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

New Generation Polar Research Vessel

Issue 2 September 2003

Introduction

This, our second Newsletter, focuses on some of the results of the initial design studies including a description of scientific features, principal characteristics, and an artist's rendition of the PRV. Dr. Robin Ross, Chair of the Antarctic Research Vessel Oversight Committee (ARVOC), has also prepared an article on their role in the PRV design and procurement effort.

For your convenience, acronyms are identified on page 8.

Your comments on the Newsletter are welcomed.

This issue:

PRV Design Unveiled

The initial design of the Polar Research Vessel (PRV) was presented at the Antarctic Research Vessel Oversight Committee's (ARVOC's) meeting on July 31 and August 1 at the Monterey Bay Aquarium Research Institute (MBARI) in Moss Landing, California.

The presentation included an overview of the design process, a review of current scientific and operational requirements, results from eight special technical studies, and the PRV design including cost estimates.

At the conclusion of the meeting, MBARI provided a brief description of their operational experience with Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs) and also provided a timely visit aboard their research vessels *ZEPHYR* and *WESTERN FLYER.*

Artist Rendition of Polar Research Vessel (PRV)

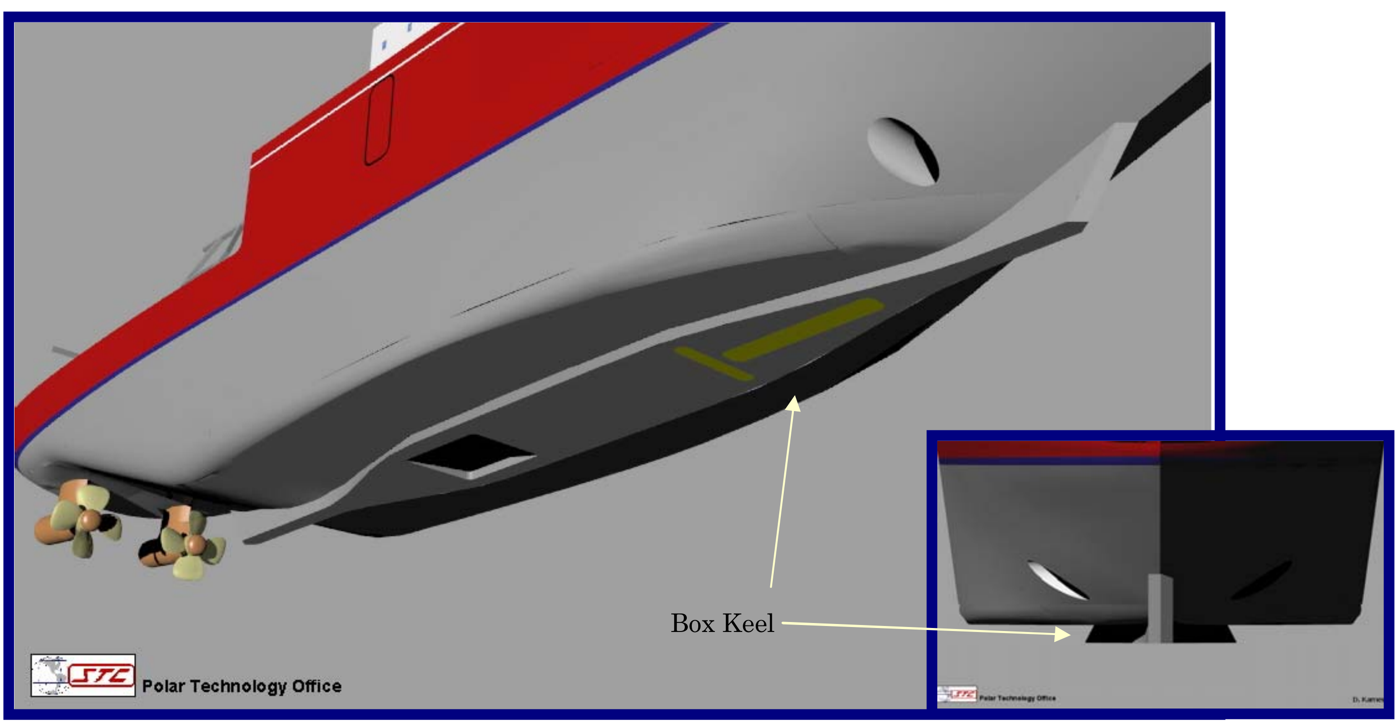
Scientific and Operational Features

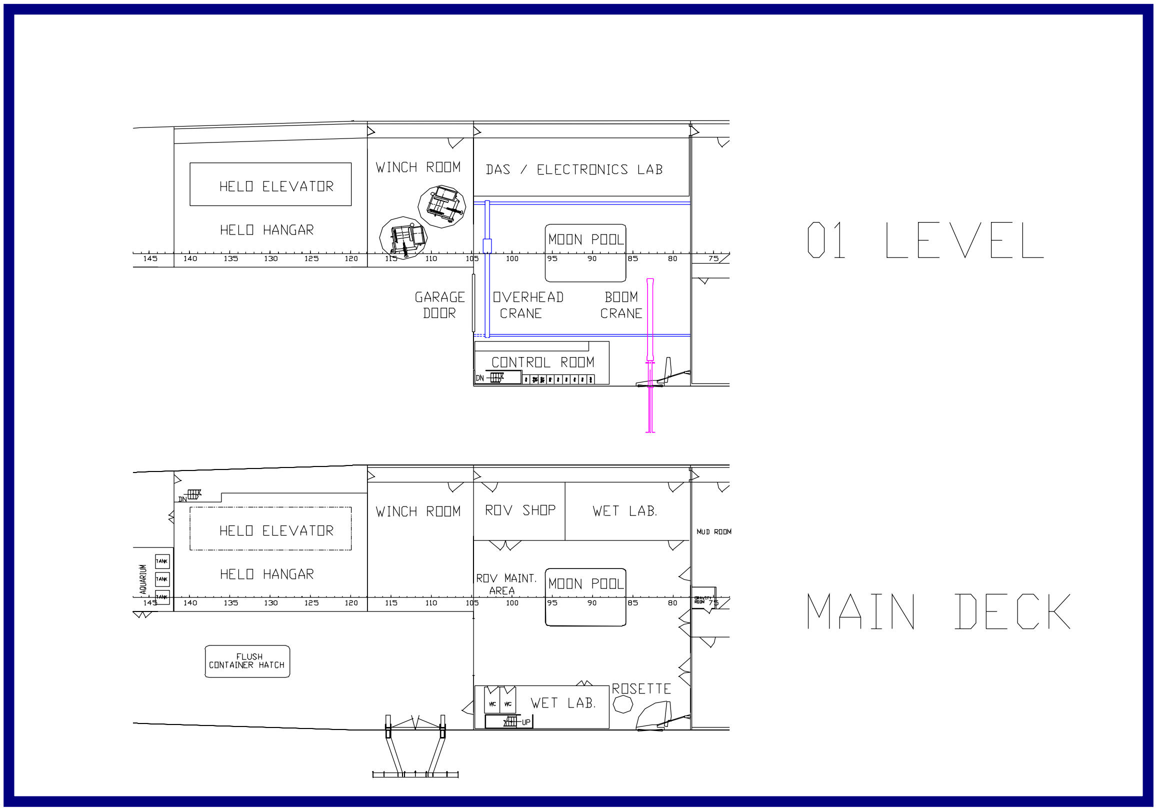
The Polar Research Vessel (PRV) is being designed to incorporate a wide range of science and operational capabilities, several of which have a pronounced effect on the design of the vessel. This article will briefly describe some of the initial design results to: improve bathymetry (bottom mapping) in ice and open water, configure a multi-purpose moon pool, provide for a helicopter complex, and enhance icebreaking capability.

Bathymetry. A box keel has been designed for the vessel to ensure the vessel's ability to conduct bottom mapping in open water and during most icebreaking operations. The design is based on two decades of operational experience aboard the German Alfred Wegener Institute's vessel *POLARSTERN*. As shown below, the forward stem diverts ice pieces and the reverse flared sides on the box keel help prevent bubble sweep down from occurring across the face of the sensors. The deep draft of the PRV also serves as an advantage during icebreaking operations.

