Polar Research Vessel
Operational Requirements and
Summary of Technical Studies

Presentation to UNOLS
by Jim St John

Science and Technology Corporation - Polar Technology Office
Why a New Antarctic Research Vessel?

- National need to expand global warming studies in polar regions
- Global climate change models point to southern oceans as critical component
- Lease of existing research vessel expires in 2012
- Scientific facilities and capabilities insufficient aboard existing research vessel

*Nathaniel B. Palmer* in ice
Statement of Work

• Translate a set of science and operational requirements into criteria for the PRV taking into account the experience gained by U.S. and foreign vessels engaged in polar research

• Perform a feasibility study of the vessel in sufficient detail to arrive at a ship size, general arrangement drawings and a cost estimate

• The work will be done in conjunction with a science oversight committee
Science and Operational Requirements
Critical New Research Requirements

• Enhanced icebreaking capabilities 1.4m (4.5 ft) at 3 kts
• Increased endurance (to 80 days) and 20,000 miles at 12kts
• Increased accommodations (for 50) and lab space
• Moon pool for geotechnical drilling - provides access to the water column through a controlled interface (no ice, limited surge, and turbulence)
• Ability to tow nets and research instrumentation from the stern during icebreaking
• Acoustically quiet
• Hull form designed for the installation of bottom mounted sensing instruments and operation during icebreaking
ANTARCTICA - Desired Enhanced Performance

- Minimum Sea Ice Extent (multiyear ice)
- Maximum Sea Ice Extent
- First Year Sea Ice
- Problematic Sea Ice Areas for NBP
- Minimum Sea Ice Extent (multiyear ice)
Additional Science and Operational Requirements

- Capability to conduct autonomous underwater vehicle remotely operated vehicle (AUV/ROV) operations
- Jumbo piston coring (JPC) capacity for 50 m
- Compliance with International Maritime Organization (IMO) guidelines for Arctic vessels
- Reduced air emission from diesel engines and incinerator and other features for a “greener” ship
- Provision for a helicopter flight deck and hangar
- Space for 6 portable lab containers
- 2.4 m (8 ft) wide passageway on the Main Deck and inter-deck elevator
- Aloft, enclosed platform for science observations
<table>
<thead>
<tr>
<th>Location</th>
<th>ABS A2</th>
<th>IACS PC4/5</th>
<th>ABS A3</th>
<th>IACS PC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arctic Offshore Shelf</td>
<td>Independently August through October</td>
<td>PC4: Year-round operation in thick first-year ice (1.2 to 2.0 m) which may include old ice inclusions</td>
<td>Independently July through December</td>
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<tr>
<td>Central Arctic Basin</td>
<td>Independent operation not allowed</td>
<td>PC5: Year-round operation in medium first-year ice (0.7 to 1.2 m) which may include old ice inclusions</td>
<td>Independently July through September for short term, short distance</td>
<td>Year-round operation in second-year ice which may include multi year ice inclusions.</td>
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<tr>
<td>Antarctic</td>
<td>Independently March through April</td>
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<td>Independently February through May</td>
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<td></td>
<td>NBP operates independently all year in first-year ice</td>
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<td>PRV can operate independently all year in first-year ice and enter areas with second year ice</td>
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<tr>
<td>Activity</td>
<td>Days</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---------------------------------------------------</td>
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<td></td>
<td></td>
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<tr>
<td>Science operations away from port and in-transit</td>
<td>265</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>In-port preparations for science operations</td>
<td>35</td>
<td></td>
<td></td>
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<tr>
<td>Repair and maintenance</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Total Days</strong></td>
<td><strong>365</strong></td>
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Results from Project Technical Studies
Special Technical Studies

1. Towing in ice – seismic operations and nets. Recommend a hull form, stern arrangement, and propulsion system that improves towing in ice.

2. Bathymetry in ice – Recommend a hull form and appendages that promote improve ice management and reduce bubble sweep down over the acoustic windows for the multi-beam swath bottom mapping system, sub-bottom profilers, ADCP, fish finding sonars and other acoustic sensors.

3. Geotechnical drilling – Recommend a hull form, propulsion system, thruster system, and drilling arrangement for shallow water drilling in land, fast ice and open water.

