Review of Technical Studies
Polar Research Vessel

Presented to ARVOC

Arlington, VA

18 October 2005

Agenda

- Welcoming remarks – Rob Dunbar
- Introduction and project objectives for 2005 – Al Sutherland
- Documentation and justification of science and operational requirements – Jim Holik
- PRV mission sensitivity study – Jim St John
- PRV project timeline – Jim St John
- Interim results from 2005 technical studies – Jim St John/David Karnes

Welcoming Remarks

Introduction and Project Objectives for 2005

Documentation/Justification of Science/Operational Requirements

Initial Science and Operational Requirements Provided to Design Team

- Acoustic profiling including bottom mapping during icebreaking
- Towing of nets and instruments from the stern during icebreaking
- Conduct of Autonomous Underwater Vehicle (AUV) / Remotely Operated Vehicle (ROV) operations from a moon pool
- Geotechnical drilling through a moon pool
- Acoustically quiet
- Comply with International Maritime Organization (IMO) guidelines for Arctic vessels
- Accommodations for 50 scientists
- 80-day endurance
- Reduced air emissions from diesels and incinerator
- Enhanced icebreaking capability
- Helicopter hangar

Sources of Refinements to Requirements

- Input from series of ARVOC/SSC meetings in May 2003; June/July 2003; November 2003
- Poster sessions at Town Meetings held at AGU, December 2003; Ocean Sciences, January 2003
- Community Memo from ARVOC Chair
- Last input from ARVOC/SSC was November 2003

Refined Science and Operational Requirements

- Moon pool size reduced to 10’ by 15’ and relocated because drill rig and AUV/ROV should not be built in
- 80 day endurance defined as 20,000 NM @ 12 Knots in open water
- Accommodation for 50 scientists; minimum 3 single PI cabins
- Jumbo piston core capability for 50 meter core, using design under development by WHOI
- Endorsed concept of podded propulsors for station-keeping, towing in ice and maneuverability but further investigation necessary – EMI and reliability

Refined Science and Operational Requirements (Cont)

- ABS A3 (PC3) Classification: 4.5 feet level icebreaking at 3 knots; operations in Central Arctic Basin in Summer
- Box Keel for transducer placement gives superior ability to survey in ice
- Helicopter Hangar
- Reduced emissions (‘green’ vessel)
- Portable lab containers (2 on 01 deck and 3-4 on Main deck)

Refined Science and Operational Requirements (Cont)

- 8 ft wide passageway on main deck for palletized cargo handing; intra-deck elevator
- 2 microscope rooms; 2 environmental rooms
- Investigate gyro-stabilized platform/lab for microscopy, micro-balances and ultra-centrifuge
- Walk in freezer, 200 sq ft
- Improved container handing in holds
- Two point winch system for large otter trawls
- No ‘water-wings’

Science and Operational Requirements - Issues

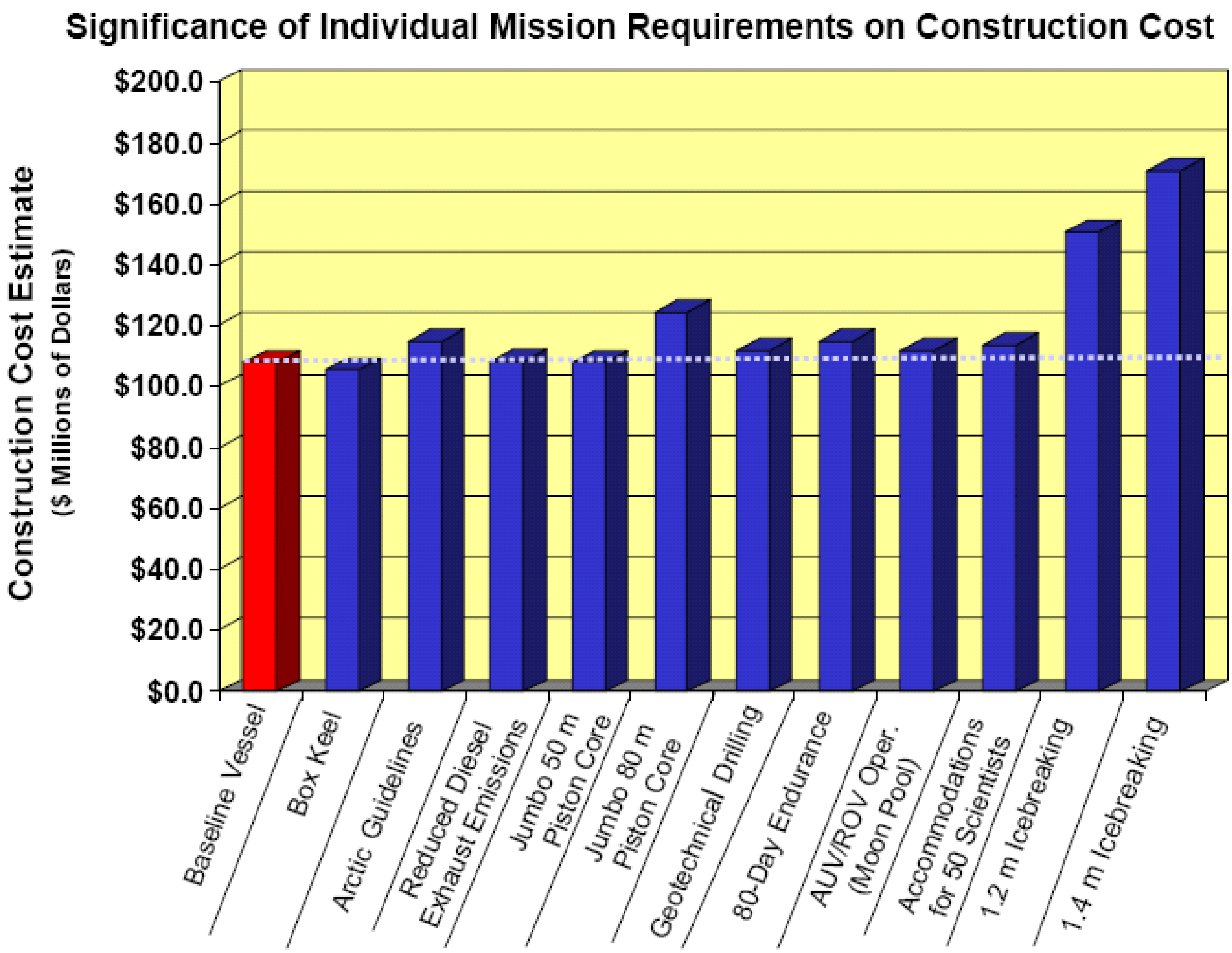
- Vessel delivery in 2012 could be adversely impacted with delays in defining scientific and operational requirements
- An initial set of “baseline” requirements should be established to assess one or more viable vessel options
- Activities of ARVOC in formulating and defining requirements unclear with pending NAS/PRB study