Moon pool. Operational requirements for the moon pool include such diverse activities as geotechnical drilling, conduct of Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs), rosettes for water samples and Conductivity, Temperature and Density (CTD) measurements, Ocean Biomass Surveys (OBS), and diving operations. The current size of the moon pool is 20 ft (6.1 m) by 16 ft (4.9 m), the maximum dimensions were based on the ROV requirements. The moon pool is located on the vessel centerline and longitudinal center of gravity for minimal vessel motion. The entire space is enclosed and provisions have been made for winches, cranes and workshops in the immediate vicinity. A preliminary arrangement of the Main Deck and 01 Level is shown on the adjacent page. Also shown is a telescoping boom on the starboard side, 01 Level, which permits the deployment of rosettes and other instruments over the side through the Baltic door as shown in the artists rendering of the PRV.

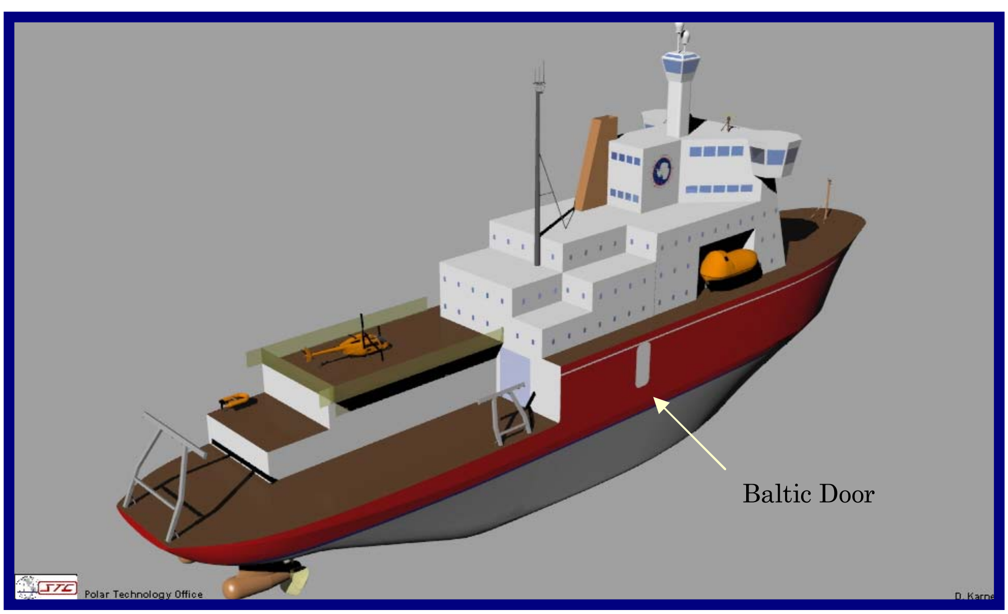
Helicopter Complex. Because of the need for vertical space at the centerline for geotechnical drilling, the traditional arrangement of an aft helicopter





landing deck and a forward hangar had to be reconsidered. It appears that the most feasible solution was for the installation of an aft helicopter deck with a flush elevator for helicopter storage below. Sufficient space is provided such that two helicopters can be stored below on the Main Deck. This space is of sufficient size that it offers an excellent inside area for scientific vans when helicopters are not required aboard the vessel.

Icebreaking Capability. Scientific requirements include enhanced icebreaking as compared to that of the present research vessel *NATHANIEL B. PALMER (NBP)*. There is also a need to deploy in landfast ice including old ice found in some bays of Antarctica. These requirements necessitated a hull and propulsion plant capable of operating in multi-year ice. As a result, the PRV will also have the capability to operate independently in Arctic ice along the coastal shelf and into the Arctic Basin in summer. Extended operations in the Central Arctic Basin can be accomplished when escorted by a more capable lead icebreaker.



Information on other science and operational features will be provided in future Newsletters.

PRV Machinery and Propulsors

An analysis of the many scientific requirements (moon pool, station keeping, towing of nets, and instruments) and operational requirements (low power open water transit and high power icebreaking) led to the selection of a diesel-electric propulsion plant with podded propulsors.

