



Statement of

Ronald O'Rourke
Specialist in Naval Affairs

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Chairman Sullivan, Ranking Member Baldwin, distinguished members of the subcommittee, thank you for the opportunity to appear before you today to testify on Coast Guard and NOAA fleet recapitalization. Ship acquisition has been a major focus of my work as a CRS analyst on naval issues for the past 34 years. I have covered Coast Guard ship acquisition for Congress for 20 years¹ and last testified before this committee on the issue in 2005.² My biography is shown in **Appendix A**.

My CRS reports on Coast Guard cutter procurement and polar icebreaker procurement provide extensive discussions of the Coast Guard's National Security Cutter (NSC) program, Offshore Patrol Cutter (OPC) program, Fast Response Cutter (FRC) program and polar icebreaker program (recently renamed the Polar Security Cutter, or PSC, program).³ As requested by the subcommittee, this statement provides some focused observations regarding these programs as well as the Coast Guard's Waterways Commerce Cutter (WCC) program and NOAA's fleet recapitalization effort.

Appendix B to this statement presents a general summary of some lessons learned in government shipbuilding. **Appendix C** presents some considerations relating to the use of warranties in government shipbuilding. **Appendix D** presents some considerations relating to avoiding procurement cost growth vs. minimizing procurement costs in government shipbuilding.

Coast Guard Fleet Recapitalization

Adequacy of Planned Quantities of NSCs, OPCs, and FRCs

The Coast Guard's 91-ship program of record (POR) for general-purpose cutters—which dates to 2004 and calls for a force of 8 NSCs, 25 OPCs, and 58 FRCs—will provide substantially more capability than the force of older-generation cutters it will replace. At the same time, it can be useful to recall that Coast Guard studies have concluded that the planned total of 91 NSCs, OPCs, and FRCs would provide only 61% of the NSCs, OPCs, and FRCs that would be needed to fully perform the service's statutory missions in coming years, in part because Coast Guard mission demands are expected to be greater in coming years than they were in the past. As shown in **Table 1**, the Coast Guard's 2011 Fleet Mix Analysis (FMA) Phase 2—the last general analysis of future Coast Guard ship force structure requirements to be publicly released by the Coast Guard—concluded that fully performing the Coast Guard's statutory missions in coming years would require a total of 149 NSCs, OPCs, and FRCs.⁴ This point may be particularly salient

¹ See, for example:

- CRS Report 98-830 F, *Coast Guard Integrated Deepwater System: Background and Issues for Congress*, by Ronald O'Rourke, first version October 5, 1998, final (i.e., archived) version June 1, 2001;
- CRS Report RS21019, *Coast Guard Deepwater Program: Background and Issues for Congress*, by Ronald O'Rourke, first version September 25, 2001, final (i.e., archived) version December 8, 2006;
- CRS Report RL33753, *Coast Guard Deepwater Acquisition Programs: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke, first version December 18, 2006, final (i.e., archived) version January 20, 2012;
- CRS Report R42567, *Coast Guard Cutter Procurement: Background and Issues for Congress*, by Ronald O'Rourke, first version June 13, 2012, current version August 3, 2018; and
- CRS Report RL34391, *Coast Guard Polar Icebreaker Program: Background and Issues for Congress*, by Ronald O'Rourke, first version February 26, 2008, current version August 3, 2018.

² See Statement of Ronald O'Rourke, Specialist in National Defense, Congressional Research Service, before the Senate Commerce, Science, and Transportation Committee, subcommittee on Fisheries and the Coast Guard, hearing on The Coast Guard's Revised Deepwater Implementation Plan, June 21, 2005, 15 pp.

³ See the final two reports cited above in footnote 1.

⁴ For additional discussion, see Appendix A of CRS Report R42567, *Coast Guard Cutter Procurement: Background and Issues for Congress*, by Ronald O'Rourke.

right now in connection with the NSC and FRC programs, procurement of which would end soon under the POR figures.

Table I. Program of Record Compared to Fleet Mix Analysis Phase 2 (2011)

Ship Type	Program of Record	Refined Objective Mix from Fleet Mix Analysis, Phase 2 (2011)
NSC	8	9
OPC	25	49
FRC	58	91
Total	91	149

Source: Coast Guard Fleet Mix Analysis, Phase 2, 2011, Table ES-2 on p. iv. For additional discussion, see Appendix A of CRS Report R42567, *Coast Guard Cutter Procurement: Background and Issues for Congress*, by Ronald O'Rourke.