PRV Mission Sensitivity Study

- 2004 effort redirected to conduct a mission sensitivity study.
- Objective were to:
    - Study the cost associated with individual science requirements
    - Determine what drives ship cost

Construction Cost Sensitivity of Added PRV Mission Capabilities

BASELINE CAPABILITY (NATHANIEL B. PALMER CAPABILITIES PLUS ELECTRIC PODDED PROPULSION)		Added capability	Cost
• AFT WORKING DECK • 3 FT ICEBREAKING • SCIENCE WORKSHOP • WINCHES • CRANES • 37 SCENCTIFIC ACCOMMODATIONS • 60-DAY ENDURANCE • LABORATORIES • WORKBOAT • SONARS & ACOUSTICAL SYSTEMS • VAN STORAGE • HELICOPTER DECK AND STORAGE	→		= 100.0%
	+	ARCTIC GUIDELINES (Double Hull) & IMPROVED HULL FORM	= 106.4%
	+	SUPERIOR ACOUSTICAL FEATURES	= baseline
	+	BOTTOM MAPPING DURING ICEBREAKING WITH BOX KEEL	= 97.7%
	+	GEOTECHNICAL DRILLING	= 103.7%
	+	ICEBREAKING 4/4.5 FT	= 139.5% / 158.2%
	+	80-DAY ENDURANCE	= 106.5%
	+	AUV/ROV OPERATIONS THROUGH MOON POOL	= 103.4%
	+	REDUCED DIESEL EXHAUST EMISSIONS	= 100.3%
	+	GREATER LENGTH FOR 80 M JUMBO PISTON CORING	= 115.5%
	+	50 SCIENTIFIC ACCOMMODATIONS	= 105.1%
	+	IMPROVED TOWING OF NETS AND INSTRUMENTATION	= baseline


Significance of Individual Mission Requirements on Construction Cost
Construction Cost Estimate
($ Millions of Dollars)
$200.0
$180.0
$160.0
$140.0
$120.0
$100.0
$80.0
$60.0
$40.0
$20.0
$0.0
Baseline Vessel
Box Keel
Arctic Guidelines
Reduced Diesel Exhaust Emissions
Jumbo 50 m Piston Core
Jumbo 80 m Piston Core
Geotechnical Drilling
80-Day Endurance
AUV/ROV Oper. (Moon Pool)
Accommodations for 50 Scientists
1.2 m Icebreaking
1.4 m Icebreaking

Selected Mission Options with 3 ft Icebreaking

	Level icebreaking	Box keel	Reduced diesel emissions	Length for 50 m jumbo piston core	50 science accommodations	80 days endurance	SHALDRIL capable	Expanded moon pool	Double hull	Length for 80 m jumbo piston core	Cost ($M)	% of baseline cost	% of 3 ft baseline cost
baseline	3 ft	○	○	○	○	○	○	○	○	○	107.9	100%	100%
	3 ft	●	●	●	○	○	○	○	○	○	105.7	98%	98%
	3 ft	●	●	●	●	○	○	○	○	○	111.4	103%	103%
	3 ft	●	●	●	○	●	○	○	○	○	113.0	105%	105%
	3 ft	●	●	●	○	○	●	○	○	○	109.8	102%	102%
	3 ft	●	●	●	○	○	○	●	○	○	109.8	102%	102%
	3 ft	●	●	●	○	○	○	○	●	○	112.5	104%	104%
	3 ft	●	●	●	●	●	○	○	○	○	118.8	110%	110%
	3 ft	●	●	●	●	●	●	○	○	○	122.6	114%	114%
	3 ft	●	●	●	●	●	●	●	○	○	126.8	117%	117%
	3 ft	●	●	●	●	●	●	●	●	○	135.0	125%	125%
	3 ft	●	●	●	●	●	●	●	●	●	136.9	127%	127%

