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Coast Guard Polar Security Cutter (Polar Icebreaker) Program: Background and Issues for Congress

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Summary

The Coast Guard Polar Security Cutter (PSC) program is a program to acquire three new heavy polar icebreakers, to be followed years from now by the acquisition of up to three new medium polar icebreakers. The Coast Guard estimates the total procurement costs of the three heavy polar icebreakers as $1,039 million (i.e., about $1.0 billion) for the first ship, $792 million for the second ship, and $788 million for the third ship, for a combined estimated cost of $2,619 million (i.e., about $2.6 billion). Within those figures, the shipbuilder's portion of the total procurement cost is $746 million for the first ship, $544 million for the second ship, and $535 million for the third ship, for a combined estimated shipbuilder's cost of $1,825 million (i.e., about $1.8 billion).

On April 23, 2019, the Coast Guard-Navy Integrated Program Office for the PSC program awarded a $745.9 million fixed-price, incentive-firm contract for the detail design and construction (DD&C) of the first PSC to VT Halter Marine of Pascagoula, MS, a shipyard owned by Singapore Technologies (ST) Engineering. VT Halter was the leader of one of three industry teams that competed for the DD&C contract. The first PSC is scheduled to begin construction in 2021 and be delivered in 2024, though the DD&C contract includes financial incentives for earlier delivery.

The DD&C contract includes options for building the second and third PSCs. If these options are exercised, the total value of the contract would increase to $1,942.8 million (i.e., about $1.9 billion). The figures of $745.9 million and $1,942.8 million cover only the shipbuilder's costs; they do not include the cost of government-furnished equipment (GFE), which is equipment for the ships that the government purchases and then provides to the shipbuilder for incorporation into the ship, or government program-management costs. When GFE and government program-management costs are included, the total estimated procurement cost of the first PSC is between $925 million and $940 million, and the total estimated procurement cost of the three-ship PSC program is about $2.95 billion.

The PSC program has received a total of $1,034.6 million (i.e., about $1.0 billion) in procurement funding through FY2019, including $300 million provided through the Navy's shipbuilding account in FY2017 and FY2018. The Coast Guard's proposed FY2020 budget requests $35 million in procurement funding for the PSC program, which is enough to cover the PSC program's FY2020 government program-management costs. The Coast Guard's FY2019 budget submission had projected that a total of $125 million in procurement funding would be requested for the PSC program in FY2020.

The operational U.S. polar icebreaking fleet currently consists of one heavy polar icebreaker, *Polar Star*, and one medium polar icebreaker, *Healy*. In addition to *Polar Star*, the Coast Guard has a second heavy polar icebreaker, *Polar Sea*. *Polar Sea*, however, suffered an engine casualty in June 2010 and has been nonoperational since then. *Polar Star* and *Polar Sea* entered service in 1976 and 1978, respectively, and are now well beyond their originally intended 30-year service lives. The Coast Guard is using *Polar Sea* as a source of spare parts for keeping *Polar Star* operational.

Issues for Congress for the PSC program include, inter alia, whether to approve, reject, or modify the Coast Guard's FY2020 procurement funding request for the program; whether to use a contract with options or a block buy contract to procure the ships; whether to continue providing at least some of the procurement funding for the PSC program through the Navy's shipbuilding account; technical, schedule, and cost risk in the PSC program; and whether to procure heavy and medium polar icebreakers to a common basic design.

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Introduction

This report provides background information and issues for Congress on the Polar Security Cutter (PSC) program—the Coast Guard's program for acquiring new polar icebreakers. The PSC program has received a total of $1,034.6 million (i.e., about $1.0 billion) in procurement funding through FY2019. The Coast Guard's proposed FY2020 budget requests $35 million in procurement funding for the PSC program, which is enough to cover FY2020 program-management costs.

The issue for Congress is whether to approve, reject, or modify the Administration's FY2020 procurement funding request for the PSC program, and, more generally, whether to approve, reject, or modify the Coast Guard's overall plan for procuring new polar icebreakers. Congress's decisions on this issue could affect Coast Guard funding requirements, the Coast Guard's ability to perform its polar missions, and the U.S. shipbuilding industrial base.

For a brief discussion of the Coast Guard's Great Lakes icebreakers, see **Appendix E**. A separate CRS report covers acquisition of general-purpose cutters for the Coast Guard.[1] Another CRS report provides an overview of various issues relating to the Arctic.[2]

Background

Missions of U.S. Polar Icebreakers

Statutory Duties and Missions

The permanent statute that sets forth the Coast Guard's primary duties—14 U.S.C. 102—states that among other things, the Coast Guard shall (emphasis added) "develop, establish, maintain, and operate, with due regard to the requirements of national defense, aids to maritime navigation, **icebreaking facilities**, and rescue facilities for the promotion of safety on, under, and over the high seas and waters subject to the jurisdiction of the United States," and "pursuant to international agreements, develop, establish, maintain, and operate **icebreaking facilities** on, under, and over waters other than the high seas and waters subject to the jurisdiction of the United States...."[3]

In addition, Section 888(a) of the Homeland Security Act of 2002 (H.R. 5005/P.L. 107-296 of November 25, 2002)—the law that established the Department of Homeland Security (DHS) and transferred the Coast Guard from the Department of Transportation to DHS—sets forth 11 specific missions for the Coast Guard (often referred to as the Coast Guard's 11 statutory missions), including the mission of "ice operations."[4]

[1] CRS Report R42567, *Coast Guard Cutter Procurement: Background and Issues for Congress*, by Ronald O'Rourke.

[2] CRS Report R41153, *Changes in the Arctic: Background and Issues for Congress*, coordinated by Ronald O'Rourke.

[3] 14 U.S.C. 102(4) and 102(5), respectively. This statute was previously 14 U.S.C. 2; it was renumbered as 14 U.S.C. 102 by Section 103 of the Frank LoBiondo Coast Guard Authorization Act of 2018 (S. 140/P.L. 115-282 of December 4, 2018). (Title I of P.L. 115-282, consisting of Sections 101-124, specified a general reorganization of Title 14.)

[4] The 11 missions set forth in Section 888(a) are marine safety; search and rescue; aids to navigation; living marine resources (fisheries law enforcement); marine environmental protection; ice operations; ports, waterways and coastal security; drug interdiction; migrant interdiction; defense readiness; other law enforcement.

Multiple Missions (Not Just Icebreaking)

The Coast Guard's polar icebreakers do not simply break ice—they are multimission cutters[5] that conduct a variety of other operations that are conducted in lower-latitude waters by the Coast Guard's general-purpose cutters. U.S. polar ice operations conducted in large part by the Coast Guard's polar icebreakers support 9 of the Coast Guard's 11 statutory missions.[6] The roles of U.S. polar icebreakers can be summarized as follows:

- conducting and supporting scientific research in the Arctic and Antarctic;
- defending U.S. sovereignty in the Arctic by helping to maintain a U.S. presence in U.S. territorial waters in the region;
- defending other U.S. interests in polar regions, including economic interests in waters that are within the U.S. exclusive economic zone (EEZ) north of Alaska;
- monitoring sea traffic in the Arctic, including ships bound for the United States; and
- conducting other typical Coast Guard missions (such as search and rescue, law enforcement, and protection of marine resources) in Arctic waters, including U.S. territorial waters north of Alaska.[7]

Polar (Not Just Arctic) Operations

The Coast Guard's large icebreakers are called polar icebreakers rather than Arctic icebreakers because they perform missions in both the Arctic and Antarctic. Operations to support National Science Foundation (NSF) research activities in both polar regions account for a significant portion of U.S. polar icebreaker operations.

Supporting NSF research in the Antarctic focuses on performing an annual mission, called Operation Deep Freeze (ODF), to break through Antarctic sea ice so as to reach and resupply McMurdo Station, the large U.S. Antarctic research station located on the shore of McMurdo Sound, near the Ross Ice Shelf. The Coast Guard states that *Polar Star*, the Coast Guard's only currently operational heavy polar icebreaker, "spends the [northern hemisphere] winter [i.e., the southern hemisphere summer] breaking ice near Antarctica in order to refuel and resupply McMurdo Station. When the mission is complete, the *Polar Star* returns to dry dock [in Seattle] in order to complete critical maintenance and prepare it for the next ODF mission. Once out of dry dock, it's back to Antarctica, and the cycle repeats itself."[8] In terms of the maximum thickness of the ice to be broken, the annual McMurdo resupply mission generally poses the greatest icebreaking challenge for U.S. polar icebreakers, though Arctic ice can frequently pose its own significant icebreaking challenges for U.S. polar icebreakers. The Coast Guard's medium

[5] Cutters are commissioned Coast Guard vessels greater than 65 feet in length.

[6] For a list of the 11 missions, see footnote 4. The two statutory missions not supported by polar ice operations are illegal drug interdiction and undocumented migrant interdiction. (Department of Homeland Security, *Polar Icebreaking Recapitalization Project Mission Need Statement, Version 1.0*, approved by DHS June 28, 2013, p. 10.)

[7] This passage, beginning with "The roles of...," originated in an earlier iteration of this CRS report and was later transferred by the Government Accountability Office (GAO) with minor changes to Government Accountability Office, *Coast Guard[:]Efforts to Identify Arctic Requirements Are Ongoing, but More Communication about Agency Planning Efforts Would Be Beneficial*, GAO-10-870, September 2010, p. 53.

[8] NyxoLyno Cangemi, "Coast Guard Icebreaker Crew Completes Second Arctic Mission; U.S. Interests in Arctic Domain Depends [sic] on Fleet Recapitalization," *DVIDS (Defense Visual Information Distribution System)*, October 19, 2018.

polar icebreaker, *Healy*, spends most of its operational time in the Arctic supporting NSF research activities and performing other operations.

Although polar ice is diminishing due to climate change, observers generally expect that this development will not eliminate the need for U.S. polar icebreakers, and in some respects might increase mission demands for them. Even with the diminishment of polar ice, there are still significant ice-covered areas in the polar regions, and diminishment of polar ice could lead in coming years to increased commercial ship, cruise ship, and naval surface ship operations, as well as increased exploration for oil and other resources, in the Arctic—activities that could require increased levels of support from polar icebreakers, particularly since waters described as "ice free" can actually still have some amount of ice.[9] Changing ice conditions in Antarctic waters have made the McMurdo resupply mission more challenging since 2000.[10]

The Coast Guard's strategy document for the Arctic region, released on May 21, 2013, states that "The United States must have adequate icebreaking capability to support research that advances fundamental understanding of the region and its evolution," and that "The Nation must also make a strategic investment in icebreaking capability to enable access to the high latitudes over the long-term."[11]

Current U.S. Polar Icebreakers

The operational U.S. polar icebreaking fleet currently consists of one heavy polar icebreaker, *Polar Star*, and one medium polar icebreaker, *Healy*. In addition to *Polar Star*, the Coast Guard has a second heavy polar icebreaker, *Polar Sea*. *Polar Sea*, however, suffered an engine casualty in June 2010 and has been nonoperational since then.

*Polar Sta*r and *Polar Sea* entered service in 1976 and 1978, respectively, and are now well beyond their originally intended 30-year service lives. The Coast Guard in recent years has invested millions of dollars to overhaul, repair, and extend the service life of *Polar Star*, but as a result of its advancing age, the ship's material condition has nevertheless become increasingly fragile, if not precarious. During its annual deployments to McMurdo Station in Antarctica, shipboard equipment frequently breaks, and shipboard fires sometimes occur.[12] Replacements for many of the ship's components are no longer commercially available. To help keep *Polar Star* operational, the Coast Guard is using *Polar Sea* as a source of replacement parts.

For additional background information on current U.S. polar icebreakers and polar research ships, see **Appendix A**.

Required Numbers of U.S. Polar Icebreakers

For background information on required numbers of U.S. polar icebreakers, see **Appendix B**.

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[9] For more on changes in the Arctic due to diminishment of Arctic ice, see CRS Report R41153, *Changes in the Arctic: Background and Issues for Congress*, coordinated by Ronald O'Rourke.

[10] National Research Council, *Polar Icebreakers in a Changing World, An Assessment of U.S. Needs*, Washington, 2007, pp. 6-7, 14, 63.

[11] *United States Coast Guard Arctic Strategy*, Washington, May 2013, p. 35; accessed May 24, 2013, at http://www.uscg.mil/seniorleadership/DOCS/CG_Arctic_Strategy.pdf.

[12] See, for example, Richard Read, "Meet the Neglected 43-Year-Old Stepchild of the U.S. Military-Industrial Complex," *Los Angeles Times*, August 2, 2019; Melody Schreiber, "The Only Working US Heavy Icebreaker Catches Fire Returning from Antarctica," *Arctic Today*, March 2, 2019; Calvin Biesecker, "Fire Breaks Out On Coast Guard's Aging, and Only, Heavy Icebreaker," *Defense Daily*, March 1, 2019.

Coast Guard Polar Security Cutter (PSC) Program

Overview

The PSC program was initiated in the Coast Guard's FY2013 budget submission, and envisages the acquisition of three new heavy polar icebreakers, to be followed years from now by the acquisition of up to three new medium polar icebreakers. The Coast Guard wants to begin construction of the first new heavy polar icebreaker in 2021 and have it enter service in 2024.

Program Name

The PSC program was previously known as the polar icebreaker (PIB) program. Changing the program's name to the PSC program is intended to call attention to the fact that the Coast Guard's polar icebreakers perform a variety of missions relating to national security, not just icebreaking.[13] Although it is now called the PSC program, many observers, as a matter of convenience, may continue to refer to it as the polar icebreaker program.

Coast Guard-Navy Integrated Program Office (IPO)

The PSC program is managed by a Coast Guard-Navy Integrated Program Office (IPO). A key aim in establishing the IPO was to permit the Navy to share its ship-procurement best practices with the Coast Guard so as to help the Coast Guard reduce the time and cost needed to design and procure the PSCs.

Parent Design Approach

The PSC program is using the parent design approach, meaning that the design of the PSC will be based on an existing icebreaker design. A key aim in using the parent design approach is to reduce cost, schedule, and technical risk in the PSC program.

Program Schedule

The PSC program's schedule calls for delivering the three PSCs at 12-month intervals, at the end of the third quarters of FY2024, FY2025, and FY2026, respectively.

Procurement Cost

As shown in **Table 1**, the Coast Guard estimates the total procurement costs of the three heavy polar icebreakers as $1,039 million (i.e., about $1.0 billion) for the first ship, $792 million for the second ship, and $788 million for the third ship, for a combined estimated cost of $2,619 million (i.e., about $2.6 billion). As also shown in **Table 1**, within those figures, the shipbuilder's portion of the total procurement cost is $746 million for the first ship, $544 million for the second ship, and $535 million for the third ship, for a combined estimated shipbuilder's cost of $1,825 million (i.e., about $1.8 billion). The shipbuilder's contract-award cost for the first ship is $745.9 million, with options for the second and third ships that, if exercised, would increase the total value of the contract to $1,942.8 million (i.e., about $1.9 billion).

[13] See, for example, Ben Werner and Sam LaGrone, "Coast Guard Renames New Icebreaker Program 'Polar Security Cutter,'" *USNI News*, September 27, 2018. See also Sydney J. Freedberg Jr., "With Funding In Peril, Coast Guard Pushes Icebreaker As 'Polar Security Cutter,'" Breaking Defense, October 29, 2018.

Table 1. Estimated PSC Procurement Costs

In millions of then-year dollars

Cost element	1st PSC	2nd PSC	3rd PSC	Total
Target contract price	746	544	535	1,825
Program costs (including GFE)	213	165	168	546
Post-delivery costs	45	47	48	140
Costs for Navy-Type, Navy-Owned (NTNO) equipment	35	36	37	108
TOTAL	**1,039**	**792**	**788**	**2,619**

Source: U.S. Navy information paper on PSC program, undated, received from Navy Office of Legislative Affairs, June 14, 2019.

Notes: Target contract price includes detail design, construction, and long lead-time materials (LLTM), and does not reflect potential costs rising to the contract ceiling price. GFE is government-furnished equipment—equipment that the government procures and then provides to the shipbuilder for installation on the ship. NTNO equipment is GFE that the Navy provides—such as combat weapons systems, sensors and communications equipment and supplies—for meeting Coast Guard/Navy naval operational capabilities wartime readiness requirements. (For additional discussion, see Coast Guard Commandant Instruction (COMDTINST) 7100.2G, May 16, 2013, accessed June 24, 2019, at: https://media.defense.gov/2017/Mar/15/2001716816/-1/-1/0/CI_7100_2G.PDF.) The Navy information paper states that program costs, post-delivery costs, and NTNO costs were taken from the Program Life Cycle Cost Estimate (PLCCE) and were in the process of being updated based on the contract award, the contractor's schedule, and refined cost estimates.

Program Funding

The PSC program received about $359.6 million in procurement funding through FY2018, including $300 million provided through the Navy's shipbuilding account (which is part of DOD's budget) and $59.6 million provided through the Coast Guard's procurement account (which is part of the Department of Homeland Security's [DHS's] budget). The FY2019 DHS Appropriations Act (Division A of H.J.Res. 31/P.L. 116-6 of February 15, 2019) provided an additional $675 million for the PSC program through the Coast Guard's procurement account, including $20 million for the procurement of long leadtime materials (LLTM) for the second ship in the program. The PSC program has thus received a total of $1,034.6 million (i.e., about $1.0 billion) in procurement funding through FY2019. The Coast Guard's proposed FY2020 budget requests $35 million in procurement funding for the PSC program, which is enough to cover the PSC program's FY2020 government program-management costs. As shown in **Table C-2**, the Coast Guard's FY2019 budget submission had projected that a total of $125 million in procurement funding would be requested for the PSC program in FY2020.

For additional background information on funding for the PSC program, see **Appendix C**.

Contract Award

On April 23, 2019, the Coast Guard-Navy Integrated Program Office for the PSC program awarded a $745.9 million fixed-price, incentive-firm contract for the detail design and construction (DD&C) of the first PSC to VT Halter Marine of Pascagoula, MS, a shipyard owned by Singapore Technologies (ST) Engineering. VT Halter was the leader of one of three industry teams that competed for the DD&C contract; the other two bidders reportedly were Bollinger

Shipyards of Lockport, Louisiana, and a partnership between Philly Shipyard of Philadelphia and Fincantieri/Marinette Marine, of Marinette, WI.[14]

The first PSC is scheduled to begin construction in 2021 and be delivered in 2024, though the DD&C contract includes financial incentives for earlier delivery. The DD&C contract includes options for building the second and third PSCs. If these options are exercised, the total value of the contract would increase to $1,942.8 million (i.e., about $1.9 billion).[15] The figures of $745.9 million and $1,942.8 million cover the shipbuilder's costs; they do not include the cost of government-furnished equipment (GFE), which is equipment for the ships that the government purchases and then provides to the shipbuilder for incorporation into the ship, or government program-management costs.

Ship Design

Figure 1, **Figure 2**, and **Figure 3** show three renderings of VT Halter's design for the PSC. An April 25, 2019, press report states that "the Coast Guard and Navy said VT Halter Marine's winning design for the new Polar Security Cutter (PSC) 'meets or exceeds all threshold requirements' in the ship specification" for the PSC program.[16]

Figure 1. Rendering of VT Halter Design for PSC

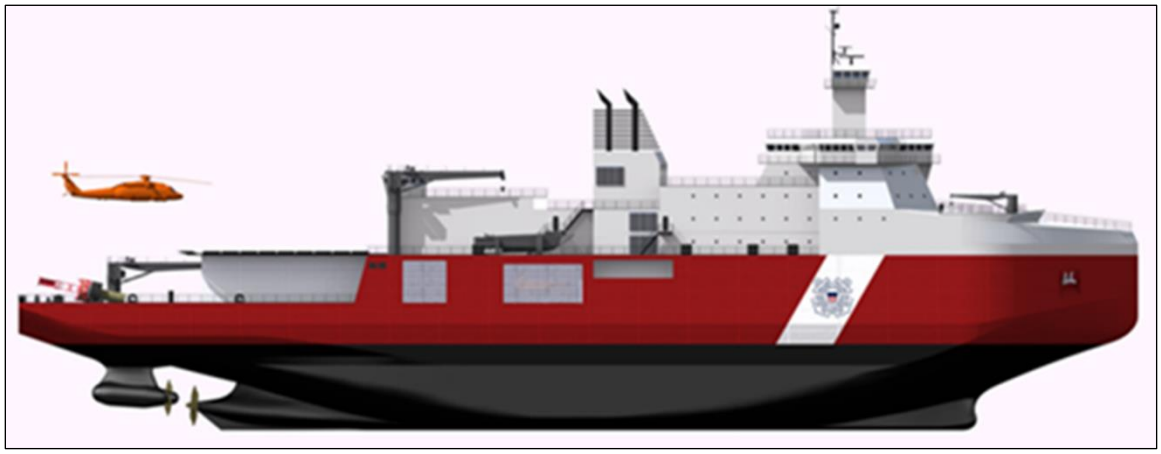
Source: Illustration accompanying Sam LaGrone, "UPDATED: VT Halter Marine to Build New Coast Guard Icebreaker," USNI News, April 23, 2019, updated April 24, 2019. The caption to the illustration states: "An artist's rendering of VT Halter Marine's winning bid for the U.S. Coast Guard Polar Security Cutter. VT Halter Marine image used with permission."

[14] "Mississippi Shipyard Gets $746M Contract for Icebreaker," *Associated Press*, April 23, 2019.

[15] See Naval Sea Systems Command, "Polar Security Cutter Contract Awarded to Recapitalize Nation's Arctic Capabilities," April 23, 2019; Department of Defense, "Contracts for April 23, 2019" (Release No. CR-076-19); Sam LaGrone, "VT Halter Marine to Build New Coast Guard Icebreaker," *USNI News*, April 23, 2019; Maria Armental, "U.S. Orders First heavy Icebreaking Vessel in Decades, as Rivals Expand Arctic Presence," Wall Street Journal, April 23, 2019; "Mississippi Shipyard Gets $746M Contract for Icebreaker," Associated Press, April 23, 2019.