PC&I Account Funding Levels

There has been some discussion recently of how certain Coast Guard procurement programs would not be affordable if the Coast Guard's Procurement, Construction, and Improvements (PC&I) account in coming years were limited to an average of about \$1.1 billion per year.⁵ An average PC&I funding level of about \$1.1 billion per year would have that effect. In 2013, then-Coast Guard Commandant Robert Papp testified that an annual PC&I funding level of about \$1 billion per year "almost creates a death spiral for the Coast Guard."⁶ The notion that the PC&I funding level will be limited to an average of about \$1.1 billion per year, however, is no longer strongly supported by recent data on Coast Guard annual funding requests,⁷ annual enacted funding levels,⁸ or projected future annual funding requests as shown in Coast Guard five-year Capital Investment Plans (CIPs).⁹

⁵ See Government Accountability Office, *Coast Guard Acquisitions[:] Actions Needed to Address Longstanding Portfolio Management Challenges*, GAO-18-454, July 2018, Figure 4 on page 22, and GAO's spoken testimony during the question-and-answer portion of a July 24, 2018, hearing on Coast Guard acquisition programs and mission balance and effectiveness before the Coast Guard and Maritime Transportation subcommittee of the House Transportation Committee, during which Figure 4, which depicts a funding funnel, was shown on the hearing room's display screens. (The funnel, which compares an annual PC&I account funding figure of \$1.1 billion to a higher figure of \$2 billion consistent with the Coast Guard's preferred PC&I account annual funding level, is not drawn to scale: Although \$1.1 billion is 55% of \$2 billion, the narrower \$1.1-billion bottom of the funnel has an opening with a diameter that is no more than 22% as wide as that of the larger, \$2-billion top of the funnel.) In report GAO-18-454, see also Figure 3 on page 15, which indicates an average requested funding level of about \$1.1 billion per year for the period FY2014-FY2018, as well as the discussion on pages 13-14.

⁶ Admiral Papp's spoken testimony during a May 14, 2013, hearing on the Coast Guard's proposed FY2014 budget before the Homeland Security subcommittee of the Senate Appropriations Committee, as reflected in the transcript for the hearing.

⁷ While the Coast Guard's annual budget submissions for the five-year period FY2014 through FY2018 requested an average of about \$1,065 million per year for the PC&I account, the Coast Guard's most recent request for the account—the request in its proposed FY2019 budget—is for \$1,886.8 million (a figure that reflects a late addition of \$720 million to the request for the polar icebreaker program), and the Coast Guard's annual budget submissions for the five-year period FY2009-FY2013 requested an average of about \$1,322 million for the account.

⁸ Over the last 10 fiscal years (FY2009-FY2018), enacted funding levels for the PC&I account (including rescissions of unobligated balances) have averaged about \$1,560 million per year. Only once during this period, in FY2015, was the enacted figure less than \$1,200 million (it was \$1,166.6 million that year). In the other nine years, it was more than \$1,200 million, and sometimes substantially more. The figures for the three most recent fiscal years—FY2016, FY2017, and FY2018—were \$1,928.4 million, \$1,370.0 million, and \$2,282.4 million, respectively.

⁹ Although the projected funding requests in the FY2014, FY2015, and FY2016 CIPs (showing figures for FY2014-FY2018, FY2015-FY2019, and FY2016-FY2020, respectively), averaged about \$1,114.8 million per year, the projected funding requests

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, which could deprive Congress of agency in the exercise of its constitutional power to set funding levels and determine the composition of federal spending.

As one example of how past funding levels were not the best guide to future funding levels, and of how Congress has exercised its constitutional power to set funding levels and determine the composition of federal spending, during the period FY2008-FY2015, when the Navy's shipbuilding account averaged about \$14.7 billion per year in then-year dollars, there was recurring discussion about the challenge of increasing the account to the substantially higher annual funding levels that would soon be needed to begin implementing the Navy's 30-year shipbuilding plan. Projections were prepared by CBO showing the decline in the size of the Navy that would occur over time if funding levels in the shipbuilding account did not increase substantially from the average level of about \$14.7 billion per year. Congress, after assessing the situation, increased the shipbuilding account to \$18.7 billion in FY2016, \$21.2 billion in FY2017, \$23.8 billion in FY2018, and \$24.2 billion in FY2019. These increasing funding levels occurred even though the Budget Control Act, as amended, remained in operation during those years. At the most recent figure of \$24.2 billion, the Navy's shipbuilding account is now 74% greater in then-year dollars than it was as recently as FY2010.