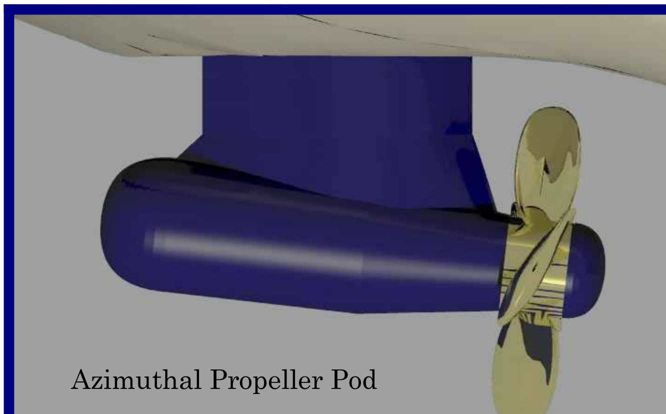
The diesel-electric propulsion plant consists of four main diesel-generator sets, two of 8,046 HP and two of 6,785 HP with a total brake power of 29,600 HP (22 mW). This configuration was selected as it provides great flexibility as it relates to the physical arrangement on the vessel as well as varying electric power demands. The diesel-electric generators can also be "floated" on isolation mounts for low-noise/vibration and provide great flexibility for varying power demands.

All electrical service loads including propulsors, bow thruster, winches, cranes, light and other general ship service needs are powered from a common bus/ integrated electric system.

Propulsors on the PRV take the form of two azimuthal propeller pods. Each pod contains a 11,200 HP (8.4 mW) electric motor driving a pulling propeller. They are independently steerable through 360 degrees and provide superior maneuverability in ice and open water (station keeping) without rudders.

Each pod drives one stainless steel four-bladed open fixed-pitch propeller measuring 17.8 ft (5.4 m) in diameter. This large propeller rotates at a slow speed and ensures low noise in open water and high thrust for icebreaking.

PRV Outboard Profile



Azimuthal Propeller Pod

PRV Principal Characteristics:

Length Overall	378.4 ft (115.3 m)
Length, Water Line	340.9 ft (103.9 m)
Beam	74.5 ft (22.7 m)
Draft	29.6 ft (9 m)
Displacement	11,000 LT (11,200 MT)
Twin Podded Propulsors	11, 200 HP (8.4 mW) each

The Role of ARVOC in PRV Design

The Antarctic Research Vessel Oversight Committee (ARVOC) exists to ensure representation of the scientific community in the management and operation of the U.S. Antarctic Program's (USAP) research vessels. An important function of ARVOC is to provide advice and make recommendations regarding the ships and other scheduling issues, efficient utilization of shipboard equipment and instruments, and the shipboard computer network and hardware.

Topics occasionally arise that warrant particular focused attention. When such topics arise, as part of the charter, an ad hoc Working Group may be formed to formulate a position, make recommendations to ARVOC, or directly to NSF's Office of Polar Program's prime support contractor, Raytheon Polar Services Company (RPSC).

The possibility of using a comprehensive design, as opposed to performance criteria as was done with the *NBP*, to serve as the basis for issuing a Request for Proposal (RFP) for the PRV meant that scientific input beyond that of the workshops was critical over the next 18 months. As a result, ARVOC is in the process of forming a Scientific Standing Committee for the PRV (SSC-PRV). The Committee will be comprised of approximately 15 members with possible additional members to provide expertise in science areas affecting the vessel design.

This committee provides an opportunity to gather and incorporate input from the broad community of potential ship users.

For more information regarding ARVOC, contact Dr. Robin Ross at robin@icess.ucsb.edu.

ARVOC Membership

Dr. Robin Ross, ARVOC Chair
robin@icess.ucsb.edu
University of California, Santa Barbara

Dr. Steven Ackley
sackley@pol.net
Clarkson University

Dr. Bob Anderson
boba@ldeo.columbia.edu
Lamont-Doherty Earth Observation
of Columbia University

Dr. Jamie Austin
jamie@utig.ig.utexas.edu
University of Texas at Austin

Dr. Teresa Chereskin
tchereskin@ucsd.edu
University of California, San Diego

Dr. Bill Detrich
iceman@neu.edu
Northeastern University

Dr. Robert Dunbar
dunbar@stanford.edu
Stanford University

Dr. Chris Fritsen
cfritsen@dri.edu
Desert Research Institute

Dr. Jim Swift
jswift@ucsd.edu
Scripps Institution of Oceanography

New Generation XBT System - A Thru-Hull Auto Launcher

The New Generation research ship will not only be a new and unique platform for research, but also an opportunity to deploy improved scientific systems at sea. One such possibility is the Expendable Bathythermograph (XBT) system.