○ = feature not selected ● = feature selected

Selected Mission Options with 4 ft Icebreaking

	Level icebreaking	Box keel	Reduced diesel emissions	Length for 50 m jumbo piston core	50 science accommodations	80 days endurance	SHALDRIL capable	Expanded moon pool	Double hull	Length for 80 m jumbo piston core	Cost ($M)	% of baseline cost	% of 3 ft baseline cost
baseline	4 ft	○	○	○	○	○	○	○	○	○	150.6	100%	140%
	4 ft	●	●	●	○	○	○	○	○	○	147.0	98%	136%
	4 ft	●	●	●	●	○	○	○	○	○	152.5	101%	141%
	4 ft	●	●	●	○	●	○	○	○	○	155.7	103%	144%
	4 ft	●	●	●	○	○	●	○	○	○	150.4	100%	139%
	4 ft	●	●	●	○	○	○	●	○	○	152.5	101%	141%
	4 ft	●	●	●	○	○	○	○	●	○	154.5	103%	143%
	4 ft	●	●	●	●	●	○	○	○	○	161.3	107%	149%
	4 ft	●	●	●	●	●	●	○	○	○	164.8	109%	153%
	4 ft	●	●	●	●	●	●	●	○	○	170.1	113%	158%
	4 ft	●	●	●	●	●	●	●	●	○	178.9	119%	166%
	4 ft	●	●	●	●	●	●	●	●	●	178.9	119%	166%

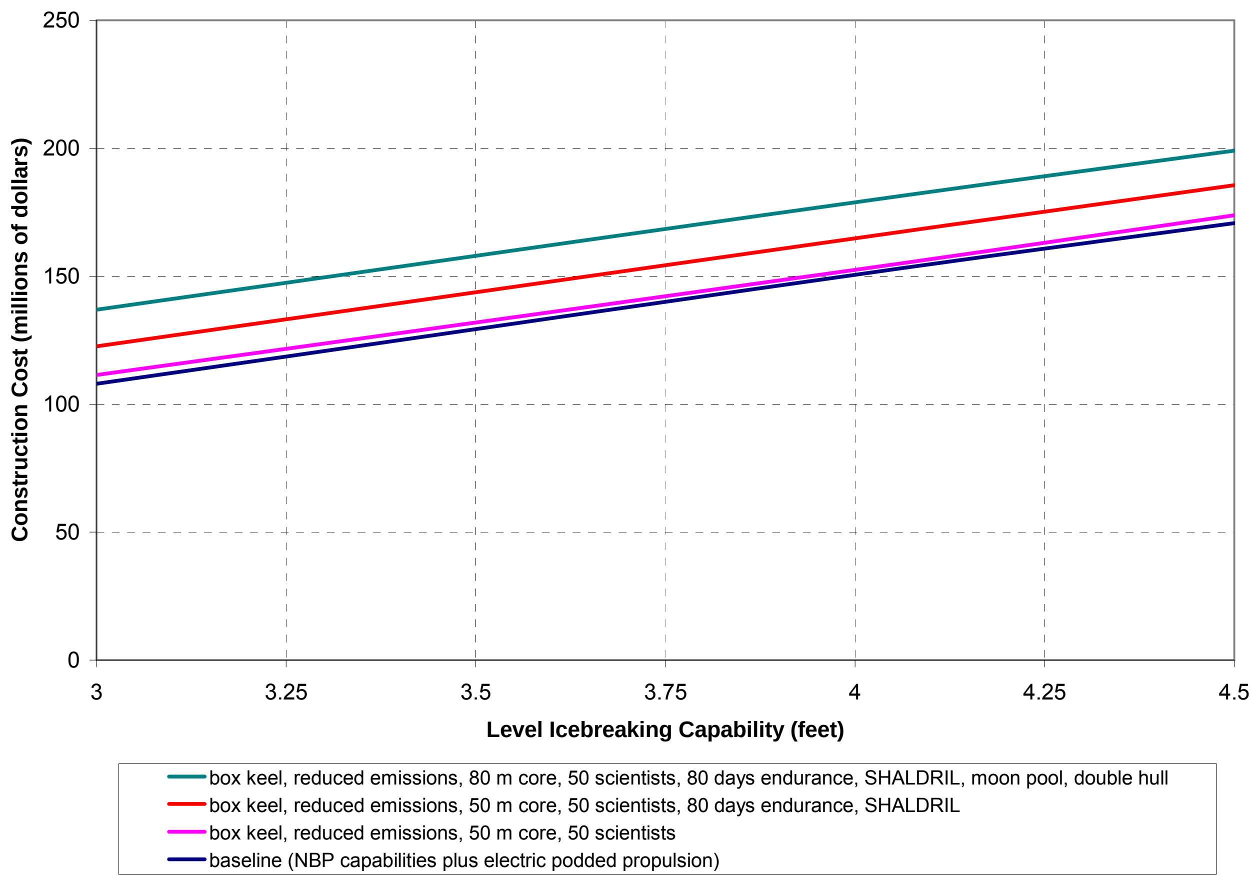
○ = feature not selected ● = feature selected