[16] Rich Abott, "Polar Icebreaker Winner Meets Threshold Requirements, Has Incentives For Early Delivery," *Defense Daily*, April 25, 2019.

Figure 2. Rendering of VT Halter Design for PSC



Source: Illustration posted by Robert A. Socha, Senior Vice President, VT Halter Marine, accessed May 6, 2019, at https://www.linkedin.com/feed/update/urn:li:activity:6526621529113976832.

A May 7, 2019, press release from VT Halter about its design for the PSC (which VT Halter updated on May 29 to provide a corrected figure for the design's full load displacement) stated:

> VT Halter Marine is teamed with Technology Associates, Inc. [TAI] as the ship designer and, for over two years, has participated in the U.S. Coast Guard's Heavy Polar Icebreaker Industry Study. The ship design is an evolution from the mature "Polar Stern II" [German icebreaker] currently in design and construction; the team has worked rigorously to demonstrate its maturity and reliability. During the study, TAI incrementally adjusted the design and conducted a series of five ship model tank tests to optimize the design. The vessels are 460 feet in length with a beam of 88 feet overall, a full load displacement of approximately 22,900 long tons at delivery. The propulsion will be diesel electric at over 45,200 horse power and readily capable of breaking ice between six to eight feet thick. The vessel will accommodate 186 personnel comfortably for an extended endurance of 90 days.
>
> In addition to TAI, VT Halter Marine has teamed with ABB/Trident Marine for its Azipod propulsion system,[17] Raytheon for command and control systems integration, Caterpillar for the main engines, Jamestown Metal Marine for joiner package, and Bronswerk for the HVAC system. The program is scheduled to bring an additional 900 skilled craftsman and staff to the Mississippi-based shipyard.[18]

[17] ABB is ASEA Brown Boveri, a multinational corporation headquartered in Zurich, Switzerland, that is, among other things, a leading maker of electric-drive propulsion systems for ships. (ASEA is an acronym for Allmänna Svenska Elektriska Aktiebolaget [i.e., General Swedish Electrical Limited Company], which merged with Brown, Boveri & Cie [BBC] in 1988 to create ABB.) Azipod is ABB's term for its azimuthing (i.e., swiveling) podded propulsors.

[18] VT Halter press release, "VT Halter Marine Awarded the USCG Polar Security Cutter," May 7, 2019, updated May 29, accessed June 12, 2019, at http://vthm.com/wp-content/uploads/2019/05/Press-Release_USCG-PSC_Singapore-Exchange-FINAL_updatedMay29.pdf. The original (May 7) version of the press release stated that the design's full load displacement at delivery would be approximately 33,000 tons.

Figure 3. Rendering of VT Halter Design for PSC

Source: VT Halter press release, "VT Halter Marine Awarded the USCG Polar Security Cutter," May 7, 2019, accessed May 8, 2019, at http://www.vthm.com/public/files/20190507.pdf.

The German icebreaker design referred to in VT Halter's press release, *Polar Stern II* (also spelled *Polarstern II*),[19] is being built as the replacement for *Polarstern*, Germany's current polar research and supply icebreaker. A May 9, 2019, press report stated that *Polarstern II*

> was designed by Germany's Ship Design & Consult (SDC)[20] and is being built by German shipbuilder HDW.[21]
>
> VT Halter's teammates on the PSC include ship designer Technology Associates, Inc. (TAI), which has been involved in the design for over two years and has made "a lot of modifications" in a number of areas to meet Coast Guard requirements, [Ronald Baczkowski, president and CEO of VT Halter Marine] said. The team went through six design spirals to refine the design and the major modifications include changes in the hull form to enhance the ship's icebreaking capabilities and keep the ice clear from the propulsors and sensors, habitability improvements for comfort particularly in open water, easier access to different areas of the ship, and maintenance and endurance capabilities….
>
> Raytheon [RTN] is the integrator for C5I capabilities[22] on the ship and the main engines will be supplied by Caterpillar [CAT]. Switzerland-based ABB and Netherlands-based Trident are supplying the Azipod propulsion system, Florida-based Jamestown Metal Marine is supplying the joiner package, and Netherlands-based Bronswerk the heating, ventilation and cooling system.[23]

Figure 4 shows a rendering of the SDC's concept design for *Polarstern II*.

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[19] *Polarstern* is the German word for Polar Star—coincidentally, the same name as the U.S. Coast Guard's operational heavy polar icebreaker.

[20] SDC Ship Design & Consult GmbH is based on Hamburg, Germany.

[21] Howaldtswerke-Deutsche Werft (HDW) is a part of Thyssenkrupp Marine Systems GmbH, based in Kiel, Germany. (Source: Thyssenkrupp Marine Systems, accessed May 9, 2019, at https://www.thyssenkrupp-marinesystems.com/en/.)

[22] C5I stands for command, control, communications, computers, collaboration, and intelligence.

[23] Calvin Biesecker, "Long-Lead Funding In FY '20 For Second Polar Security Cutter Would Help With Planning, Shipbuilder Says," *Defense Daily*, May 9, 2019. Abbreviations for firm names in brackets as in original.

Figure 4. Rendering of SDC Concept Design for *Polarstern II*

Source: SDC Ship Design & Consult GmbH, design SDC2187, 133m Research Vessel, accessed May 9, 2019, at: http://www.shipdesign.de/html/index.php?navi=3&navi2=80&navi3=115. The image is enlarged at: http://www.shipdesign.de/html/detail.php?id=396.

SDC states that its concept design for *Polarstern II* has a length of 133 meters (about 436.4 feet) long, a beam of 27 meters (about 88.6 feet), and a draft of 10.5 meters (about 34.4 feet), but does not provide the design's displacement.[24] A briefing on a preliminary version of the ship's design stated that the design at that point was somewhat larger, with a length of 145 meters (about 476 feet), a beam of 27.3 meters (about 89.6 feet), a draft of about 11 meters (about 36.1 feet), and a displacement (including payload) of about 26,000 tons.[25] These figures suggest that SDC's somewhat smaller concept design for *Polarstern II* might have a displacement (including payload) of something less than 26,000 tons, and perhaps closer to 23,000 tons.

VT Halter's 22,900-ton design for the PSC is considerably larger than the Coast Guard's current polar icebreakers. As shown in tons **Table A-1**, the Coast Guard's largest polar icebreaker, *Healy*, is 420 feet long and has a full load displacement of 16,000 tons. VT Halter's 460-foot design for

[24] SDC Ship Design & Consult GmbH, design SDC2187, 133m Research Vessel, accessed May 9, 2019, at http://www.shipdesign.de/html/index.php?navi=3&navi2=80&navi3=115.

[25] Briefing entitled "Shipboard Polar Research, 32 Years Polarstern and the requirement for Polarstern II," accessed May 8, 2019, at http://www.ervo-group.eu/np4/np4/%7B$clientServletPath%7D/?newsId=43&fileName=Pr_sentation_Markterkundung_09.09.14_fin.pdf. The briefing is undated but includes a statement on one of its slides that refers in the past tense to an event that took place in January 2016.

the PSC is 40 feet longer than *Healy*, and its 22,900-ton displacement is about 43% greater than *Healy's*.

The horsepower generated by the propulsion plant in VT Halter's design ("over 45,200") is roughly one-quarter less than the 60,000 shaft horsepower of the propulsion plant in the Coast Guard's heavy polar icebreaker, *Polar Star*. A shown in **Figure 1** and **Figure 2**, however, VT Halter's design includes a centerline shafted propeller flanked by two azimuthing (i.e., swiveling) podded propulsors—an arrangement that, along with other modern icebreaker hull design features, is expected to give VT Halter's design a capability for breaking ice comparable to that of *Polar Star*. A May 8, 2019 press report states:

> "We picked the most modern icebreaker that was on the market, soon to be production-level design that roughly met the Coast Guard's requirements, and we took it and modified it," Baczkowski said.
>
> "It has a contoured shape. The shape of the hull does the icebreaking. Instead of being a mass breaking ice, this actually slices the ice. The shape of the hull pushed the broken ice aside, so it doesn't interfere with your propulsion systems, with your instrumentation that's on the other side of the ship."
>
> The design of the cutter is optimized for seakeeping to support the long voyage from its homeport in Washington state to as far away as the Antarctic, he said.
>
> "It's an optimum design between icebreaking and seakeeping."
>
> "With the propulsors, with one fixed and two steerable, we were able to optimize the seakeeping capability so when you're going on long transits from Washington to Antarctica the crew is not beat to a pulp or heavily fatigued because of the stability characteristics in open water."[26]

Home Port

On June 17, 2019, the Coast Guard announced that it intends to homeport its PSCs at Seattle, WA, where the Coast Guard's current polar icebreakers are homeported.[27]

Issues for Congress

FY2020 Funding

One issue for Congress is whether to approve, reject, or modify the Coast Guard's FY2020 procurement funding request for the PSC program. In considering this issue, Congress may consider, among other things, whether the Coast Guard has accurately priced the work it is proposing to do each year in the program, and whether the procurement of the second and/or third PSCs should be deferred or accelerated.

As noted earlier, the $35 million in procurement funding that the Coast Guard has requested for the PSC program for FY2020 is enough to cover the program's FY2020 government program-management costs. As shown in **Table C-2**, the Coast Guard's FY2019 budget submission had projected that a total of $125 million in procurement funding would be requested for the PSC program in FY2020, suggesting that the Coast Guard had projected requesting, beyond the $35

[26] Sam LaGrone, "VT Halter Marine Details Coast Guard Icebreaker Bid," *USNI News*, May 8, 2019.

[27] See, for example, Ben Werner, "Coast Guard Polar Security Cutter Will Be Homeported in Seattle," *USNI News*, June 17, 2019; Navy Times Staff, "Coast Guard Picks Homeport for New Icebreaker Fleet," *Navy Times*, June 17, 2019.

million, another $90 million or so for other costs, such as procurement of long leadtime materials (LLTM) for the second PSC. An April 15, 2019, press report states:

> The Coast Guard's fiscal year 2020 budget request of $35 million for its new heavy icebreaker is insufficient for the purchase of long-lead time materials to maintain the program schedule, Rep. Lou Correa (D-Calif.) said April 9th in his opening remarks at a House Homeland Security Transportation and Maritime Security Subcommittee hearing with the heads of the Coast Guard and Transportation Security Administration. Correa, chairman of the subcommittee, was referring to the advance purchase of materials for the second Polar Security Cutter (PSC). The Coast Guard is expected to award a contract for the detailed design and construction of the first PSC within a month and already has the funding. House staffers say the Coast Guard has told them it needs $100 million for long-lead materials for the second PSC or the ship's schedule will be a risk.[28]

Funding the procurement of LLTM for both the second and third PSCs in FY2020 might enable improved production economies of scale for that LLTM, which could reduce at the margin the procurement cost of the second and third PSCs.

Contract with Options vs. Block Buy Contract

Another potential issue for Congress is whether to use a contract with options or a block buy contract to acquire the ships. As noted earlier, the baseline plan for the PSC program calls for acquiring ships using a contract with options, but Coast Guard and Navy officials are open to the idea of instead using a block buy contract to acquire the ships, and have requested information on this possibility as part of the request for proposals (RFP) for the PSC program that was released on March 2, 2018. Section 311 of the Frank LoBiondo Coast Guard Authorization Act of 2018 (S. 140/P.L. 115-282 of December 4, 2018) provides permanent authority for the Coast Guard to use block buy contracting with economic order quantity (EOQ) purchases (i.e., up-front batch purchases) of components in its major acquisition programs. The authority is now codified at 14 U.S.C. 1137.

Although a contract with options covers multiple years, it operates more like a form of annual contracting, and it does not generate the kinds of savings that are possible with a block buy contract. Compared to a contract with options, a block buy contract would reduce the government's flexibility regarding whether and when to acquire the second and third ships, and what design to build them to,[29] and in return reduce the combined acquisition cost of the ships covered by the contract. The Navy has used block buy contracts to reduce procurement costs of Virginia-class attack submarines and (in more recent years) Littoral Combat Ships (LCSs) and

[28] "Icebreaker Concerns," *Defense Daily*, April 15, 2019.

[29] Stated more fully, from a congressional perspective, trade-offs in using block buy contracting include the following:

-- reduced congressional control over year-to-year spending, and tying the hands of future Congresses;

-- reduced flexibility for making changes in Coast Guard acquisition programs in response to unforeseen changes in strategic or budgetary circumstances (which can cause any needed funding reductions to fall more heavily on acquisition programs not covered by multiyear contracts);

-- a potential need to shift funding from later fiscal years to earlier fiscal years to fund economic order quantity (EOQ) purchases (i.e., up-front batch purchases) of components;

-- the risk of having to make penalty payments to shipbuilders if multiyear contracts need to be terminated due to unavailability of funds needed to the continue the contracts; and

-- the risk that materials and components purchased for ships to be acquired in future years might go to waste if those ships are not eventually acquired.

John Lewis (TAO-205) class oilers.[30] CRS estimates that compared to costs using a contract with options, using a block buy contract that included economic order quantity (EOQ) purchases (i.e., up-front batch purchases) of materials and components for three heavy polar icebreakers would reduce the combined acquisition cost of the three ships by upwards of 7%, which could equate to a savings of upwards of $150 million.

A congressionally mandated July 2017 National Academies of Sciences, Engineering, and Medicine (NASEM) report on acquisition and operation of polar icebreakers states the following (emphasis as in original):

> **3. Recommendation: USCG should follow an acquisition strategy that includes block buy contracting with a fixed price incentive fee contract and take other measures to ensure best value for investment of public funds.**
>
> Icebreaker design and construction costs can be clearly defined, and a fixed price incentive fee construction contract is the most reliable mechanism for controlling costs for a program of this complexity. This technique is widely used by the U.S. Navy. To help ensure best long-term value, the criteria for evaluating shipyard proposals should incorporate explicitly defined lifecycle cost metrics....
>
> A block buy authority for this program will need to contain specific language for economic order quantity purchases for materials, advanced design, and construction activities. A block buy contracting program with economic order quantity purchases enables series construction, motivates competitive bidding, and allows for volume purchase and for the timely acquisition of material with long lead times. It would enable continuous production, give the program the maximum benefit from the learning curve, and thus reduce labor hours on subsequent vessels....
>
> If advantage is taken of learning and quantity discounts available through the recommended block buy contracting acquisition strategy, the average cost per heavy icebreaker is approximately $791 million, on the basis of the acquisition of four ships.[31]

Funding Coast Guard Polar Icebreakers through Navy's Shipbuilding Account

Another potential issue for Congress is whether to continue providing at least some of the procurement funding for the PSC program through the Navy's shipbuilding account, known formally as the Shipbuilding and Conversion Navy (SCN) appropriation account. A May 2018 GAO report states that agreements between DHS, the Coast Guard, and the Navy that were made following the establishment of the Coast Guard-Navy integrated program office for the PSC program "state that the program's contracting actions could be funded by either USCG or Navy appropriations, and the source of the appropriations will award the contract."[32] As noted earlier, of the $300 million of the procurement funding that has provided for the PSC program was

[30] See CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke and Moshe Schwartz; CRS Report RL33741, *Navy Littoral Combat Ship (LCS) Program: Background and Issues for Congress*, by Ronald O'Rourke; and CRS Report R43546, *Navy John Lewis (TAO-205) Class Oiler Shipbuilding Program: Background and Issues for Congress*, by Ronald O'Rourke.

[31] National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies and Transportation Research Board, *Acquisition and Operation of Polar Icebreakers: Fulfilling the Nation's Needs*, Letter Report, with cover letter dated July 11, 2017, pp. 14, 15.

[32] Government Accountability Office, *Homeland Security Acquisitions[:] Leveraging Programs' Results Could Further DHS's Progress to Improve Portfolio Management*, GAO-18-339SP, May 2018, p. 86.

provided through the SCN account—$150 million in FY2017, and another $150 million in FY2018.

Although providing funding for Coast Guard ships through the SCN account creates some complexity in tracking and executing funding for Coast Guard ship acquisition, and can raise a question as to whether that funding would otherwise go toward the acquisition of Navy ships, it has been used in the past for funding Coast Guard ships other than heavy polar icebreakers:

- *Healy* was funded largely (about 89%) through the SCN account.[33]
- Thirty-three of the Coast Guard's 49 Island-class 110-foot patrol boats (i.e., about 67% of the boats) were procured under a Navy contract. The contract was for the construction of 21 of the boats, and included FY1990 SCN funds and prior year DOD nonexpiring funding. During the construction phase of the contract, the Navy exercised options under the contract for the construction 12 additional boats using FY1990 SCN funding.[34]

Subsections (a), (b), and (c) of Section 122 of the FY2018 National Defense Authorization Act (H.R. 2810/P.L. 115-91 of December 12, 2017) state the following:

> SEC. 122. Icebreaker vessel.
>
> (a) Authority to procure one polar-class heavy icebreaker.—
>
> (1) IN GENERAL.—There is authorized to be procured for the Coast Guard one polar-class heavy icebreaker vessel.
>
> (2) CONDITION FOR OUT-YEAR CONTRACT PAYMENTS.—A contract entered into under paragraph (1) shall provide that any obligation of the United States to make a payment under the contract for a fiscal year after fiscal year 2018 is subject to the availability of appropriations or funds for that purpose for such later fiscal year.
>
> (b) Limitation on availability of funds for procurement of icebreaker vessels.—None of the funds authorized to be appropriated by this Act or otherwise made available for the Department of Defense for any fiscal year that are unobligated as of the date of the enactment of this Act may be obligated or expended for the procurement of an icebreaker vessel other than the one polar-class heavy icebreaker vessel authorized to be procured under subsection (a)(1).
>
> (c) Contracting authority.—

[33] The somewhat complicated funding history for the ship is as follows: The Coast Guard's proposed FY1990 budget requested $244 million for the acquisition of an icebreaker. The FY1990 DOD appropriations act (H.R. 3072/P.L. 101-165 of November 21, 1989) provided $329 million for the ship in the SCN account. (See pages 77 and 78 of H.Rept. 101-345 of November 13, 1989.) This figure was then reduced by $4.2 million by a sequester carried out under the Balanced Budget And Emergency Deficit Control Act of 1985, also known as the Gramm-Rudman-Hollings Act (H.J.Res. 372/P.L. 99-177 of December 12, 1985). Another $50 million was rescinded by the Dire Emergency Supplemental Appropriations for Disaster Assistance, Food Stamps, Unemployment Compensation Administration, and Other Urgent Needs, and Transfers, and Reducing Funds Budgeted for Military Spending Act of 1990 (H.R. 4404/P.L. 101-302 of May 25, 1990). An additional $59 million for the ship was then appropriated in the FY1992 DOD Appropriations Act (H.R. 2521/P.L. 102-172 of November 26, 1991). Also, an additional $40.4 million in procurement funding for the ship was provided through a series of annual appropriations in the Coast Guard's Acquisition, Construction, and Improvements (AC&I) account (as it was known prior to FY2019) from FY1988 through FY2001. The resulting net funding for the ship was thus $374.2 million, of which $333.8 million, or 89.2%, was DOD funding, and $40.4 million, or 10.8%, was Coast Guard procurement funding. (Source: Undated Coast Guard information paper provided to CRS by Coast Guard legislative liaison office, March 3, 2016.)

[34] Source: Navy information paper dated August 15, 2017, provided to CRS by Navy Office of Legislative Affairs on August 23, 2017.

> (1) COAST GUARD.—If funds are appropriated to the department in which the Coast Guard is operating to carry out subsection (a)(1), the head of contracting activity for the Coast Guard shall be responsible for contracting actions carried out using such funds.
>
> (2) NAVY.—If funds are appropriated to the Department of Defense to carry out subsection (a)(1), the head of contracting activity for the Navy, Naval Sea Systems Command shall be responsible for contracting actions carried out using such funds.
>
> (3) INTERAGENCY ACQUISITION.—Notwithstanding paragraphs (1) and (2), the head of contracting activity for the Coast Guard or head of contracting activity for the Navy, Naval Sea Systems Command (as the case may be) may authorize interagency acquisitions that are within the authority of such head of contracting activity.[35]

Regarding Section 122, the conference report (H.Rept. 115-404 of November 9, 2017) on H.R. 2810/P.L. 115-91 states the following:

> *Icebreaker vessel (sec. 122)*
>
> The House bill contained provisions (sec. 122, 123, and 1012) that would authorize the Secretary of the Navy to act as a general agent for the Secretary of the Department in which the Coast Guard is operating and enter into a contract for icebreaker vessels; prohibit funds for the Department of Defense from being used for the procurement of an icebreaker vessel; and amend section 2218 of title 10, United States Code, to authorize funds associated with the National Defense Sealift Fund for the construction of icebreaker vessels.
>
> The Senate amendment contained a similar provision (sec. 1048).
>
> The Senate recedes with an amendment that would authorize one polar-class heavy icebreaker vessel, prohibit funds for the Department of Defense from being used for the procurement of an icebreaker vessel other than this one polar-class heavy icebreaker vessel, clarify contracting authorities, and require a Comptroller General report.
>
> The conferees recognize the national importance of recapitalizing the U.S. icebreaker fleet and the extraordinary circumstances that necessitated use of Department of Defense funding to procure the first polar-class heavy icebreaker, as partially provided in the Department of Defense Appropriations Act for Fiscal Year 2017. Accordingly, the conferees support the authorization of this icebreaker in this Act.
>
> The conferees note the Undersecretary of Management in the Department of Homeland Security (DHS) serves as the Acquisition Decision Authority for the Polar Icebreaker Program and that this program is governed in accordance with DHS Acquisition Management Directive 102–01 and Instruction 102–01–001.
>
> The conferees believe maintaining clear lines of authority, responsibility, accountability, and resources with the Secretary and Acquisition Decision Authority of the department in which the U.S. Coast Guard is operating are essential to delivering icebreakers on cost and schedule.
>
> Accordingly, the conferees believe the Secretary of the Department of Homeland Security and the Undersecretary of Management in the DHS should be the officials provided with authorities and resources related to the Polar Icebreaker Program.
>
> Therefore, the conferees expect subsequent icebreakers to be authorized by the congressional committees with jurisdiction over the Coast Guard and funded using Coast Guard appropriations. (Pages 765-766)

[35] Section 122 also includes a subsection (d) that requires a GAO report assessing the cost of, and schedule for, the procurement of new icebreakers.