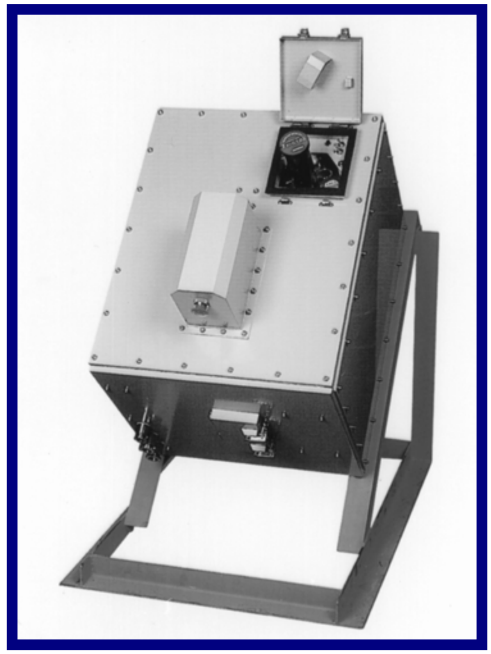
XBTs and XCTDs are expendable sensor probes that are launched from the ship to measure the salinity and temperature structure in the water column. They are a fundamental part of collecting large amounts of data while underway. The probes are also expensive, with the XCTDs costing approximately $500 each.

Currently, technicians must launch probes from the outside decks or use an auto-launcher that can store up to six probes. Probe launches and surveys are often cancelled due to rough weather when decks are secured for personnel safety as shown in the photograph at the lower right. The end result is that data collection opportunities are lost and technicians spend a considerable amount of time servicing equipment punished by extreme weather and waves.

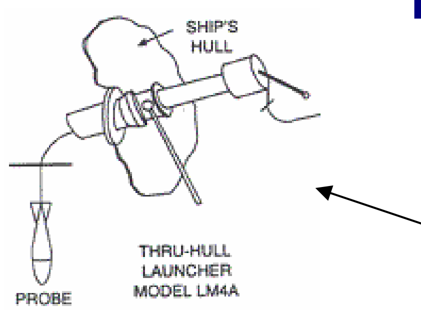
One possible solution to both of these problems is to modify and integrate two state-of-the-art systems, the LM4A thru-hull launcher from Sippican, Inc., and the AL12 12-probe auto-launching revolver from TSKA, Inc.

The configuration would place all equipment inside the hull and provide the capability to launch up to 12 probes automatically versus the current six-probe system.

The benefits would be removing technicians from potentially dangerous situations in rough weather, improving data collection and survey completions, and preserving the equipment inside the ship, thereby reducing labor and spare part expenses.



AL12 12-probe revolving auto-launcher
(photo courtesy of TSKA, Inc.)



LM4A thru-hull launcher
(illustration courtesy of Sippican, Inc.)

A wave breaks over the starboard aft-deck of the *LAURENCE M. GOULD.*
All decks are secured and the XBT survey is cancelled.
(photo courtesy of Andy Nunn)

PRV: a Green Ship

90% lower diesel exhaust emissions compared to existing research vessels

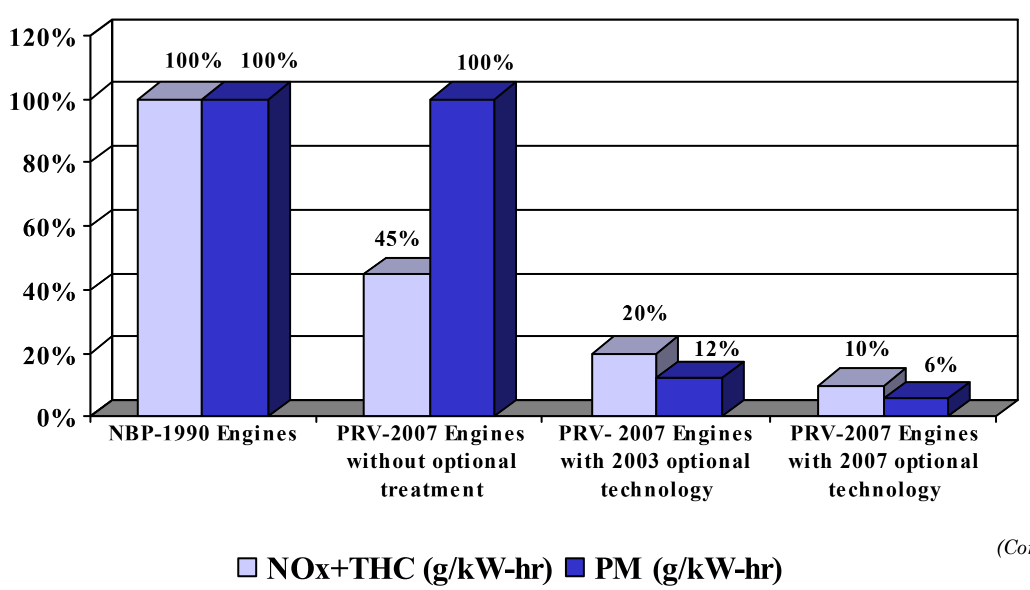
The PRV has the potential to significantly reduce diesel air emission rates in addition to the many new and expanded scientific missions.

