U.S. Department of Transportation
Maritime Administration
Office of Shipbuilding and Marine Technology

New Generation Polar Research Vessel

Issue 3 September 2005

Highlights

This, our third newsletter, describes the 2005 project studies and includes the latest artist's rendering of the PRV, the project schedules, and the results of a mission sensitivity study. Additionally, there are articles on the surge of new construction activity for very capable commercial icebreakers and the initiation of a study by the National Academies of Science to assess the future role of U.S. Coast Guard icebreakers.

Additional information on the PRV can be found on the web site: *www.polar.org/prv*

As always, your comments on the newsletter are welcomed.

This issue:

PRV Project Studies Continue

The objectives of this year's efforts are to complete an assessment of vessel characteristics, size, and cost that satisfy both the scientific and operational requirements. With this information, both the science community and National Science Foundation (NSF) management can make value judgments on the need to continue or revise the requirements for the new generation Polar Research Vessel (PRV). Specifically, the project team's goals are to: (1) define and justify scientific and operational requirements and (2) complete a series of technical studies that result in a feasible vessel with a construction cost estimate.

An artist rendering of the stern-quarter view of the PRV is shown below. It incorporates recent Antarctic Research Vessel Oversight Committee – Scientific Standing Committee – PRV (ARVOC-SSC-PRV) comments on the original concept. In particular, it was determined that some of the

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Artist rendering of Polar Research Vessel

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PRV Project Studies Continue

science and operational requirements that were originally proposed could be modified to produce a better and more useful configuration.

Some of the changes include: geotechnical drilling capability is now external to the superstructure with a smaller moon pool; provision has been made for a 50 m Jumbo Piston Coring capability as shown by the recess on the starboard side midship with suitable working area aft; a reconfigured port side helicopter landing deck and hangar (space for two); and scientific van storage is provided on the main deck below the helicopter deck. The clear view aft from the starboard bridge wing control station to the main deck has been maintained.

Other requirements continue to be met and include an icebreaking capability of 1.4 m (4.5 ft), enhanced bathymetry in ice with a box keel (see Newsletter No. 2), reductions in ship generated noise, significantly lower emissions from diesel engines, and a double hull, to name a few.

These features continue to be accommodated on a vessel having the following 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, twin propellers)	16.8 MW	22,400 HP

In 2005, the science requirements will be documented and compiled in a report that justifies specific needs and uses of the vessel. These requirements cover a wide spectrum of scientific disciplines and operational requirements. Additionally, a definition of acoustical requirements for the vessel will be determined including the frequency range and maximum tolerable noise level for all sensors including towing of seismic instrumentation. Also, the station keeping requirements for the conduct of geotechnical drilling shall be specified including the upper limit of environmental conditions and vessel movement. Clearly defined operational uses for the moon pool and support equipment as well as space requirements on all decks will be developed.

Technical studies include a feasibility-level study of the vessel with appropriate deck arrangements, outboard profile, lines drawing and a vessel construction cost estimate. As part of this technical effort, standard one- and two-person cabin arrangements for scientists will be prepared. Justification for the use of diesel-electric propulsion systems will be prepared by documenting the advantages of this system over diesel-geared systems for reduction of ship generated noise. Information on electric propulsion alternatives will be compiled and include the use of electric and mechanical pods and conventional electric motor with propeller shafting. Two propulsion machinery studies, including arrangements, will be made to compare a podded system and a traditional electrical system with line shafting.

Deliverables from 2005 Project Studies Include:

- **Documentation and justification for science and operational requirements**
- **Vessel dimensions and characteristics that satisfy the requirements**
- **Lines plan and Hydrostatics**
- **Outboard profile and Deck plans including laboratories**
- **Standard scientist cabin plan**
- **Construction cost estimate**
- **Initial set of vessel specifications based on feasibility studies**

Mission Sensitivity Study Completed

A sensitivity study of vessel construction cost for various mission requirements was recently completed. Basically, the synthesis model allows the determination of vessel characteristics and an estimate of vessel costs without going into many naval architectural calculations. A special feature of the model is that it allows both single and multiple sets of scientific and operational missions to be compared.

As shown below, the sensitivity model was systematically varied for several different configurations of science features and icebreaking capabilities. The baseline ship accommodates 37 scientists, an endurance of 60 days, a 0.9 m (3 ft) icebreaking capability, and is modeled after the existing research vessel *Nathaniel B. Palmer*. New scientific mission/capability was then examined for bottom mapping (box keel), double hull, diesel emission reduction, jumbo piston coring (JPC) of 50 m (164 ft) and 80 m (262 ft) capability, geotechnical drilling, 80-day endurance, AUV/ROV operations through a moon pool, accommodations for 50 scientists , and icebreaking capability of 1.2 m (4 ft) and 1.4 m (4.5 ft).