Selected Mission Options with 4.5 ft Icebreaking

	Level icebreaking	Box keel	Reduced diesel emissions	Length for 50 m jumbo piston core	50 science accommodations	80 days endurance	SHALDRIL capable	Expanded moon pool	Double hull	Length for 80 m jumbo piston core	Cost ($M)	% of baseline cost	% of 3 ft baseline cost
baseline	4.5 ft	○	○	○	○	○	○	○	○	○	170.8	100%	158%
	4.5 ft	●	●	●	○	○	○	○	○	○	168.3	99%	156%
	4.5 ft	●	●	●	●	○	○	○	○	○	173.8	102%	161%
	4.5 ft	●	●	●	○	●	○	○	○	○	176.6	103%	164%
	4.5 ft	●	●	●	○	○	●	○	○	○	171.6	100%	159%
	4.5 ft	●	●	●	○	○	○	●	○	○	173.1	101%	160%
	4.5 ft	●	●	●	○	○	○	○	●	○	176.0	103%	163%
	4.5 ft	●	●	●	●	●	○	○	○	○	182.2	107%	169%
	4.5 ft	●	●	●	●	●	●	○	○	○	185.5	109%	172%
	4.5 ft	●	●	●	●	●	●	●	○	○	190.2	111%	176%
	4.5 ft	●	●	●	●	●	●	●	●	○	199.1	117%	184%
	4.5 ft	●	●	●	●	●	●	●	●	●	199.1	117%	184%

○ = feature not selected ● = feature selected

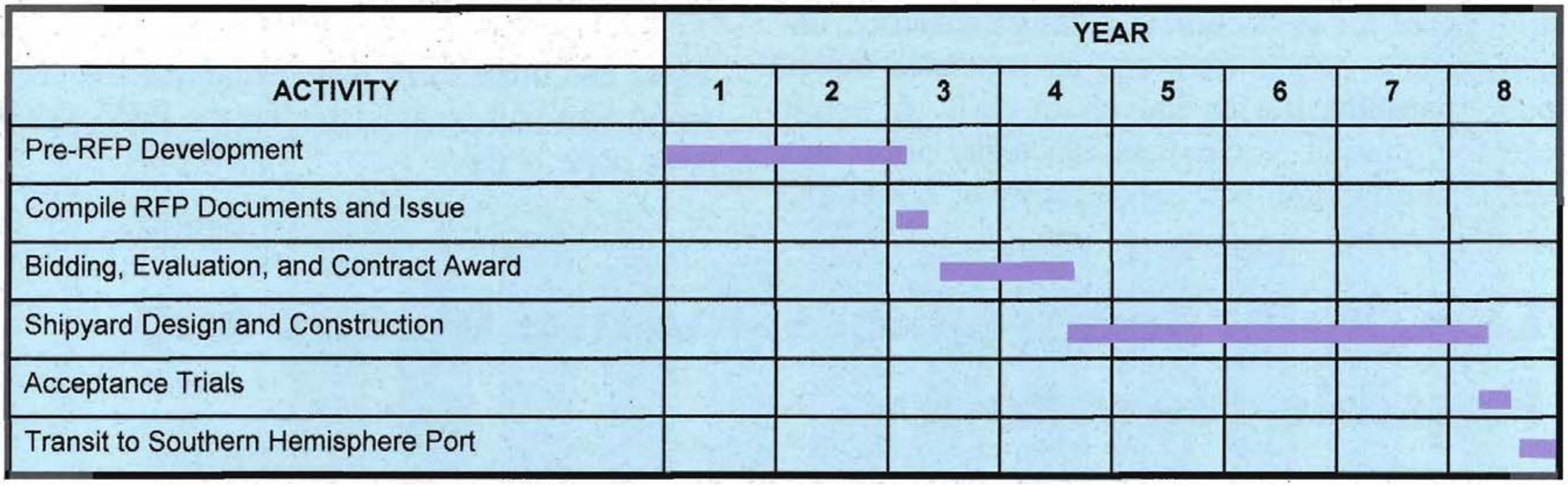
Construction Cost for Selected Mission Capabilities



Sensitivity Study Conclusions

- The selection of 1.4 m icebreaking capability provides a large ship where many of the other features can be incorporated at no additional cost.

PRV Project Timeline



Interim Results from 2005 Technical Studies

- Principal vessel characteristics
- Ship performance characteristics
- Cabin alternative arrangements
- Arrangement drawings
- Propulsion machinery
  - diesel electric
  - alternative propulsors
- Summary of efforts
- Next step
  - feedback on technical studies
  - completion of 2005 effort

Principal Vessel Characteristics

- Length Overall 115.3 m (378.4 ft)
- Length, Water Line 103.9 m (340.9 ft)
- Beam 22.7 m (74.5 ft)
- Draft 9.0 m (29.6 ft)
- Displacement 11,200 MT (11,000 LT)
- Propulsive Horsepower - total, both podded propulsors 16.8 MW (22,400 HP)

Ship Performance Characteristics

- Icebreaking performance
  - 4.5 ft (1.4 m) at 3 kt continuous
- Open water performance
  - Cruising speed 12 kt
  - Maximum speed 17.6 kt