Diesel engines aboard existing research vessels, such as the *NBP*, were not subject to any emissions regulations when they were built. However, the new engines to be installed on the PRV must comply with recent regulatory requirements of the Environmental Protection Agency that limits exhaust emissions, particularly lower NOx. In addition, optional emission reduction equipment can be installed to reduce emissions further.

Emission Estimates for Various Engine Configurations	NOx + THC (g/kW-hr)	PM (g/kW-hr)
NBP-1990 engines	20	0.50
PRV-2007 engines without optional treatment	9	0.50
PRV-2007 engines with 2003 optional technology	4	0.06
PRV-2007 engines with 2007 optional technology	2	0.03

Several optional emission reduction technologies are currently available and more are in the developmental stage. These technologies can be divided into two broad categories. The first category affects the basic combustion process and prevents the formation of undesirable air emissions in the engine. These technologies include fuel selection or treatment, electronic control of fuel injection and valve timing, ceramic coating of combustion parts, exhaust gas recirculation, and the injection of water into the combustion chamber, to name a few. The second category focuses on the removal of undesirable emissions from the exhaust after they form in the engine. These include the use of catalyzed reaction and filtration processes including selective catalytic reduction, diesel oxidation catalysts, and particulate traps.

Emission Reduction Per Horsepower



(Continued on page 8)

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

400 Seventh Street, SW
Washington, DC 20590

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

Acronyms

ARVOC	Antarctic Research Vessel Oversight Committee
AUV	Autonomous Underwater Vehicle
AWI	Alfred Wegener Institute for Polar and Marine Research
CTD	Conductivity, Temperature, Depth
HP	Horsepower
kW	Kilowatt
MARAD	Maritime Administration
MBARI	Monterey Bay Aquarium Research Institute
mW	Megawatt
NBP	*NATHANIEL B. PALMER*
NOx	Nitrogen Oxides
NSF	National Science Foundation
OBS	Ocean Biomass Survey
PM	Particulate Matter
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
THC	Total Hydrocarbons
XBT	Expendable Bathythermograph
XCTD	Expendable CTD

PRV: a Green Ship

(Continued from page 7)

Emission estimates have been made for diesel engines based on various technologies and treatments for Nitrogen Oxides (NOx), Total Hydrocarbons (THC), and Particulate Matter (PM). These estimates are for the "off-the-shelf" regulatory compliant engine after 2007, for the 2007 engine with currently available, year 2003, optional technology and finally for 2007 engine with optional technology that may be available in 2007. These levels are all compared with the likely emission levels from engines on vessels of the *NBP* vintage. Because of the rapidly changing technology and marketplace for emission reduction technology and equipment, it is not possible to accurately predict what specific technologies will be available or what the capital or operational costs will be when the PRV is built.

In summary, it is clear that the new generation PRV provides an opportunity to significantly reduce diesel engine emissions – the technology is available.

Next Issue

The next Newsletter will feature an article by Skip Owen, RPSC, that gives a historical perspective of Antarctic marine science and the evolution of U.S. research vessel capability from the *HERO* to the current PRV design.

PRV Design 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@marad.dot.gov
Jim St. John	STC	jstjohn7@earthlink.net
Alex Iyerusalimskiy	STC	alexiyer@earthlink.net
David Karnes	STC	dkarnes7@earthlink.net