The sensitivity study for the PRV revealed that some of the mission requirements are associated

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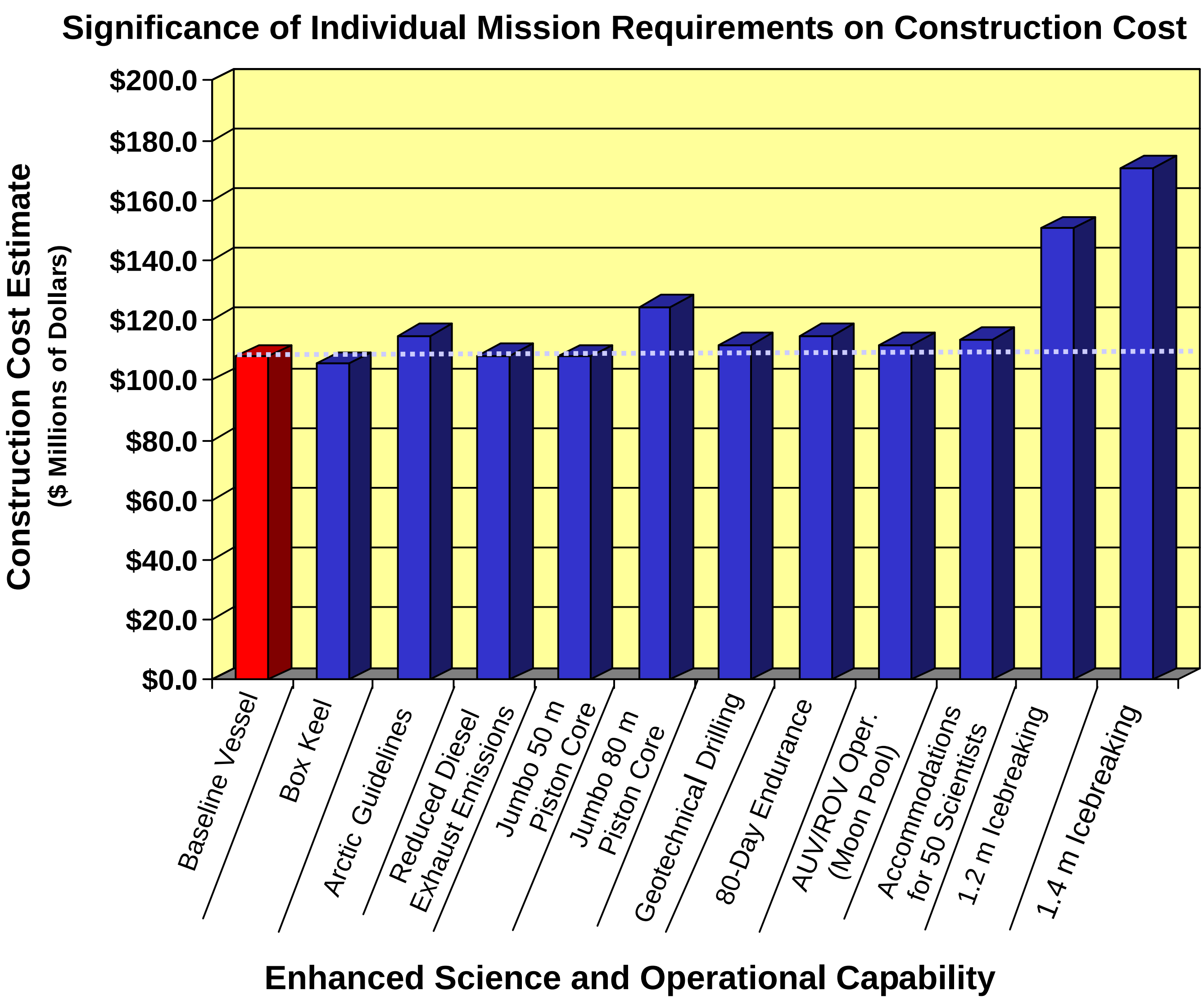

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Mission Sensitivity Study Completed

with no significant increase in construction cost. For example, the vessel has sufficient length for the 50 m (164 ft) JPC operations, excluding equipment cost or the impact its weight has on stability (they were not considered in this model). Tthere is no added cost for including this requirement. Interestingly, a box keel for enhanced bottom mapping capability in open water and during icebreaking actually reduces the vessel construction cost by effectively providing displacement without the accompanying structural weight.