Technical, Schedule, and Cost Risk for PSC Program

Another potential issue for Congress concerns technical, schedule, and cost risk in the PSC program. A September 2018 GAO report on the PSC program states that the Coast Guard

> did not have a sound business case in March 2018, when it established the cost, schedule, and performance baselines for its heavy polar icebreaker acquisition program, because of risks in four key areas:
>
> **Design.** The Coast Guard set program baselines before conducting a preliminary design review, which puts the program at risk of having an unstable design, thereby increasing the program's cost and schedule risks. While setting baselines without a preliminary design review is consistent with DHS's current acquisition policy, it is inconsistent with acquisition best practices. Based on GAO's prior recommendation, DHS is currently evaluating its policy to better align technical reviews and acquisition decisions.
>
> **Technology.** The Coast Guard intends to use proven technologies for the program, but did not conduct a technology readiness assessment to determine the maturity of key technologies prior to setting baselines. Coast Guard officials indicated such an assessment was not necessary because the technologies the program plans to employ have been proven on other icebreaker ships. However, according to best practices, such technologies can still pose risks when applied to a different program or operational environment, as in this case. Without such an assessment, the program's technical risk is underrepresented.
>
> **Cost.** The lifecycle cost estimate that informed the program's $9.8 billion cost baseline substantially met GAO's best practices for being comprehensive, well-documented, and accurate, but only partially met best practices for being credible. The cost estimate did not quantify the range of possible costs over the entire life of the program. As a result, the cost estimate was not fully reliable and may underestimate the total funding needed for the program.
>
> **Schedule.** The Coast Guard's planned delivery dates were not informed by a realistic assessment of shipbuilding activities, but rather driven by the potential gap in icebreaking capabilities once the Coast Guard's only operating heavy polar icebreaker—the Polar Star—reaches the end of its service life....
>
> GAO's analysis of selected lead ships for other shipbuilding programs found the icebreaker program's estimated construction time of 3 years is optimistic. As a result, the Coast Guard is at risk of not delivering the icebreakers when promised and the potential gap in icebreaking capabilities could widen.[36]

Common Design for Heavy and Medium Polar Icebreakers

Another potential issue for Congress is whether to procure heavy and medium polar icebreakers to a common basic design. As noted earlier, the DHS polar icebreaker mission need statement (MNS) states that "current requirements and future projections ... indicate the Coast Guard will need to expand its icebreaking capacity, potentially requiring a fleet of up to six icebreakers (3 heavy and 3 medium) to adequately meet mission demands in the high latitudes...." Consistent with this statement, the Coast Guard envisages procuring up to three new medium icebreakers after it procures three new heavy polar icebreakers. The question is whether to develop a separate design for the medium polar icebreakers, or instead build the medium polar icebreakers to the same basic design as the heavy polar icebreakers.

[36] Government Accountability Office, *Coast Guard Acquisitions[:] Polar Icebreaker Program Needs to Address Risks before Committing Resources*, GAO-18-600, summary page.

A congressionally mandated July 2017 report from the National Academies of Sciences, Engineering, and Medicine (NASEM) on the acquisition and operation of polar icebreakers concluded that notional operational requirements for new medium polar icebreakers would result in ships that would not be too different in size from new heavy polar icebreakers. (As shown in **Table A-1**, the Coast Guard's current medium polar icebreaker, *Healy*, is actually somewhat larger than the Coast Guard's heavy polar icebreaker, *Polar Star*.) Given what it concluded as the probable similarity in size between future U.S. heavy and medium polar icebreakers, the NASEM report recommended building a single medium polar icebreaker to the same common design as three new heavy polar icebreakers. This approach, the report concluded, would reduce the cost of the medium icebreaker by avoiding the cost of developing a new design and by making the medium polar icebreaker the fourth ship on an existing production learning curve rather than the first ship on a new production learning curve. The NASEM report stated the following (emphasis as in original):

> **2. Recommendation: The United States Congress should fund the construction of four polar icebreakers of common design that would be owned and operated by the United States Coast Guard (USCG).**
>
> The current Department of Homeland Security (DHS) Mission Need Statement... contemplates a combination of medium and heavy icebreakers. The committee's recommendation is for a single class of polar icebreaker with heavy icebreaking capability. Proceeding with a single class means that only one design will be needed, which will provide cost savings. The committee has found that the fourth heavy icebreaker could be built for a lower cost than the lead ship of a medium icebreaker class....
>
> The DHS Mission Need Statement contemplated a total fleet of "potentially" up to six ships of two classes—three heavy and three medium icebreakers. Details appear in the High Latitude Mission Analysis Report. The Mission Need Statement indicated that to fulfill its statutory missions, USCG required three heavy and three medium icebreakers; each vessel would have a single crew and would homeport in Seattle. The committee's analysis indicated that four heavy icebreakers will meet the statutory mission needs gap identified by DHS for the lowest cost....
>
> **4. Finding: In developing its independent concept designs and cost estimates, the committee determined that the costs estimated by USCG for the heavy icebreaker are reasonable. However, the committee believes that the costs of medium icebreakers identified in the High Latitude Mission Analysis Report are significantly underestimated**....
>
> Although USCG has not yet developed the operational requirements document for a medium polar icebreaker, the committee was able to apply the known principal characteristics of the USCG Cutter Healy to estimate the scope of work and cost of a similar medium icebreaker. The committee estimates that a first-of-class medium icebreaker will cost approximately $786 million. The fourth ship of the heavy icebreaker series is estimated to cost $692 million. Designing a medium-class polar icebreaker in a second shipyard would incur the estimated engineering, design, and planning costs of $126 million and would forgo learning from the first three ships; the learning curve would be restarted with the first medium design. Costs of building the fourth heavy icebreaker would be less than the costs of designing and building a first-of-class medium icebreaker....
>
> **6. Recommendation: USCG should ensure that the common polar icebreaker design is science-ready and that one of the ships has full science capability.**
>
> All four proposed ships would be designed as "science-ready," which will be more cost-effective when one of the four ships—most likely the fourth—is made fully science capable. Including science readiness in the common polar icebreaker design is the most cost-effective way of fulfilling both the USCG's polar missions and the nation's scientific

> research polar icebreaker needs.... The incremental costs of a science-ready design for each of the four ships ($10 million to $20 million per ship) and of full science capability for one of the ships at the initial build (an additional $20 million to $30 million) are less than the independent design and build cost of a dedicated research medium icebreaker.... In briefings at its first meeting, the committee learned that the National Science Foundation and other agencies do not have budgets to support full-time heavy icebreaker access or the incremental cost of design, even though their science programs may require this capability. Given the small incremental cost, the committee believes that the science capability cited above should be included in the acquisition costs.
>
> Science-ready design includes critical elements that cannot be retrofitted cost-effectively into an existing ship and that should be incorporated in the initial design and build. Among these elements are structural supports, appropriate interior and exterior spaces, flexible accommodation spaces that can embark up to 50 science personnel, a hull design that accommodates multiple transducers and minimizes bubble sweep while optimizing icebreaking capability, machinery arrangements and noise dampening to mitigate interference with sonar transducers, and weight and stability latitudes to allow installation of scientific equipment. Such a design will enable any of the ships to be retrofitted for full science capability in the future, if necessary....
>
> Within the time frame of the recommended build sequence, the United States will require a science-capable polar icebreaker to replace the science capabilities of the *Healy* upon her retirement. To fulfill this need, one of the heavy polar icebreakers would be procured at the initial build with *full* science capability; the ability to fulfill other USCG missions would be retained. The ship would be outfitted with oceanographic overboarding equipment and instrumentation and facilities comparable with those of modern oceanographic research vessels. Some basic scientific capability, such as hydrographic mapping sonar, should be acquired at the time of the build of each ship so that environmental data that are essential in fulfilling USCG polar missions can be collected.[37]

If policymakers decide to procure a second new medium polar icebreaker or a third new medium polar icebreaker, the same general approach recommended by the NASEM report could be followed—a second medium polar icebreaker and third medium polar icebreaker could be built to the same common design used for the three new heavy polar icebreakers and the first new medium polar icebreaker.

An April 12, 2018, press report states the following:

> As the Coast Guard prepares to review industry bids for a new heavy polar icebreaker, the service is keeping its options open for the right number and mix of polar icebreakers it will need in the future, Adm. Paul Zukunft, the [then-]commandant of the Coast Guard, said on Wednesday [April 11].
>
> The Coast Guard's program of record is for three heavy and three medium polar icebreakers but Zukunft said the "jury is still out" whether that will remain so. Right now, the service is aiming toward building three new heavy icebreakers, but it might make sense just to keep building these ships, he told reporters at a Defense Writers Group breakfast in Washington, D.C.
>
> Zukunft said that "when you start looking at the business case after you build three, and then you need to look at what is the economy of scale when you start building heavy icebreakers, and would it be less expensive to continue to build heavies and not mediums." He added that the heavy icebreakers provide more capability, and if the price is

[37] National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies and Transportation Research Board, *Acquisition and Operation of Polar Icebreakers: Fulfilling the Nation's Needs*, Letter Report, with cover letter dated July 11, 2017, pp. 2, 4-6.

> "affordable" and in "the same range" as building medium icebreakers, then "maybe you end up with one class of heavy icebreakers."
>
> Building only one class of ships has a number of advantages in terms of maintenance, crew familiarity, configuration management, and more, he said. A decision on what the future icebreaker fleet will consist of is "still probably several years out .... but that's one option that we want to keep open going forward," Zukunft said.[38]

Short-Term Bridge to One or More New Polar Icebreakers

Overview: Two Basic Options

As mentioned earlier, a new heavy polar icebreaker that begins construction in FY2019 might enter service in 2023, while *Polar Star* was refurbished and reentered service in December 2012 for an intended period of 7 to 10 years—a period that will end between December 2019 and December 2022.[39] Consequently, another potential issue for Congress concerns how to bridge a potential gap in time between the end of *Polar Star's* current intended service life and the entry into service of one or more new heavy polar icebreakers.

As testified by CRS on July 21, 2016,[40] there are at least two options for bridging this time period: One would be to further extend the service life of *Polar Star*. The other would be to charter (i.e., lease) one or more other icebreakers (perhaps foreign-owned ones), if such ships are available for charter and have capabilities for performing missions performed by U.S. heavy polar icebreakers. The United States has used both of these approaches in the past to mitigate polar icebreaking capacity gaps.[41]

Coast Guard Plan is to Further Extend Life of Polar Star

The Coast Guard plans to pursue the first of the two options outlined above—further extend the service life of *Polar Star*—and has requested funding in its FY2019 budget for service life extension work on *Polar Star*. A September 25, 2017, GAO report on polar icebreakers states the following:

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[38] Calvin Biesecker, "Coast Guard Leaving Options Open For Future Polar Icebreaker Fleet Type," *Defense Daily*, April 12, 2018. Ellipse as in original.

[39] The September 25, 2017, GAO report on polar icebreakers states the following: "According to Coast Guard planning documents, the *Polar Star's* useful service life will end between fiscal years 2020 and 2023." (Government Accountability Office, *Coast Guard: Status of Polar Icebreaking Fleet Capability and Recapitalization Plan*, GAO-17-698R, September 25, 2017, p. 6.

[40] See CRS Testimony TE10012, *Coast Guard Arctic Implementation Capabilities*, by Ronald O'Rourke.

[41] Regarding the first option, the Coast Guard, in addition to the work done to extend the service life of *Polar Star* by an additional 7 to 10 years, also mitigated a polar icebreaking capacity gap in the 1970s by putting two of its older Wind-class icebreakers through a vessel rehabilitation and modernization (VRAM) program. (See National Research Council, Polar Icebreakers in a Changing World: An Assessment of U.S. Needs, Washington, 2007, p. 55. See also Donald L. Canney, "Icebreakers and the U.S. Coast Guard," accessed June 28, 2016, at http://www.uscg.mil/history/webcutters/Icebreakers.asp.)

Regarding the second option, since 2005, the National Science Foundation (NSF) has occasionally chartered foreign polar icebreakers—specifically, the Russian icebreakers *Krasin* and *Vladimir Ignatyuk*, and the Swedish icebreaker *Oden*—to help perform icebreaking missions in polar waters. (Regarding the charters of *Krasin* and *Oden*, see National Research Council, *Polar Icebreakers in a Changing World: An Assessment of U.S. Needs*, Washington, 2007, pp. 6, 14, 63, 80, 97, 111, and U.S. Coast Guard Research & Development Center and ABS Consulting, *Polar Icebreaker Options, Paths Forward to Accomplish U.S. Coast Guard Missions and Contribute to Mission Critical National Science Needs*, May 17, 2011, pp. 9, 14.)

> While the Coast Guard considered various options to bridge this potential heavy icebreaker gap, in a January 2017 study the Coast Guard reported that it was planning for a limited service life extension of the Polar Star to keep it operational until fiscal year 2025, at an initial cost estimate of $75 million. However, the Coast Guard has not completed a formal cost estimate for this effort and we have previously reported that the $75 million estimate may be unrealistic....
>
> The Coast Guard's Capital Investment Plan for fiscal years 2018-2022 includes $60 million of a planned $75 million for polar icebreaker sustainment, which officials reported as being the rough estimate for the Polar Star's limited service life extension. Coast Guard officials stated that the $75 million rough estimate is based on the cost of the Polar Star's prior 7-10 year service life extension which was completed in fiscal year 2013. However, in July 2017 we reported that the Coast Guard has not completed a cost estimate for this effort, and that the $75 million estimate may be unrealistic based on the assumptions the Coast Guard used, such as continuing to use parts from the Polar Sea as has been done in previous maintenance events.[42]

A July 2018 GAO report states the following:

> The Coast Guard is planning a SLEP on the Polar Star to keep it operational until the first and second new heavy polar icebreakers are delivered (planned for 2023 and 2025, according to current acquisition plans) in order to bridge a potential operational gap. This approach would allow the Coast Guard to operate a minimum of two heavy icebreakers once the first polar icebreaker is delivered. The approach would also provide the Coast Guard with a self-rescue capability—the ability for one icebreaker to rescue the other if it became incapacitated while performing icebreaking operations.
>
> The Coast Guard's plan to conduct the Polar Star SLEP during its existing annual depot-level maintenance periods may not be feasible given the amount of maintenance already required on the cutter. The Polar Star's mission capable rating has been decreasing in recent years and reached a low point of 29 percent—well below the target of 41 percent—from October 2016 to September 2017. Based on mission capable data, we found this is mostly due to additional time spent in depot-level maintenance, which has increased in recent years from about 6 months in 2015 to more than 8 months in 2017.
>
> Additionally, the Polar Star has required extensions of about 3 months for its annual dry dock periods—the period of time when a cutter is removed from the water so that maintenance can be conducted—in 2016 and 2017 to complete required maintenance activities. These dry docks were originally planned to last between 2-1/2 months and 4 months. These extensions also compressed the amount of time that the crew had to prepare for its annual mission to Antarctica, which, according to members of the Polar Star crew, placed a large stress on the crew, risked the quality of work, and reduced or eliminated the crews' planned rest and personal preparation for their roughly 4-month deployment. Based on our analysis, these delays and extensions are likely to continue as the cutter ages. According to Coast Guard officials, the Polar Star's SLEP work will be conducted during the annual dry dock periods by adding an additional 1 or 2 months to the annual dry docks. However, if the work is unable to be completed during this time frame, it could force the Coast Guard to miss its commitment to conduct the annual Antarctica mission. Coast Guard maintenance officials stated that until the Polar Star completes the SLEP, its repairs will likely continue to get more expensive and time consuming. We will continue to monitor the Polar Star's SLEP through our annual review of DHS programs.
>
> As we found in July 2017, the Polar Star SLEP effort has a rough order cost estimate of $75 million, which is based on the reactivation work completed in 2013.41 However, this estimate may be unrealistic based on assumptions the Coast Guard used, such as that it

[42] Government Accountability Office, *Coast Guard: Status of Polar Icebreaking Fleet Capability and Recapitalization Plan*, GAO-17-698R, September 25, 2017, pp. 3, 8.

> would continue to use parts from the Coast Guard's other heavy polar icebreaker, the Polar Sea, which has been inactive since 2010.42 The Coast Guard's recent assessment of the Polar Star's material condition—the physical condition of the cutter, which includes the hull structure, habitability, major equipment systems, and spare parts availability—was completed in January 2018.43 The material assessment stated that many of the available parts from the Polar Sea have already been removed and installed on the Polar Star. As a result of the finite parts available from the Polar Sea, the Coast Guard may have to acquire new parts for the Polar Star that could increase the $75 million SLEP estimate. The Polar Star's recent material assessment will form the basis to determine which systems will be overhauled during the SLEP and for a more detailed cost estimate. The Coast Guard expects the program to reach the obtain phase of the acquisition life cycle by December 2019, at which time the Polar Star could reach the end of its current useful service life (currently projected to be between 2020 to 2023). This timeline contains risk that the Polar Star could be rendered inoperable before the cutter is able to undergo a SLEP.[43]

Another Option: Chartering an Icebreaker

Overview

The feasibility of the second of the two options outlined above—charter (i.e., lease) one or more other icebreakers—would depend on whether an icebreaker was available for charter at the time of the year when the United States would need it to perform desired missions in the Arctic or Antarctic. Foreign polar icebreakers are used by their own countries for icebreaking operations, and may not always be available for charter when the United States might want to use them. If an icebreaker were available for charter, the potential cost effectiveness of this option would then depend on the cost of the charter, the ability of the ship to perform U.S. polar icebreaker missions, and how these costs and capabilities compare to the option of extending the service life of *Polar Star*.

The Coast Guard stated in July 2016 that

> NSF leased the icebreaker KRASIN from Russia from 2005-2006, ODEN from the Swedish government from 2007-2010, and VLADIMIR IGNATYUK from Russia in 2012 to support the McMurdo resupply mission. All leases were time charters, and crews were supplied with the leases. As a contingency measure, NSF obtained assurances of assistance from other vessels in the area, such as the Chinese flagged [icebreaking] vessel XUE LONG, in the event they encountered difficulty. They also hired icebreaker captains with previous McMurdo experience to supplement the crew. NSF acquired these leases through a RFP process, and had no assurances that icebreakers would be available to perform the mission, or what price would be quoted.
>
> This process came with risks, as there was no way to gauge icebreaker availability until NSF received responses to their RFP. Additionally, a foreign-flagged commercial or state vessel can become unavailable for a variety of environmental and political reasons. For example, the Swedish government abruptly terminated their contract during the spring/summer of 2011, and NSF was left without a platform to conduct its mission. NSF requested support from CGC [Coast Guard cutter] HEALY, but it was employed in the Arctic. NSF ultimately leased the Russian icebreaker VLADIMIR IGNATYUK. After that incident, NSF decided to utilize CGC POLAR STAR to support the McMurdo mission, which it has been doing since 2013.[44]

[43] Government Accountability Office, *Coast Guard Acquisitions[:] Actions Needed to Address Longstanding Portfolio Management Challenges*, GAO-18-454, July 2018, pp. 29-31.

[44] Source: Email from Guard Office of Congressional Affairs to CRS, July 8, 2016.

Aiviq Being Offered for Lease

One ship that is being offered for lease to the Coast Guard as an interim polar icebreaker is *Aiviq* (**Figure 5**), an Arctic oil-exploration support ship owned by Edison Chouest Offshore (ECO). The 361-foot-long ship was ordered in 2009, completed in 2012, and chartered by Royal Dutch Shell to support that company's effort (now ended) to explore for oil in Arctic waters.[45]

Figure 5. *Aiviq*

Source: "Arctic Supply Vessel Aiviq," accessed September 14, 2017, at http://www.mascoat.com/arctic-supply-vessel-aiviq1.html.

Following Shell's decision to end that effort, alternative uses for *Aiviq* have been sought. The ship has been modified to serve as a polar icebreaker, and it is being offered to the Coast Guard for lease as an interim polar icebreaker. It reportedly has also been offered for use as an icebreaker to the Canadian government.

The possibility of leasing *Aiviq* as an interim polar icebreaker has been discussed at certain recent hearings about the Coast Guard. For example, at a July 25, 2017, hearing on Coast Guard capabilities before the Coast Guard and Maritime transportation subcommittee of the House Transportation and Infrastructure Committee, the following exchange occurred:

> REPRESENTATIVE DON YOUNG (continuing):
>
> Have you looked at, Admiral, I know this has been an ongoing battle with me and the Coast Guard over the years, the other possibility of getting an ice breaker into the arena quicker

[45] See for example, "More Sparks Fly in Canada Shipbuilding Controversy," *Marine Log*, March 18, 2016; Pierre Leblanc, "An Out-of-the-Blue Icebreaker Opportunity," *Maritime Executive*, January 2, 2018.

than having one constructed like leasing from another outfit? You know, I've been talking about this a long time. Have you analyzed this again?

I know the last time we had a study, it was 1980. That's a long time ago. So is there a way we can put metal on the water, especially for the new shipping through and the—and the cruise ships, because that Healy is old, and—is—have you looked at that at all?