Coast Guard's Non-Use of Multiyear Contracting

In connection with my work on ship acquisition, I maintain the CRS report on multiyear procurement (MYP) and block buy contracting.¹⁰ In both that report and in testimony I have given to other committees in recent years on Coast Guard ship acquisition,¹¹ I have noted the stark contrast between the Navy—which uses multiyear contracting (in the form of MYP or block buy contracting) extensively to reduce its ship- and aircraft-procurement costs by billions of dollars—and the Coast Guard, which to date has never used multiyear contracting in one of its ship or aircraft acquisition programs.

The Navy in recent years, with congressional approval, has used multiyear contracting for, among other things, all three of its year-to-year shipbuilding programs—the Virginia-class attack submarine program, the DDG-51 destroyer program, and the Littoral Combat Ship (LCS) program.¹² The Navy has been using multiyear contracting for the Virginia-class and DDG-51 programs more or less continuously since the 1990s. Savings from the use of MYP recently have, among other things, helped Congress and the Navy to

in the FY2017 CIP (for the period FY2017-FY2021) averaged about \$1,427.5 million, and those in the FY2018 CIP (for the period FY2018-FY2022) averaged about \$1,533.1 million.

¹⁰ 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.

¹¹ See, for example, CRS Testimony TE10020, *Building a 21st Century Infrastructure for America: Coast Guard Sea, Air, and Land Capabilities: Part II*, by Ronald O'Rourke, and CRS Testimony TE10004, *The Status of Coast Guard Cutter Acquisition Programs*, by Ronald O'Rourke.

¹² The term year-to-year shipbuilding program is used here to mean a shipbuilding program in which at least one ship of that kind is procured each year. The Coast Guard plans to execute the OPC program as a year-to-year shipbuilding program.

convert a nine-ship buy of DDG-51 class destroyers in FY2013-FY2017 into a 10-ship buy, and a nine-ship buy of Virginia-class attack submarines in FY2014-FY2018 into a 10-ship buy. The Navy is also now using block buy contracting in the John Lewis (TAO-205) class oiler program, and is considering or anticipating using them for procuring LPD-17 Flight II amphibious ships, FFG(X) frigates, and Columbia-class ballistic missile submarines. The Navy's use or prospective use of multiyear contracting for its year-to-year shipbuilding programs is arguably now almost more of a rule than an exception in Navy shipbuilding. For Congress, granting approval for using multiyear contracting involves certain tradeoffs, particularly in connection with retaining year-to-year control of funding.¹³ In the case of Navy shipbuilding, Congress has repeatedly accepted these tradeoffs.

In contrast with Navy practice, the Coast Guard often uses contracts with options in its ship-procurement programs. Contracts with options can be referred to as *multiple-year* contracts, but they are not *multiyear* contracts. Instead, contracts with options operate more like annual contracts, and they cannot achieve the kinds of savings that are possible with multiyear contracts.¹⁴ Like the other military services, the Coast Guard has statutory authority to use MYP contracting and can be granted authority by Congress to use block buy contracting.

National Security Cutter (NSC) Program

The NSCs were procured at irregular rather than regular intervals, and they were procured with annual rather than multiyear contracts. Both of these aspects of their acquisition made the ships more expensive. If NSCs had instead been procured at regular intervals under multiyear contracts that included authority for economic order quantity (EOQ) purchases (i.e., up-front batch orders of selected components for some or all of the ships covered under the contract), the reduction in their combined procurement cost could have been substantial—possibly enough (or even more than enough) to have paid for one of the 11 NSCs that have been fully funded through FY2018.

As discussed below in the section on the OPC program, building additional NSCs is one option for acquiring replacements for retiring medium-endurance cutters more quickly than currently planned, so as to close more quickly any gap in time between retirements of the medium-endurance cutters and the entry into service of their replacements. The NSCs are bigger and in some respects more capable than OPCs, and they would individually be more expensive to procure and to operate and support than OPCs. The difference in size, capability, and cost between the NSC and OPC design is not insignificant, but neither is it a night-and-day difference. With an estimated full-load displacement of 3,500 to 3,730 tons,¹⁵ for example, OPCs are to be roughly 80% as large as NSCs, which have a full load displacement of about

¹³ From a congressional perspective, tradeoffs in making greater use of multiyear 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 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 EOQ 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 for the continuation of the contracts; and the risk that materials and components purchased for ships to be procured in future years might go to waste if those ships are not eventually procured. Congress has considered these tradeoffs in deciding whether to grant the Navy authority for using multiyear contracting in the service's shipbuilding and other acquisition programs.