In contrast, the mission requirement for increasing level icebreaking capability has a significant construction cost increase. The thicker the ice a ship must break, the more expensive its construction cost. Other mission requirements such as weight allowances for geotechnical drilling capability, inclusion of a double hull, and an expanded moon pool contribute less to the vessel cost. In some cases, a mission requirement can either affect the vessel construction cost significantly or not at all. The 80 m JPC is the primary example of this. For a 0.9 m (3 ft) icebreaking baseline ship, adding only the 80 m (262.4 ft) JPC requirement greatly affects the cost because the ship must be significantly longer to accommodate the capability. However, a larger ship, such as one with 1.4 m (4.5 ft) icebreaking capability, already has the length required for the 80 m (262.4 ft) JPC and has little affect on construction cost.

In addition to assessing the cost for individual requirements, many cases were examined for various combinations or sets of features. As an example, the vessel characteristics needed to satisfy 1.4 m (4.5 ft) icebreaking capability, resulted in a cost increase of less than one-half of one percent for inclusion of a double hull, a moon pool, 50 m jumbo piston core, a box keel, reducing diesel emissions, and geotechnical drilling.

Likewise, a cost increase of 17 percent over the single mission requirement of 1.4 m (4.5 ft) icebreaking provided a vessel that satisfied all scientific and operational needs.

These and other cases were examined and are in a report that will shortly be available on the web site *www.polar.org/prv.*

U.S. Polar Icebreakers: Future Needs and Possible New Policy

A number of studies by federal agencies are examining the future need and role of U.S. polar icebreakers. One of these studies is being conducted by the National Academies of Science (NAS) with interim results scheduled for later this year. The NAS study will assess the role of the U.S. Coast Guard (USCG) polar icebreakers in supporting U.S. operations in the Antarctic and the Arctic, including scenarios for continuing those operations as well as alternative approaches.

Since 1965, the USCG has been the principal provider of polar icebreaking services for the Nation. These icebreakers provide a capability for national defense, search and rescue, maritime law enforcement, marine environmental protection, scientific research, and logistics support. In the Antarctic, the USCG has two ships that normally operate in the Southern Ocean, the *Polar Star* (commissioned in 1976) and the *Polar Sea* (commissioned in 1978). These are the two most powerful in the USCG icebreaker fleet. The newest and most technologically advanced U.S. polar icebreaker, the *Healy* (commissioned in 2000), was specifically designed to support a wide range of scientific research activities and operates primarily in the Arctic.

Powerful Icebreakers Under Construction

International shipyards are busy building very capable icebreaking vessels to support petroleum development and other commercial activity in the Russian Arctic. Many of these vessels have icebreaking capability of 1.5 m (5 ft) at 3 knot speed and have diesel-electric machinery plants with podded propulsion systems.

Several of these powerful icebreaking ships are described in the table below. They include icebreaking supply boats, icebreaking tugs, an icebreaking shuttle tanker, and an icebreaking container ship. Delivery of these vessels was scheduled as early as May 2005 and as late as 2007. In effect, there will be a significant increase in powerful commercial icebreaking ships over the next two years and it will be of great interest to learn of their operational performance in ice.

Purpose	Supply Boat[1] (shown below)		Standby and Supply Vessel[2]		Tug[3]		Containership[4]		Shuttle Tanker[5]	
Length, Overall	91.5 m	300 ft	99.9 m	328 ft	71 m	233 ft	168.6 m	553 ft	260 m	853 ft
Beam	19.0 m	62 ft	21.2 m	70 ft	17 m	56 ft	23.1 m	76 ft	34 m	112 ft
Draft	8.25 m	27 ft	7.5 m	25 ft	6.5 m	21 ft	9.0 m	30 ft	13.6 m	45 ft
Icebreaking @ 3 kts	1.5 m	5 ft					1.5 m	5 ft		
Propulsion Power	16.6 MW		13 MW		11 MW				25 MW	
Propulsors	Mechanical pods		Electric pods		Electric pods		Electric pods		Electric pods	
No. of Propulsors	2		2		2		2		2	

Footnotes to table are on bottom of page 5

Three supply boats with 1.5 m (5 ft) icebreaking capability are being built in Norway.
The UT 758 ICE was designed by Rolls Royce Marine AS