ADMIRAL PAUL ZUKUNFT, [THEN-]COMMANDANT, U.S. COAST GUARD:

We have. In fact, one potential vendor, we've had multiple interactions. They have a platform that has yet to complete ice trials. We—we would not want to lease something they can't demonstrate its ability to actually operate in the ice that—that Healy sees. Healy was actually beset in ice for 36 hours last year, so it's not ice free up there, and that's a medium ice breaker. This particular platform doesn't have the capability of Healy.

But we would at least want to make sure that ice trials were completed. That we could actually be a good steward of taxpayer dollars, so at least a platform that would meet our requirements. So we've had multiple interactions, the last one was probably in May, and the issue of ice trials is still on the table right now.[46]

Later in the same hearing, the following exchange occurred:

REPRESENATIVE DUNCAN HUNTER, CHAIRMAN:

Going back to Mr. Young's question. too, about leasing. You said you—you're—you're waiting for—I'm—I'm guessing money for ice trials. That's what you said.

ZUKUNFT:

No real dollars have been negotiated in any of this. So...

HUNTER:

But in—in real terms, you're only paying for gas? I mean what—what does it cost to do ice trials. It's gas, right? You're not going to hire more Coast Guardsmen to come in and—and do it. I mean so that's a figure—your—your overhead's fixed. So what is the cost to—to go do ice trials with the (inaudible)?

ZUKUNFT:

That would really be for the...

HUNTER:

The ice—once again the only...

ZUKUNFT:

... vendor to decide.

HUNTER:

... existing U.S. made ice breaker in America.

ZUKUNFT:

Yeah. So this—this is a ship that is built with direct drive diesel. Ice breakers are typically diesel electric, which means the generators push the shaft, and they absorb that shock load every time you collide with ice.

A reduction gear, fixed gear is going to that—that gear box is going to absorb all that shock. So if you're going to do ice trials, there's a likelihood you might have to replace a reduction

[46] Source: Transcript of hearing.

> gear. There might be real hidden costs of doing ice trials. So if I'm a vendor, I might want to protect myself from some of that risk.
>
> Now I'm not the vendor but those would be some of my thoughts of, OK, if you're really serious about this and I do ice trials and now I've just caused X number of dollars that I am now going to have to fit. And oh, by the way, you're not going to lease it because it didn't meet your requirements. I think those are some of the issues that we still have to negotiate.[47]

At a June 14, 2016, hearing on Coast Guard mission needs and resource allocation before the Coast Guard and Maritime Transportation subcommittee of the House Transportation and Infrastructure Committee, the following exchange occurred:

> REPRESENTATIVE HUNTER (Chairman):
>
> How do you plan on—on filling the capability gap until you get a heavy icebreaker, which is 10 years at the least based on the best projections of Congress and everybody working together? You still haven't answered that one.
>
> ADMIRAL MICHEL:
>
> Well, right—the alternatives now, since we'll provide the answer to that, and it's probably going to be either a rolling recapitalization of the *Polar Star* or to try to bring—let *Polar Star* taper off and then try to bring *Polar Sea* back on and bridge out to the new icebreaker.
>
> I do not know which one at this point, which path we would want to take. I'm not aware of any other—we've looked out there for vessels to lease for heavy icebreaking capabilities. There's nothing out there on planet earth that you can lease in the heavy icebreaking area. So that's kind of where we are, sir.
>
> HUNTER:
>
> Was it the—the Finns that came into my office?
>
> (UNKNOWN)
>
> Mm-hmm.
>
> HUNTER:
>
> Can't remember whether we had the Norwegians or the Finns. I mean, they—have you—you've obviously looked at that, right?
>
> MICHEL:
>
> Yes. As a matter of fact I—I traveled to Sweden and Finland...
>
> HUNTER:
>
> Yeah.
>
> MICHEL:
>
> ... and talked to them. And they do not have heavy icebreaking capability that will meet the needs as in the FedBizOpps. As a matter of fact, in—when I'm talking FedBizOpps [I mean] there's a technical package that the Coast Guard put out for our [new] heavy icebreaker [i.e., the one that the Obama Administration wanted to begin building in 2020].
>
> It kind of lays out our basic requirements including the long pole in the tent which is the icebreaking requirement, which is six foot minimum at three knots, desirable eight-foot minimum at three knots and then 21 feet backing and ramming.

[47] Source: Transcript of hearing.

> When I talked to the shipbuilders over there, they said there is not a vessel like that that currently exists that will meet those requirements in the—in the FedBizOpps technical package. So you'd have to build a vessel like that. And that's the type of vessel that we're looking for.[48]

Legislative Activity for FY2020

Summary of Appropriation Action on FY2020 Funding Request

The Coast Guard's proposed FY2020 budget requests $35 million in Coast Guard procurement funding for the PSC program. **Table 2** summarizes congressional appropriation action on the program's FY2019 funding request.

Table 2. Summary of Congressional Appropriations Action on FY2030 Funding Request

(millions of dollars)

Polar icebreaker	Request	HAC	SAC	Conf.
New polar icebreaker				
Coast Guard acquisition account	35	135		
Navy shipbuilding account	0	0		
Total new polar icebreaker	***35***	***135***		
Polar sustainment (service life extension of* Polar Star*)				
Coast Guard acquisition account	15	15		
Total	**50**	**150**		

Source: Table prepared by CRS, based on Coast Guard's FY2020 budget submission and HAC committee report, SAC chairman's recommendation and explanatory statement on FY2020 DHS Appropriations Act and FY2020 DOD Appropriations Act, joint explanatory statement for H.J.Res. 31, and committee and conference reports on the FY2019 DOD appropriations act. **HAC** is House Appropriations Committee; **SAC** is Senate Appropriations Committee; **Conf.** is conference agreement.

FY2020 DHS Appropriations Act (H.R. ----)

House

On June 11, 2019, the House Appropriations Committee approved, 29-20, its version of the FY2020 DHS Appropriations Act. As of July 25, 2019, the bill as approved by the committee and the committee's report on the bill were not posted on Congress.gov. The committee's draft version of the bill, the amendments to it that were adopted during the full committee markup, and the committee's draft report on the bill, however, were posted at the committee's website, and the discussion here is based on that information.

The House Appropriations Committee, in its draft report (H.Rept. 116----) on the FY2020 DHS Appropriations Act (H.R. ----), recommended the funding levels shown in the HAC column of **Table 2**. The committee's draft report states:

[48] Transcript of hearing.

> *Ice Breaking Vessels.*—The Committee recognizes that Polar icebreakers are essential to securing the nation's security and economic interests in the polar regions. The Committee was pleased that the Coast Guard recently awarded a contract for the first Polar Security Cutter (PSC) with funding appropriated in fiscal year 2019 and looks forward to updates on the execution of the contract to inform the planning for the next phase of the program. The recommendation includes $135,000,000 for this program, $100,000,000 above the request, for long lead time materials for a second PSC.
>
> The Committee notes that $10,000,000 has been appropriated in prior fiscal years for survey and design of a Great Lakes Icebreaker. The Committee encourages the Coast Guard to explore whether the acquisition of medium icebreakers that are at least as capable as USCGC MACKINAW could fulfill mission requirements in both the polar regions and the Great Lakes. (Page 41)

The committee's draft report also states (emphasis added):

> *Asset Acquisition Report.*—The Commandant is directed to provide to the Committee, not later than one year after the date of enactment of this Act, a report that examines the number and type of Coast Guard assets required to meet the Service's current and foreseeable needs in accordance with its statutory missions. The report shall include, but not be limited to, an assessment of the required number and types of cutters and aircraft for current and planned asset acquisitions. The report shall also specifically address regional mission requirements in the Western Hemisphere, **including the Polar regions**; support provided to Combatant Commanders; and trends in illicit activity and illegal migration. (Pages 39-40)

Coast Guard Authorization Act of 2019 (H.R. 3409/S. 2297)

House

Section 411 of H.R. 3409 as reported (amended) on July 23, 2019, by the House Transportation and Infrastructure Committee (H.Rept. 116-172; text of report not posted on Congress.gov as of July 25, 2019) states:

> SEC. 411. Polar security cutter acquisition report.
>
> Not later than one year after the date of the enactment of this Act, the Commandant of the Coast Guard shall submit a report to the Committees on Transportation and Infrastructure and Armed Services of the House of Representatives, and the Committees on Commerce, Science and Transportation and Armed Services of the Senate on—
>
> (1) the extent to which specifications, key drawings, and detail design for the Polar Security Cutter are complete before the start of construction;
>
> (2) the extent to which Polar Security Cutter hulls numbers one, two, and three are science ready; and
>
> (3) what actions will be taken to ensure that Polar Security Cutter hull number four is science capable, as described in the National Academies of Sciences, Engineering, and Medicine's Committee on Polar Icebreaker Cost Assessment letter report entitled "Acquisition and Operation of Polar Icebreakers: Fulfilling the Nation's Needs" and dated July 11, 2017.

Section 412 of H.R. 3409 as reported (amended) states:

> SEC. 412. Sense of the Congress on the need for a new Great Lakes icebreaker.
>
> (a) Findings.—The Congress finds the following:
>
> (1) The Great Lakes shipping industry is crucial to the American economy, including the U.S. manufacturing base, providing important economic and national security benefits.

(2) A recent study found that the Great Lakes shipping industry supports 237,000 jobs and tens of billions of dollars in economic activity.

(3) United States Coast Guard icebreaking capacity is crucial to full utilization of the Great Lakes shipping system, as during the winter icebreaking season up to 15 percent of annual cargo loads are delivered and many industries would have to reduce their production if Coast Guard icebreaking services were not provided.

(4) Six of the Coast Guard's nine icebreaking cutters in the Great Lakes are more than 30 years old and are frequently inoperable during the winter icebreaking season, including those that have completed a recent service life extension program.

(5) During the previous 10 winters, Coast Guard Great Lakes icebreaking cutters have been inoperable for an average of 65 cutter-days during the winter icebreaking season, with this annual lost capability exceeding 100 cutter-days, with a high of 246 cutter-days during the winter of 2017–2018.

(6) The 2019 ice season provides further proof that current Coast Guard icebreaking capacity is inadequate for the needs of the Great Lakes shipping industry, as only six of the nine icebreaking cutters are operational and millions of tons of cargo was not loaded or was delayed due to inadequate Coast Guard icebreaking assets during a historically average winter for Great Lakes ice coverage.

(7) The Congress has authorized the Coast Guard to acquire a new Great Lakes icebreaker as capable as Coast Guard Cutter MACKINAW (WLBB–30), the most capable Great Lakes icebreaker, and $10 million has been appropriated to fund the design and initial acquisition work for this icebreaker.

(8) The Coast Guard has not initiated a new acquisition program for this Great Lakes icebreaker.

(b) Sense of the Congress.—It is the sense of the Congress of the United States that a new Coast Guard icebreaker as capable as Coast Guard Cutter MACKINAW (WLBB–30) is needed on the Great Lakes and the Coast Guard should acquire this icebreaker as soon as possible.

Senate

On July 31, 2019, the Senate Commerce, Science, and Transportation Committee ordered S. 2297 to be reported with an amendment favorably. In S. 2297 as introduced on July 25, 2019, **Section 105** states:

SEC. 105. Procurement authority for polar security cutters.

(a) In general.—For fiscal year 2020 and each fiscal year thereafter, the Secretary of the department in which the Coast Guard is operating shall enter into one or more contracts for the procurement of not fewer than three heavy polar security cutters and three medium polar security cutters and the associated equipment for such polar security cutters.

(b) Funding.—Of the amounts made available for fiscal years 2020 and 2021 by this Act, not less than $745,000,000 shall be available for each heavy polar security cutter authorized to be procured in such fiscal years.

(c) Prohibition on contracts or use of funds for development of common hull design.—Notwithstanding any other provision of law, the Secretary of the department in which the Coast Guard is operating may not enter into any contract for, and no funds shall be obligated or expended on, the development of a common hull design for medium polar security cutters and Great Lakes icebreakers.

Section 403 of S. 2297 as introduced states (emphasis added):

SEC. 403. Unmanned maritime systems.

(a) Assessment.—

(1) IN GENERAL.—The Commandant shall regularly assess available unmanned maritime systems for potential use to support missions of the Coast Guard.

(2) CONSULTATION.—The Commandant shall make the assessment required under paragraph (1) after consultation with the Department of Defense, other Federal agencies, the academic sector, and developers and manufacturers of unmanned maritime systems.

(b) Report.—

(1) IN GENERAL.—Not later than 1 year after the date of enactment of this Act, and biennially thereafter, the Commandant shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a report on the actual and potential effects of the use of available unmanned maritime systems on the mission effectiveness of the Coast Guard.

(2) CONTENTS.—Each report submitted under paragraph (1) shall include the following:

(A) An inventory of available unmanned maritime systems used by the Coast Guard, an overview of such usage, and a discussion of the mission effectiveness of such systems, including any benefits realized or risks or negative aspects of such usage.

(B) A prioritized list of Coast Guard mission requirements that could be met with additional unmanned maritime systems, and the estimated costs of acquiring and operating such systems. This list should take into consideration interoperability with the current and future fleet of National Security Cutters, Fast Response Cutters, Offshore Patrol Cutters, **Polar Security Cutters**, and in-service legacy cutters such as the 270-foot, 210-foot, and 225-foot Buoy Tenders.

(c) Definitions.—In this section:

(1) UNMANNED MARITIME SYSTEM.—

(A) IN GENERAL.—The term "unmanned maritime system" means a remotely operated or autonomous vehicle that—

(i) is produced by the commercial sector;

(ii) is designed to travel in the air, on or under the ocean surface, on land, or any combination thereof; and

(iii) functions without an on-board human presence.

(B) INCLUSIONS.—The term "unmanned maritime system" includes—

(i) associated components, such as control and communications, data transmission, and processing systems;

(ii) an unmanned undersea vehicle;

(iii) an unmanned surface vehicle;

(iv) an unmanned aerial vehicle;

(v) an autonomous underwater vehicle;

(vi) an autonomous surface vehicle; and

(vii) an autonomous aerial vehicle.

(2) AVAILABLE UNMANNED MARITIME SYSTEMS.—The term "available unmanned maritime systems" includes unmanned maritime systems that can be purchased

commercially or are available to the Coast Guard in coordination with the Department of Defense or other Federal agency.

Appendix A. Current U.S. Polar Icebreakers and Polar Research Ships

This appendix provides background information on current U.S. polar icebreakers and polar research ships.

Three Coast Guard Polar Icebreakers

Two Heavy Polar Icebreakers—Polar Star and Polar Sea

Polar Star (WAGB-10) and *Polar Sea* (WAGB-11),[49] sister ships built to the same general design (**Figure A-1** and **Figure A-2**), were acquired in the early 1970s as replacements for earlier U.S. icebreakers. They were designed for 30-year service lives, and were built by Lockheed Shipbuilding of Seattle, WA, a division of Lockheed that also built ships for the U.S. Navy, but which exited the shipbuilding business in the late 1980s.

Figure A-1. *Polar Star* and *Polar Sea*

(Side by side in McMurdo Sound, Antarctica)

Source: Coast Guard photograph that was accessed on April 21, 2011, at http://www.uscg.mil/pacarea/cgcpolarsea/history.asp (link no longer active). The photograph accompanies Kyung M. Song, "Senate Passes Cantwell Measure to Postpone Scrapping of Polar Sea Icebreaker," *Seattle Times*, September 22, 2012, posted at http://blogs.seattletimes.com/politicsnorthwest/2012/09/22/senate-passes-cantwell-measure-to-postpone-scrapping-of-polar-sea-icebreaker/.

[49] The designation WAGB means Coast Guard icebreaker. More specifically, W means Coast Guard ship, A means auxiliary, G means miscellaneous purpose, and B means icebreaker.

Figure A-2. *Polar Sea*

Source: Coast Guard photograph that was accessed April 21, 2011, at http://www.uscg.mil/pacarea/cgcpolarsea/img/PSEApics/FullShip2.jpg (link no longer active). The photograph accompanies Associated Press, "Reprieve for Seattle-Based Icebreaker Polar Sea," KOMO News, June 15, 2012, posted at https://komonews.com/news/local/reprieve-for-seattle-based-icebreaker-polar-sea.

The ships are 399 feet long and displace about 13,200 tons.[50] They are among the world's most powerful nonnuclear-powered icebreakers, with a capability to break through ice up to 6 feet thick at a speed of 3 knots. Because of their icebreaking capability, they are considered (in U.S. parlance) heavy polar icebreakers. In addition to a crew of 134, each ship can embark a scientific research staff of 32 people.

Polar Star was commissioned into service on January 19, 1976, and consequently is now more than 10 years beyond its originally intended 30-year service life. Due to worn-out electric motors and other problems, the Coast Guard placed the ship in caretaker status on July 1, 2006.[51] Congress in FY2009 and FY2010 provided funding to repair *Polar Star* and return it to service for 7 to 10 years; the repair work, which reportedly cost about $57 million, was completed, and the ship was reactivated on December 14, 2012.[52]

Polar Sea was commissioned into service on February 23, 1978, and consequently is also more than 10 years beyond its originally intended 30-year service life. In 2006, the Coast Guard completed a rehabilitation project that extended the ship's expected service life to 2014. On June 25, 2010, however, the Coast Guard announced that *Polar Sea* had suffered an engine casualty, and the ship was unavailable for operation after that.[53] The Coast Guard placed *Polar Sea* in

[50] By comparison, the Coast Guard's new National Security Cutters—its new high-endurance cutters—are about 418 feet long and displace roughly 4,000 tons.

[51] Source for July 1, 2006, date: U.S. Coast Guard email to CRS on February 22, 2008. The Coast Guard's official term for caretaker status is "In Commission, Special."

[52] See, for example, Kyung M. Song, "Icebreaker Polar Star Gets $57 Million Overhaul," *Seattle Times*, December 14, 2012.

[53] "Icebreaker POLAR SEA Sidelined By Engine Troubles," *Coast Guard Compass (Official Blog of the U.S. Coast Guard)*, June 25, 2010. See also "USCG Cancels Polar Icebreaker's Fall Deployment," *DefenseNews.com*, June 25, 2010; Andrew C. Revkin, "America's Heavy Icebreakers Are Both Broken Down," *Dot Earth (New York Times blog)*,

commissioned, inactive status on October 14, 2011. The Coast Guard transferred certain major equipment from *Polar Sea* to *Polar Star* to facilitate *Polar Star*'s return to service.[54]

Although the Coast Guard in recent years has invested millions of dollars to overhaul, repair, and extend the service life of *Polar Star*, the ship's material condition, as a result of its advancing age, has nevertheless become increasingly fragile, if not precarious. During its annual deployments to McMurdo Station in Antarctica, shipboard equipment frequently breaks, and shipboard fires sometimes occur.[55] Replacements for many of the ship's components are no longer commercially available. To help keep *Polar Star* operational, the Coast Guard continues to use *Polar Sea* as a source of replacement parts.

One Medium Polar Icebreaker—Healy

Healy (WAGB-20) (**Figure A-3**) was funded in the early 1990s as a complement to *Polar Star* and *Polar Sea*, and was commissioned into service on August 21, 2000.

June 25, 2010.

[54] Source: October 17, 2011, email to CRS from Coast Guard Congressional Affairs office. Section 222 of the Coast Guard and Maritime Transportation Act of 2012 (H.R. 2838/P.L. 112-213 of December 20, 2012) prohibited the Coast Guard from removing any part of Polar Sea and from transferring, relinquishing ownership of, dismantling, or recycling the ship until it submitted a business case analysis of the options for and costs of reactivating the ship and extending its service life to at least September 30, 2022, so as to maintain U.S. polar icebreaking capabilities and fulfill the Coast Guard's high latitude mission needs, as identified in the Coast Guard's July 2010 High Latitude Study. The business case analysis was submitted to Congress with a cover date of November 7, 2013. For more on the High Latitude Study, see **Appendix B**.

[55] See, for example, Richard Read, "Meet the Neglected 43-Year-Old Stepchild of the U.S. Military-Industrial Complex," *Los Angeles Times*, August 2, 2019; Melody Schreiber, "The Only Working US Heavy Icebreaker Catches Fire Returning from Antarctica," *Arctic Today*, March 2, 2019; Calvin Biesecker, "Fire Breaks Out On Coast Guard's Aging, and Only, Heavy Icebreaker," *Defense Daily*, March 1, 2019.

Figure A-3. *Healy*

Source: Coast Guard photograph accessed August 12, 2019, at https://www.history.uscg.mil/US-Coast-Guard-Photo-Gallery/igphoto/2002136680/.

The ship was built by Avondale Industries, a shipyard located near New Orleans, LA, that built numerous Coast Guard and Navy ships, and which eventually became part of Huntington Ingalls Industries (HII). (HII subsequently wound down shipbuilding activities at Avondale, and the facility is no longer building ships.)

Although it is referred to (in U.S. parlance) as a medium polar icebreaker, *Healy* is actually larger than *Polar Star* and *Polar Sea*—it is 420 feet long and displaces about 16,000 tons. Compared to *Polar Star* and *Polar Sea*, *Healy* has less icebreaking capability (which is why it is referred to as a medium polar icebreaker rather than a heavy polar icebreaker), but more capability for supporting scientific research. The ship can break through ice up to 4½ feet thick at a speed of 3 knots, and embark a scientific research staff of 35 (with room for another 15 surge personnel and 2 visitors). The ship is used primarily for supporting scientific research and conducting other operations in the Arctic.

Three National Science Foundation (NSF) Polar Research Ships

Nathaniel B. Palmer

Nathaniel B. Palmer (**Figure A-4**) was built for the NSF in 1992 by North American Shipbuilding, of Larose, LA.

Figure A-4. *Nathaniel B. Palmer*

Source: Photograph accompanying Peter Rejcek, "System Study, LARISSA Takes Unique Approach for Research on Ice Shelf Ecosystem," *Antarctic Sun* (Untied States Antarctic Program), September 18, 2009. A caption to the photograph states: "Photo Courtesy: Adam Jenkins."

