOV Handling Systems, Training Procedures for HOV Crew, and Science User Safety Guidelines. The effort to develop Safety Standards will be a multi-year effort with a goal of being completed before the new HOV comes on line. Phone/web conferences will continue to review chapters and make changes as needed. Ideas, suggestions or comments regarding this effort are welcome and can be sent by e-mail to <[office@unols.org](mailto:office@unols.org)> (Attention to Annette DeSilva).

**Replacement HOV Update** - Bob Brown provided a report on the status of the Replacement HOV (RHOV) design/build project. His slides are included as *Appendix XVIII*.

There have been some personnel changes on the Replacement HOV Oversight Committee (RHOC). Karen Von Damm has stepped down as Chair and from the Committee. Cindy Van Dover has been appointed as the new Chair. George Luther replaces Karen on the RHOC.

Bob summarized the science improvements offered by the replacement HOV, which include improved fields of view, increased depth capability, increased bottom time, and improved interior ergonomics. Bob reviewed the milestone history and risk management phased approach. In July 2004, NSF awarded a Cooperative Agreement with WHOI to design and fabricate the replacement HOV. In November 2005 a contract from Southwest Research Institute (SwRI) for personnel sphere design was signed. To address areas of higher risk the project has been broken into two phases: Phase One will consist of design and forging of the personnel sphere, feasibility testing for the prospective energy system, and qualification testing for the syntactic buoyancy foam. During Phase Two the personnel sphere will be completed, and the design and fabrication of remaining vehicle will be accomplished.

To date, the test and fabrication specifications have been developed and ABS has approved the specifications. The syntactic buoyancy foam development continues to be a challenge. Syntactic foam has been developed with a 32 lb/ft<sup>3</sup> foam density. Foam with a density of 30 lb/ft<sup>3</sup> foam is desired. They will continue development of a lower density foam with 30 lb/ft<sup>3</sup> as a target.

Various Li polymer & Li ion batteries have been evaluated. Baseline and environmental performance testing and safety testing of the batteries are being conducted. The batteries are about 1/3 the weight of the lead-acid batteries.

WHOI is looking into alternative solutions to a few of the ABS rules, such as for oxygen storage solutions. They are trying to convince ABS that the way they do it for *Alvin* is ok

Bob reviewed the personnel sphere design status. Preliminary trade studies and analyses have been completed. The material characterization (Ti 6 Al-4 V ELI) is complete and the contract has been let for the titanium purchase. The titanium purchase was early in order to lock in the price. A Preliminary Design Review (PDR) meeting is scheduled for early December 2006. Bids for forging and fabrication of the sphere are due at the time of the PDR. A baseline penetrator tradeoff study was conducted. Sixteen penetrations are planned; 5 electrical, 5 fiber optic, and 6 expansion.

Bob explained that if WHOI were required to build the RHOV to ABS specifications, the hull thickness would have to be very thick. ABS realizes the hull thickness problem, so they agreed that if WHOI uses the Navy methodology used for *Sea Cliff*, it would be acceptable. WHOI is in the process of developing the methodology (since it was never done for *Sea Cliff*). The *Sea Cliff* finite element analysis (FEA) model and preliminary analysis has been completed. This material study was required since WHOI is building the replacement HOV out of slightly different titanium than *Sea Cliff*. The *Sea Cliff* never had an FEA and was not destructively tested.

WHOI has asked SwRI to compare various viewport options. The comparison considered options for five or three viewports with sizes of 5 inches, six inches, and seven inches. A



comparison table was presented in the slides. The pros and cons of the options were reviewed. Generally, DESSC participants favored the side windows (total of 5 viewports).

A Request for Information (RFI) for vehicle fabrication was released in April 2006 and responses (Statement of Interest) were received from six companies. An industry day was held on *Atlantis* on 1 Aug 2006 and a Request for Proposals (RFP) was issued on 2 Nov 2006. Responses are due on 4 Jan 2007.

Some of the RHOV prototype development work is being done using *Alvin*. The prototype work includes development of an inertial navigation system, a fiber optic penetrator, and shaped memory alloy releases.

The schedule for the RHOV construction indicates that the vehicle would be ready for science sea trials in 2010.

Dolly stated that if there is any input on what Bob has presented it should be sent to the RHOC Chair, Cindy Van Dover and Bob Brown at WHOI.