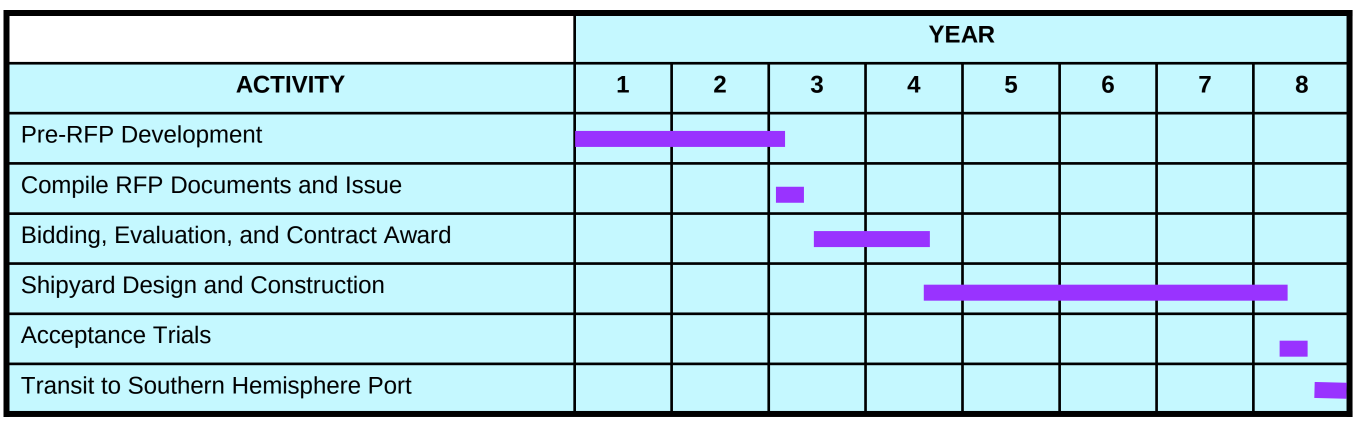
PRV Timeline

A representative schedule for the PRV has been developed based on one of several possible procurement strategies. In particular, the below schedule is based on a strategy of using Technical Specifications with guidance drawings of the vessel. This strategy is based on incorporating the experience, knowledge, and preferences gained from prior polar science operations while still allowing innovation on the part of the vessel owner and shipbuilder. In essence, it provides a framework before the final design by the shipyard and vessel construction.

The pre-RFP (Request for Porposal) development activities, where the project is today, takes a little over two years to complete. It is during this time period that the scientific and operational requirements are finalized; a procurement strategy is developed; construction cost sensitivity studies are performed; a number of studies related to the hull, machinery, laboratory arrangements, environmental protection, and the like, are conducted; and guidance plans and specifications are developed.

Alternate procurement strategies can either lengthen or shorten the timeline. In particular, a performance only based technical specification would probably result in a one year shorter time frame. However, a contract design technical specification with drawings would add about another two years before delivery of the vessel and severely limit changes to the design after contract award.

Additional details regarding the PRV project schedule are in the report *PRV Project Master Plan* and will be available on the project web site: *www.polar.org/prv*.



Footnotes for Page 4 Table of Powerful Icebreakers Under Construction

[1]Owner: Swine Pacific Offshore, Singapore; Shipyard: Aker Langston, Norway; Operating Area: Sakhalin, Russia; 3 vessels; Delivery: TBD

[2]Owner: Far Eastern Shipping Company (FESCO), Russia; Shipyard: Aker Finnyards, Finland; Operating Area: Sakhalin Island (Okhotsk Sea); Delivery: 2005

[3]Owner: Primorsk Shipping Corporation; Operator: Rieber Shipping AS; Shipyard: Aker Langsten; Operating Area: Dekastri Oil Terminal, Sakhalin; Delivery: 2006

[4]Owner: MMC Norilsk, Russia; Shipyard: Aker Finnyards, Finland; Operating Area: Northern Sea Route of Russia; Delivery: 2006

[5]Owner: ZAO Sevmorneftegaz, Russia; Shipyard: FSVE Admirality St. Peterburg, Russia; Operating Area: Prirazlomnoye Oil field, Arctic Ocean; 2 Ships; Delivery: 2007 and 2008

Stakeholders reliant on icebreaker support are facing many challenges, particularly the NSF which requires the use of the aging POLAR Class icebreakers that serve in the Antarctic. An example of this occurred in the 2005 Austral Summer when two icebreakers were needed for the McMurdo break-in (as they have been since 2002). The *Polar Sea*, however, was undergoing extensive maintenance and was unable to assist. The NSF, therefore, chartered the Russian icebreaker *Krasin* to provide this assistance. In the 2006 Austral Summer, NSF has again chartered the *Krasin*. This year, however, due to reliability and economic issues with the *Polar Star*, the *Krasin* will be the primary icebreaker and the *Polar Star* (again the only USCG icebreaker available) will be used as a backup in the event the *Krasin* cannot complete the break-in on her own. The *Polar Star* is not expected to be deployed to the Antarctic unless *Krasin* cannot do the icebreaking mission alone.

