APPENDIX VII

DRAFT CONCEPT OF OPERATIONS

Woods Hole Oceanographic Institution

National Deep Submergence Facility

Concept of Operations
(Proposed)

by

Richard F. Pittenger
Associate Director for Marine Operations

18 September 1996

Richard Pittenger
17 September 1996
Woods Hole Oceanographic Institution
National Deep Submergence Facility
Deep Submergence Operations Group
Concept of Integrated Facility Operations

Executive Summary

Woods Hole Oceanographic Institution (WHOI) has operated the U.S. National Facility for Deep Submergence for the past 33 years. The seagoing support ship, and the deep submergence vehicles that are launched and recovered from it, which WHOI operates for the academic community, represent the principal modes of access for U.S. scientists to study the deep ocean and sea floor in situ. The work that WHOI and the oceanographic community have done with these facilities has revolutionized our understanding of earth and ocean processes. Research that is conducted with the submersible Alvin, the remotely operated vehicle (ROV) Jason, and the other towed and autonomous vehicles that WHOI operates for scientists, is essential to the investigation of many fundamental oceanographic and earth science problems that will impact society well into the 21st century. Problems as diverse as: the temperature and chemical structure of the world's oceans, tectonics of the mid-ocean ridge system, understanding the crustal structure and physical processes at continental margins, transfer of heat and chemicals from the Earth's mantle to the biosphere, and the ecology and genetic history of deep ocean hydrothermal vent fauna, all require the capability to access the deep ocean and sea bed via deep submergence vehicles.

The U.S. Federal funding agencies which have a mandate to support oceanographic science (the National Science Foundation, the U.S. Navy Office of Naval Research, and the National Oceanic and Atmospheric Administration), have, over the past few years, furthered their commitment to exploration and study of the deep ocean by making possible the conversion of the R/V Atlantis to serve as the new support ship for the National Deep Submergence Facility vehicles: Alvin, ROV Jason, Argo-II and the DSL-120 sonar. Starting in Summer, 1997, the R/V Atlantis and the National Facility vehicles will be operated from Atlantis, which will usher in an era of integrated deep submergence vehicle operations that have enormous potential to facilitate and enhance scientific research in the deep ocean and on the sea bed to depths of 6,000 m.

Given the challenge of operating the integrated National Facility vehicles in this new paradigm afforded by R/V Atlantis, WHOI has developed a draft plan for the concept of operations of the National Facility vehicles and support ship. The following brief description and attached tables and charts will serve to introduce this concept of operations to the Deep Submergence Science Committee (DESSC) and the Federal funding agency representatives. It is hoped that this draft concept of operations will provide DESSC members and funding agency representatives with sufficient information so that operational procedures, staffing requirements, and budgetary information can be placed in their proper, facility-wide context.

Summary information is provided on the R/V Atlantis, and the various vehicle systems. Additional information for the ship, vehicles and WHOI is available on-line in the new WHOI Marine Operations and Deep Submergence Operations Group (DSOG) website(http://www.marine.whoi.edu/marops) which has undergone major revisions and is now nearly complete. This will be complemented by updated science user information and manuals (to be posted on the web site) and instructional video tapes which are under development. Specific personnel responsibilities and wiring diagrams between various levels of WHOI Marine Operations and DSOG and related WHOI technical support groups have been updated, as have the procedures by which scientists interact and communicate with the WHOI system. These changes have been conceived after discussion with scientists in the community and DESSC in an effort to improve and streamline the manner in which WHOI provides deep submergence science services. We see this as a necessary component of the new, integrated facility given the potential use of multiple vehicle systems during a science cruise and the requirement to stage and operate the appropriate vehicle assets, personnel,

and supporting material/expendables in different configurations over the course of an operating year.

Key issues in terms of long-range planning and facility management and support for WHOI and the Federal supporting agencies are related to the logistics of vehicle operations on R/V Atlantis or on other suitable UNOLS vessels when the ROV/tethered systems are required to be operated separate from joint field programs with Alvin/Atlantis. WHOI envisions that specific protocols be adopted to allow for various operating models to be implemented, without affecting the short-term operational capability of the facility, and ensuring the long-term, continued upgrade and maintenance of the National Deep Submergence Facility.

Operation of the integrated facility on the new R/V Atlantis will require sufficient shake-down of all the ship and vehicle systems prior to conducting funded science programs; this has been planned and budgeted for in our draft 1997 operations timetable. After consultation with DESSC and the funding agencies, we have proposed two deep submergence operational schedules for 1997-1998. Our objectives in providing these schedules are to accommodate as much funded science as possible given weather and logistical constraints on the vehicle systems, and to facilitate the integration of joint Alvin and ROV Jason/tethered vehicle operations on R/V Atlantis as rapidly as possible.

WHOI is committed to providing excellence in deep submergence vehicle support services to the research community as it has done over the past few decades. It is poised to meet the challenges of operating the World's premier, integrated deep submergence facility for science in an efficient and cost-effective manner. We welcome comments and criticisms of our draft Concept of Operations.

The Facility

R/V ATLANTIS

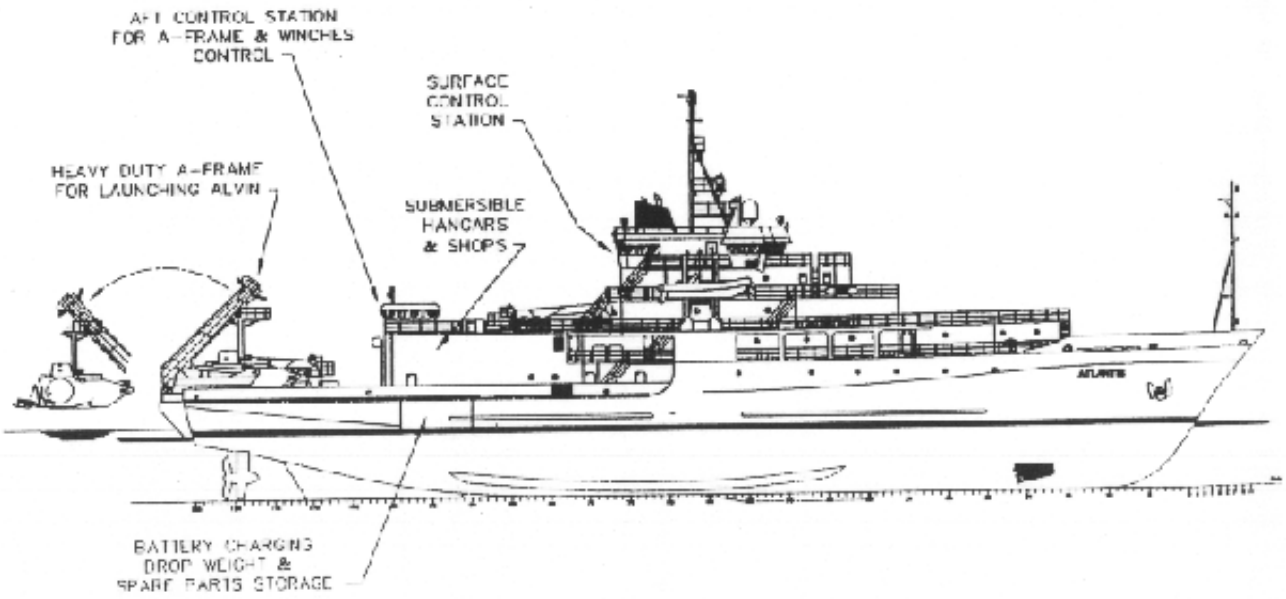
DSV ALVIN

ARGO/MEDIA/JASON/DSL-120

ABE

R/V *ATLANTIS*

Outboard Profile of *R/V Atlantis* with Deep Submergence Modifications Highlighted



ATLANTIS OUTBOARD PROFILE STARBOARD

Plan View of *Atlantis* Main Deck

New Features:

Alvin A-Frame and Tracks

- A-Frame will be taken from *Atlantis II*, completely refurbished and new, more powerful hydraulic system.
- Positive control traversing and track system to move *Alvin* into and out of hangar.