Called *Palmer* for short, it is operated for NSF by Edison Chouest Offshore (ECO) of Galliano, LA, a firm that owns and operates research ships and offshore deepwater service ships.[56] *Palmer* is 308 feet long and has a displacement of about 6,500 tons. It has a crew of 22 and can embark a scientific staff of 27 to 37.[57] It was purpose-built as a single-mission ship for conducting and supporting scientific research in the Antarctic. It is capable of breaking ice up to 3 feet thick at speeds of 3 knots, which is sufficient for breaking through the ice conditions found in the vicinity of the Antarctic Peninsula, so as to resupply Palmer Station, a U.S. research station on the peninsula. The ship might be considered less an icebreaker than an oceanographic research ship with enough icebreaking capability for the Antarctic Peninsula. *Palmer's* icebreaking capability is not considered sufficient to perform the McMurdo resupply mission.

Laurence M. Gould

Like *Palmer*, the polar research and supply ship *Laurence M. Gould* (**Figure A-5**) was built for NSF by North American Shipping. It was completed in 1997 and is operated for NSF on a long-term charter from ECO. It is 230 feet long and has a displacement of about 3,800 tons. It has a crew of 16 and can embark a scientific staff of 26 to 28 (with a capacity for 9 more in a berthing van). It can break ice up to 1 foot thick with continuous forward motion. Like *Palmer*, it was built

[56] For more on ECO, see the firm's website at http://www.chouest.com/.

[57] Sources vary on the exact number of scientific staff that can be embarked on the ship. For some basic information on the ship, see http://www.nsf.gov/od/opp/support/nathpalm.jsp;

http://www.usap.gov/vesselScienceAndOperations/documents/prvnews_june03.pdfprvnews_june03.pdf;

http://nsf.gov/od/opp/antarct/treaty/pdf/plans0607/15plan07.pdf;

http://www.nsf.gov/pubs/1996/nsf9693/fls.htm; and

http://www.hazegray.org/worldnav/usa/nsf.htm.

to support NSF operations in the Antarctic, particularly operations at Palmer Station on the Antarctic Peninsula.

Figure A-5. *Laurence M. Gould*

Source: Photograph accompanying Alchetron, "RV Laurence M. Gould," updated August 25, 2018, accessed August 7, 2019, at: https://alchetron.com/RV-Laurence-M.-Gould#-.

Sikuliaq

Sikuliaq (see-KOO-lee-auk; **Figure A-6**), which is used for scientific research in polar areas, was built by Marinette Marine of Marinette, WI, and entered service in 2015. It is operated for NSF by the College of Fisheries and Ocean Sciences at the University of Alaska Fairbanks as part of the U.S. academic research fleet through the University National Oceanographic Laboratory System (UNOLS). *Sikuliaq* is 261 feet long and has a displacement of about 3,600 tons. It has a crew of 22 and can embark an additional 26 scientists and students. The ship can break ice 2½ or 3 feet thick at speeds of 2 knots. The ship is considered less an icebreaker than an ice-capable research ship.

Figure A-6. *Sikuliaq*

Source: Photograph accompanying Lauren Frisch, "UAF Joins International Consortium of Icebreaker Operators," *UAF [University of Alaska Fairbanks] News and Information*, February 6, 2018. A caption to the photograph states in part: "Photo by Mark Teckenbrock. The research vessel Sikuliaq navigates through Arctic ice in summer 2016."

Summary

Table A-1 summarizes the above six ships. In addition to the ships shown in **Table A-1**, another U.S.-registered polar ship with icebreaking capability— the Arctic oil-exploration support ship *Aiviq*—was used by Royal Dutch Shell oil company to support an oil exploration and drilling effort (now ended) in Arctic waters off Alaska. The ship, which completed construction in 2012, is owned by ECO and chartered by Royal Dutch Shell. It was used primarily for towing and laying anchors for drilling rigs, but is also equipped for responding to oil spills.

Table A-1. Coast Guard and NSF Polar Ships

	Coast Guard			*NSF*		
	Polar Star	***Polar Sea***	***Healy***	***Palmer***	***Laurence M. Gould***	***Sikuliaq***
Currently operational?	Yes	No	Yes	Yes	Yes	Yes
Entered service	1976	1978	2000	1992	1997	2015
Length (feet)	399	399	420	308	230	261
Displacement (tons)	13,200	13,200	16,000	6,500	3,780	3,665
Icebreaking capability (ice thickness in feet) at 3 knots or other speed	6 feet	6 feet	4.5 feet	3 feet	1 foot at continuous forward motion	2.5 or 3 feet at 2 knots
Icebreaking capability using back and ram (ice thickness in feet)	21 feet	21 feet	8 feet	n/a	n/a	n/a
Operating temperature	-60° Fahrenheit	-60° Fahrenheit	-50° Fahrenheit	n/a	n/a	n/a
Crew (when operational)	155[a]	155[a]	85[b]	22	16	22
Additional scientific staff	32	32	35[c]	27-37	26 to 28[d]	26

Sources: Prepared by CRS using data from U.S. Coast Guard, National Research Council, National Science Foundation, DHS Office of Inspector General, and (for *Palmer*) additional online reference sources. n/a is not available.

a. Includes 24 officers, 20 chief petty officers, 102 enlisted, and 9 in the aviation detachment.

b. Includes 19 officers, 12 chief petty officers, and 54 enlisted.

c. In addition to 85 crew members 85 and 35 scientists, the ship can accommodate another 15 surge personnel and 2 visitors.

d. Plus 9 more in a berthing van.

Appendix B. Required Numbers of U.S. Polar Icebreakers

This appendix provides background information on required numbers of U.S. polar icebreakers.

June 2013 DHS Polar Icebreaker Mission Need Statement

DHS in June 2013 approved a Mission Need Statement (MNS) for the polar icebreaker recapitalization project. The MNS states the following (emphasis added):

> This Mission Need Statement (MNS) establishes the need for polar icebreaker capabilities provided by the Coast Guard, to ensure that it can meet current and future mission requirements in the polar regions....
>
> Current requirements and future projections based upon cutter demand modeling, as detailed in the HLMAR [High Latitude Mission Analysis Report], indicate **the Coast Guard will need to expand its icebreaking capacity, potentially requiring a fleet of up to six icebreakers (3 heavy and 3 medium) to adequately meet mission demands in the high latitudes**.... The analysis took into account both the Coast Guard statutory mission requirements and additional requirements for year-round presence in both polar regions detailed in the Naval Operations Concept (NOC) 2010.... The analysis also evaluated employing single and multi-crewing concepts.... Strategic home porting analysis based upon existing infrastructure and distance to operational areas provided the final input to determine icebreaker capacity demand.[58]

While the MNS can be viewed as an authoritative U.S. government statement regarding required numbers of U.S. polar icebreakers, it can be noted that the key sentence in the above-quoted passage from the MNS (i.e., the sentence in bold) includes the terms "potentially" and "up to." These terms, which are often overlooked in discussions of required numbers of U.S. polar icebreakers, make the key sentence less ironclad as a requirements statement than it would have been if the terms had not been included, and could be interpreted as an acknowledgment that the requirement might amount to something less than three heavy and three medium polar icebreakers.

It can also be noted, as stated in the above-quoted passage from the MNS, that the MNS was informed by the High Latitude Mission Analysis Report (HILMAR), and that the HLMAR took into account not only Coast Guard statutory mission requirements, but additional Department of Defense (DOD) requirements for year-round presence in both polar regions as detailed in the 2010 Naval Operations Concept (NOC). This is potentially significant, because DOD appears to have subsequently dropped its 2010 requirement for year-round presence in the polar regions.[59]

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[58] Department of Homeland Security, *Polar Icebreaking Recapitalization Project Mission Need Statement, Version 1.0*, approved by DHS June 28, 2013, pp. 1, 2, 9, 10, 11, 12.

[59] A September 25, 2017, GAO report on polar icebreakers states the following (emphasis added):

> In December 2016, DOD reported to Congress that it had no specific defense requirement for icebreaking capability because Navy Arctic requirements are met by undersea and air assets which can provide year-round presence.
>
> -- DOD reported in April 2017 that its only potential defense requirement—for the Thule Air Force Base resupply [mission] in Greenland—is met by the Canadian Coast Guard through a Memorandum of Understanding with USCG.
>
> -- USCG's 2013 Polar Icebreaker Mission Needs Statement identified polar icebreaker capacity

The use in the MNS of the terms "potentially" and "up to," combined with DOD's decision to drop its requirement for year-round presence in the polar regions, together raise a question, other things held equal, as to whether required numbers of U.S. polar icebreakers might be something less than three heavy and three medium polar icebreakers. It is also possible, however, that there have been other changes since the MNS was issued in 2013 that would have the effect, other things held equal, of *increasing* U.S. requirements for polar icebreakers. The net result of this situation appears uncertain.

In recent years, Coast Guard officials have tended to refer simply to a total Coast Guard requirement for three heavy and three medium polar icebreakers. For example, in the October 25, 2016, summary of a request for information (RFI) that the Coast Guard released the next day to receive industry feedback on its notional polar icebreaker acquisition approach and schedule, the Coast Guard states that "the United States Coast Guard has a need for three Heavy Polar Icebreakers and three Medium Polar Icebreakers with the priority being Heavy Polar Icebreakers."[60] A requirement for three heavy and three medium polar icebreakers is often abbreviated as 3+3.

Short of a 3+3 requirement, Coast Guard officials in the past have sometimes stated that, as a bare minimum number of heavy polar icebreakers, the Coast Guard needs two such ships. For example, at a November 17, 2015, hearing before the Europe, Eurasia, and Emerging Threats subcommittee and the Western Hemisphere subcommittee of the House Foreign Affairs Committee, then-Vice Admiral Charles Michel, the Vice Commandant of the Coast Guard, stated during the discussion portion of the hearing that the "Coast Guard needs at least two heavy icebreakers to provide year-round assured access and self-rescueability in the polar regions."[61] Similarly, at a June 14, 2016, hearing before the Coast Guard and Maritime Transportation subcommittee of the House Transportation and Infrastructure Committee, Admiral Michel testified that "our commandant also testified that we need self-rescue capability for our heavy icebreaker and that includes the existing *Polar Star* that we have out there now. So that means at least two [ships], [and] the High Latitude study says three heavy polar icebreakers is what the Coast Guard's requirement is. So that's kind of where we're talking about for heavy icebreakers."[62]

A September 25, 2017, Government Accountability Office (GAO) report on polar icebreakers states that

> the Coast Guard has been unable to address all polar icebreaking requests since 2010. For example, the Coast Guard reported fulfilling 78 percent (25 of 32) of U.S. government

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needs as partly based on the 2010 Naval Operations Concept—[a document that provides] joint maritime security strategy implementation guidance for the Navy, Marine Corps, and USCG—which stated that U.S. naval forces had a demand for year-round polar icebreaking presence in the Arctic and Antarctic.

-- In April 2017, DOD joint staff officials confirmed that DOD and Naval defense strategy had been updated and does not include icebreaking requirements. DOD officials in charge of operations in the Pacific said that although they do not have a requirement for a heavy icebreaker, icebreakers play a key role in aiding the icebreaking mission to McMurdo.

(Government Accountability Office, *Coast Guard: Status of Polar Icebreaking Fleet Capability and Recapitalization Plan*, GAO-17-698R, September 25, 2017, p. 20 (briefing slide 11).)

[60] Summary of RFI, October 25, 2016, page 2, accessed November 10, 2016, at https://www.uscg.mil/acquisition/icebreaker/pdf/Acquisition-Strategy-RFI.pdf.

[61] Transcript of hearing.

[62] Transcript of hearing.

> agency requests for polar icebreaking services during fiscal year 2010 through 2016. Coast Guard officials cited various factors affecting the Coast Guard's ability to meet all requests, particularly the unavailability of its heavy polar icebreakers.[63]

A July 2018 GAO report stated that

> the Coast Guard operates one medium icebreaker, the Healy, which has an expected end of service life in 2029. Despite the requirement for three medium icebreakers, Coast Guard officials said they are not currently assessing acquisition of the medium polar icebreakers because they are focusing on the heavy icebreaker acquisition and plan to assess the costs and benefits of acquiring medium polar icebreakers at a later time.[64]

In addition to the HILMAR, a number of other studies have been conducted in recent years to assess U.S. requirements for polar icebreakers and options for sustaining and modernizing the Coast Guard's polar icebreaker fleet.

Polar Icebreakers Operated by Other Countries

In discussions of U.S. polar icebreakers, observers sometimes note the size of the polar icebreaking fleets operated by other countries. **Table B-1** shows a Coast Guard summary of major icebreakers around the world; the figures in the table include some icebreakers designed for use in the Baltic Sea.

Observers sometimes highlight the difference between the number of U.S. polar icebreakers and the much larger number of Russian polar icebreakers. In considering these relative numbers, it can be noted that Russia's Arctic coastline is much longer than the U.S. Arctic coastline, that many more people live in Russia's Arctic (about roughly 2 million) than in the U.S. Arctic (fewer than 68,000 as of July 1, 2017),[65] and that maritime transportation along Russia's Arctic coast is critical for supporting numerous Russian Arctic communities. Countries with interests in the polar regions have differing requirements for polar icebreakers, depending on the nature and extent of their polar interests and activities.

[63] Government Accountability Office, *Coast Guard: Status of Polar Icebreaking Fleet Capability and Recapitalization Plan*, GAO-17-698R, September 25, 2017, pp. 2-3. A similar statement appears on page 4.

[64] Government Accountability Office, *Coast Guard Acquisitions[:] Actions Needed to Address Longstanding Portfolio Management Challenges*, GAO-18-454, July 2018, p. 13.

[65] For additional discussion, see the Background section of CRS Report R41153, *Changes in the Arctic: Background and Issues for Congress*, coordinated by Ronald O'Rourke.

Table B-1. Major Icebreakers of the World as of May 1, 2017

(Includes some icebreakers designed for Baltic use)

	Total all types, in inventory (+ under construction + planned)	In inventory, government owned or operated			In inventory, privately owned and operated		
		45,000 or more BHP	20,000 to 44,999 BHP	10,000 to 19,999 BHP	45,000 or more BHP	20,000 to 44,999 BHP	10,000 to 19,999 BHP
Russia	46 (+11 + 4)	6 (all nuclear powered; 2 not operational)	16 (1 nuclear powered; 5 designed for Baltic use)	7		9	8
Finland	10		7 (4 designed for Baltic use)	1			2
Canada	7 (+2 +5)		2	5			
Sweden	7 (+0 +3)		4 (3 designed for Baltic use)				3
United States	5 (+0 +3)	2 (*Polar Star* and *Polar Sea*; *Polar Sea* not operational)	1 (*Healy*)			1 (*Aiviq*)	1 (*Palmer*)
Denmark	4						4 (all 4 designed for Baltic use)
China	3 (+1 +0)			3			
Estonia	2			2 (both designed for Baltic use)			
Norway	1 (+1 +0)			1			
Germany	1 (+0 +1)						1
Chile	1 (+0 +1)			1			
Australia	1 (+0 +1)			1			
Latvia	1			1 (designed for Baltic use)			
Japan	1		1				
South Korea	1			1			
South Africa	1			1			
Argentina	1			1 (not operational)			
United Kingdom	0 (+1 +0)						

Source: Table prepared by CRS based on U.S. Coast Guard chart showing data compiled by the Coast Guard as of May 1, 2017, accessed September 14, 2017, at http://www.dco.uscg.mil/Portals/9/DCO%20Documents/Office%20of%20Waterways%20and%20Ocean%20Policy/20170501%20major%20icebreaker%20chart.pdf?ver=2017-06-08-091723-907.

Notes: BHP = the brake horsepower of the ship's power plant. A ship with 45,000 or more BHP might be considered a heavy polar icebreaker, a ship with 20,000 to 44,999 BHP might be considered a medium polar icebreaker, and a ship with 10,000 to 19,999 BHP might be considered a light polar icebreaker or an ice-capable polar ship.

July 2017 National Academies (NASEM) Report

A July 2017 report on the acquisition and operation of polar icebreakers by the National Academies of Sciences, Engineering, and Medicine (NASEM) that was directed by Congress in Section 604 of the Coast Guard Authorization Act of 2015 (H.R. 4188/P.L. 114-120 of February 8, 2016) concluded the following:

> INTRODUCTION
>
> The United States has strategic national interests in the polar regions. In the Arctic, the nation must protect its citizens, natural resources, and economic interests; assure sovereignty, defense readiness, and maritime mobility; and engage in discovery and research. In the Antarctic, the United States must maintain an active presence that includes access to its research stations for the peaceful conduct of science and the ability to participate in inspections as specified in the Antarctic Treaty. The committee's charge... was to advise the U.S. House of Representatives and the U.S. Senate on an assessment of the costs incurred by the federal government in carrying out polar icebreaking missions and on options that could minimize lifecycle costs. The committee's consensus findings and recommendations are presented below. Unless otherwise specified, all estimated costs and prices for the future U.S. icebreakers are expressed in 2019 dollars, since that is the year in which the contracts are scheduled to be made. Supporting material is found in the appendices.
>
> FINDINGS AND RECOMMENDATIONS
>
> **1. Finding: The United States has insufficient assets to protect its interests, implement U.S. policy, execute its laws, and meet its obligations in the Arctic and Antarctic because it lacks adequate icebreaking capability.**
>
> For more than 30 years, studies have emphasized the need for U.S. icebreakers to maintain presence, sovereignty, leadership, and research capacity—but the nation has failed to respond....The strong warming and related environmental changes occurring in both the Arctic and the Antarctic have made this failure more critical. In the Arctic, changing sea ice conditions will create greater navigation hazards for much of the year, and expanding human industrial and economic activity will magnify the need for national presence in the region. In the Antarctic, sea ice trends have varied greatly from year to year, but the annual requirements for access into McMurdo Station have not changed. The nation is ill-equipped to protect its interests and maintain leadership in these regions and has fallen behind other Arctic nations, which have mobilized to expand their access to ice-covered regions. The United States now has the opportunity to move forward and acquire the capability to fulfill these needs....
>
> **2. Recommendation: The United States Congress should fund the construction of four polar icebreakers of common design that would be owned and operated by the United States Coast Guard (USCG).**
>
> The current Department of Homeland Security (DHS) Mission Need Statement (DHS 2013) contemplates a combination of medium and heavy icebreakers. The committee's recommendation is for a single class of polar icebreaker with heavy icebreaking capability. Proceeding with a single class means that only one design will be needed, which will provide cost savings. The committee has found that the fourth heavy icebreaker could be built for a lower cost than the lead ship of a medium icebreaker class....
>
> The DHS Mission Need Statement contemplated a total fleet of "potentially" up to six ships of two classes—three heavy and three medium icebreakers. Details appear in the High Latitude Mission Analysis Report. The Mission Need Statement indicated that to fulfill its statutory missions, USCG required three heavy and three medium icebreakers; each vessel would have a single crew and would homeport in Seattle. The committee's analysis

indicated that four heavy icebreakers will meet the statutory mission needs gap identified by DHS for the lowest cost. Three of the ships would allow continuous presence in the Arctic, and one would service the Antarctic.

As noted in the High Latitude Report, USCG's employment standard is 185 days away from home port (DAFHP) for a single crew. Three heavy icebreakers in the Arctic provide 555 DAFHP, sufficient for continuous presence. In addition, the medium icebreaker USCG Cutter Healy's design service life runs through 2030. If greater capacity is required, USCG could consider operating three ships with four crews, which would provide 740 DAFHP. The use of multiple crews in the Arctic could require fewer ships while providing a comparable number of DAFHP. For example, two ships (instead of the recommended three) operating in the Arctic with multiple crews could provide a similar number of annual operating days at a lower cost, but such an arrangement may not permit simultaneous operations in both polar regions and may not provide adequate redundancy in capability. More important, an arrangement under which fewer boats are operated more often would require more major maintenance during shorter time in port, often at increasing cost. In addition, if further military presence is desired in the Arctic, USCG could consider ice-strengthening the ninth national security cutter.

One heavy icebreaker servicing the Antarctic provides for the McMurdo breakout and international treaty verification. The availability of the vessel could be extended by homeporting in the Southern Hemisphere. If the single vessel dedicated to the Antarctic is rendered inoperable, USCG could redirect an icebreaker from the Arctic, or it could rely on support from other nations. The committee considers both options to be viable and believes it difficult to justify a standby (fifth) vessel for the Antarctic mission when the total acquisition and lifetime operating costs of a single icebreaker are projected to exceed $1.6 billion. Once the four new icebreakers are operational, USCG can reasonably be expected to plan for more distant time horizons. USCG could assess the performance of the early ships once they are operational and determine whether additional capacity is needed.

USCG is the only agency of the U.S. government that is simultaneously a military service, a law enforcement agency, a marine safety and rescue agency, and an environmental protection agency. All of these roles are required in the mission need statement for a polar icebreaker. USCG, in contrast to a civilian company, has the authorities, mandates, and competencies to conduct the missions contemplated for the polar icebreakers. Having one agency with a multimission capability performing the range of services needed would be more efficient than potentially duplicating effort by splitting polar icebreaker operations among other agencies.

The requirement for national presence is best accomplished with a military vessel. In addition, USCG is fully interoperable with the U.S. Navy and the nation's North Atlantic Treaty Organization partners. USCG is already mandated to operate the nation's domestic and polar icebreakers. Continuing to focus this expertise in one agency remains the logical approach....

Government ownership of new polar icebreakers would be less costly than the use of lease financing (see Appendix C). The government has a lower borrowing cost than any U.S.-based leasing firm or lessor. In addition, the lessor would use higher-cost equity (on which it would expect to make a profit) to cover a portion of the lease financing. The committee's analysis shows that direct purchase by the government would cost, at a minimum, 19 percent less than leasing on a net present value basis (after tax). There is also the risk of the lessor going bankrupt and compromising the availability of the polar icebreaker to USCG. For its analysis, the committee not only relied on its extensive experience with leveraged lease financing but also reviewed available Government Accountability Office reports and Office of Management and Budget rules, examined commercial leasing

economics and current interest rates, and validated its analysis by consulting an outside expert on the issue....