USCGC *Healy* (WAGB-20) underway to commence Arctic West East Summer (AWES) 2005 deployment. Principal characteristics and capabilities can be found at *www.uscg.mil/pacarea/healy*

USCGC *Polar Star* (WAGB-10) and USCGC *Polar Sea* (WAGB-11) at Murdo Station, Antarctica
Principal characteristics and capabilities can be found at *www.uscg.mil/pacarea/iceops/shipinfo.htm*

In the spring of 2005, the Advisory Committee to NSF's Office of Polar Programs (OPP) formed a subcommittee to review and advise OPP on the U.S. Antarctic Program re-supply missions. Obviously, much of the focus was on icebreakers, but the Committee had a number of suggestions that would reduce the sole dependence in icebreakers for re-supply. The Committee indicated, "commercial business models (possibly involving the private sector) should be examined considering procurement and/or operation of (an) icebreaker." A copy of their report may be found at: *http://www.nsf.gov/news/news_summ.jsp?cntn_id=104354&org=OPP&from=news*

This summer, the NAS established a committee for the "Assessment of U.S. Coast Guard Polar Icebreaker Roles and Future Needs" and held its first fact-finding meeting on August 24 and 25, 2005. The USCG and NSF were the primary presenters.

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U.S. Polar Icebreakers: Future Needs and Possible New Policy

The Arctic Research Commission and the OPP Advisory Subcommittee also made presentations. The charge to NAS and the membership of the Committee may be found at: *http://www4.nas.edu/cp.nsf/Projects+_by+_PIN/PRBX-U-05-02-A?OpenDocument*

It is expected that the findings and recommendations of the NAS Committee will be far reaching. The future needs for the Nation's polar icebreaking fleet will depend heavily upon what services must be provided by this fleet. Should this fleet be dedicated to science or are there other more pressing national needs? Has the National need changed enough since the end of the cold war that maintaining a polar fleet as a National Asset is not necessary? The NAS is sorting out such issues. There are many possible options and outcomes of the NAS study.

The NAS is scheduled to deliver a preliminary report in November 2005. If major shifts in current operating procedures are recommended, it is likely that a White House level decision (A Presidential Decision Directive (PDD)) may be made.

What does all this mean to the PRV? It means that some PRV technical studies and acquisition must await the results of the NAS study and any White House directives to be issued. These decisions and directions should be made in fiscal year 2006 (October 1, 2005—September 30, 2006).

Acronyms

ARVOC	Antarctic Research Vessel Oversight Committee
AUV	Autonomous Underwater Vehicle
HP	Horsepower
JPC	Jumbo Piston Coring
MARAD	Maritime Administration
MW	Megawatt
NAS	National Academies of Science
NBP	*Nathaniel B. Palmer*
NSF	National Science Foundation
OPP	Office of Polar Programs
PDD	Presidential Decision Directive
PRV	Polar Research Vessel
RFP	Request for Proposals
ROV	Remotely Operated Vehicle
RPSC	Raytheon Polar Services Company
SSC-PRV	Scientific Standing Committee for PRV
STC	Science and Technology Corporation
USCG	United States Coast Guard

Visit the PRV web site at:

www.polar.org/prv

PRV Project Team E-Mail Addresses

Al Sutherland	NSF	alsuther@nsf.gov
Jim Holik	RPSC	jim.holik@usap.gov
Paul Olsgaard	RPSC	paul.olsgaard@usap.gov
Skip Owen	RPSC	harold.owen@usap.gov
Dick Voelker	MARAD	richard.voelker@dot.gov
Jim St. John	STC	jstjohn7@earthlink.net
Alex Iyerusalimskiy	STC	alexiyer@earthlink.net
David Karnes	STC	dkarnes7@earthlink.net

Newsletter comments and distribution inquiries: MARAD point of contact regina.farr@dot.gov