Alvin Hangar

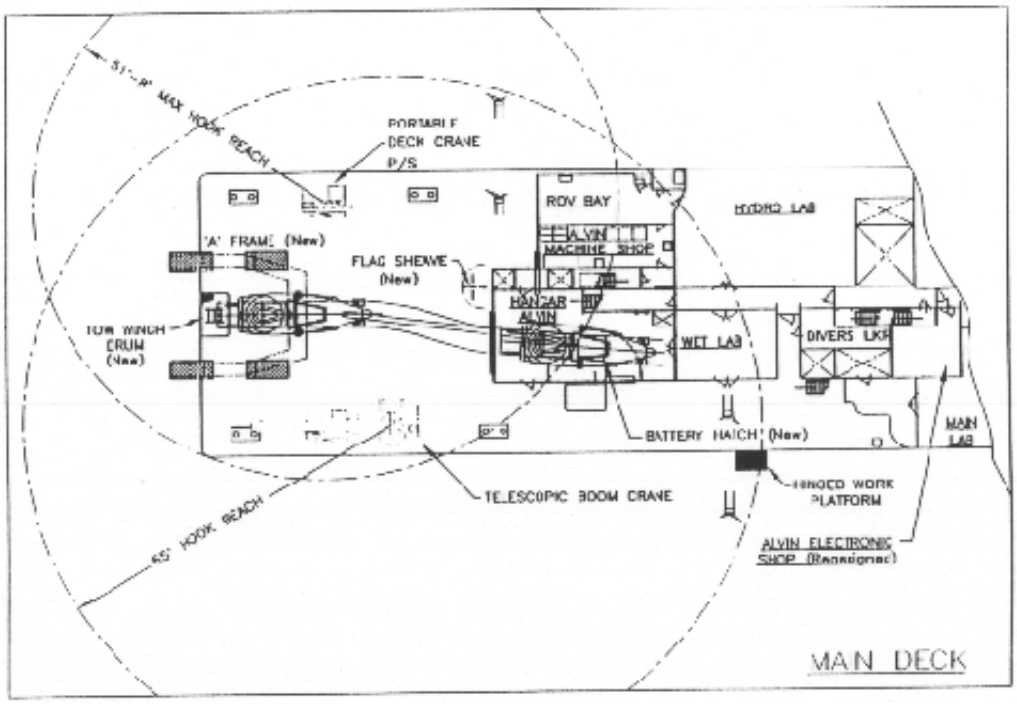
- To provide secure, covered storage and easy access for maintenance.

Shops (Mechanical, Electric, and Electronics)

- Near hangar for efficiency.

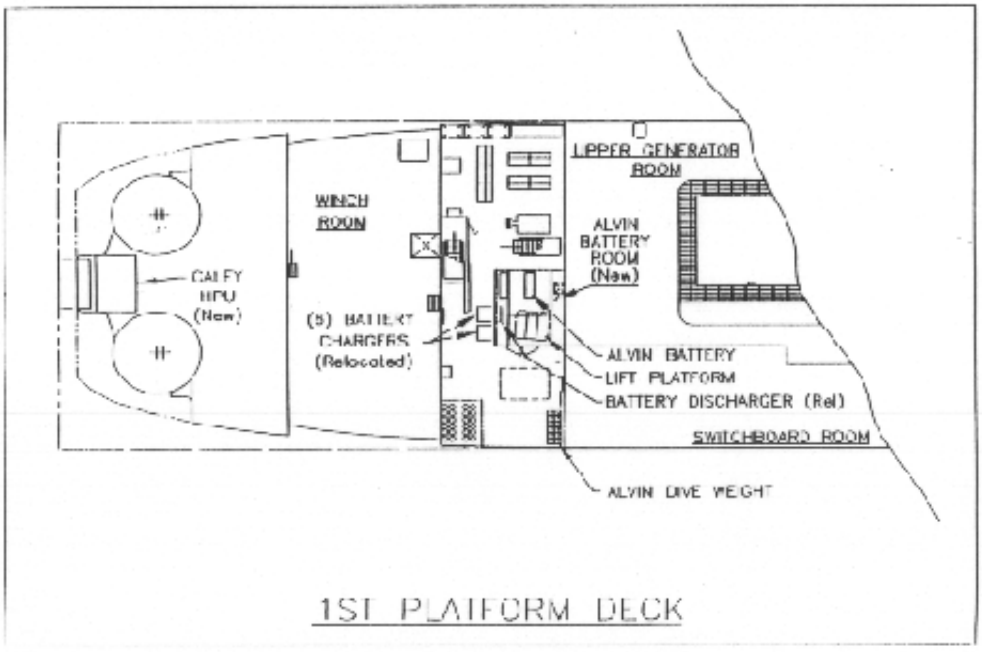
ROV Bay

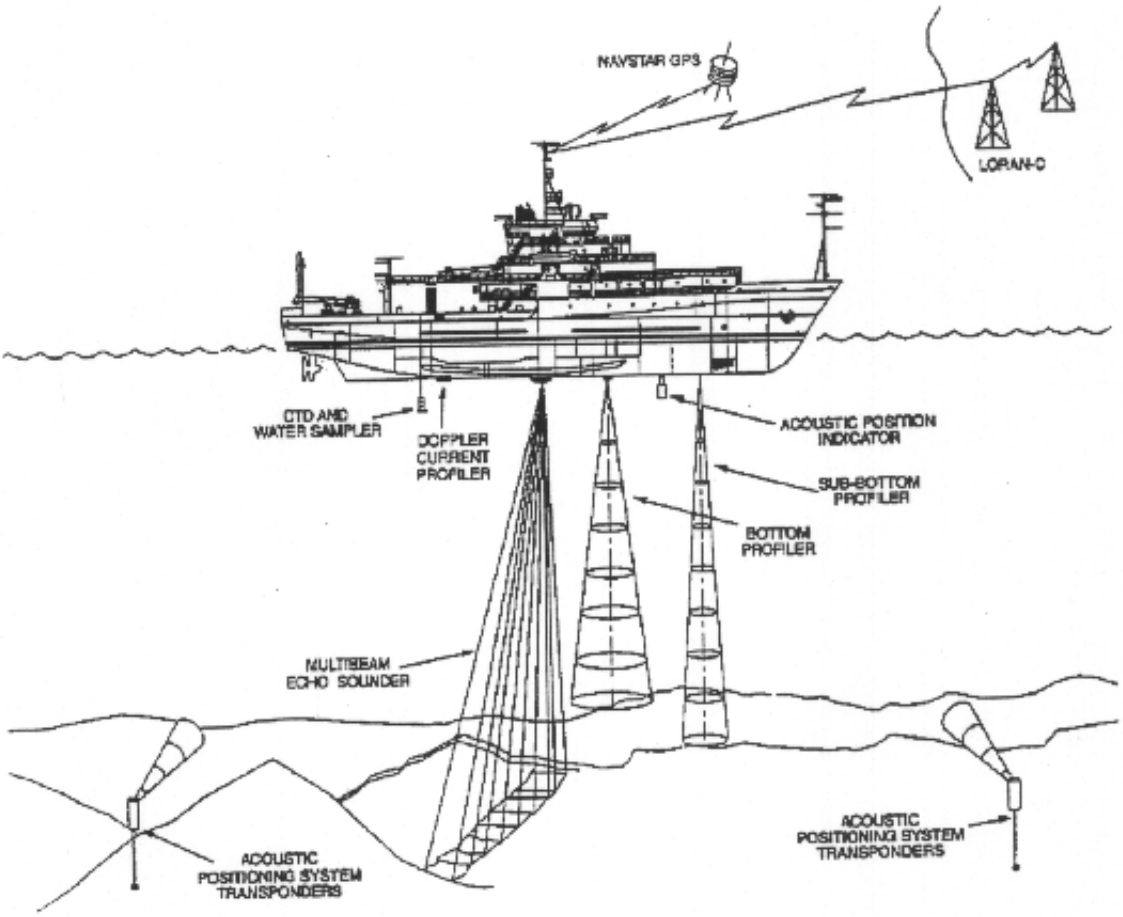
- For Storage and maintenance of WHOI ROV's.



Alvin Dive Weight, Battery Charging and Spare Part Storage

- Co-located conveniently immediately below *Alvin* hangar.
- Battery service facility includes charger, storage for replacement battery and hydraulic lift for removing/installing heavy battery units.
- *Alvin* uses 1,000 lbs. of steel as descent weights on each dive. Typically the ship will carry 75,000 lbs. of expendable weights.
- Having an adjacent dedicated large spare parts storage for submersibles will greatly enhance the at-sea groups' efficiency.