Chartering (an operating lease) is not a viable option.... The availability of polar icebreakers on the open market is extremely limited. (The committee is aware of the sale of only one heavy icebreaker since 2010.) U.S. experience with chartering a polar icebreaker for the McMurdo resupply mission has been problematic on two prior charter attempts. Chartering is workable only if the need is short term and mission specific. The committee notes that chartering may preclude USCG from performing its multiple missions....

In the committee's judgment, an enlarged icebreaker fleet will provide opportunities for USCG to strengthen its icebreaking program and mission. Although the number of billets that require an expert is small compared with the overall number of billets assigned to these icebreakers, more people performing this mission will increase the pool of experienced candidates. This will provide personnel assignment officers with a larger pool of candidates when the more senior positions aboard icebreakers are designated, which will make icebreaking more attractive as a career path and increase the overall level of icebreaking expertise within USCG. Importantly, the commonality of design of the four recommended heavy icebreakers will reduce operating and maintenance costs over the service life of these vessels through efficiencies in supporting and crewing them. Having vessels of common design will likely improve continuity of service, build icebreaking competency, improve operational effectiveness, and be more cost-efficient....

3. Recommendation: USCG should follow an acquisition strategy that includes block buy contracting with a fixed price incentive fee contract and take other measures to ensure best value for investment of public funds.

Icebreaker design and construction costs can be clearly defined, and a fixed price incentive fee construction contract is the most reliable mechanism for controlling costs for a program of this complexity. This technique is widely used by the U.S. Navy. To help ensure best long-term value, the criteria for evaluating shipyard proposals should incorporate explicitly defined lifecycle cost metrics....

A block buy authority for this program will need to contain specific language for economic order quantity purchases for materials, advanced design, and construction activities. A block buy contracting program with economic order quantity purchases enables series construction, motivates competitive bidding, and allows for volume purchase and for the timely acquisition of material with long lead times. It would enable continuous production, give the program the maximum benefit from the learning curve, and thus reduce labor hours on subsequent vessels.

The acquisition strategy would incorporate (a) technology transfer from icebreaker designers and builders with recent experience, including international expertise in design, construction, and equipment manufacture; (b) a design that maximizes use of commercial off-the-shelf (COTS) equipment, applies Polar Codes and international standards, and only applies military specifications (MIL-SPEC) to the armament, aviation, communications, and navigation equipment; (c) reduction of any "buy American" provisions to allow the sourcing of the most

suitable and reliable machinery available on the market; and (d) a program schedule that allows for completion of design and planning before the start of construction. These strategies will allow for optimization of design, reduce construction costs, and enhance reliability and maintainability....

4. Finding: In developing its independent concept designs and cost estimates, the committee determined that the costs estimated by USCG for the heavy icebreaker are reasonable. However, the committee believes that the costs of medium icebreakers identified in the High Latitude Mission Analysis Report are significantly underestimated.

The committee estimates the rough order-of-magnitude (ROM) cost of the first heavy icebreaker to be $983 million. (See Appendix D, Table D-6.) Of these all-in costs, 75 to 80 percent are shipyard design and construction costs; the remaining 20 to 25 percent cover government-incurred costs such as government-furnished equipment and government-incurred program expenses. If advantage is taken of learning and quantity discounts available through the recommended block buy contracting acquisition strategy, the average cost per heavy icebreaker is approximately $791 million, on the basis of the acquisition of four ships. The committee's analysis of the ship size to incorporate the required components (stack-up length) suggests an overall length of 132 meters (433 feet) and a beam of 27 meters (89 feet). This is consistent with USCG concepts for the vessel.

Costs can be significantly reduced by following the committee's recommendations. Reduction of MIL-SPEC requirements can lower costs by up to $100 million per ship with no loss of mission capability.... The other recommended acquisition, design, and construction strategies will control possible cost overruns and provide significant savings in overall life-cycle costs for the program.

Although USCG has not yet developed the operational requirements document for a medium polar icebreaker, the committee was able to apply the known principal characteristics of the USCG Cutter Healy to estimate the scope of work and cost of a similar medium icebreaker. The committee estimates that a first-of-class medium icebreaker will cost approximately $786 million. The fourth ship of the heavy icebreaker series is estimated to cost $692 million. Designing a medium-class polar icebreaker in a second shipyard would incur the estimated engineering, design, and planning costs of $126 million and would forgo learning from the first three ships; the learning curve would be restarted with the first medium design. Costs of building the fourth heavy icebreaker would be less than the costs of designing and building a first-of-class medium icebreaker... . In developing its ROM cost estimate, the committee agreed on a common notional design and basic assumptions.... Two committee members then independently developed cost estimating models, which were validated internally by other committee members. These analyses were then used to establish the committee's primary cost estimate....

5. Finding: Operating costs of new polar icebreakers are expected to be lower than those of the vessels they replace.

The committee expects the operating costs for the new heavy polar icebreakers to be lower than those of USCG's Polar Star. While USCG's previous experience is that operating costs of new cutters are significantly higher than those of the vessels they replace, the committee does not believe this historical experience applies in this case. There is good reason to believe that operating costs for new ships using commercially available modern technology will be lower than costs for existing ships.... The more efficient hull forms and modern engines will reduce fuel consumption, and a well-designed automation plant will require fewer operation and maintenance personnel, which will allow manning to be reduced or freed up for alternative tasks. The use of COTS technology and the minimization of MIL-SPEC, as recommended, will also reduce long-term maintenance costs, since use of customized equipment to meet MIL-SPEC requirements can reduce reliability and increase costs. A new vessel, especially over the first 10 years, typically has significantly reduced major repair and overhaul costs, particularly during dry-dock periods, compared with existing icebreakers—such as the Polar Star—that are near or at the end of their service life.... The Polar Star has many age-related issues that require it to be extensively repaired at an annual dry-docking. These issues will be avoided in the early years of a new ship. However, the committee recognizes that new ship operating costs can be higher than those of older ships if the new ship has more complexity to afford more capabilities. Therefore, any direct comparisons of operating costs of newer versus older ships would need to take into account the benefits of the additional capabilities provided by the newer ship.

USCG will have an opportunity to evaluate the manning levels of the icebreaker in light of the benefits of modern technology to identify reductions that can be made in operating costs....

6. Recommendation: USCG should ensure that the common polar icebreaker design is science-ready and that one of the ships has full science capability.

All four proposed ships would be designed as "science-ready," which will be more cost-effective when one of the four ships—most likely the fourth—is made fully science capable. Including science readiness in the common polar icebreaker design is the most cost-effective way of fulfilling both the USCG's polar missions and the nation's scientific research polar icebreaker needs.... The incremental costs of a science-ready design for each of the four ships ($10 million to $20 million per ship) and of full science capability for one of the ships at the initial build (an additional $20 million to $30 million) are less than the independent design and build cost of a dedicated research medium icebreaker.... In briefings at its first meeting, the committee learned that the National Science Foundation and other agencies do not have budgets to support full-time heavy icebreaker access or the incremental cost of design, even though their science programs may require this capability. Given the small incremental cost, the committee believes that the science capability cited above should be included in the acquisition costs.

Science-ready design includes critical elements that cannot be retrofitted cost-effectively into an existing ship and that should be incorporated in the initial design and build. Among these elements are structural supports, appropriate interior and exterior spaces, flexible accommodation spaces that can embark up to 50 science personnel, a hull design that accommodates multiple transducers and minimizes bubble sweep while optimizing icebreaking capability, machinery arrangements and noise dampening to mitigate interference with sonar transducers, and weight and stability latitudes to allow installation of scientific equipment. Such a design will enable any of the ships to be retrofitted for full science capability in the future, if necessary....

Within the time frame of the recommended build sequence, the United States will require a science-capable polar icebreaker to replace the science capabilities of the Healy upon her retirement. To fulfill this need, one of the heavy polar icebreakers would be procured at the initial build with full science capability; the ability to fulfill other USCG missions would be retained. The ship would be outfitted with oceanographic overboarding equipment and instrumentation and facilities comparable with those of modern oceanographic research vessels. Some basic scientific capability, such as hydrographic mapping sonar, should be acquired at the time of the build of each ship so that environmental data that are essential in fulfilling USCG polar missions can be collected.

7. Finding: The nation is at risk of losing its heavy polar icebreaking capability—experiencing a critical capacity gap—as the Polar Star approaches the end of its extended service life, currently estimated at 3 to 7 years.

The Polar Star, built in 1976, is well past its 30-year design life. Its reliability will continue to decline, and its maintenance costs will continue to escalate. Although the ship went through an extensive life-extending refit in 2011–2012, the Polar Star's useful life is estimated to end between 2020 and 2024. As USCG has recognized, the evaluation of alternative arrangements to secure polar icebreaking capacity is important, given the growing risks of the Polar Star losing its capability to fulfill its mission....

8. Recommendation: USCG should keep the Polar Star operational by implementing an enhanced maintenance program (EMP) until at least two new polar icebreakers are commissioned.

Even if the committee's notional schedule for new polar icebreakers is met, the second polar icebreaker would not be ready until July 2025.... The committee's proposed EMP could be designed with planned—and targeted—upgrades that allow the Polar Star to

> operate every year for its Antarctic mission. The necessary repairs could be performed in conjunction with the ship's current yearly dry-docking schedule within existing annual expenditures, estimated to average $5 million. In particular, the EMP would require improvements in the ship's operating systems, sanitary system, evaporators, main propulsion systems, and controllable pitch propellers. In the committee's judgment, the EMP could be accomplished within USCG's average annual repair expenditures for the Polar Star, which currently range between $2 million and $9 million.[66]

Coast Guard High Latitude Study Provided to Congress in July 2011

In July 2011, the Coast Guard provided to Congress a study on the Coast Guard's missions and capabilities for operations in high-latitude (i.e., polar) areas. The study, commonly known as the High Latitude Study, is dated July 2010 on its cover. The High Latitude Study concluded the following:

> [The study] concludes that future capability and capacity gaps will significantly impact four [Coast Guard] mission areas in the Arctic: Defense Readiness, Ice Operations, Marine Environmental Protection, and Ports, Waterways, and Coastal Security. These mission areas address the protection of important national interests in a geographic area where other nations are actively pursuing their own national goals....
>
> The common and dominant contributor to these significant mission impacts is the gap in polar icebreaking capability. The increasing obsolescence of the Coast Guard's icebreaker fleet will further exacerbate mission performance gaps in the coming years....
>
> The gap in polar icebreaking capacity has resulted in a lack of at-sea time for crews and senior personnel and a corresponding gap in training and leadership. In addition to providing multi-mission capability and intrinsic mobility, a helicopter-capable surface unit would eliminate the need for acquiring an expensive shore-based infrastructure that may only be needed on a seasonal or occasional basis. The most capable surface unit would be a polar icebreaker. Polar icebreakers can transit safely in a variety of ice conditions and have the endurance to operate far from logistics bases. The Coast Guard's polar icebreakers have conducted a wide range of planned and unscheduled Coast Guard missions in the past. Polar icebreakers possess the ability to carry large numbers of passengers, cargo, boats, and helicopters. Polar icebreakers also have substantial command, control, and communications capabilities. The flexibility and mobility of polar icebreakers would assist the Coast Guard in closing future mission performance gaps effectively....
>
> Existing capability and capacity gaps are expected to significantly impact future Coast Guard performance in two Antarctic mission areas: Defense Readiness and Ice Operations. Future gaps may involve an inability to carry out probable and easily projected mission requirements, such as the McMurdo resupply, or readiness to respond to less-predictable events. By their nature, contingencies requiring the use of military capabilities often occur quickly. As is the case in the Arctic, the deterioration of the Coast Guard's icebreaker fleet is the primary driver for this significant mission impact. This will further widen mission performance gaps in the coming years. The recently issued Naval Operations Concept 2010 requires a surface presence in both the Arctic and Antarctic. This further exacerbates the capability gap left by the deterioration of the icebreaker fleet....

[66] National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies and Transportation Research Board, *Acquisition and Operation of Polar Icebreakers: Fulfilling the Nation's Needs*, Letter Report, with cover letter dated July 11, 2017, pp. 9-20.

The significant deterioration of the Coast Guard icebreaker fleet and the emerging mission demands to meet future functional requirements in the high latitude regions dictate that the Coast Guard acquire material solutions to close the capability gaps....

To meet the Coast Guard mission functional requirement, the Coast Guard icebreaking fleet must be capable of supporting the following missions:

- **Arctic North Patrol.** Continuous multimission icebreaker presence in the Arctic.
- **Arctic West Science.** Spring and summer science support in the Arctic.
- **Antarctic, McMurdo Station resupply.** Planned deployment for break-in, supply ship escort, and science support. This mission, conducted in the Antarctic summer, also requires standby icebreaker support for backup in the event the primary vessel cannot complete the mission.
- **Thule Air Base Resupply and Polar Region Freedom of Navigation Transits.** Provide vessel escort operations in support of the Military Sealift Command's Operation Pacer Goose; then complete any Freedom of Navigation exercises in the region.

In addition, the joint Naval Operations Concept establishes the following mission requirements:

- **Assured access and assertion of U.S. policy in the Polar Regions.** The current demand for this mission requires continuous icebreaker presence in both Polar Regions.

Considering these missions, the analysis yields the following findings:

- **The Coast Guard requires three heavy and three medium icebreakers to fulfill its statutory missions.** These icebreakers are necessary to (1) satisfy Arctic winter and transition season demands and (2) provide sufficient capacity to also execute summer missions. Single-crewed icebreakers have sufficient capacity for all current and expected statutory missions. Multiple crewing provides no advantage because the number of icebreakers required is driven by winter and shoulder season requirements. Future use of multiple or augmented crews could provide additional capacity needed to absorb mission growth.
- **The Coast Guard requires six heavy and four medium icebreakers to fulfill its statutory missions and maintain the continuous presence requirements of the Naval Operations Concept.** Consistent with current practice, these icebreakers are single-crewed and homeported in Seattle Washington.
- **Applying crewing and home porting alternatives reduces the overall requirement to four heavy and two medium icebreakers.** This assessment of nonmaterial solutions shows that the reduced number of icebreakers can be achieved by having all vessels operate with multiple crews and two of the heavy icebreakers homeporting in the Southern Hemisphere.

Leasing was also considered as a nonmaterial solution. While there is no dispute that the Coast Guard's polar icebreaker fleet is in need of recapitalization, the decision to acquire this capability through purchase of new vessels, reconstruction of existing ships, or commercial lease of suitable vessels must be resolved to provide the best value to the taxpayer. The multi-mission nature of the Coast Guard may provide opportunities to conduct some subset of its missions with non government-owned vessels. However, serious consideration must be given to the fact that the inherently governmental missions of the Coast Guard must be performed using government-owned and operated vessels. An interpretation of the national policy is needed to determine the resource level that best supports the nation's interests....

> The existing icebreaker capacity, two inoperative heavy icebreakers and an operational medium icebreaker, does not represent a viable capability to the federal government. The time needed to augment this capability is on the order of 10 years. At that point, around 2020, the heavy icebreaking capability bridging strategy expires.[67]

At a July 27, 2011, hearing on U.S. economic interests in the Arctic before the Oceans, Atmosphere, Fisheries, and Coast Guard subcommittee of the Senate Commerce, Science, and Transportation Committee, the following exchange occurred:

> SENATOR OLYMPIA J. SNOWE: On the high latitude study, do you agree with—and those—I would like to also hear from you, Admiral Titley, as well, on these requirements in terms of Coast Guard vessels as I understand it, they want to have—I guess, it was a three medium ice breakers. Am in correct in saying that? Three medium ice breakers.
>
> ADMIRAL ROBERT PAPP, COMMANDANT OF THE COAST GUARD: I agree with the mission analysis and as you look at the requirements for the things that we might do up there, if it is in the nation's interest, it identifies a minimum requirement for three heavy ice breakers and three medium ice breakers and then if you want a persistent presence up there, it would require—and also doing things such as breaking out (inaudible) and other responsibilities, then it would take up to a maximum six heavy and four medium.
>
> SNOWE: Right. Do you agree with that?
>
> PAPP: If we were to be charged with carrying out those full responsibilities, yes, ma'am. Those are the numbers that you would need to do it.
>
> SNOWE: Admiral Titley, how would you respond to the high latitude study and has the Navy conducted its own assessment of its capability?
>
> REAR ADMIRAL DAVID TITLEY, OCEANORGRAPHER AND NAVIGATOR OF THE NAVY: Ma'am, we are in the process right now of conducting what we call a capabilities based assessment that will be out in the summer of this year.
>
> We are getting ready to finish that—the Coast Guard has been a key component of the Navy's task force on climate change, literally since day one when the Chief of Naval Operations set this up, that morning, we had the Coast Guard invited as a member of our executive steering committee.
>
> So we have been working very closely with the Coast Guard, with the Department of Homeland Security, and I think Admiral Papp—said it best as far as the specific comments on the high latitude study but we have been working very closely with the Coast Guard.[68]

January 2011 DHS Office of Inspector General Report

A January 2011 report on the Coast Guard's polar icebreakers from the DHS Office of the Inspector General stated the following:

> The Coast Guard does not have the necessary budgetary control over its [polar] icebreakers, nor does it have a sufficient number of icebreakers to accomplish its missions in the Polar Regions. Currently, the Coast Guard has only one operational [polar] icebreaker [i.e., *Healy*], making it necessary for the United States to contract with foreign nations to perform scientific, logistical, and supply activities. Without the necessary budgetary control and a sufficient number of icebreaking assets, the Coast Guard will not have the capability to perform all of its missions, will lose critical icebreaking expertise, and may

[67] *United States Coast Guard High Latitude Region Mission Analysis Capstone Summary*, July 2010, pp. 10-13, 15.

[68] Source: Transcript of hearing.

> be beholden to foreign nations to perform its statutory missions. The Coast Guard should improve its strategic approach to ensure that it has the long-term icebreaker capabilities needed to support Coast Guard missions and other national interests in the Arctic and Antarctic regions.[69]

Regarding current polar icebreaking capabilities for performing Arctic missions, the report states the following:

> The Coast Guard's icebreaking resources are unlikely to meet future demands. [The table below] outlines the missions that Coast Guard is unable to meet in the Arctic with its current icebreaking resources.

Arctic Missions Not Being Met

Requesting Agency	Missions Not Being Met
United States Coast Guard	—Fisheries enforcement in Bering Sea to prevent foreign fishing in U.S. waters and overfishing
	—Capability to conduct search and rescue in Beaufort Sea for cruise line and natural resource exploration ships
	—Future missions not anticipated to be met: 2010 Arctic Winter Science Deployment
NASA	Winter access to the Arctic to conduct oceanography and study Arctic currents and how they relate to regional ice cover, climate, and biology
NOAA and NSF	Winter research
Department of Defense	Assured access to ice-impacted waters through a persistent icebreaker presence in the Arctic and Antarctic[70]

The report also states the following:

> Should the Coast Guard not obtain funding for new icebreakers or major service life extensions for its existing icebreakers with sufficient lead-time, the United States will have no heavy icebreaking capability beyond 2020 and no polar icebreaking capability of any kind by 2029. Without the continued use of icebreakers, the United States will lose its ability to maintain a presence in the Polar Regions, the Coast Guard's expertise to perform ice operations will continue to diminish, and missions will continue to go unmet.[71]

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[69] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, p. 1 (Executive Summary). Report accessed September 21, 2011, at https://www.oig.dhs.gov/assets/Mgmt/OIG_11-31_Jan11.pdf.

[70] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, p. 9.

[71] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, p. 10.

Regarding current polar icebreaking capabilities for performing Antarctic missions, the report states the following:

> The Coast Guard needs additional icebreakers to accomplish its missions in the Antarctic. The Coast Guard has performed the McMurdo Station resupply in Antarctica for decades, but with increasing difficulty in recent years. The Coast Guard's two heavy-duty icebreakers [i.e., *Polar Star* and *Polar Sea*] are at the end of their service lives, and have become less reliable and increasingly costly to keep in service....
>
> In recent years, the Coast Guard has found that ice conditions in the Antarctic have become more challenging for the resupply of McMurdo Station. The extreme ice conditions have necessitated the use of foreign vessels to perform the McMurdo break-in....
>
> As ice conditions continue to change around the Antarctic, two icebreakers are needed for the McMurdo break-in and resupply mission. Typically, one icebreaker performs the break-in and the other remains on standby. Should the first ship become stuck in the ice or should the ice be too thick for one icebreaker to complete the mission, the Coast Guard deploys the ship on standby. Since the Polar Sea and Polar Star are not currently in service, the Coast Guard has no icebreakers capable of performing this mission. [The table below] outlines the missions that will not be met without operational heavy-duty icebreakers.

Arctic Missions Not Being Met

Requesting Agency	Missions Not Being Met
NSF	Missions not anticipated to be met: 2010-2011 Operation Deep Freeze – McMurdo Station Resupply
Department of State	Additional inspections of foreign facilities in Antarctica to enforce the Antarctic Treaty and ensure facilities' environment compliance[72]

The report's conclusion and recommendations were as follows:

> **Conclusion**
>
> With an aging fleet of three icebreakers, one operational and two beyond their intended 30-year service life, the Coast Guard is at a critical crossroads in its Polar Icebreaker Maintenance, Upgrade, and Acquisition Program. It must clarify its mission requirements, and if the current mission requirements remain, the Coast Guard must determine the best method for meeting these requirements in the short and long term.
>
> **Recommendations**
>
> We recommend that the Assistant Commandant for Marine Safety, Security, and Stewardship:
>
> **Recommendation #1:** Request budgetary authority for the operation, maintenance, and upgrade of its icebreakers.
>
> **Recommendation #2:** In coordination with the Department of Homeland Security, request clarification from Congress to determine whether Arctic missions should be performed by Coast Guard assets or contracted vessels.