**Community Input on science instrumentation, tools, sensors, etc** - Deb Kelley reported that a community on-line survey on science sensors and instrumentation for the RHOV is being developed. The draft survey will be reviewed at the spring DESSC meeting and will be available to the community over the summer. A summary of responses will be provided at the fall DESSC meeting.

### ***Break***

**HROV Status Report** – Dan Yoerger provided the Hybrid ROV (HROV) status report. His slides are included as ***Appendix XIX***. The HROV was named *Nereus* through a student competition. Progress has been made on the HROV development effort. They successfully conducted deep fiber optic link tests in June 2006. Buoyancy and pressure housings have been tested. The vehicle structure is in fabrication. The battery packs and manipulator are in bench testing. The electrical design is near completion and tests on the riskiest elements are underway.

The AUV of the HROV system has a survey speed of up to 3 knots with 70 KM of coverage (sonar). The ROV is estimated to have up to 7 KM of transits with a projected bottom time of 8 hours. The basic sensor suite for the HROV will include two Seabird 49 FastCat CTDs, a magnetometer, an optical backscatter, and profiling and imaging sonar. In December 2005, fiber optic tether tests with *ABE* were conducted to 2000m and the longest dive of greater than 16 hours was obtained. In June 2006, fiber optic tether & depressor tests were conducted and the HROV was been deployed four times with, no failures on the last three. The buoyancy spheres and ceramic pressure housings features were presented. There has been a total in-water weight savings of approximately 730 lbs over titanium.

The HROV manipulator work package is suspended from the core vehicle structure. Flexible sample storage facilities will reside within the frame of the ROV work package. The pan and tilt will be on the opposite side of the manipulator for good visibility of the workspace. Much of this development is based on lessons learn with the *Alvin*, *Jason I* and *Jason II* systems. The manipulator and power pack features were reviewed. The system is hydraulically powered. The arm and power pack are presently operating in the shop. The vehicle batteries have 18 KWh total capacity. Lastly, the features of the LED arrays were reviewed. In summary, Andy stated

that *Nereus* will provide a new level of accessibility for deep ocean research, with prototype testing in 2007.

### **Outreach and Education Programs:**

**RIDGE Lectureship Program** - The Ridge 2000 Distinguished Lecturer Series provides mid-ocean ridge research information to colleges and universities, concentrating on those without existing ocean-science programs. The goal is to reach audiences not familiar with this kind of research, and to attract future students into ocean sciences programs. The 2006 lecturers included Dan Fornari (WHOI), Chris German (WHOI), Peter Girguis (Harvard), and Maya Tolstoy (L-DEO).

**Marine Advanced Technology Education (MATE) Program** – Annette DeSilva summarized the MATE report, which is included in *Appendix XX*. The report is very thorough and provides information on the:

- MATE Technical Internship Program - Since the program began in 1999, MATE has placed 162 students in at-sea and shore-based internship positions. Eighty-seven of those students have sailed on board UNOLS vessels.
- Regional ROV Contest Network
- MATE 2006 International ROV Competition for Students - For the second year in a row, the team from Memorial University of St. John's, Newfoundland, Canada took first place.
- Ocean Career Expo
- HROV Naming Contest - *Nereus*, was chosen from the more than 20 entries submitted.
- Celebrating the International Polar Year - The 2007 MATE competition will focus on polar science and technology and will be held June 22 – 24 at the Marine Institute (MI) of Memorial University and the Institute for Ocean Technology (IOT), located in Canada.

**Ocean Exploration** – NOAA Education and Outreach Activities Featuring NDSF – Craig Russel reported on NOAA's education and outreach activities. His slides are included as *Appendix XXI*. Over the past year NOAA's web coverage included seven web logs highlighting *DSL-120*, *Medea* and/or *Alvin*. The web pages include profiles and logs on NDSF and DESSC personnel. Media coverage included a Galapagos Podcast with *DSL-120* and *Medea*. There was also an article in *Nature* on the discovery of a black smoker with Chris German and *ABE*. Other NOAA education and outreach activities included web coverage during the Project PHAEDRA 2006 cruise. Web logs, lesson plans, highlights, background pieces on SeaBED and WHOI science and technical staff were offered.