NAVSTAR GPS
LORAN-C
CTD AND WATER SAMPLER
DOPPLER CURRENT PROFILER
ACOUSTIC POSITION INDICATOR
SUB-BOTTOM PROFILER
BOTTOM PROFILER
MULTIBEAM ECHO SOUNDER
ACOUSTIC POSITIONING SYSTEM TRANSPONDERS
ACOUSTIC POSITIONING SYSTEM TRANSPONDERS

Installed Equipment in *Atlantis*

P-Code GPS

Doppler Speed Log

Dynamic Positioning System

Acoustic Positioning / Navetronix

Swath Bathymetry System / SeaBeam 2112

Bottom Profilers / 12 kHz, 3.5 kHz

ADCP / Narrow Band 150 kHz

2 Air Compressor / Price A-300

IMET / Sea Surface Sensors

Attitude Sensors (Heading, Roll, Pitch, Yaw)/ASHTEC + Hippy

Winches

- **Two Markey DESH-5**
  10,000 m .322EM or 1/4" Hydro-wire
- **One Traction with Dual Storage Reels**
  - **Fiber Optic (.68")**
  - **EM**
  - **9/16" Trawl wire**

Cranes

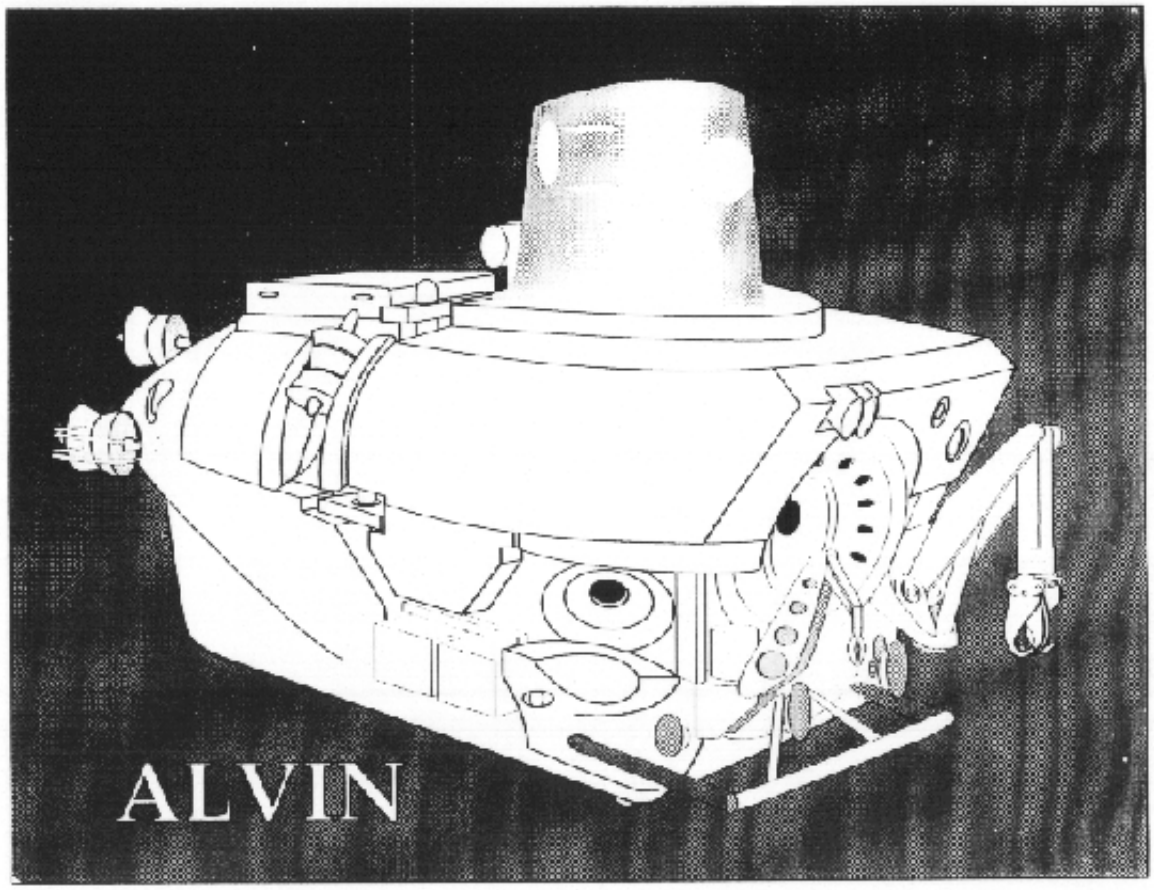
- **2 Telescopic Cranes**
  42,000 lb. lift capacity
- **2 Portable "Hiabs"**
  2,200 lb. lift capacity