¹⁴ For additional discussion, 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, particularly the section entitled "MYP and BBC vs. Contracts with Options."

¹⁵ As of May 26, 2017, the OPC's light ship displacement (i.e., its "empty" displacement, without fuel, water, ballast, stores, and crew) was preliminarily estimated at about 2,640 to 2,800 tons, and its full load displacement was preliminarily estimated at about 3,500 to 3,730 tons. (Source: Figures provided to CRS by Coast Guard liaison office, May 26, 2017.)

4,500 tons.¹⁶ In terms of size, capability, and cost, the OPC is a lot closer to the NSC than it is to the FRC, which is a large patrol craft with a full load displacement of 353 tons.

Procurement of NSCs for replacing retiring Hamilton-class high-endurance cutters is approaching its end. If additional NSCs were procured in the near term in parallel with OPC procurement as part of a strategy for more quickly replacing retiring medium-endurance cutters, the additional NSCs could be built using the currently open NSC production line, avoiding a break in that production line and thereby maximizing production learning curve benefits. The procurement cost of any additional NSCs might be further reduced by procuring them at regular intervals and using an MYP contract.

OPC Program

The Coast Guard is using a contract with options to procure the first nine OPCs. As stated earlier, although a contract with options might look like a multiyear contract, it is not a form of multiyear contracting. A contract with options operates more like annual contracting and cannot achieve the kinds of savings that are possible with multiyear contracting.¹⁷

Using multiyear contracting in the 25-ship OPC program—specifically, block buy contracting with EOQ authority for the initial ships in the program, followed by either block buy contracting with EOQ authority or MYP contracting for later ships in the program—rather than annual contracting might reduce the total acquisition cost of the program by about \$1 billion. This potential savings of \$1 billion—a figure equal to or greater than the acquisition cost of either a polar icebreaker or a 35-ship Waterways Commerce Cutter program—represents a rare opportunity for using multiyear contracting to reduce the cost of an individual Coast Guard acquisition program by such an amount.

Acquiring the first nine ships in the OPC program under the current contract with options could forego roughly \$350 million of the \$1 billion in potential savings. Much of this \$350 million in potential savings might be recaptured by renegotiating the current contract so as to convert it, with congressional approval, into a block buy contract with EOQ authority. If acquisition regulations prohibit such a renegotiation, the Coast Guard alternatively could choose to not exercise most of the options in the current contract and hold a new competition for building the current NSC design under a block buy contract. The current OPC builder—Eastern Shipbuilding of Panama City, FL—would be well positioned to win such a competition, since it would involve building Eastern’s own design and Eastern would already have moved down the initial (i.e., the steepest) part of the learning curve for building the design.

The current planned procurement profile for the OPC, which reaches a maximum projected rate of two ships per year, would deliver OPCs many years after the end of the originally planned service lives of the medium-endurance cutters that they are to replace. Coast Guard officials have testified that the service plans to extend the service lives of the medium-endurance cutters until they are replaced by OPCs. There will be maintenance and repair expenses associated with extending the service lives of medium-endurance cutters, and if the Coast Guard does not also make investments to increase the capabilities of these ships, the ships may have less capability in certain regards than OPCs.

One possible option for addressing this situation would be to increase the maximum annual procurement rate of the replacement ships from the currently planned two ships per year to a higher figure. Increasing the rate to three or four ships per year, for example, could result in the 25th ship being delivered about four years or six years sooner, respectively, than under the currently planned maximum rate. Increasing

¹⁶ Source for figure of 4,500 tons: Coast Guard NSC fact sheet, accessed October 3, 2018, at: <https://www.dcms.uscg.mil/Portals/10/CG-9/Acquisition%20PDFs/Factsheets/NSC.pdf?ver=2017-04-24-142526-023>.

¹⁷ For additional discussion, 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, particularly the section entitled “MYP and BBC vs. Contracts with Options.”

the procurement rate would require a substantial increase to the Coast Guard's AC&I account, which gets back to the issue discussed earlier of future funding levels for that account and Congress's agency in setting funding levels and determining the composition of federal spending.