[72] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, pp. 10-11.

> **Recommendation #3:** In coordination with the Department of Homeland Security, request clarification from Congress to determine whether Antarctic missions should be performed by Coast Guard assets or contracted vessels.
>
> **Recommendation #4:** Conduct the necessary analysis to determine whether the Coast Guard should replace or perform service-life extensions on its two existing heavy-duty icebreaking ships.
>
> **Recommendation #5:** Request appropriations necessary to meet mission requirements in the Arctic and Antarctic.[73]

The report states that

> The Coast Guard concurred with all five of the recommendations and is initiating corrective actions. We consider the recommendations open and unresolved. The Coast Guard provided information on some of its ongoing projects that will address the program needs identified in the report.[74]

2010 U.S. Arctic Research Commission Report

A May 2010 report from the U.S. Arctic Research Commission (USARC) on goals and objectives for Arctic research for 2009-2010 stated the following:

> To have an effective Arctic research program, the United States must invest in human capital, research platforms, and infrastructure, including new polar class icebreakers, and sustained sea, air, land, space, and social observing systems.... The Commission urges the President and Congress to commit to replacing the nation's two polar class icebreakers.[75]

2007 National Research Council Report

A 2007 National Research Council (NRC) report, *Polar Icebreakers in a Changing World: An Assessment of U.S. Needs*, assessed roles and future needs for Coast Guard polar icebreakers.[76] The study was required by report language accompanying the FY2005 DHS appropriations act (H.R. 4567/P.L. 108-334).[77] The study was completed in 2006 and published in 2007. Some

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[73] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, p. 12.

[74] Department of Homeland Security, Office of Inspector General, *The Coast Guard's Polar Icebreaker Maintenance, Upgrade, and Acquisition Program*, OIG-11-31, January 2011, p. 13.

[75] U.S. Arctic Research Commission, *Report on Goals and Objectives for Arctic Research 2009-2010, May 2010*, p. 4. Accessed online December 5, 2011, at https://storage.googleapis.com/arcticgov-static/publications/goals/usarc_goals_2009-10.pdf.

[76] National Research Council, *Polar Icebreakers in a Changing World, An Assessment of U.S. Needs*, Washington, 2007, 122 pp.

[77] H.R. 4567/P.L. 108-334 of October 18, 2004. The related Senate bill was S. 2537. The Senate report on S. 2537 (S.Rept. 108-280 of June 17, 2004) stated the following:

> The Committee expects the Commandant to enter into an arrangement with the National Academy of Sciences to conduct a comprehensive study of the role of Coast Guard icebreakers in supporting United States operations in the Antarctic and the Arctic. The study should include different scenarios for continuing those operations including service life extension or replacement of existing Coast Guard icebreakers and alternative methods that do not use Coast Guard icebreakers. The study should also address changes in the roles and missions of Coast Guard icebreakers in support of future marine operations in the Arctic that may develop due to environmental change, including the amount and kind of icebreaking support that may be required in the future to support marine operations in the Northern Sea Route and the Northwest Passage; the suitability of the Polar Class icebreakers for these new roles; and appropriate changes in existing laws governing Coast Guard

sources refer to the study as the 2006 NRC report. The report made the following conclusions and recommendations:

> Based on the current and future needs for icebreaking capabilities, the [study] committee concludes that the nation continues to require a polar icebreaking fleet that includes a minimum of three multimission ships [like the Coast Guard's three current polar icebreakers] and one single-mission [research] ship [like Palmer]. The committee finds that although the demand for icebreaking capability is predicted to increase, a fleet of three multimission and one single-mission icebreakers can meet the nation's future polar icebreaking needs through the application of the latest technology, creative crewing models, wise management of ice conditions, and more efficient use of the icebreaker fleet and other assets. The nation should immediately begin to program, design, and construct two new polar icebreakers to replace the POLAR STAR and POLAR SEA.
>
> Building only one new polar icebreaker is insufficient for several reasons. First, a single ship cannot be in more than one location at a time. No matter how technologically advanced or efficiently operated, a single polar icebreaker can operate in the polar regions for only a portion of any year. An icebreaker requires regular maintenance and technical support from shipyards and industrial facilities, must reprovision regularly, and has to effect periodic crew changeouts. A single icebreaker, therefore, could not meet any reasonable standard of active and influential presence and reliable, at-will access throughout the polar regions.
>
> A second consideration is the potential risk of failure in the harsh conditions of polar operations. Despite their intrinsic robustness, damage and system failure are always a risk and the U.S. fleet must have enough depth to provide backup assistance. Having only a single icebreaker would necessarily require the ship to accept a more conservative operating profile, avoiding more challenging ice conditions because reliable assistance would not be available. A second capable icebreaker, either operating elsewhere or in homeport, would provide ensured backup assistance and allow for more robust operations by the other ship.
>
> From a strategic, longer-term perspective, two new Polar class icebreakers will far better position the nation for the increasing challenges emerging in both polar regions. A second new ship would allow the U.S. Coast Guard to reestablish an active patrol presence in U.S. waters north of Alaska to meet statutory responsibilities that will inevitably derive from increased human activity, economic development, and environmental change. It would allow response to emergencies such as search-and-rescue cases, pollution incidents, and assistance to ships threatened with grounding or damage by ice. Moreover, a second new ship will leverage the possibilities for simultaneous operations in widely disparate geographic areas (e.g., concurrent operations in the Arctic and Antarctic), provide more flexibility for conducting Antarctic logistics (as either the primary or the secondary ship for the McMurdo break-in), allow safer multiple-ship operations in the most demanding ice conditions, and increase opportunities for international expeditions. Finally, an up-front decision to build two new polar icebreakers will allow economies in the design and construction process and provide a predictable cost reduction for the second ship....
>
> The [study] committee finds that both operations and maintenance of the polar icebreaker fleet have been underfunded for many years, and the capabilities of the nation's icebreaking

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> icebreaking operations and the potential for new operating regimes. The study should be submitted to the Committee no later than September 30, 2005.

The conference report on H.R. 4567 (H.Rept. 108-774 of October 9, 2004) stated the following:

> As discussed in the Senate report and the Coast Guard authorization bill for fiscal year 2005, the conferees require the National Academy of Sciences to study the role of Coast Guard icebreakers.

The earlier House report on H.R. 4567 (H.Rept. 108-541 of June 15, 2004) contained language directing a similar report from the Coast Guard rather than the National Academies. (See the passage in the House report under the header "Icebreaking.")

fleet have diminished substantially. Deferred long-term maintenance and failure to execute a plan for replacement or refurbishment of the nation's icebreaking ships have placed national interests in the polar regions at risk. The nation needs the capability to operate in both polar regions reliably and at will. Specifically, the committee recommends the following:

- The United States should continue to project an active and influential presence in the Arctic to support its interests. This requires U.S. government polar icebreaking capability to ensure year-round access throughout the region.
- The United States should continue to project an active and influential presence in the Antarctic to support its interests. The nation should reliably control sufficient icebreaking capability to break a channel into and ensure the maritime resupply of McMurdo Station.
- The United States should maintain leadership in polar research. This requires icebreaking capability to provide access to the deep Arctic and the ice-covered waters of the Antarctic.
- National interests in the polar regions require that the United States immediately program, budget, design, and construct two new polar icebreakers to be operated by the U.S. Coast Guard.
- To provide continuity of U.S. icebreaking capabilities, the POLAR SEA should remain mission capable and the POLAR STAR should remain available for reactivation until the new polar icebreakers enter service.
- The U.S. Coast Guard should be provided sufficient operations and maintenance budget to support an increased, regular, and influential presence in the Arctic. Other agencies should reimburse incremental costs associated with directed mission tasking.
- Polar icebreakers are essential instruments of U.S. national policy in the changing polar regions. To ensure adequate national icebreaking capability into the future, a Presidential Decision Directive should be issued to clearly align agency responsibilities and budgetary authorities.[78]

The Coast Guard stated in 2008 that it "generally supports" the NRC report, and that the Coast Guard "is working closely with interagency partners to determine a way forward with national polar policy that identifies broad U.S. interests and priorities in the Arctic and Antarctic that will ensure adequate maritime presence to further these interests. Identification and prioritization of U.S. national interests in these regions should drive development of associated USCG [U.S. Coast Guard] capability and resource requirements." The Coast Guard also stated the following: "Until those broad U.S. interests and priorities are identified, the current USG [U.S. Government] polar icebreaking fleet should be maintained in an operational status."[79]

[78] National Research Council, *Polar Icebreakers in a Changing World, An Assessment of U.S. Needs*, Washington, 2007, pp. 2-3.

[79] Coast Guard point paper provided to CRS on February 12, 2008, and dated with the same date, providing answers to questions from CRS concerning polar icebreaker modernization.

Appendix C. PSC Program Funding

This appendix presents additional background information on funding for the PSC program.

Summary of Funding in FY2013-FY2020 Budget Submissions

Table C-1 shows requested and projected funding for the PSC program in the Coast Guard's budget submissions from the initiation of the PSC program in the FY2013 submission through the FY2020 submission.

Table C-1. Funding for Acquisition of New Polar Icebreaker Under FY2013-FY2020 Budget Submissions

(millions of then-year dollars)

Budget	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	5-year total
FY13	8	120	380	270	82								860
FY14		2	8	100	20	100							230
FY15			6	4	100	20	100						230
FY16				4	10	2	100	50					166
FY17					150	0	50	150	430				780
FY18						19	50	150	430	300			949
FY19							750	125	385	345	200		1,805
FY20								35	n/a	n/a	n/a	n/a	n/a

Source: Table prepared by CRS based on Coast Guard FY2013-FY2020 budget submissions.

Notes: For each line in the table, the first figure shown (e.g., $8 million in the case of the FY2013 budget) is the amount of funding that was requested for that fiscal year. Actual funding figures for FY2013-FY2019 are different.

The reduction in programmed five-year funding for a new polar icebreaker during the FY2014-FY2016 budget submissions shown in **Table C-1** appears to have been related to the substantial reduction in the annual funding levels in the Coast Guard's Acquisition, Construction, and Improvements (AC&I) account[80] in those budget submission that is shown in **Table C-2**. Prior to the release of the Administration's September 1, 2015, fact sheet, the Coast Guard testified that if annual funding levels in the AC&I account were not increased from the reduced levels in those budget submissions, the icebreaker would be, essentially, an unfunded requirement. For example, at an April 28, 2015, hearing on Coast Guard resources and priorities before the Oceans, Atmosphere, Fisheries, and Coast Guard subcommittee of the Senate Commerce, Science, and Transportation Committee, Admiral Paul Zukunft, the then-Commandant of the Coast Guard, testified that

> by reactivating Polar Star, we have purchased up to 10 years of decision space to recapitalize our ice-breaking fleet. Two of those years have expired. And while I'm exploring several options to reconstitute our nation's fleet of icebreakers, I will need topline relief [i.e., an increase] in my acquisition budget to make this requirement a reality.[81]

[80] Prior to FY2019, the PC&I account was called the Acquisition, Construction, and Improvements (AC&I) account.

[81] Source: Transcript of hearing.

Table C-2. Funding in Procurement, Construction, and Improvements (PC&I) Account in FY2013-FY2020 Budgets

(millions of dollars, rounded to nearest tenth)

Budget	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Avg.
FY13	1,217.3	1,429.5	1,619.9	1,643.8	1,722.0								1,526.5
FY14		951.1	1,195.7	901.0	1,024.8	1,030.3							1,020.6
FY15			1,084.2	1,103.0	1,128.9	1,180.4	1,228.7						1,145.0
FY16				1,017.3	1,125.3	1,255.7	1,201.0	1,294.6					1,178.8
FY17					1,136.8	1,259.6	1,339.9	1,560.5	1,840.8				1,427.5
FY18						1,203.7	1,360.9	1,602.7	1,810.6	1,687.5			1,533.1
FY19							1,886.8	1,473.0	1,679.8	1,555.5	1,698.5		1,658.8
FY20								1,234.7	n/a	n/a	n/a	n/a	n/a

Source: Table prepared by CRS based on Coast Guard FY2013-FY2020 budget submissions. Prior to FY2019, the PC&I account was called the Acquisition, Construction, and Improvements (AC&I) account.

For additional discussion of the issue of the funding level of the Procurement, Construction, and Improvements (PC&I) account, see **Appendix D**. Below are some additional details on each of the budget submissions since the FY2013 submission.

FY2013 Submission

The Administration's FY2013 budget submission initiated a new project for the design and construction of a new polar icebreaker, and included $860 million over five years for the acquisition of the ship (**Table C-1**)—enough or almost enough to fully fund the acquisition of a new polar icebreaker. (Any remaining needed funding might have been projected for FY2018 and perhaps also FY2019, which were beyond the five-year window of the FY2013 budget submission.) The submission stated that DHS anticipated awarding a construction contract for the ship "within the next five years" (i.e., by FY2018) and taking delivery on the ship "within a decade" (i.e., by 2023).[82]

FY2014 Submission

The Administration's FY2014 budget submission reduced the five-year funding for a new polar icebreaker to $230 million (**Table C-1**)—a 73% reduction from the figure in the FY2013 budget submission—but still stated that DHS anticipated awarding a construction contract for the ship "within the next four years" (i.e., by FY2018).[83]

[82] U.S. Department of Homeland Security, *Annual Performance Report, Fiscal Years 2011-2013*, p. CG-AC&I-40 (PDF page 1,777 of 3,134).

[83] Department of Homeland Security, United States Coast Guard, *Fiscal Year 2014 Congressional Justification*, p. CG-AC&I-32 (PDF page 204 of 403).

FY2015 Submission

The Administration's FY2015 budget submission maintained five-year funding for a new polar icebreaker at $230 million (**Table C-1**), but did not state when a construction contract for the ship might be awarded, creating uncertainty about the timing of the project.[84]

FY2016 Submission

The Administration's FY2016 budget submission, submitted to Congress in February 2015, reduced five-year funding for a new polar icebreaker further, to $166 million (**Table C-1**)—an 81% reduction from the figure in the FY2013 budget submission—and again did not state when a construction contract for the ship might be awarded, maintaining the uncertainty about the timing of the project.[85]

On September 1, 2015, the White House issued a fact sheet in conjunction with a visit to Alaska by President Obama indicating that the Administration, in its own internal planning, had at some point over the past two years deferred acquisition of a new polar icebreaker to FY2022, but that this had been changed to FY2020.[86] The newly announced construction start date of FY2020 was a two-year acceleration from the previously unpublicized date of FY2022, and a two-year deferral from the FY2018 date implied in the FY2013 and FY2014 budget submissions. The fact sheet states that the Administration will also "begin planning for construction of additional icebreakers" beyond the one that the Obama Administration proposed to begin building in FY2020.

On January 13, 2016, the Coast Guard announced that it intended to hold an industry day for the PSC program, followed by one-on-one meetings between the Coast Guard and prospective shipbuilders and ship designers, as a part of the Coast Guard's ongoing market research for the

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[84] Department of Homeland Security, United States Coast Guard, *Fiscal Year 2015, Congressional Justification*, p. CG-AC&I-42 (PDF page 196 of 474).

[85] Department of Homeland Security, United States Coast Guard, *Fiscal Year 2016 Congressional Justification*, p. CG-AC&I-36 (PDF page 202 of 518).

[86] The White House, "Fact Sheet: President Obama Announces New Investments to Enhance Safety and Security in the Changing Arctic," September 1, 2015, accessed September 2, 2015, at https://www.whitehouse.gov/the-press-office/2015/09/01/fact-sheet-president-obama-announces-new-investments-enhance-safety-and. Regarding icebreakers, the fact sheet states the following:

> **Accelerating the acquisition of new Coast Guard icebreakers.** After World War II, the United States Coast Guard had seven icebreakers in its fleet—four under the U.S. Navy and three under the U.S. Coast Guard. Today, the United States technically has three icebreakers in its fleet—all under the command of the U.S. Coast Guard. However, when age and reliability are taken into account, the fleet is down to the equivalent of two fully functional icebreakers and only one heavy-duty icebreaker. Russia, on the other hand, has forty icebreakers and another eleven planned or under construction.
>
> The growth of human activity in the Arctic region will require highly engaged stewardship to maintain the open seas necessary for global commerce and scientific research, allow for search and rescue activities, and provide for regional peace and stability. Accordingly, meeting these challenges requires the United States to develop and maintain capacity for year-round access to greater expanses within polar regions.
>
> That is why the Administration will propose to accelerate acquisition of a replacement heavy icebreaker to 2020 from 2022, begin planning for construction of additional icebreakers, and call on Congress to work with the Administration to provide sufficient resources to fund these critical investments. These heavy icebreakers will ensure that the United States can meet our national interests, protect and manage our natural resources, and strengthen our international, state, local, and tribal relationships.

program.[87] The industry day was held on March 18, 2016, and the one-on-one meetings between the Coast Guard and industry officials were scheduled for March 28-31, with industry feedback to be submitted to the Coast Guard by April 5, 2016.[88]

FY2017 Submission

The Coast Guard's proposed FY2017 budget requested $150 million in procurement funding for a new polar icebreaker. The figure of $150 million included $147.6 million in the polar icebreaker line of the Coast Guard's Acquisition, Construction, and Improvements (AC&I) account, and $2.4 million that was embedded in the personnel and management line in the AC&I account.[89] The Coast Guard's FY2017-FY2021 five-year Capital Investment Plan (CIP) included a total of $780 million in procurement funding for a new polar icebreaker. As shown in **Table C-1**, the $150 million requested for FY2017 was the first major increment of procurement funding requested (not just projected for a future fiscal year) for a new polar icebreaker.

FY2018 Submission

The Coast Guard's proposed FY2018 budget requested $19 million in procurement funding for a new polar icebreaker and includes a total of $949 million over the five-year period FY2018-FY2022. The Coast Guard states that

> This request supports activities to complete and release a Request for Proposal (RFP) for Detail Design and Construction in FY 2018. Specifically, this funding supports program-wide activities including open water and ice tank model testing; review of Industry Studies contract deliverables; Integrated Program Office (IPO) and Ship Design Team (SDT) support; logistics and integration development for government furnished information and equipment; and additional modeling efforts to inform the evaluation and source selection process for the Detail Design & Construction RFP....
>
> Currently, the Program is maturing the system specification, developing the RFP for Detail Design & Construction, and completing required documentation to transition to the "Obtain" phase - planned for early FY 2018. In July 2016, the Coast Guard established an Integrated Program Office with the Navy to continue efforts to accelerate the construction timeline and leverage the expertise and best practices from shipbuilding programs in both services. Based on this collaboration and lessons learned by the Navy, the Program was able to significantly mature the acquisition approach with the incorporation of Industry Studies to identify solutions to minimize cost, schedule, production and technology risks. Industry Studies are focusing on leveraging industry perspectives, existing vessel designs, and use of mature technology to inform the iterative development of the Heavy Polar Icebreaker system specification. Future "Obtain" phase activities include award of a contract for Detail Design & Construction for the heavy polar icebreaker.[90]

[87] "USCG Polar Class Icebreaker Replacement Program," accessed January 15, 2016, at https://www.fbo.gov/index?s=opportunity&mode=form&id=a778c49349c443d2658666e19cc100e9&tab=core&tabmode=list&=.

[88] "Heavy Polar Icebreaker Industry Engagement Activities," accessed April 4, 2016, at http://www.uscg.mil/ACQUISITION/icebreaker/Industry_Day_031816.asp.

[89] Department of Homeland Security, United States Coast Guard, *Fiscal Year 2017 Congressional Justification*, pp. CG-AC&I-28 and CG-AC&I-47 (PDF pages 170 and 189 of 407).

[90] Department of Homeland Security, U.S. Coast Guard, *Fiscal Year 2018 Congressional Justification*, undated but released May 2017, pp. AC&I-50 and AC&I-51.

FY2019 Submission

The Coast Guard's proposed FY2018 budget requested $750 million in procurement funding for the PSC program and included a total of $1,805 million over the five-year period FY2019-FY2023. The request for $750 million for the PSC program was a late change to the FY2019 budget that is not reflected in Coast Guard FY2019 budget-justification documents that were printed prior to the change. In those earlier documents, the amount of funding requested for FY2019 shows as $30 million rather than $750 million, and the total amount of funding requested in the Coast Guard's PC&I account was correspondingly $720 million less than the figure of $1,886.8 million shown in **Table C-2**.

FY2020 Submission

The Coast Guard's proposed FY2020 budget requests $35 million in procurement funding for the PSC program, which is enough to cover the PSC program's FY2020 government program-management costs.

Appendix D. Funding Level in PC&I Account

This appendix presents additional discussion of the funding level of the Coast Guard's Procurement, Construction, and Improvements (PC&I) account.[91]

Overview

The Coast Guard has testified that funding the PC&I account at a level of about $1 billion to $1.2 billion per year—the approximate average annual funding level programmed in the FY2014, FY2015, and FY2016 budget submissions, as shown in **Table C-2**—would make it difficult to fund various Coast Guard acquisition projects, including a new polar icebreaker and improvements to Coast Guard shore installations. Coast Guard plans call for procuring Offshore Patrol Cutters (OPCs) at an eventual rate of two per year.[92] If each OPC costs roughly $400 million, procuring two OPCs per year in an PC&I account of about $1 billion to $1.2 billion per year would leave about $200 million to $400 million per year for all other PC&I-funded programs.

Since 2017, Coast Guard officials have been stating more regularly what they stated only infrequently in earlier years: that executing the Coast Guard's various acquisition programs fully and on a timely basis would require the PC&I account to be funded in coming years at a level of about $2 billion per year. Statements from Coast Guard officials on this issue in past years have sometimes put this figure as high as about $2.5 billion per year.