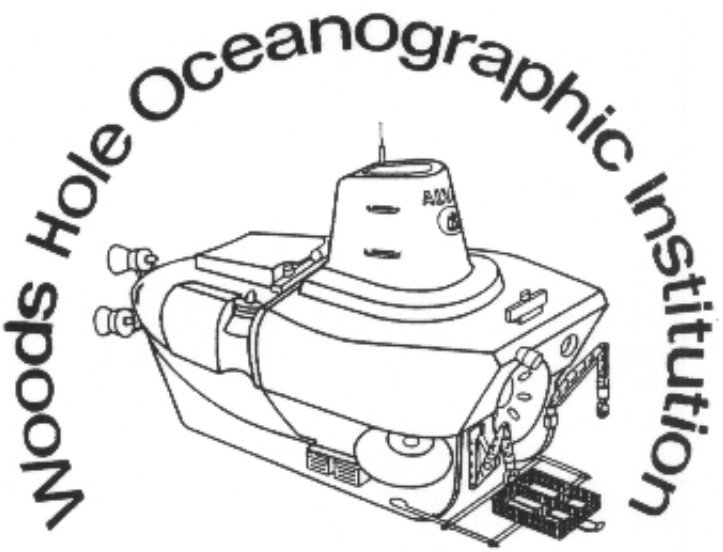
Van Spots - 6 above main deck

Lab Space - 4,000 square feet

Science Berths - 24

DSV *ALVIN*





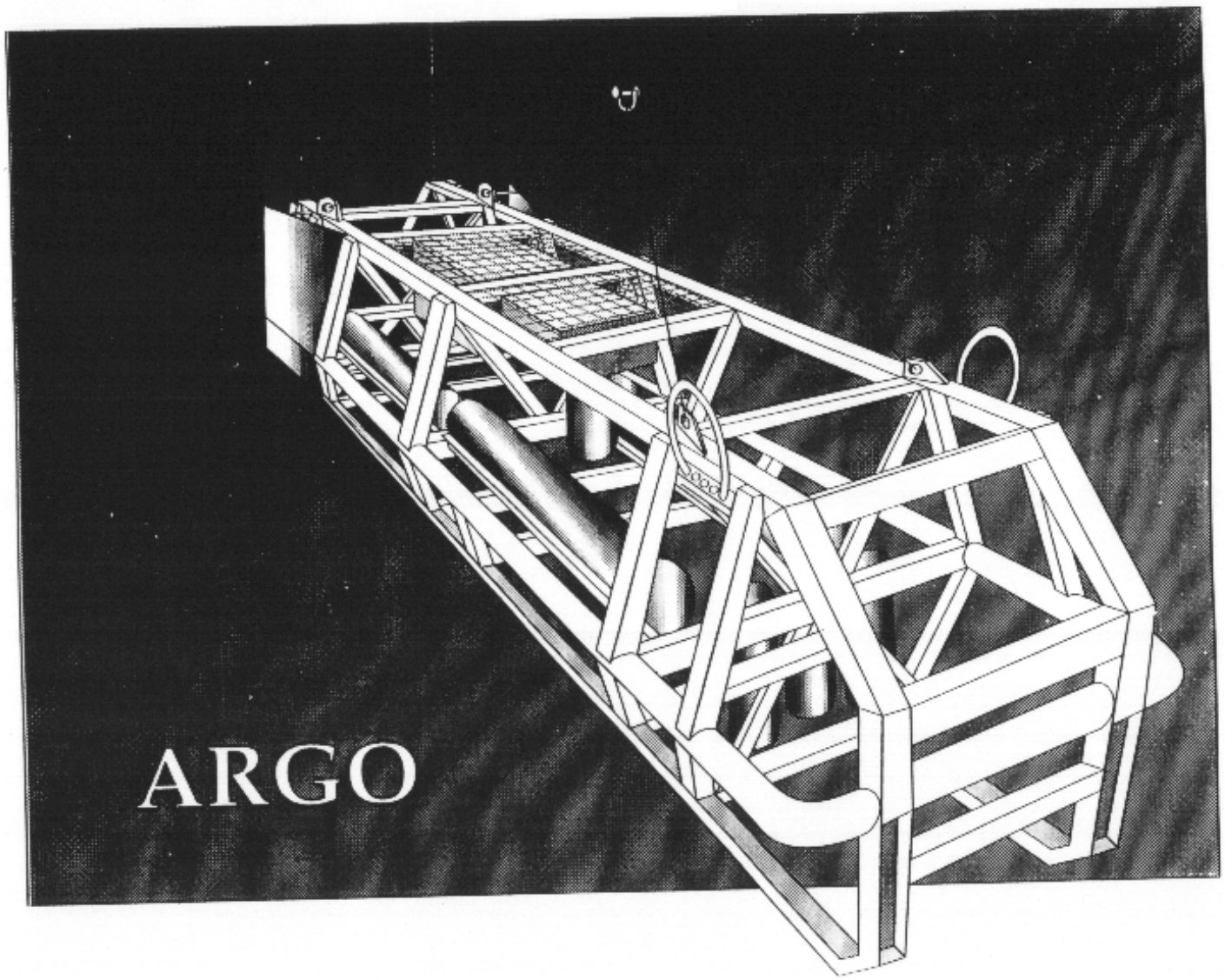
ALVIN

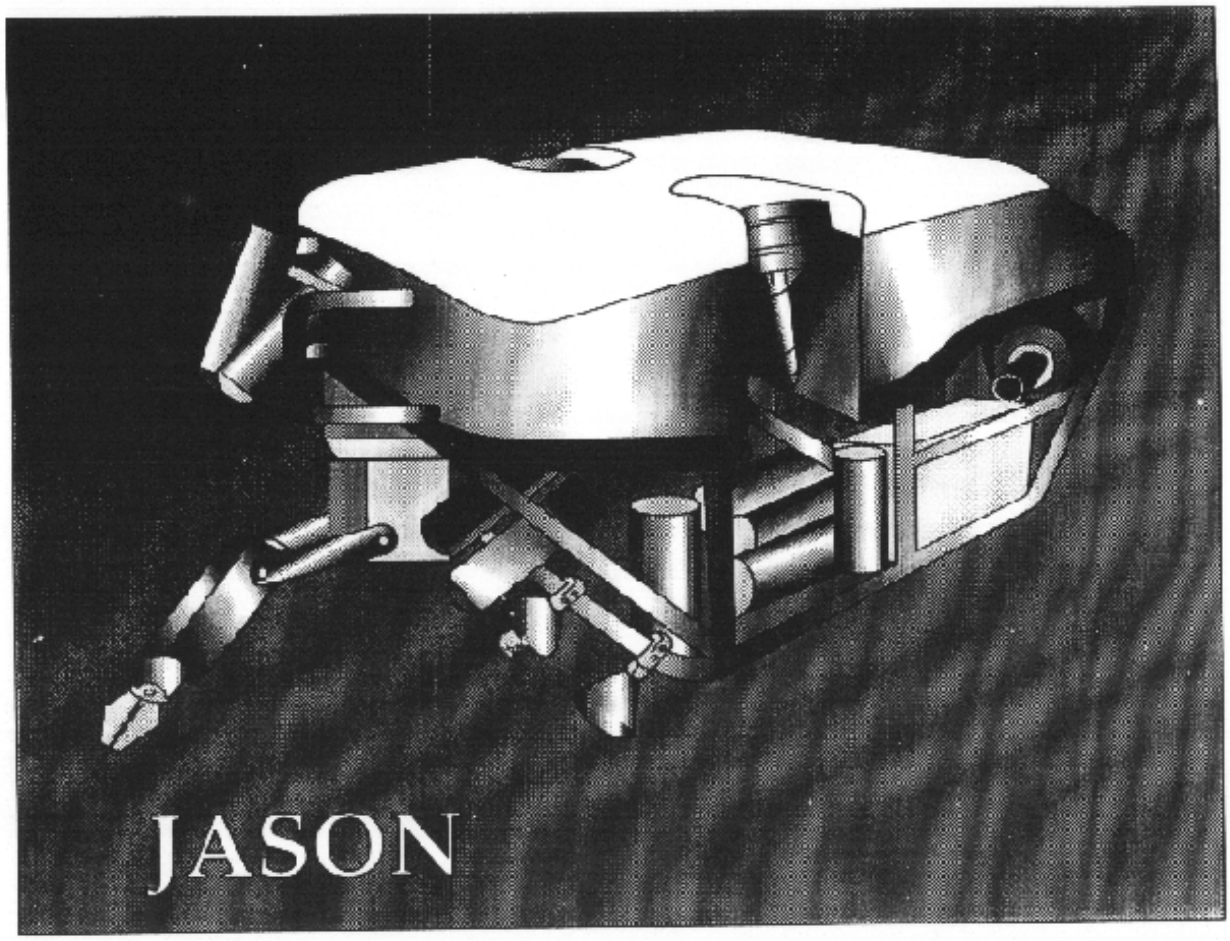
- **Human presence at the ocean floor.**
- **8-10 hour dives**
- **Safe, reliable, versatile platform for a wide variety of benthic sampling, mapping and instrument installation strategies.**

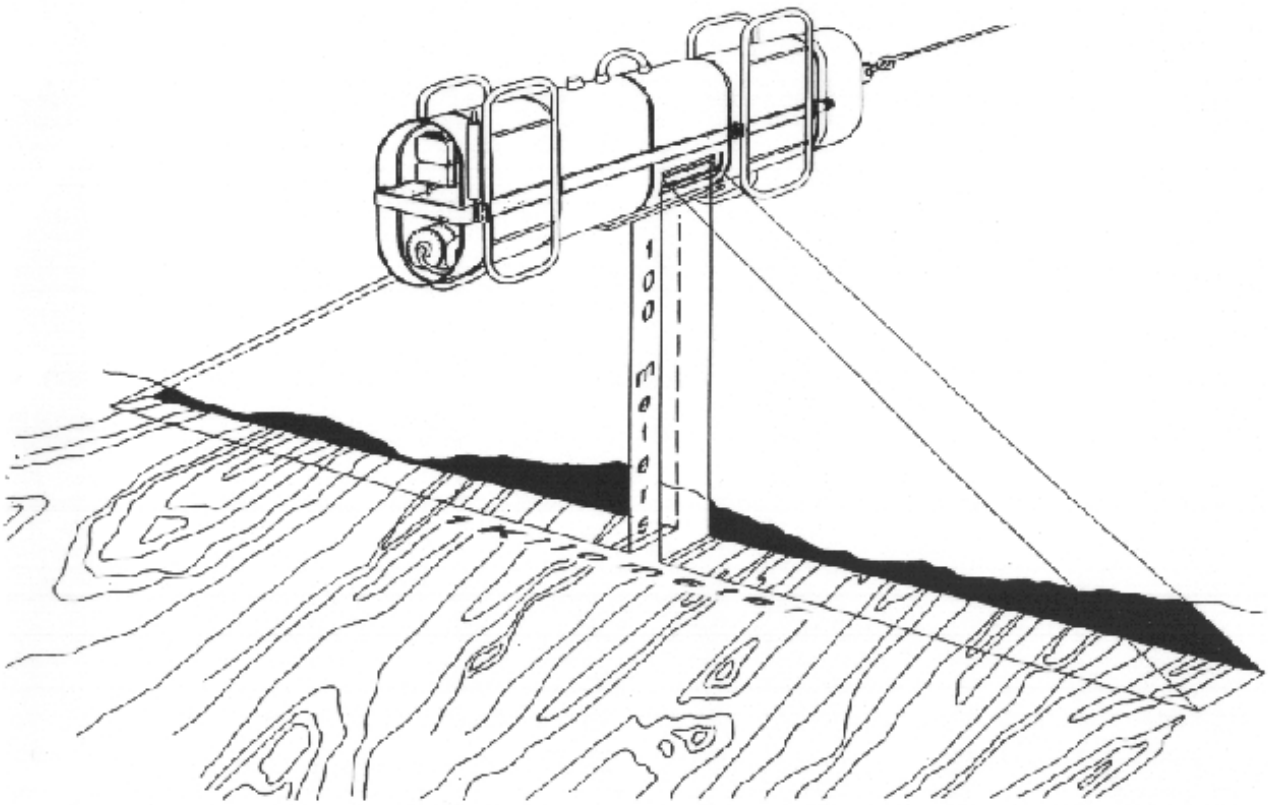
Alvin Science Equipment

- Two hydraulic manipulator arms, each with at least 100 lb. lift capacity.
- Sample basket.
- External cameras
  - ◊ Stereo 35mm film
  - ◊ 1- and 3-chip video
  - ◊ Benthos 5010 digital camera
  - ◊ Color and SIT video
  - ◊ HMI, TI and QI lighting
- Internal cameras
  - ◊ Hi-8 video camcorder
  - ◊ Hand-held 35mm SLRs
- Data display and logging system
- Sonars
  - ◊ Mesotech scanning altimeter
  - ◊ CTFM
- Science hydraulic manifold
- External electrical feeds/hook-ups
- Samplers:
  - ◊ Water
  - ◊ Sediment
  - ◊ Water temperature
  - ◊ Biota
- Sensors:
  - ◊ Heat flow probe

ARGO/MEDIA/JASON/DSL-120




JASON


100 meters

ROV *Jason* and Tethered Vehicles

- *Jason/Medea*
  - ◊ Detailed local-area surveys, and precise multisensory imaging, mapping, and sampling to 6,000 meters using fiber-optic telemetry.

- *Argo-II*
  - ◊ Large-area, towed fiber-optic acoustical and optical imaging and mapping system.

- DSL-120 kHz Towed Sonar
  - ◊ Split-beam towed sonar system designed for near-bottom acoustic imaging and phase-bathymetric mapping with ~1 km swath width and ~1-2 m vertical and horizontal resolution.