From a production point of view, there are at least three options for increasing the annual procurement rate of replacement ships from the currently planned two ships per year to a higher rate, so as to close any gap in time between the retirements of medium-endurance cutters and the entry into service of their replacements. These options are as follows:

- increasing the annual OPC production rate at Eastern Shipbuilding, if Eastern's capacity would permit this;
- building additional OPCs at one or two additional shipyards, such as Bollinger Shipyards of Lockport, LA and/or General Dynamics' Bath Iron Works (GD/BIW) of Bath, ME—the two other finalists in the OPC competition; and
- building additional NSCs at Huntington Ingalls Industries/Ingalls Shipbuilding (HII/Ingalls).

These three options are not mutually exclusive—they could be pursued in combination. Additional OPCs built at Bollinger and/or GD/BIW could be built to the OPC designs that those two shipbuilders submitted for the OPC competition. (Those designs are presumably optimized for the production facilities at Bollinger and GD/BIW. The Coast Guard, moreover, currently does not have data rights for the complete vessel design for Eastern's OPC design.¹⁸) Building additional OPCs at Bollinger and/or GD/BIW to the designs developed by those two shipbuilders would result in a fleet with two or three classes of OPCs, a situation that would increase OPC life-cycle operation and support costs and complicate the training and assignment of OPC crew members. These additional life-cycle costs and complications, however, might be deemed acceptable in return for avoiding the costs and risks of extending the service lives of medium-endurance cutters and shortening any gap in time between the retirement of medium-endurance cutters and the entry into service of their replacements. The Navy decided in 2010 to fill its requirement for LCSs by building two different LCS designs at the same time, and did so knowing that this would result in some additional life-cycle operation and support costs and crewing-related complications compared to the option of building all LCSs to a single design.¹⁹ The option of building additional NSCs as replacements for retiring medium-endurance cutters was discussed above in the section on the NSC program.

FRC Program

With 50 FRCs procured through FY2018 and four more requested for FY2019, the FRC is approaching the 58-ship figure called for in the Coast Guard's program of record. As shown earlier in **Table 1**, however, the Coast Guard's 2011 Fleet Mix Analysis Phase II concluded that a total of 91 FRCs would be needed as part of an overall force of 149 general-purpose cutters to fully perform the service's statutory missions in coming years.

Procuring additional FRCs beyond the 58th would require additional procurement funding, which gets back to the issue discussed earlier of future funding levels for the PC&I account and Congress's agency in setting funding levels and determining the composition of federal spending. As with the option discussed earlier of procuring additional NSCs, procuring additional FRCs immediately following the procurement of the 58th FRC would permit them to be built using the currently open NSC production line, avoiding a break in that production line and thereby maximizing production learning curve benefits. And as with the

¹⁸ Source regarding data rights: Email from Coast Guard liaison office to CRS, September 6, 2017.

¹⁹ For additional discussion of the LCS program, see CRS Report RL33741, *Navy Littoral Combat Ship (LCS) Program: Background and Issues for Congress*, by Ronald O'Rourke. A total of 35 LCSs have been funded through FY2019. Of these 35 ships, 17 will be built to one of the LCS designs, and 18 will be built to the other.

NSC option discussed earlier, the cost of any such additional FRCs could be reduced by procuring them under an MYP or block buy contract. The resulting increase in Coast Guard force structure from 58 FRCs to some higher number would increase long-term Coast Guard operation and support costs above currently planned levels.

Polar Security Cutter (PSC) (aka Polar Icebreaker)

Reduction in Estimated Procurement Cost and Business Case

One of the most notable changes in the PSC program over the last year or two has been the reduction in the estimated unit procurement cost of the ships. The procurement cost of a new heavy polar icebreaker had earlier been estimated informally at roughly \$1 billion, but the Coast Guard and Navy informed CRS and CBO in March 2018 that they now believe that three polar icebreakers could be acquired for a total cost of about \$2.1 billion, or an average of about \$700 million per ship.²⁰ (The first ship will cost more than the other two because it will incorporate design costs for the class and be at the start of the production learning curve for the class.) Other information identifies a smaller reduction in procurement cost, to something more than \$900 million per ship.²¹ Other things held equal, reductions in the estimated unit procurement cost of the polar icebreaker strengthen the business case for the program. A reduction in estimated unit procurement cost to an average of \$700 million per ship would strengthen it substantially.