Cabin Alternative Arrangements

- criteria and standards
- arrangement alternatives
- overall arrangements

Cabin Criteria & Standards

Two Person

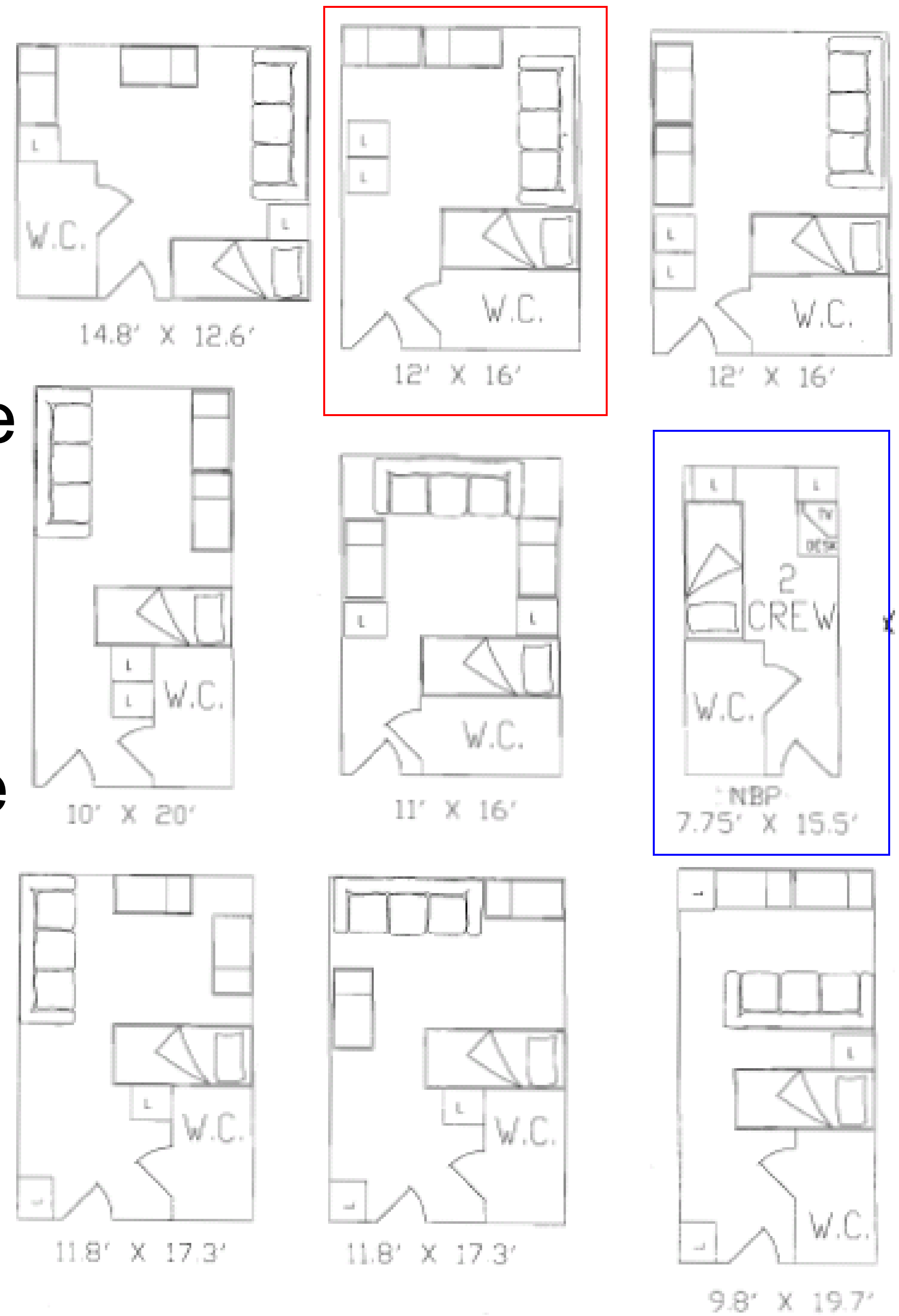
- Bottom berth to have drawers below
- Upper berth to be of Pullman type that can folded against the bulkhead
- Berths to be in fore and aft direction
- Berths have draw curtains to close off light
- Desks for two with two chairs, one phone, and various electrical outlets including LAN, and others (consider extra lighting at desk)
- Two clothing lockers for bulk clothing such as Polar outdoor clothing
- Lockers or other suitable location for two life preservers
- Lockers suitable to hang clothes and some drawers
- Head for two occupants of room

Cabin Criteria & Standards

Two Person

- Carpeting on floor
- Porthole in each stateroom with Plexiglas sheet covering to act as insulator
- Stateroom door to have kick-out panel and lockable
- Eight foot high ceiling
- Electrical outlets suitable for vacuum cleaner
- Flat panel TV monitor suspended from ceiling
- Optional features for some alternative arrangements
  - Two person settee
  - Coffee table
  - Shelving at bed
  - Lighting in bed

- Several alternative two person cabins are shown and compared to a standard cabin on NBP (blue)
- Selected cabin for the arrangement is highlighted in red