ROV and Tethered Vehicle Science Equipment/Sensors

Jason

- Video, still, electronic cameras and lighting
- Attitude, heading, altitude, depth, acceleration
- Navigation
- CTD
- Electric manipulator
- 200 kHz sonar
- Seven thrusters
- HMI and QI lighting
- Hydraulic power pack

Medea

- Video and still cameras, lighting
- Attitude/navigation

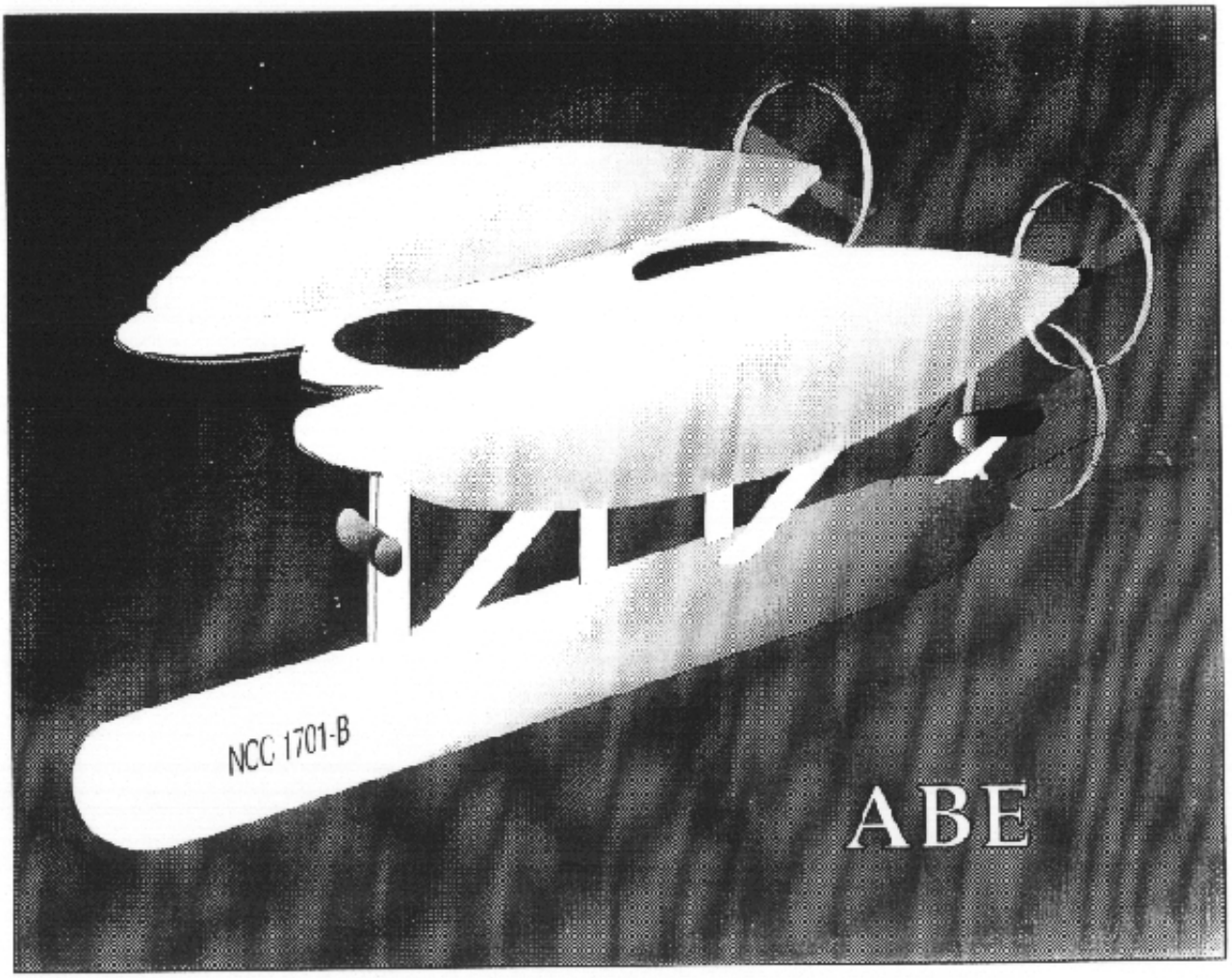
Argo-II

- Video, still, electronic cameras and lighting
- Attitude/navigation
- 100 kHz obstacle avoidance sonar
- 200 kHz split-beam sonar yielding acoustic backscatter and phase bathymetric sonar swaths of ~300 m
- Imagenix scanning/altimetric sonar
- CTD
- HMI and QI lighting and 1200 w/s strobes
- Heading control thrusters (2)

DSL-120 Sonar

- 120 kHz split beam sonar
- Attitude, heading, depth
- Variable range scales
- CTD
- Magnetometer

ABE



ORGANIZATION

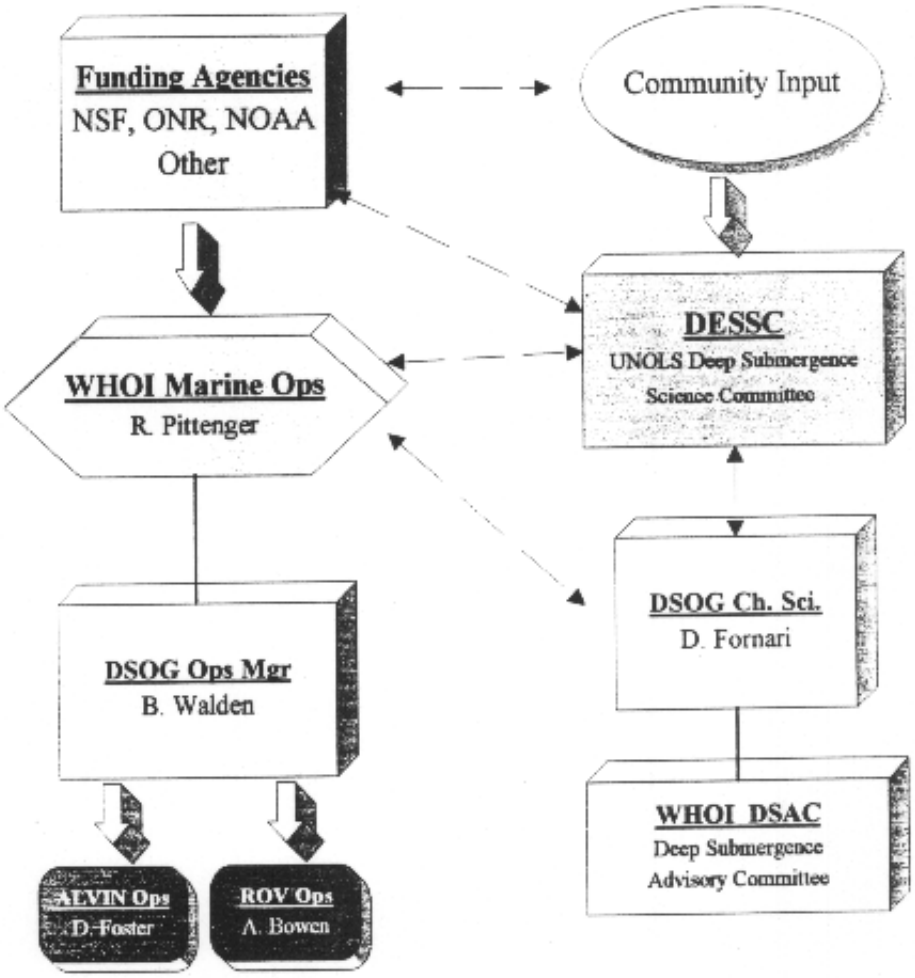
W.H.O.I. - OSS
(Operational Scientific Services)

- Marine Technicians (SSSG)
- Shipboard Data Management
- Shared Use Equipment
- Calibration Facilities
- Mooring/Rigging Shop
- Diving Program