4. Establish requirements for a moon pool to deploy and recover ROVs and AUVs in ice and consider CTD/rosette deployment through the moon pool.

5. Evaluate increased icebreaking capability and evaluate one or more propulsion concepts to satisfy mission requirements and develop recommendation.

6. Examine compliance with new IMO requirements for Arctic vessels including provision for no pollutants carried directly against the outer shell.

7. Investigate and recommend an approach to improve the ship’s self-generated noise signature to improve scientific acoustic sensor performance.

8. Analyze and recommend an approach on methods to reduce emissions from diesel engines and the incinerator.
Podded Propulsion

• MV Botnica showing the clear track achievable with podded propulsion systems
Podded Propulsion System

- Direct drive diesels are hard to fit into a ship with a large moon pool – electric plant provides flexibility
- Diesel generators can be “floated” on isolation mounts for low noise/vibration
- Twin azimuthal propulsors give greater maneuverability in ice and open water station keeping
- However other viable alternatives still are under consideration
Underwater view of PRV box keel with bottom mapping sensors
Environmental Features Incorporated in PRV

- Rate of greenhouse emissions reduced by 90% compared to existing vessel
- No emissions in port; PRV connects to shore side electric power (cold ironing)
- In addition:
  - Designed for 40-year ship life and environmentally friendly disposal
  - Waste water and waste oil treated to highest international standards
  - Environmental management system on-board and ashore
- Improved hull form reduces energy by 20%
- Double hull construction minimizes risk of oil spill
- Employs latest ballast water exchange and treatment technology
- Hull coated with non-toxic paint
Sensitivity Studies

Added Science Mission Capability

Cost
($ Millions of Dollars)

Baseline
Box Keel
Arctic Guidelines (Double Hull)
Reduced Diesel Exhaust Emissions
Jumbo 50m Piston Core
Jumbo 80m Piston Core
Geotechnical Drilling
80-Day Endurance
AUV/ROV Op. (Moon Pool)
50 Scientists Accommodations
1.2m Icebreaking
1.4m Icebreaking

Added Science Mission Capability
Enhanced Capability and Features of New Generation Polar Research Vessel

- 62% increase in displacement
- 79% increase in shaft power
- 50% increase in icebreaking capability
- 128% increase in space available for laboratories
- 32% increase in accommodations for scientists
- 33% increase in endurance
- 69% increase in construction cost
- 50% increase in design service life of vessel
How did the Planned PRV Procurement Differ from the NBP

• NBP procurement had limited design guidance in the RFP technical specifications and bidders were to submit competing designs at all levels of detail including science spaces

• The PRV procurement would contain significantly more details in the specification, including a conceptual design of the vessel and guidance drawings of laboratory spaces that reflect the preferences of the science community
## Project Timeline

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>YEAR</th>
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<tbody>
<tr>
<td>Pre-RFP Development</td>
<td>1</td>
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<tr>
<td>Compile RFP Documents and Issue</td>
<td>2</td>
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<tr>
<td>Bidding, Evaluation, and Contract Award</td>
<td>3, 4</td>
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<tr>
<td>Shipyard Design and Construction</td>
<td>5, 6</td>
</tr>
<tr>
<td>Acceptance Trials and Final Outfitting</td>
<td>7</td>
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<tr>
<td>Transit to Southern Hemisphere Port</td>
<td>8</td>
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Above water features of PRV
Features of Main Deck and 01 Level

- Combined moon pool and Baltic room with 22 ft deck height
- Control room overlooks moon pool and boom crane
- 8 ft-wide corridor through laboratory spaces
- Garage door between Baltic room and starboard-side deck
- Removable lower section of geo-tech drill rig
- 01 Level winches service moon pool, starboard A-frame and boom crane
- Dedicated microscope room
Two-Person Science Cabin

- Water Closet
- Berths
- Settee
- Desks
- Lockers
Principal Characteristics

- LOA: 115 m
- LWL: 104 m
- Beam: 23 m
- Draft: 9 m
- Displacement: 11,200 LT
- Propulsive horsepower: 16,700 kW (total, twin propellers)