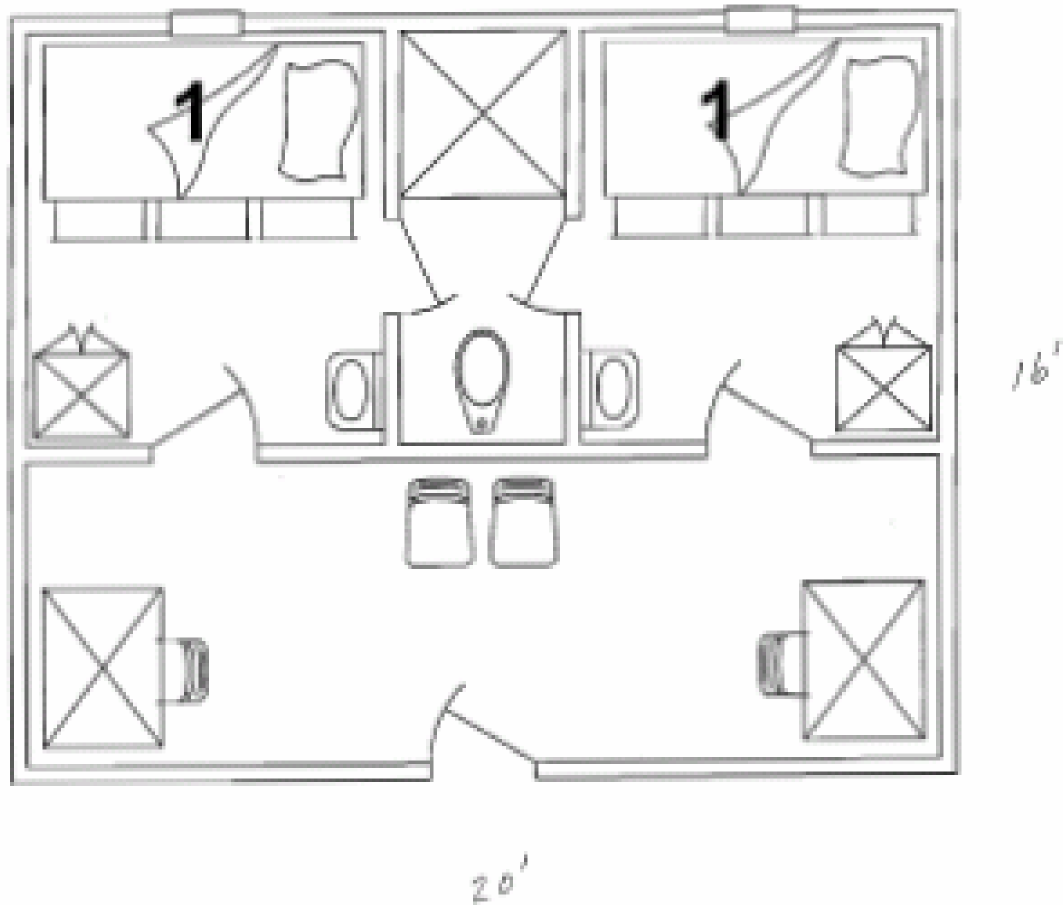
Cabin Criteria & Standards

One Person with Day Room

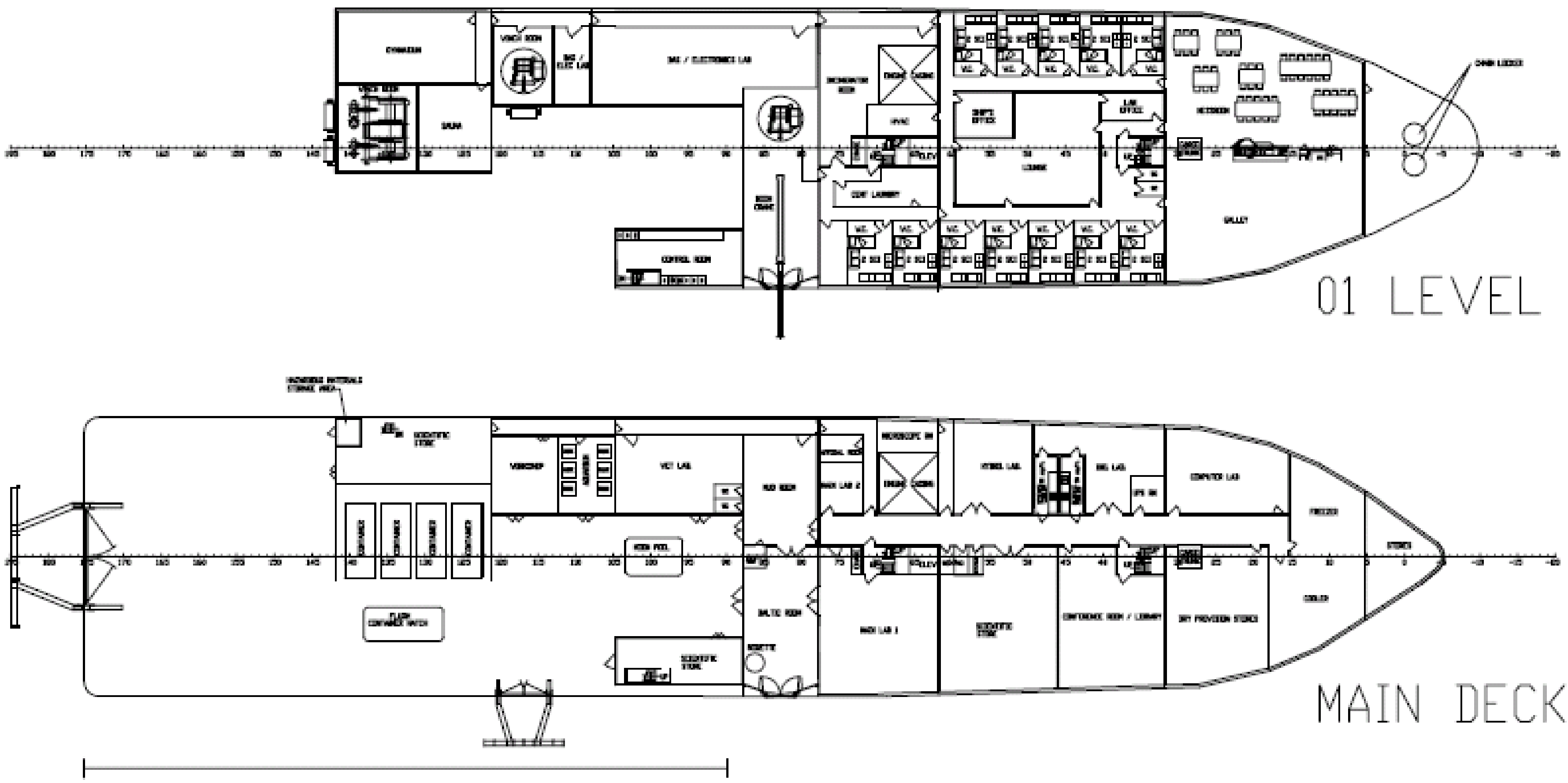
- Stateroom
  - i. Single bunk under porthole
  - ii. Head
  - iii. Locker
  - iv. Phone next to bed
  - v. Shelving next to bed
- Day-room
  - i. Desk with special lighting and chair
  - ii. Phone at desk with other electrical outlets
  - iii. Table with wrap around seating
  - iv. File cabinet
  - v. Other items associated with day-cabin