DEEP SUBMERGENCE FACILITY

Functional Relationships

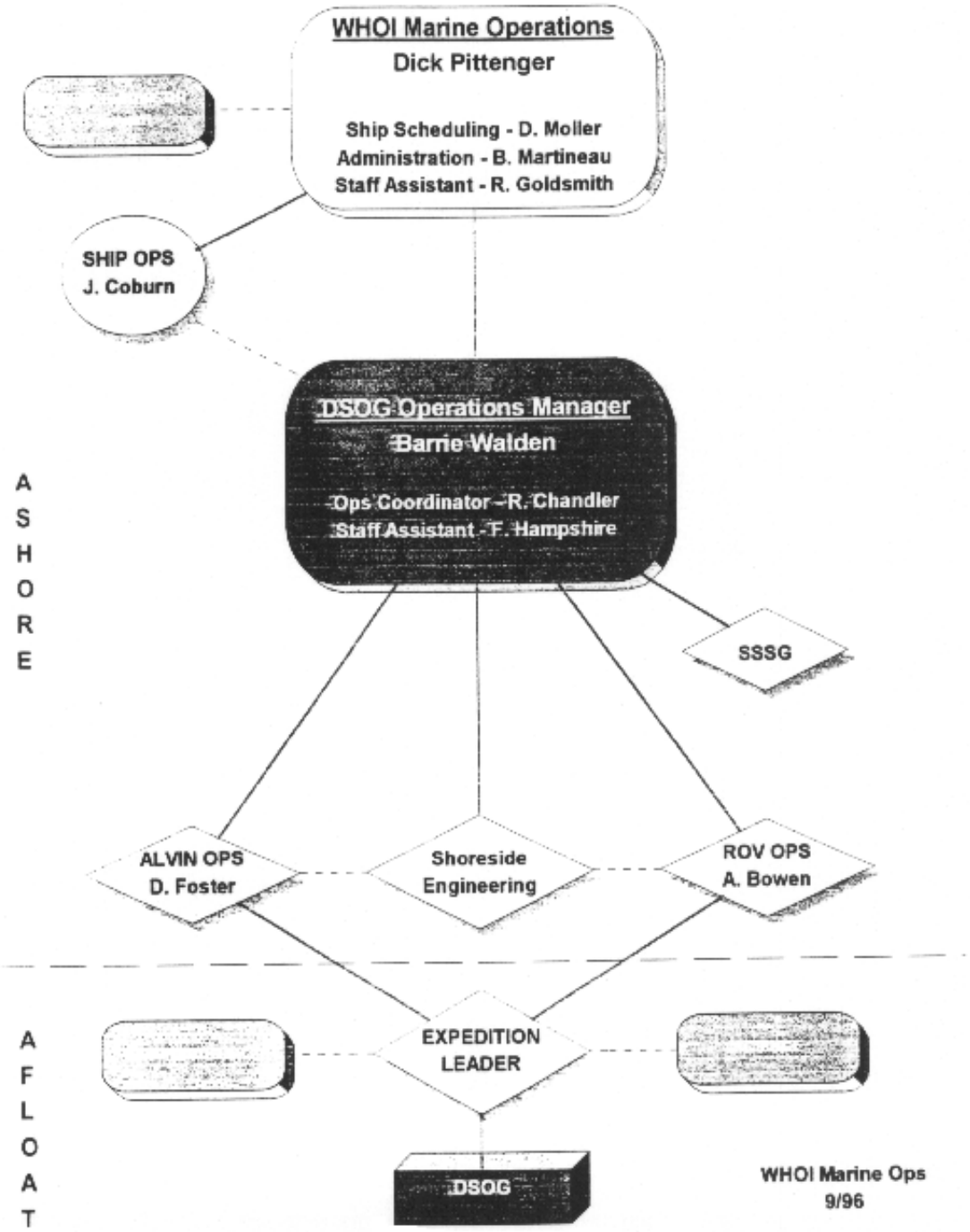
DESSC / WHOI / Funding Agencies



WHOI Marine Ops
9/96

NATIONAL DEEP SUBMERGENCE FACILITY

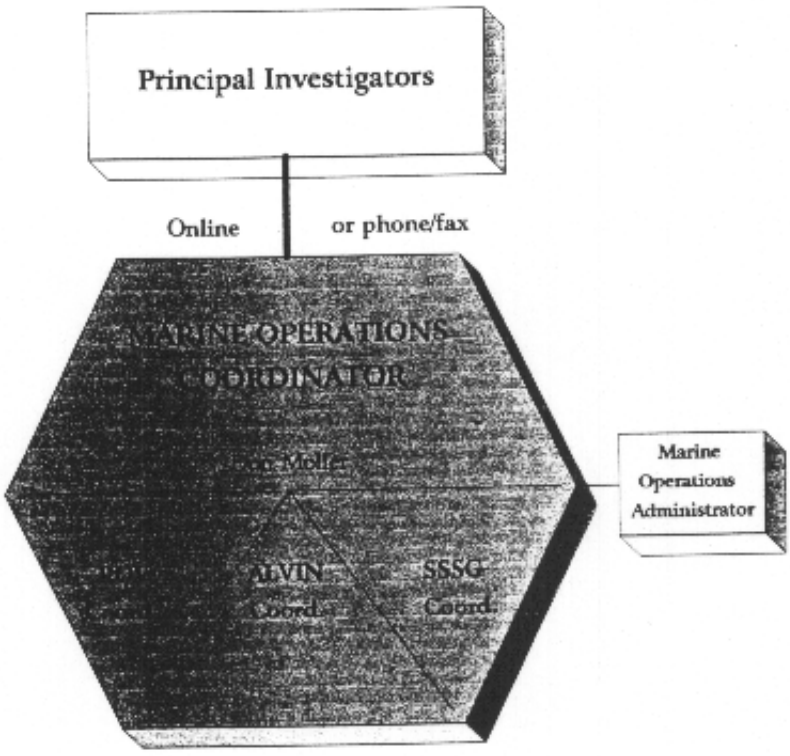
Personnel



WHOI MARINE OPERATIONS

Centralized

Cruise Preparation and Science Liaison



- SINGLE POINT OF CONTACT
- NO HAND OFFS -- Coordination stays with this office through all stages
  - -Planning
  - -Scheduling
  - -Mobilization
  - -De-mobilzation
  - -Billing

WHOI Marine Ops
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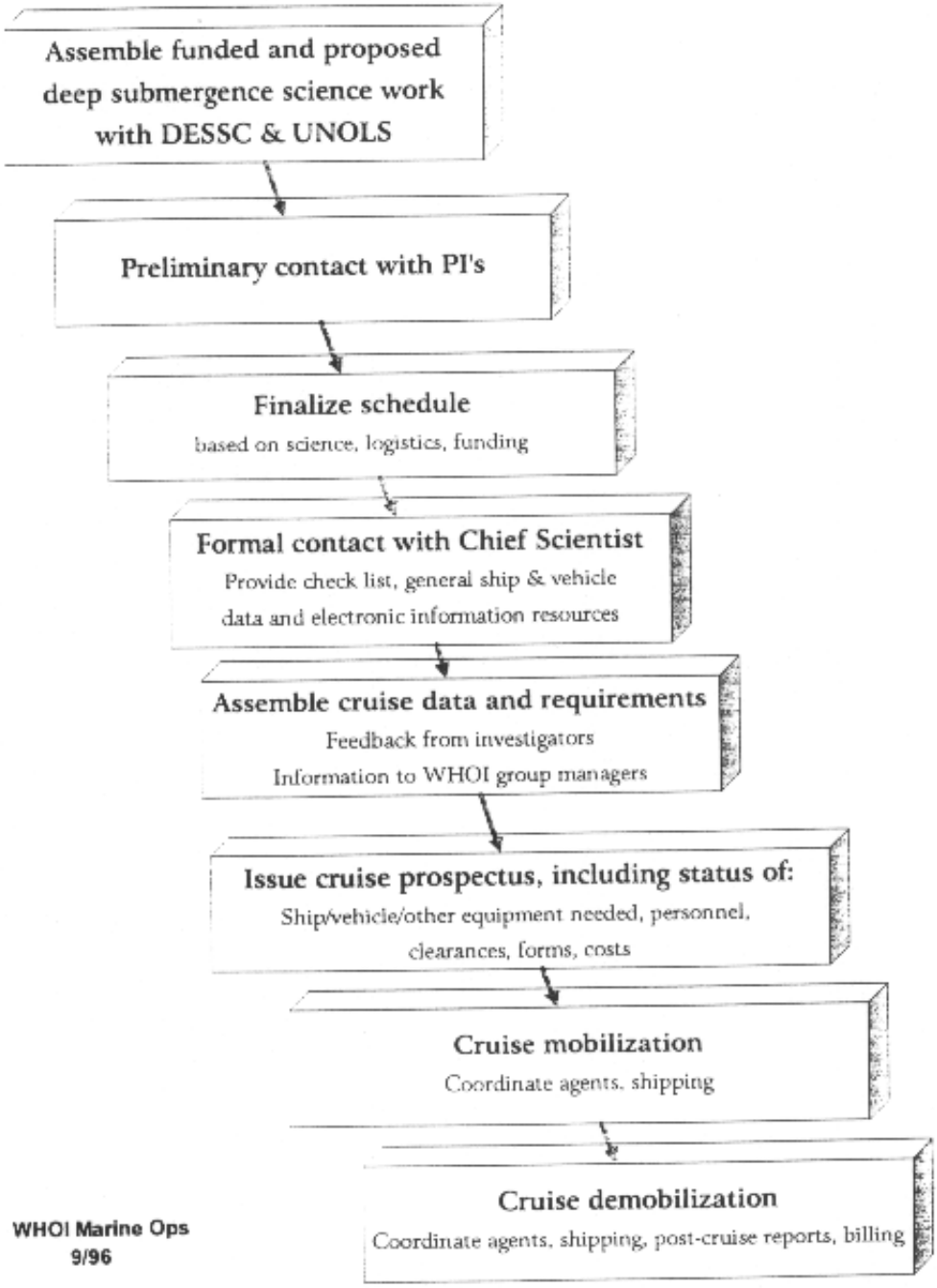
WHOI Marine Ops CRUISE PREP SEQUENCE



WHOI Marine Ops
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OPTIMUM INTEGRATED DSOG PERSONNEL REQUIREMENTS

Administrative Support (4)

Submersible Engineering & Operations Manager
Submersible Operations Coordinator
Marine Operations Administrator
Staff Assistant

Engineering Support (10)

ALVIN Project Leader
ROV Project Leader
Electrical Engineer (2)
Mechanical Engineer (2)
Structural/Drafting Engineer
Electrical Technician
Mechanical Technician
Computer Specialist/Programmer

Combined ATLANTIS Operations (12)

Expedition Leader
Electronics Technician (3)
Mechanical Technician (3)
Electrical Technician (2)
Navigator
Data Processor
Sonar Technician