### **Long-Range Planning Issues:**

**Ocean Observatory Initiative (OOI) Status** - Bob Detrick provided that status of OOI. His slides are included as *Appendix XXII*. In the NSF FY07 budget OOI was passed by both the House and Senate. The Conceptual Network Design (CND) for OOI was completed in June 2006. In July, a report on OOI science goals and CND was reviewed by a "Blue Ribbon Panel." The OOI Conceptual Design Review (CDR) was successfully completed in August. From September 2006 to the present (November 2006) the CND is being revised and de-scoped to fit within the MREFC capital budget (\$309M) and the operation and maintenance target of \$50M/yr in 2013 (accounting for inflation). The OOI timeline for 2006 through mid-2008 is included in *Appendix XXII*.

**NEPTUNE Canada** – Deb Kelley provided an update on the status of NEPTUNE Canada. Information about the program can be found in *Appendix XXIII*. One component of OOI that has a strong start is Phase I of NEPTUNE Canada. The Canadians were successful in getting initial funds for support of the program and then additional funds to offset costs that were higher than planned.

During Phase I of the NEPTUNE project, an 800 km ring of cable will be laid over the northern part of the Juan de Fuca tectonic plate. The NEPTUNE Canada cable network will feature five or six nodes, some of which are located at Ocean Drilling Program (ODP) sites. These nodes will host over 700 sensors. This work has gone out for bid. Information and images gathered by NEPTUNE instruments will flow via the Internet2 to shore. In 2007, the plan is to lay the cable in Canadian waters. This cable will be the main backbone of the observatory. The secondary infrastructure will be installed in 2008, completing Phase 1. The U.S. Phase 2 effort is expected to be operational in 2013, but may be delayed a bit. The U.S. will look at the lessons learned during installation of Phase I. Additional details about NEPTUNE Canada can be found at <http://www.neptunecanada.ca/>.

**Coordination of Multi-Vehicle Operations at Observatory Sites** - Chris German lead a discussion on coordination of multi-vehicle operations at observatory sites. His slides are included as *Appendix XXIV*. As observatories are installed, multi-vehicle coordination will become a growing concern. There are four key issues for multi-vehicle operations: safety, navigation, seafloor compatibility, and seafloor traffic control. The standard safety rule regarding HOV operations has been to maintain a minimum one water-depth spacing from other vehicles. The space requirement has been relaxed for “untethered” seafloor objects. Concurrent operations with AUVs like *ABE/Sentry* are probably fine, but operations with “torpedo” AUVs will require additional evaluation. *Alvin* and *Nautile* worked together in 1997. The safety rule for ROV operations has been to keep all vehicles separated by one water-depth. AUVs can be safely launched with ROVs deployed from the same ship. Safe AUV launches have also been achieved during HOV ascent. AUVs can also be sent to sleep on the seafloor if needed.

The key to avoiding trouble is good navigation. Long Baseline (LBL) navigation is possible with multi-frequency for multi-vehicle operations. LBL compatibility with USBL systems has been used. The ability to import both LBL and USBL into common space is needed. Examples of multi-vehicle operations with LBL and USBL navigation systems were sited (*ABE* and ROV *Quest*, *ABE* and *Jason*, and *Alvin* and *Nautile*). Future developments with navigation systems that are underway at WHOI were highlighted.

As observatories are planned and vehicles developed it is important to consider seafloor compatibilities for HOV/ROV inter-operability. Compatibilities would include common instrument and package “handles” to allow install, connect, activate/deactivate, disconnect, and recovery operations. There should be a “one size fits all” for AUV docking.

High latitude observatories (e.g., RCO) will have shorter weather windows and as a result operations will require multi-vehicle usage to accomplish all work. Seafloor traffic control will be required for careful coordination to prioritize of operations and vehicle compatibility. A single coordination point would be needed for each observatory.

These issues will need further consideration at future meetings.

**Other business:**

2007 DESSC Meeting Plan – The spring DESSC meeting will be at WHOI. Committee members will be polled for available dates. The 2007 winter DESSC meeting will be at the fall AGU meeting in San Francisco, CA.

DESSC Membership – Many of the DESSC membership terms end 2007. In order to maintain continuity, a staggered rotation will be proposed and presented at the spring meeting.

**1700 *Adjourn***