Cabin Arrangement Alternatives

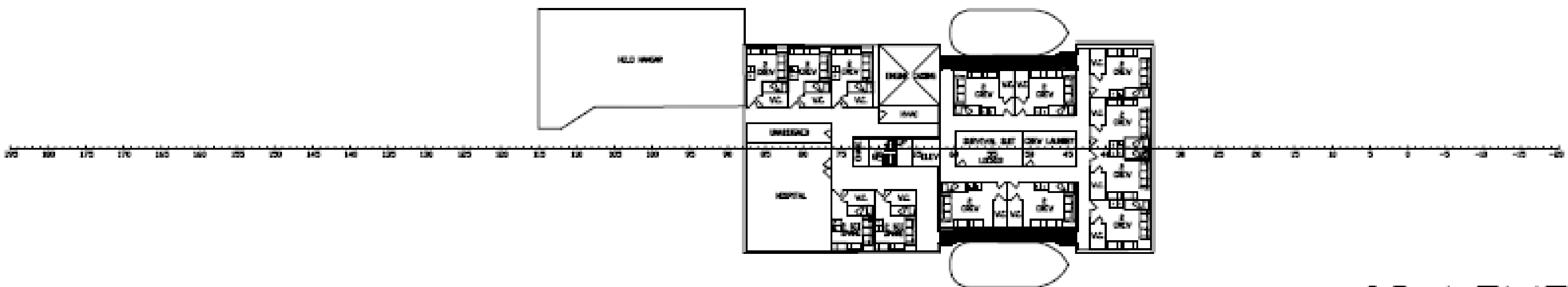
Single room with shared head and desk area
Area = 160 sq. ft. per berth