Flyaway ROV Operations (19)

ALVIN/ATLANTIS	ROV/Other Ship
Expedition Leader	Expedition Leader
Electronics Tech (3)	Electronics Tech (2)
Mechanical Tech (3)	Mechanical Tech (2)
Electrical Tech (2)	Electrical Tech (2)
	Navigator
	Data Processor
	Sonar Tech

WHOI Marine Ops
9/96

OPERATING MODES

Operating Modes

Alvin* and ROVs on *Atlantis

- Pros: Most cost-effective, efficient asset utilization
- Cons: Limited geographic/temporal coverage

***Alvin* on *Atlantis*, ROVs infly-away mode**

- Pros: Extended geographic capability
- Cons:
  - More expensive
  - Harder on equipment and personnel
  - 2-3 month of ROV non-availability due to shipping in addition to actual ops

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Operation Models

A	=	Annual *Atlantis* Operating Cost	
a	=	Annual *Alvin* Operating Cost	= 1/2 A
r	=	Annual ROV Operating Cost	= 1/2 A
s	=	Annual *Alvin*/ROV Joint Operations Cost	= 2/3 A

- **Combined Ops on *Atlantis:***
  - **Assume ideal Schedule, 240-270 Operating Days**
  - **Six months A + a, three months A + a + r**

WHOI Cost = A + s = 1 2/3 A

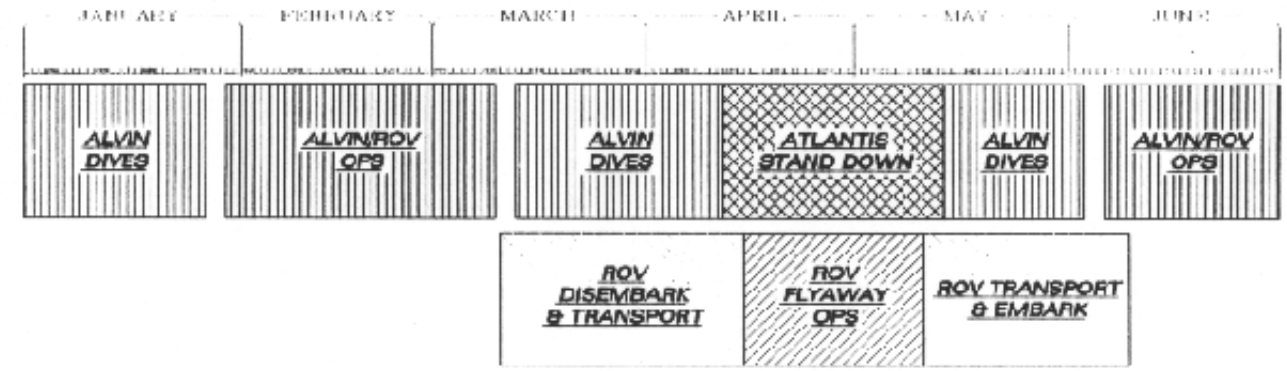
- **Independent ROV Ops:**

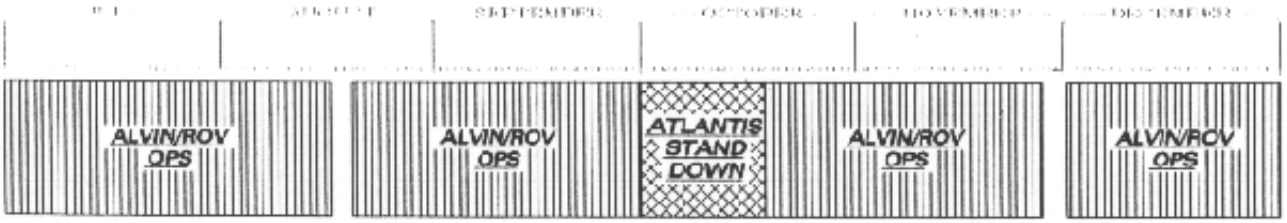
WHOI Cost = A + a + r = 2 A

- Plus -

- **Second Ship Cost**
- **Shipping from and back to *Atlantis***
- **Personnel Travel Costs**
- **Additional Manpower**

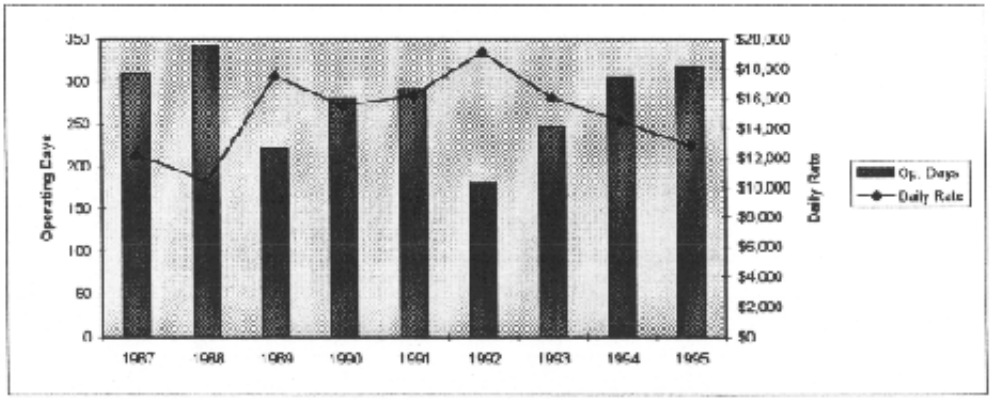
IDEALIZED SCHEDULE
R/V ATLANTIS, ROV & ALVIN OPERATIONS

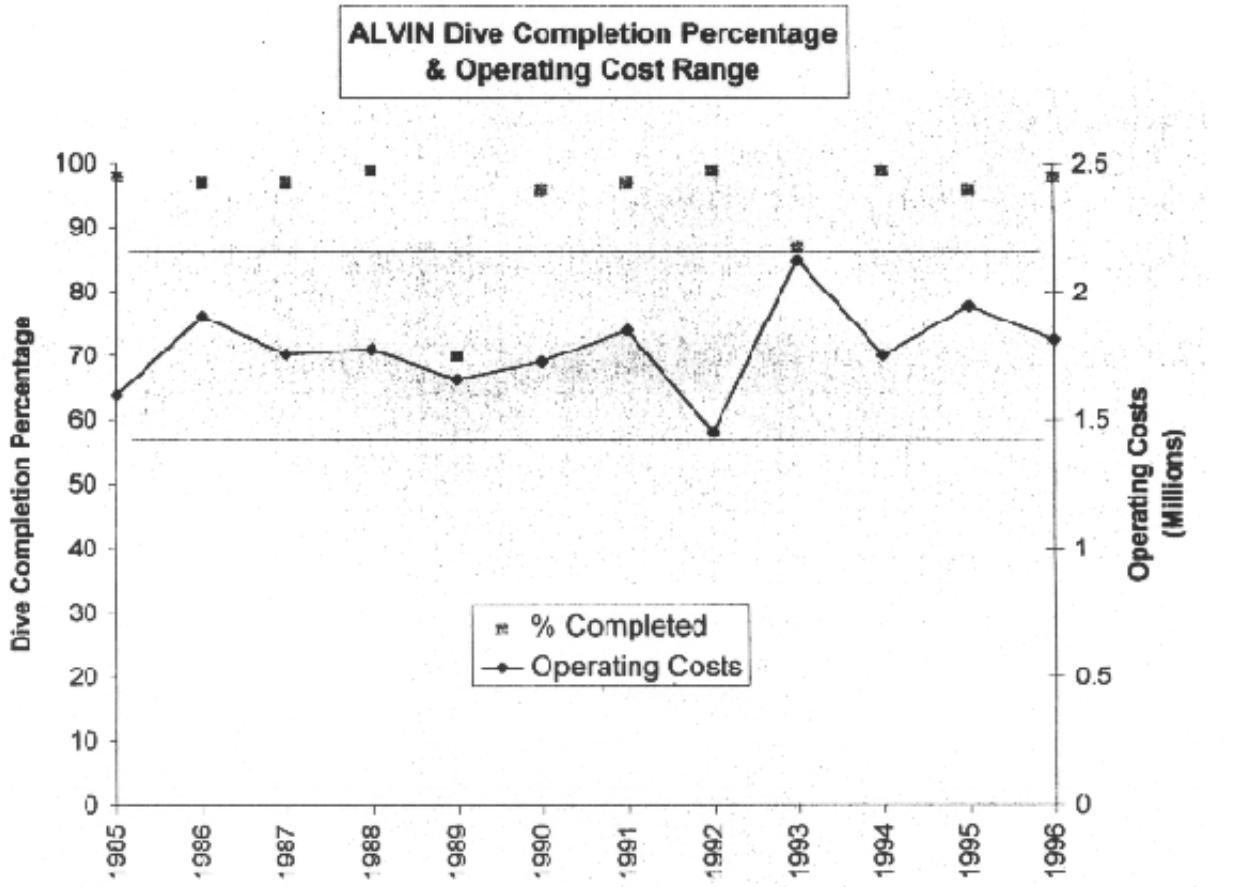




R/V Atlantis II
Yearly Costs

	1987 Actual	1988 Actual	1989 Actual	1990 Actual	1991 Actual	1992 Actual	1993 Actual	1994 Actual	1995 Actual
Op. Days	310	343	222	281	292	179	247	306	319
Days @ Sea	259	293	202	245	254	157	224	265	279
Daily Rate	$12,221	$10,580	$17,543	$15,551	$16,223	$19,167	$16,090	$14,440	$12,890
Total Costs	$3,788,596	$3,560,340	$3,894,546	$4,364,211	$4,737,116	$3,430,893	$3,974,344	$4,418,611	$4,092,790





