Feasibility-level Design of New Generation Polar Research Vessel (PRV)

May 1, 2003
Introductory Remarks

• NSF long-term objectives
• NSF near-term objectives
• Role of Maritime Administration
Presentation Overview

- Some project management issues
- Project overview
- Visit to Baltic icebreakers and AWI
- Feasibility-level design begins
Management Issues
How the PRV procurement activity is different 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.

This PRV procurement will contain significantly more details in the specification, including guidance drawings that reflect the preferences of the science community.
Project Organization for Polar Research Vessel (PRV)

- **National Science Foundation (NSF)**
  - PRV Project Manager
  - Al Sutherland

- **Technical Manager**
  - U.S. Maritime Administration (MARAD)
  - Richard Voelker

- **Procurement and Science Manager**
  - Raytheon Polar Services Corporation (RPSC)
  - Jim Holick

- **Design Agent**
  - Science and Technology Corporation

- **Antarctic Research Vessel Oversight Committee (ARVOC)**
  - Research Institutes
Possible long-term perspective

- **NSF**
  - Directs project activities

- **MARAD**
  - Provides technical and shipbuilding expertise
  - Develops vessel conceptual design and cost
  - Supports RPSC in procurement activities

- **RPSC**
  - Manages the procurement process
  - Signs contract for vessel charter
  - Accepts delivery of vessel
Communication between scientists and designers

- Web page for this project is under development by RPSC
  - Monthly newsletter describing project activities prepared by MARAD with RPSC
  - Science and operational requirements
  - PRV technical specification for the vessel
    - Format suitable for review and comment
    - Specification changes can be made on an on-going basis, but access is limited to make revisions
  - Links to other sites, including NBP specifications
  - At completion of current design effort, results on web
PRV Home Page (under development)
Method for sending a comment to the vessel designers and others:

**Moon Pool**

4.7.1. The ship shall be fitted with a Moon Pool of 72 in round pipe, open to the main working deck, starboard side, and running vertically down through the ship to an opening of equal diameter in the hull bottom plate. The hull plate penetration shall be flared to minimize drag, preserve ship's speed, and fuel efficiency. The Moon Pool is to be located on the working deck in such a location as to allow for the erecting of a derrick with a footprint of at least ten feet square, over the opening. The Moon Pool opening at the working deck shall be covered with a removable flush mounted plate.

There should be 75” round pipe instead of 72” round pipe.
### E-mail addresses of project team

<table>
<thead>
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<th>Organization</th>
<th>E-mail Address</th>
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Project Overview
Some of the initial PRV requirements

- Acoustic profiling including bottom mapping during icebreaking
- Towing of nets and instruments from the stern during icebreaking
- Conduct of AUV/ROV operations from a moon pool
- Geotechnical drilling through a moon pool
- Acoustically quiet
- Comply with IMO guidelines for Arctic vessels
- Accommodations for 50 scientists
- 80-day endurance
- Reduced air emissions from diesels and incinerator
- Enhanced icebreaking capability (5 ft and operations in MY ice)
Current Statement of Work

- Translate an initial set of science and operational requirements into design criteria taking into account the experience gained by U.S. and foreign vessels engaged in polar research
- Conduct a number of special studies to properly understand the full implications of these requirements
- Perform a feasibility-level ship design in sufficient detail to arrive at a ship size, general arrangement drawings and a vessel cost estimate
- Deliverables include a copies of special studies, vessel plans and characteristics, technical specifications, cost estimate and design history
Special Technical Studies

- Towing in ice (seismics and nets), recommend a hull form and propulsion system that improves towing in ice
- Bathymetry in ice, recommend a hull form and appendages that improves ice management and reduces bubble sweep down over acoustic windows
- Geotechnical drilling, recommend a hull form, propulsion/thruster and drilling arrangement for shallow water drilling in landfast ice and open water
- Establish requirements for moon pool to deploy and recover ROVs and AUVs in ice and consider CTD /rosette deployment and diving operations through the moon pool
- Evaluate an increase in icebreaking capability and evaluate one or more propulsion concepts to satisfy mission requirements
- Examine compliance with new IMO requirements for Arctic vessels including provision for no pollutants carried directly against the outer shell
- Investigate and recommend an approach to improve the ship’s self-generated noise to enhance scientific acoustic sensor performance
- Analyze and recommend an approach on methods to reduce emissions from diesel engines and the incinerator
Project Milestones
(Feasibility-level design study)

• Project started on March 11, 2003
• End of April
  – Trip report on visit to Baltic icebreakers
  – Outline of select sections of the vessel technical specification
  – Presentation of work to ARVOC
• End of May
  – Interim report on special design studies
  – Meet with RPSC and geotechnical drilling contractor and AUV/ROV operator
• End of June
  – Final report on special design studies
  – Draft of the design arrangement and hull form
• End of July
  – Design history, technical specification, drawings and cost estimate
  – A presentation is planned after July
Visit to Baltic icebreakers and AWI
March 2003

• Finnish Maritime Administration and their icebreaker BOTNICA

• Swedish Maritime Administration and their icebreaker ODEN

• Alfred Wegener Institute for Polar and Marine Studies (POLARSTERN)
Purpose of the trip