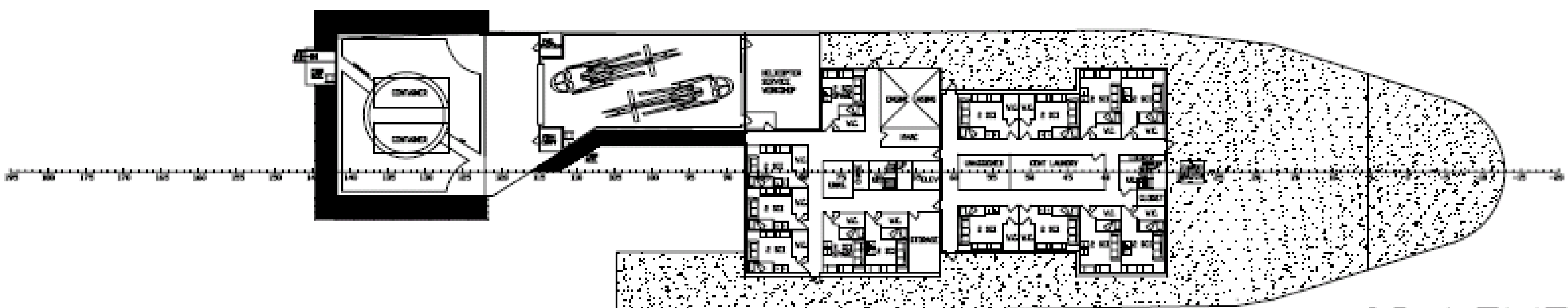
Arrangement Drawings



Arrangement Drawings

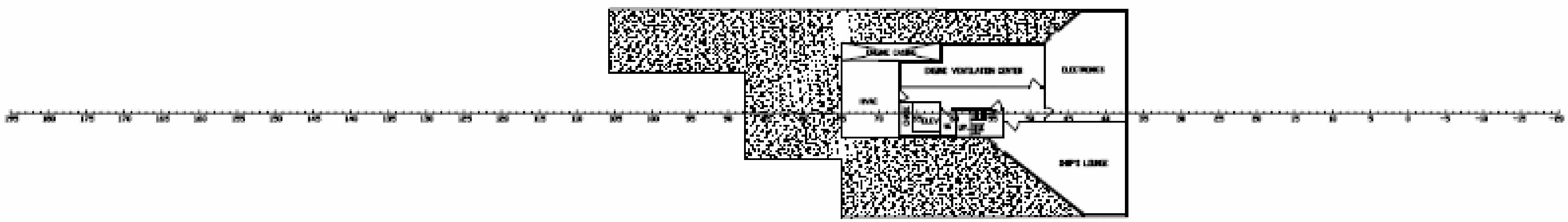


03 LEVEL

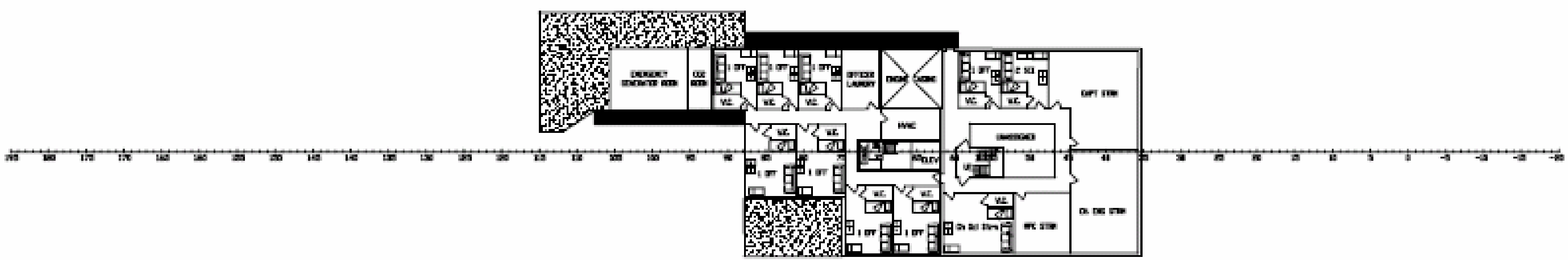


02 LEVEL

Arrangement Drawings

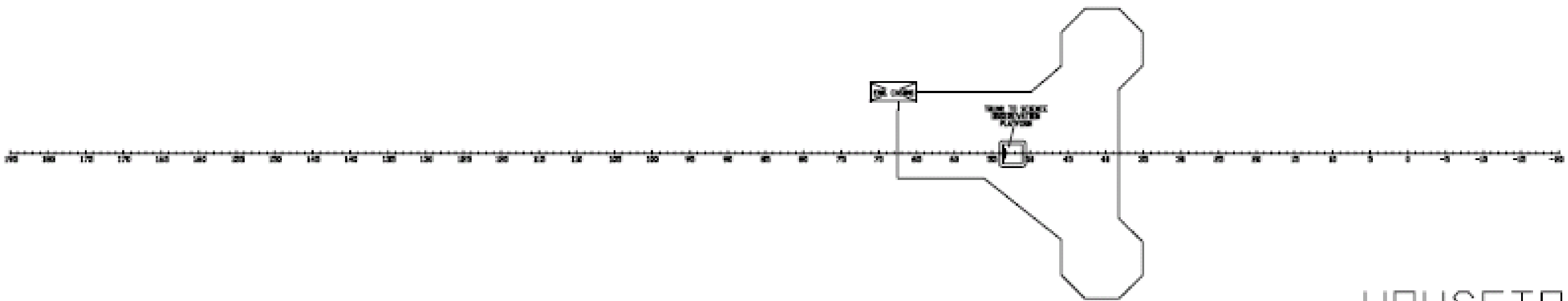


05 LEVEL

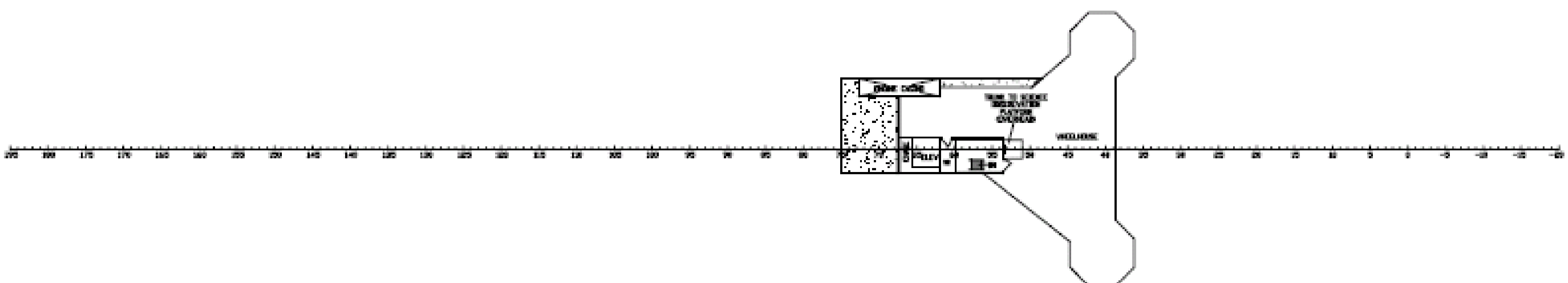


04 LEVEL

Arrangement Drawings



HOUSETOP



06 LEVEL

Propulsion Machinery
Diesel Electric Selected

- Multiple generators produce power
- Common bus – all equipment powered by the same set of generators
- Excellent torque characteristics for operation in ice
- Quiet operation
- Flexible plant for varying loads
- Motor generators for clean power

Propulsion Machinery
Alternative Propulsors Considered

- Podded propulsors
    - Azipod – open propeller & motor in pod
    - Mermaid – open propeller, motor in ship & Z drive
    - Aquamaster – nozzle, motor in ship & Z drive
    - Siemans-Schottel – open propellers on both ends (Counter-rotating) & motor in the pod
- Conventional propulsion
    - Twin propellers, shafts and motors in the hull with conventional rudders and skegs
    - Slight increase in length with this alternative

Summary of Output

- Documentation and justification for science and operational requirements
- Vessel dimensions and characteristics that satisfy the requirements
- Lines plan, hydrostatics, and stability
- Outboard profile and deck plans
- Standard scientist cabin plan
- Construction cost estimate
- Initial set of vessel specifications based on feasibility studies

The Next Step

- ARVOC provides feedback on technical studies
- MARAD/STC completion of 2005 effort

Closing Remarks/Adjourn