WHOI Marine Ops
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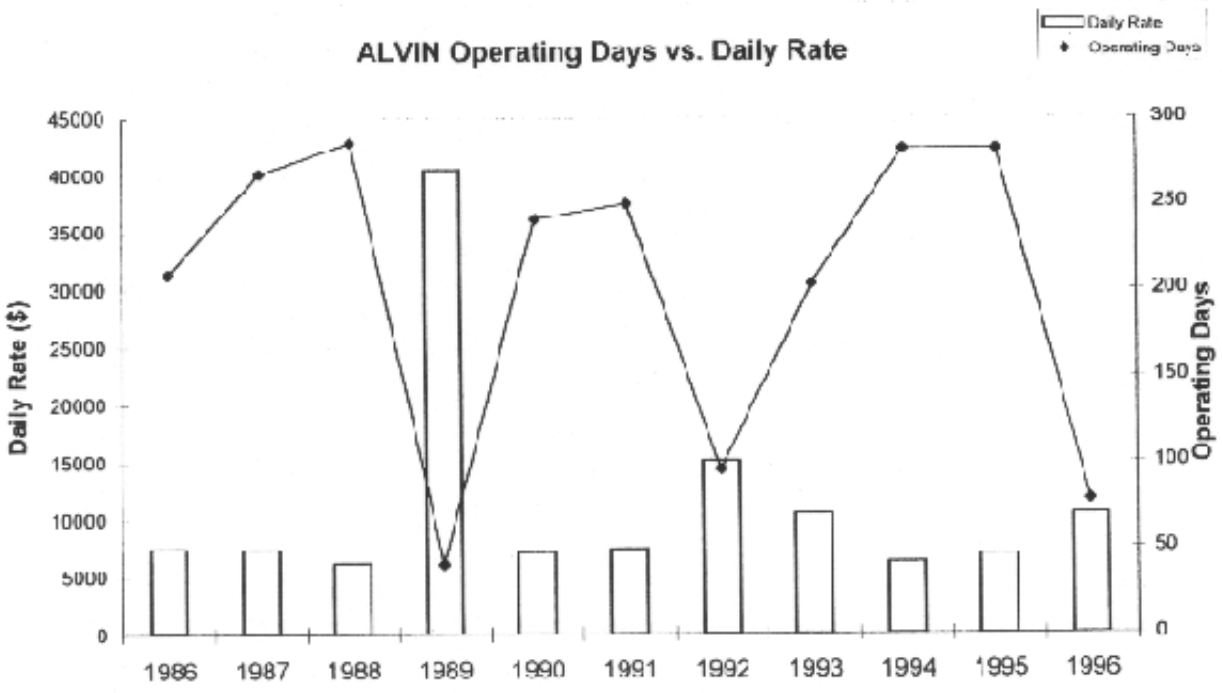

WHOI Marine Ops
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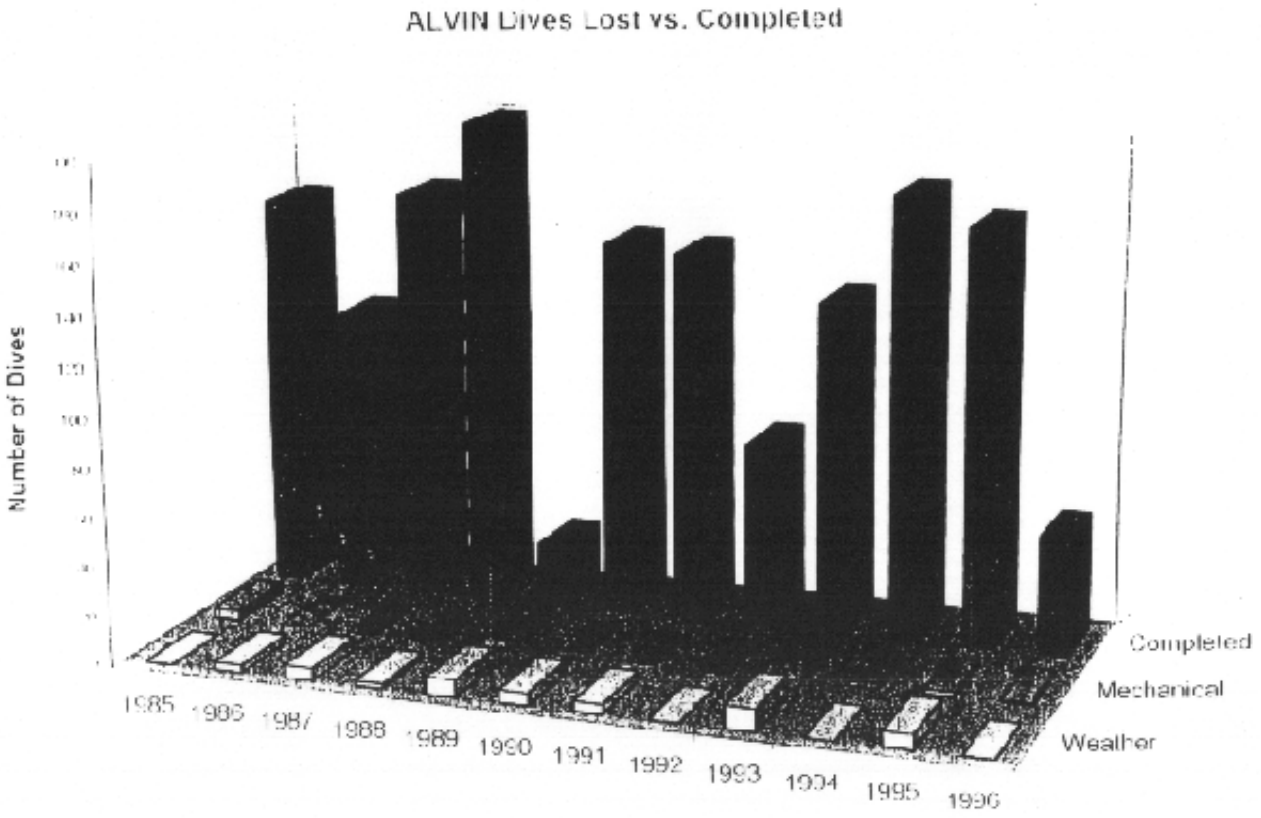
ALVIN Dives Lost vs. Completed
Number of Dives
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Completed
Mechanical
Weather

OPERATIONAL/MANAGEMENT ISSUES/POLICY

Integrated Facility Operational/Management Issues

Operational/Safety Issues/Policy

- *Alvin* crew rest periods are primary concern during joint Alvin - ROV/tethered vehicle operations.
- *Alvin* pilots require 24-hour period between suspension of ROV ops and commencement of *Alvin* dive ops.
- ROV/tethered vehicle equipment safety is also a key concern.
- Turn-around time of 24 hours is the established, initial figure for the interval between submersible operations and ROV/tethered vehicle lowerings.
- Switch-over times for ROV and tethered vehicles will depend on various operational and logistical issues are approximately as follows: *Jason to ARGO-II* and vice versa - 12-18 hours, DSL-120 sonar to either *Jason or ARGO-II* and vice-versa - 6-12 hours.
- Definition of deep submergence tool suite and general operational criteria and logistics must be defined during planning stage of field work by PI and DSOG. Because equipment and personnel will be tailored on a by-cruise-basis, it is not reasonable to assume that a tethered vehicle can be substituted for *Alvin* or another vehicle in the field (on the fly as it were).

Cost and Logistical Issues

- Advance planning and scheduling of deep submergence science programs are necessary for cost-effective, integrated deep submergence facility operations and efficient management of personnel.
- There are synergistic benefits to accrue from operating all National Facility vehicles on *R/V Atlantis* - for science programs and facility cost-effectiveness.
- There are some logistical and operational benefits to preserving fly-away mode of operations for ROV/tethered vehicles on other suitable UNOLS vessels.
- Projected operational models, facility costs, and scheduling impacts require well-established protocols between the Federal funding agencies, UNOLS and WHOI. Updating and revision of Memorandum of Understanding between the supporting agencies must accommodate to new integrated nature of the Facility and future projected operations.
- Adequate personnel/engineering support and long-range planning for facility vehicle/equipment upgrades should be factored into continued support for the National Deep Submergence Facility.