Using Past PC&I Funding Levels as a Guide for Future PC&I Funding Levels

In assessing future funding levels for executive branch agencies, a common practice is to assume or predict that the figure in coming years will likely be close to where it has been in previous years. While this method can be of analytical and planning value, for an agency like the Coast Guard, which goes through periods with less acquisition of major platforms and periods with more acquisition of major platforms, this approach might not always be the best approach, at least for the PC&I account.

More important, in relation to maintaining Congress's status as a co-equal branch of government, including the preservation and use of congressional powers and prerogatives, an analysis that assumes or predicts that future funding levels will resemble past funding levels can encourage an artificially narrow view of congressional options regarding future funding levels, depriving Congress of agency in the exercise of its constitutional power to set funding levels and determine the composition of federal spending.

Past Coast Guard Statements About Required PC&I Funding Level

At an October 4, 2011, hearing on the Coast Guard's major acquisition programs before the Coast Guard and Maritime Transportation subcommittee of the House Transportation and Infrastructure Committee, the following exchange occurred:

[91] Prior to FY2019, the PC&I account was called the Acquisition, Construction, and Improvements (AC&I) account.

[92] For more on the OPC program, see CRS Report R42567, *Coast Guard Cutter Procurement: Background and Issues for Congress*, by Ronald O'Rourke.

> REPRESENATIVE FRANK LOBIONDO:
>
> Can you give us your take on what percentage of value must be invested each year to maintain current levels of effort and to allow the Coast Guard to fully carry out its missions?
>
> ADMIRAL ROBERT J. PAPP, COMMANDANT OF THE COAST GUARD:
>
> I think I can, Mr. Chairman. Actually, in discussions and looking at our budget—and I'll give you rough numbers here, what we do now is we have to live within the constraints that we've been averaging about $1.4 billion in acquisition money each year.
>
> If you look at our complete portfolio, the things that we'd like to do, when you look at the shore infrastructure that needs to be taken care of, when you look at renovating our smaller icebreakers and other ships and aircraft that we have, we've done some rough estimates that it would really take close to about $2.5 billion a year, if we were to do all the things that we would like to do to sustain our capital plant.
>
> So I'm just like any other head of any other agency here, as that the end of the day, we're given a top line and we have to make choices and tradeoffs and basically, my tradeoffs boil down to sustaining frontline operations balancing that, we're trying to recapitalize the Coast Guard and there's where the break is and where we have to define our spending.[93]

An April 18, 2012, blog entry stated the following:

> If the Coast Guard capital expenditure budget remains unchanged at less than $1.5 billion annually in the coming years, it will result in a service in possession of only 70 percent of the assets it possesses today, said Coast Guard Rear Adm. Mark Butt.
>
> Butt, who spoke April 17 [2012] at [a] panel [discussion] during the Navy League Sea Air Space conference in National Harbor, Md., echoed Coast Guard Commandant Robert Papp in stating that the service really needs around $2.5 billion annually for procurement.[94]

At a May 9, 2012, hearing on the Coast Guard's proposed FY2013 budget before the Homeland Security subcommittee of the Senate Appropriations Committee, Admiral Papp testified, "I've gone on record saying that I think the Coast Guard needs closer to $2 billion dollars a year [in procurement funding] to recapitalize—[to] do proper recapitalization."[95]

At a May 14, 2013, hearing on the Coast Guard's proposed FY2014 budget before the Homeland Security Subcommittee of the Senate Appropriations Committee, Admiral Papp stated the following regarding the difference between having about $1.0 billion per year rather than about $1.5 billion per year in the PC&I account:

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[93] Source: Transcript of hearing.

[94] David Perera, "The Coast Guard Is Shrinking," *FierceHomelandSecurity.com*, April 18, 2012, accessed July 20, 2012, at http://www.fiercehomelandsecurity.com/story/coast-guard-shrinking/2012-04-18.

[95] Source: transcript of hearing. Papp may have been referring to remarks he made to the press before giving his annual state of the Coast Guard speech on February 23, 2012, in which reportedly stated that the Coast Guard would require about $2 billion per year in procurement funding to fully replace its current assets. (See Adam Benson, "Coast Guard Cutbacks Will Cost 1,000 Jobs," *Norwich Bulletin*, February 23, 2012, accessed May 31, 2012, at http://www.norwichbulletin.com/x1138492141/Coast-Guard-cutbacks-will-cost-1-000-jobs. See also "Coast Guard Leader Calls For More Ships," *MilitaryFeed.com*, February 24, 2012, accessed May 31, 2012, at http://militaryfeed.com/coast-guard-leader-calls-for-more-ships-5/; Associated Press, "Coast Guard Commandant Calls for New Ships," *TheLog.com*, March 10, 2012, accessed May 31, 2012, at http://www.thelog.com/SNW/Article/Coast-Guard-Commandant-Calls-for-New-Ships-to-Replace-Aging-Fleet; Mickey McCarter, "Congress Poised to Give Coast Guard More Money Than Requested for FY 2013," *HSToday.us*, May 10, 2012, accessed May 31, 2012, at http://www.hstoday.us/focused-topics/customs-immigration/single-article-page/congress-poised-to-give-coast-guard-more-money-than-requested-for-fy-2013.html.) See also "Interview, Adm. Robert Papp, US Coast Guard Commandant," *Defense News*, November 11, 2013: 30.

> Well, Madam Chairman, $500 million—a half a billion dollars—is real money for the Coast Guard. So, clearly, we had $1.5 billion in the [FY]13 budget. It doesn't get everything I would like, but it—it gave us a good start, and it sustained a number of projects that are very important to us.
>
> When we go down to the $1 billion level this year, it gets my highest priorities in there, but we have to either terminate or reduce to minimum order quantities for all the other projects that we have going.
>
> If we're going to stay with our program of record, things that have been documented that we need for our service, we're going to have to just stretch everything out to the right. And when we do that, you cannot order in economic order quantities. It defers the purchase. Ship builders, aircraft companies—they have to figure in their costs, and it inevitably raises the cost when you're ordering them in smaller quantities and pushing it off to the right.
>
> Plus, it almost creates a death spiral for the Coast Guard because we are forced to sustain older assets—older ships and older aircraft—which ultimately cost us more money, so it eats into our operating funds, as well, as we try to sustain these older things.
>
> So, we'll do the best we can within the budget. And the president and the secretary have addressed my highest priorities, and we'll just continue to go on the—on an annual basis seeing what we can wedge into the budget to keep the other projects going.[96]

At a March 12, 2014, hearing on the Coast Guard's proposed FY2015 budget before the Homeland Security subcommittee of the House Appropriations Committee, Admiral Papp stated the following:

> Well, that's what we've been struggling with, as we deal with the five-year plan, the capital investment plan, is showing how we are able to do that. And it will be a challenge, particularly if it sticks at around $1 billion [per year]. As I've said publicly, and actually, I said we could probably—I've stated publicly before that we could probably construct comfortably at about 1.5 billion [dollars] a year. But if we were to take care of all the Coast Guard's projects that are out there, including shore infrastructure that that fleet that takes care of the Yemen [sic: inland] waters is approaching 50 years of age, as well, but I have no replacement plan in sight for them because we simply can't afford it. Plus, we need at some point to build a polar icebreaker. Darn tough to do all that stuff when you're pushing down closer to 1 billion [dollars per year], instead of 2 billion [dollars per year].
>
> As I said, we could fit most of that in at about the 1.5 billion [dollars per year] level, but the projections don't call for that. So we are scrubbing the numbers as best we can.[97]

At a March 24, 2015, hearing on the Coast Guard's proposed FY2016 budget before the Homeland Security subcommittee of the House Appropriations Committee, Admiral Paul Zukunft, Admiral Papp's successor as Commandant of the Coast Guard, stated the following:

> I look back to better years in our acquisition budget when we had a—an acquisition budget of—of $1.5 billion. That allows me to move these programs along at a much more rapid pace and, the quicker I can build these at full-rate production, the less cost it is in the long run as well. But there's an urgent need for me to be able to deliver these platforms in a timely and also in an affordable manner. But to at least have a reliable and a predictable acquisition budget would make our work in the Coast Guard much easier. But when we see variances of—of 30, 40% over a period of three or four years, and not knowing what the Budget Control Act may have in store for us going on, yes, we are treading water now

[96] Transcript of hearing. The remarks were made in response to a question from Sen. Mary Landrieu.

[97] Transcript of hearing.

> but any further reductions, and now I am—I am beyond asking for help. We are taking on water.[98]

An April 13, 2017, press report states the following (emphasis added):

> [Then-]Coast Guard Commandant Adm. Paul Zukunft on Wednesday [April 12] said that for the Coast Guard to sustain its recapitalization plans and operations the service needs a $2 billion annual acquisition budget that grows modestly overtime to keep pace with inflation.
>
> The Coast Guard needs a "predictable, reliable" acquisition budget "and within that we need 5 percent annual growth to our operations and maintenance (O&M) accounts," Zukunft told reporters at a Defense Writers Group breakfast. Inflation will clip 2 to 3 percent from that, but "at 5 percent or so it puts you on a moderate but positive glide slope so you can execute, so you can build the force," he said.[99]

In an interview published on June 1, 2017, Zukunft said the following (emphasis added):

> We cannot be more relevant than we are now. But what we need is predictable funding. We have been in over 16 continuing resolutions since 2010. I need stable and repeatable funding. **An acquisition budget with a floor of $2 billion.** Our operating expenses as I said, they've been funded below the Budget Control Act floor for the past five years. I need 5 percent annualized growth over the next five years and beyond to start growing some of this capability back.
>
> But more importantly, we [need] more predictable, more reliable funding so we can execute what we need to do to carry out the business of the world's best Coast Guard.[100]

[98] Transcript of hearing. The remarks were made in response to a question from Rep. John Culberson.

[99] Calvin Biesecker, "Zukunft Wants $2 Billion Baseline Acquisition Budget; Sustained Growth In O&M Funding," *Defense Daily*, April 13, 2017: 1.

[100] Jill Aitoro, "Interview: Adm. Paul Zukunft Demands Coast Guard Respect," *Defense News*, June 1, 2017.

Appendix E. Great Lakes Icebreakers

This appendix provides a brief discussion of the Coast Guard's Great Lakes icebreakers.[101]

The Coast Guard's current Great Lakes icebreaker fleet consists of nine cutters:

- one heavy icebreaker—*Mackinaw* (WLBB-30), a 240-foot ship displacing 3,500 tons;
- six 140-foot *Bay*-class icebreaking tugs displacing 662 tons each; and
- two 225-foot *Juniper*-class seagoing buoy tenders displacing about 2,000 tons each that have a light icebreaking capability.[102]

Although *Mackinaw* is referred to as a heavy icebreaker, the word *heavy* in this instance is being used in the context of Great Lakes icebreaking—*Mackinaw* is much larger and has more icebreaking capability than the eight other ships listed above.[103] *Mackinaw* would not, however, qualify as a heavy polar icebreaker, as it is much smaller and has much less icebreaking capability than a heavy polar icebreaker.[104]

Coast Guard officials have stated that they do not view the procurement of additional Great Lakes icebreakers as an urgent near-term acquisition need. In support of this assessment, they cite the capabilities of the current Great Lakes icebreaking fleet, the relatively young age of *Mackinaw* (which entered service in 2006), service life extension work being done on the ice-breaking tugs that is designed to add 15 years to their service lives,[105] and Canada's own Great Lakes icebreaking capabilities. A 2016 Coast Guard report to Congress on the Great Lakes icebreaking mission stated the following:

> The current mix of heavy and medium [Great Lakes] icebreakers is capable of managing priorities and requests for icebreaking in Tier 1 and 2 waterways. When a severe ice season stresses Coast Guard asset capabilities, the existing agreement and partnership with Canada fills the capability gap and brings in extra heavy-icebreaking resources to manage the ice.... [T]he 2014 and 2015 ice seasons were a 20-year anomaly, consuming almost twice as many cutter resource hours as in any other year since 2005.

[101] This appendix is adapted from the section entitled "Great Lakes Icebreakers" on pages 7-10 of CRS Testimony TE10030, *Icebreaker Acquisition and the Need for a National Maritime Strategy*, by Ronald O'Rourke.

[102] Source: U.S. Coast Guard, "Ninth Coast Guard District Units," accessed November 19, 2018, at https://www.atlanticarea.uscg.mil/Atlantic-Area/Units/District-9/Ninth-District-Units/. A total of 10 cutters are assigned to the Ninth District, which is responsible for the Great Lakes, the Saint Lawrence Seaway, and parts of the surrounding states. The tenth cutter assigned to the Ninth District is a 100-foot inland buoy tender whose primary missions do not include icebreaking.

[103] At continuous speeds of 3 knots, *Mackinaw* can break ice up to 32 inches thick, the 140-foot icebreaking tugs can break ice up to 22 inches thick, and the 225-foot seagoing buoy tenders can break ice up to 14 inches thick.

[104] As discussed earlier in this report, the Coast Guard's two heavy polar icebreakers—the operational *Polar Star* and the nonoperational *Polar Sea*, are 399 feet long and displace about 13,200 tons each. *Polar Star* can break ice up to six feet (72 inches) thick at a continuous speed of 3 knots. The Coast Guard states that *Mackinaw* is equivalent to the Canadian Coast Guard ship *Samuel Risley*, a Great Lakes-homeported icebreaker and buoy tender that Canada classifies as a light icebreaker in a comparison conducted across its entire icebreaking fleet, including its Arctic icebreakers. (U.S. Coast Guard, *Great Lakes Icebreaking Mission Analysis, Fiscal Year 2016 Report to Congress*, August 30, 2016, p. 5.)

[105] For more on this service life extension work, see U.S. Coast Guard, "In-Service Vessel Sustainment Program," accessed November 19, 2018, at https://www.dcms.uscg.mil/Our-Organization/Assistant-Commandant-for-Acquisitions-CG-9/Programs/Surface-Programs/In-Service-Vessel-Sustainment-Program/.

> The Coast Guard cannot reliably predict the economic impact of maintaining a single heavy Great Lakes icebreaker. Additionally, given the extreme conditions when ice coverage exceeds 90 percent, it is not clear that shipping delays would be significantly mitigated by an increase in icebreaking capability. Delays can be associated with several factors such as slow transit speeds, availability of pilots, and simultaneous and competing demand signals for icebreaking services across the Great Lakes.[106]

The Coast Guard's position notwithstanding, some Members of Congress in recent years have expressed interest in the possibility of bolstering the Coast Guard's Great Lakes icebreaking fleet by procuring a second icebreaker with capabilities generally similar to those of *Mackinaw*. Interest in this option was reinforced by the winters of 2013-2014 and 2014-2015, which featured particularly high levels of ice coverage on the Great Lakes.[107] The committee report language requiring the above-quoted Coast Guard report to Congress is one example of this interest.[108] Another example is Section 820 of the Frank LoBiondo Coast Guard Authorization Act of 2018 (S. 140/P.L. 115-282 of December 4, 2018), which states the following:

> SEC. 820. Great Lakes icebreaker acquisition.
>
> (a) Icebreaking on the Great Lakes.—For fiscal years 2018 and 2019, the Commandant of the Coast Guard may use funds made available pursuant to section 4902 of title 14, United States Code, as amended by this Act, for the construction of an icebreaker that is at least as capable as the Coast Guard Cutter Mackinaw to enhance icebreaking capacity on the Great Lakes.
>
> (b) Acquisition plan.—Not later than 45 days after the date of enactment of this Act, the Commandant shall submit a plan to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure of

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[106] U.S. Coast Guard, *Great Lakes Icebreaking Mission Analysis, Fiscal Year 2016 Report to Congress*, August 30, 2016, p. 11. The report was required by S.Rept. 114-68 of June 18, 2015, the Senate Appropriations Committee's report on S. 1619, the Department of Homeland Security Appropriations Bill, 2016 (see page 75).

[107] Although interest in procuring a second heavy Great Lakes icebreaker was reinforced by high levels of ice coverage in the winters of 2013-2014 and 2014-2015, interest in Congress in procuring such a ship dates back further than 2013. See, for example, H.R. 1747 of the 111th Congress, the Great Lakes Icebreaker Replacement Act, which was introduced on March 26, 2009, reported by the Committee on Transportation and Infrastructure on April 21, 2009 (H.Rept. 111-81), and agreed to by the House by voice vote on April 27, 2009. A similar bill, S. 1024, was introduced in the Senate on May 12, 2009.

[108] S.Rept. 114-68 stated the following:

> GREAT LAKES ICEBREAKING CAPACITY
>
> The Coast Guard is required by law to maintain a heavy icebreaking capability on the Great Lakes to assist in keeping channels and harbors open to navigation in response to the reasonable demands of commerce to meet the winter shipping needs of industry. The Committee is concerned that the Coast Guard does not possess adequate capacity to meet its statutorily required icebreaking mission on the Great Lakes, with negative consequences to the regional and national economy as well as to the safety of local communities. While the Committee fully supports the Coast Guard's Service Life Extension Project for its nine-vessel 140-foot icebreaking tugs as part of the In-Service Vessel Sustainment Program, it notes that additional assets may be necessary to successfully operate in the heavy ice conditions often experienced by the Great Lakes. The Committee directs the Coast Guard to undertake an updated mission analysis study to determine the assets necessary to effectively carry out its icebreaking requirements on the Great Lakes, including consideration of a second heavy icebreaker for the Great Lakes, consistent with the capabilities of the Mackinaw. The updated mission analysis should factor in recent historically high levels of ice coverage and the economic costs of reduced Great Lakes shipping associated with maintaining only one heavy icebreaker. The updated mission analysis shall be submitted to the Committee not later than 180 days after the date of enactment of this act. (Page 75)

> the House of Representatives for acquiring an icebreaker described in subsections (a) and (b). Such plan shall include—
>
> (1) the details and schedule of the acquisition activities to be completed; and
>
> (2) a description of how the funding for Coast Guard acquisition, construction, and improvements that was appropriated under the Consolidated Appropriations Act, 2017 (Public Law 115–31) will be allocated to support the acquisition activities referred to in paragraph (1).[109]

An examination of procurement costs for *Mackinaw*, the National Science Foundation's ice-capable research ship *Sikuliaq*, new oceanographic research ships being procured for NOAA, and OPCs suggests that a new *Mackinaw*-sized heavy Great Lakes icebreaker built in a U.S. shipyard might have a design and construction cost between $175 million and $300 million, depending on its exact capabilities and the acquisition strategy employed.[110] The design portion of the ship's

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[109] In addition, Section 819 of S. 140/P.L. 115-282 states the following:

> SEC. 819. Acquisition plan for inland waterway and river tenders and bay-class icebreakers.
>
> (a) Acquisition plan.—Not later than 270 days after the date of the enactment of this Act, the Commandant of the Coast Guard shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives a plan to replace or extend the life of the Coast Guard fleet of inland waterway and river tenders, and the Bay-class icebreakers.
>
> (b) Contents.—The plan under subsection (a) shall include—
>
> (1) an analysis of the work required to extend the life of vessels described in subsection (a);
>
> (2) recommendations for which, if any, such vessels it is cost effective to undertake a ship-life extension or enhanced maintenance program;
>
> (3) an analysis of the aids to navigation program to determine if advances in navigation technology may reduce the needs for physical aids to navigation;
>
> (4) recommendations for changes to physical aids to navigation and the distribution of such aids that reduce the need for the acquisition of vessels to replace the vessels described in subsection (a);
>
> (5) a schedule for the acquisition of vessels to replace the vessels described in subsection (a), including the date on which the first vessel will be delivered;
>
> (6) the date such acquisition will be complete;
>
> (7) a description of the order and location of replacement vessels;
>
> (8) an estimate of the cost per vessel and of the total cost of the acquisition program of record; and
>
> (9) an analysis of whether existing vessels can be used.

[110] Source: CRS analysis of cost per weight for *Mackinaw* (adjusted for inflation), *Sikuliaq*, new NOAA oceanographic research ships now being procured, and OPCs.

Some press reports in 2015 and 2016 cited a cost of about $200 million for a new heavy Great Lakes icebreaker. (See, for example, Todd Spangler, "A New Icebreaker for the Great Lakes? It's Far from Certain," *Detroit Free Press*, August 7, 2015; "Frozen Commerce: Great Lakes Businesses Need a New Icebreaker," *Pittsburgh Post-Gazette*, August 17, 2015; Todd Spangler, "Call for Arctic Icebreakers Could Hurt Great Lakes," *Detroit Free Press*, September 1, 2015; Bob Gross, "Congress Authorizes New Icebreaker for Great Lakes," *Times Herald (Port Huron, MI)*, February 3, 2016; "Task Force Calls Anew for More Great Lakes Icebreakers, Second Poe-Sized Lock," *Professional Mariner*, February 17, 2016 [the article states that it presents the text of a news release from the Great Lakes Maritime Task Force].) An opinion column in 2016 cited a figure of $240 million. (John Hageman, "Is Winter Great Lakes Shipping Necessary?" *Sandusky Register*, February 18, 2016.)

The Great Lakes Maritime Task Force, an organization that states that it "was founded in 1992 in Toledo, Ohio, to promote waterborne commerce and related industries on the Great Lakes" (see Great Lakes Maritime Task Force, "About Us," accessed November 26, 2018, at http://www.glmtf.org/about), states in its annual report for 2017 that a second heavy Great Lakes icebreaker "is projected to cost $240 million." (*2017 Annual Report of Great Lakes Maritime Task Force*, PDF page 3 of 6, accessed November 26, 2018, at http://www.glmtf.org/wp-content/uploads/2018/05/2017-Annual-Report.pdf.) The same figure is cited in the organization's annual report for 2016. The organization's annual report for 2015 cited a figure of approximately $200 million.

cost might be reduced if *Mackinaw's* design or the design of some other existing icebreaker were to be used as the parent design. Depending on the capabilities and other work load of the shipyard selected to build the ship, the construction time for a new heavy Great Lakes icebreaker might be less than that of a new heavy polar icebreaker.

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Specialist in Naval Affairs

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