To gain insight into the design and operational experience of some of the innovative icebreakers with advanced hull forms, propulsion systems and specialized capabilities. This included ice shedding bow forms, podded propulsion units, moon pools, box keel for bottom mapping and the like.
The participants with Capt. Anders Backman aboard ODEN
Icebreaking operations aboard BOTNICA and ODEN were observed in the Gulf of Bothnia.
BOTNICA – Operating in a broken ice channel
BOTNICA ship model with derrick
**BOTNIKA principal characteristics**

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<td>Beam</td>
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**BOTNIKA is approximately 10 percent larger than NBP**
BOTNICA - moon pool cover
BOTNICA’s 20ft by 20ft moon pool
BOTNICA - inside the moon pool
BOTNICA

View of broken ice behind the icebreaker in thin, stable ice cover
BOTNICA - View aft of broken ice channel
BOTNICA - view inside cabin
BOTNICA - showing electrical and electronic outlets and telephone at desk
BOTNICA - Cabin window
(Hard plastic covers recessed window, shades and curtains)
Aboard BOTNICA
Name card holder outside each cabin

Kocksteward
Maria Hermansson
BOTNICA

Sign shown at each deck in the stairwell
BOTNICA - looking aft at pilot house
BOTNICA - Starboard bridge wing
BOTNICA - view of center of pilot house
OTSO - Bridge
Podded propulsion unit
BOTNICA - top view of Azipod
BOTNICA’s conical bow at waterline  
(hull structural vibration occurred during all icebreaking operations  
due to insufficient stiffness of the hull at this waterline, but at a  
deeper draft at summer open water operation, the vibration ceases)
A Sign Aboard BOTNICA -

Have you had a toxic gift recently?
Some observations from BOTNICA visit

• Moon pool primarily used for ROV operations, to date
• Moon pool bottom cover is of very rudimentary design
• Azipods provide excellent station keeping ability, maneuvering and reversing (more expensive than direct drive propulsion, some oil leakage)
• Prefer Intering (active) roll stabilization system vice passive roll tanks
• Double hull environmental protection
• 12 diesel engines (high-speed type) are excessive and selected based on initial cost only
Some observations from BOTNIKA visit (contd.)

- Bridge is regarded by crew as best known to date. Visibility from starboard side control station is excellent.
- Cabin layout of interest (desk arrangement, bathroom and ceiling height)
- Hull form is poor with “continuous” vibration aboard vessel during icebreaking and slamming in waves
Approaching ODEN - March 2003
ODEN - Ship model
<table>
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<th>Value</th>
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<td>Crew</td>
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ODEN is approximately twice as large as NBP
ODEN - Onboard laboratory space
ODEN - Research laboratory in van
ODEN - Research laboratory in van
ODEN - Moon Pool
ODEN cabin
(Note that upper berth can be stowed)
ODEN - Office area adjacent to cabin
Elevator aboard Swedish icebreaker ODEN

Note: All Finnish icebreakers have elevators
ODEN - Ice conditions at bow while backing
ODEN - Broken ice looking aft
ODEN’s pub (a delightful place)
ODEN

Towing cargo vessel in notch
ODEN - View of bridge from aft
Some observations from ODEN visit

- Large vessel with excellent ahead propeller thrust and icebreaking ability in Baltic
- Flat bow directs broken ice under flat bottom of vessel
- Broken ice channel behind vessel similar to BOTNICA
- Flat bow form unsuitable for open water transit in waves
- Diesel direct drive to propellers similar to NBP (most cost-effective)
- Nice staterooms and cabins with fold-away upper bunk
- Vessel does not back well with reamers - primarily a one-direction vessel
- No intent of Swedish Maritime Administration to use this hull form again
Visit to Alfred Wegener Institute for Polar and Marine Research
AWI’s POLARSTERN
Who we met at AWI

Dr. Eberhard Fahrbach  Scientific Program Manager
Dr. Hans Schenke  Hydroacoustics
Dr. Jorn Thiede  Director, AURORA BOREALIS
Dr. Martin Boche  Former Captain POLARSTERN now Logistics Manager
Dr. Saad El Naggar  Physicist, Dep. Director Logistics
Dr. Michael Klages  AUV/ROV Operations
Dr. Wilfried Jokat  Geophysical
Mr. Eberhard Wagner  Operator, Shipping Co. LAEISZ
Some Comments from AWI

• Use box keel to house all of their transducers
  - Avoids bubble sweepdown in front of transducers
  - Continuously conduct bottom mapping during icebreaking
  - Deep draft of POLARSTERN helps in pressure ridges transits
  - Recommend 1-meter deep box keel on research vessels
  - Will modify METEOR with box keel to avoid bubble sweep down

• Power of POLARSTERN insufficient to maintain speed in Arctic ice, dual ship operations preferred

• Believe all ships have the same broken ice pattern behind the vessel, regardless of bow form

• Stern ramp on the fantail aids geophysical operations
POLARSTERN box keel
(transducer in front, echo sounder center and receiver aft)
Some Comments from AWI (contd.)

• New Arctic drilling research vessel AURORA BOREALIS design is complete with two moon pools (4mx5m) and design will be available
• Believe all new research vessels should have AUV/ROV capability
• One helicopter is good for 10 miles away from the vessel; for greater distances use two
• Use of podded propulsion is unclear in terms of its affect on vessel acoustics and impact of electromagnetic radiation on other instrumentation
• Accommodations for 50 scientists is good
• POLARSTERN will continue to operate for next 15 years