Option for Block Buy Contract

The baseline plan for the PSC program calls for acquiring the 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 at least some of the ships, and requested information on this possibility as part of the request for proposals (RFP) for the PSC program that was released on March 2, 2018. Using the above \$2.1 billion estimated cost for a three-ship procurement of PSCs, and based on savings estimates provided by the Navy in the past for Navy shipbuilding programs that were being proposed for multiyear contracting, using a block buy contract that included EOQ purchases rather than a contract with options might reduce the combined acquisition cost of three PSCs 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 (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,

²⁰ Source: March 16, 2018, Coast Guard-Navy briefing to CRS and CBO on the polar icebreaker program. For further discussion, see the section entitled “Estimated Acquisition Cost Has Declined Substantially” in CRS Report RL34391, *Coast Guard Polar Icebreaker Program: Background and Issues for Congress*, by Ronald O’Rourke.

²¹ May 2018 GAO report states that the acquisition program baseline (APB) approved for the polar icebreaker program in January 2018 estimated the program’s acquisition cost at \$3.207 billion, and that the “current estimate” of the program’s acquisition as of January 2018 was \$2.789 billion, or an average of about \$930 million per ship. (Government Accountability Office, *Homeland Security Acquisitions[:] Leveraging Programs’ Results Could Further DHS’s Progress to Improve Portfolio Management*, GAO-18-339SP, May 2018, p. 85.) See also Government Accountability Office, *Coast Guard Acquisitions[:] Actions Needed to Address Longstanding Portfolio Management Challenges*, GAO-18-454, July 2018, which states on page 18 that “The polar icebreaker program has an estimated total acquisition cost of more than \$3 billion....”

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.²²

Although Coast Guard officials have expressed interest in using a block buy contract for procuring PSCs, they are considering the option of procuring the first PSC under a single-ship contract and then using a block buy contract to procure subsequent PSCs. In support of that option, Coast Guard officials have noted the risks involved in building a lead ship and the fact that the United States has not built a heavy polar icebreaker in more than 40 years. Opponents of including the first PSC in a block buy contract might argue, for example, that problems with the design of PSC components might be transmitted from the first PSC to later PSCs by up-front EOQ purchases of those components made under a block buy contract. They might additionally argue that excluding the first PSC from a block buy contract preserves more government flexibility on whether and when to procure a second PSC, which could be advantageous for responding to potential changes in operational needs or budgetary circumstances.

Supporters of including the first PSC in a block buy contract could argue that block buy contracting was invented to a large degree expressly to permit a lead ship to be included in the contract, that the Navy has included lead ships in block buy contracts in the Virginia-class attack submarine program and the TAO-205 class oiler program, and that the Navy is considering using a block buy contract that includes the lead ship for procuring the initial ships in the Columbia-class ballistic missile submarine program. The comparison with the Navy's plans for the Columbia class, they could argue, is of particular note, because the United States has not procured the lead ship of a new class of ballistic missile submarines in more than 40 years, the Columbia-class design is more complex in certain regards than the PSC design, and the Columbia-class design will incorporate a new-design electric-drive propulsion plant—something that the United States has never before done on a series-production nuclear-powered submarine.

The lead ship in the PSC program will carry a risk of requiring design changes to fix problems in the design that are only discovered as a result of building the design. That risk, however, will exist regardless of whether the lead ship is built under a single-ship contract or a block buy contract, and it is not clear how much more chance there would be under a block buy contract of transmitting any such design problems to the second PSC, because the Coast Guard's notional schedule for the PSC program calls for procuring the second ship about 18 months after the first (i.e., while construction of the first PSC is still in progress). To the extent that there would be a greater chance of transmitting design problems to the second PSC under a block buy contract, the question would then become one of weighing the potential cost of fixing those design problems against the added economies of including the first PSC in a block buy contract. Supporters of including the lead ship in a block buy contract could argue that the risks of encountering a design problem in the first ship have been mitigated by the industry's shift since the last polar icebreakers were built from paper designs to computer-aided design, by the Navy's involvement in the PSC program, and by the PSC program's strategy of using a parent design (i.e., an existing polar-capable icebreaker design) as the basis for the PSC design. As shown in **Appendix B**, a key lesson-

²² 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.

learned in government shipbuilding is to bring the design of the ship in question to a high level of completion before beginning construction of the ship, precisely so as to minimize the risk of design problems. Supporters of including the lead ship in a block buy contract could argue that if there is a significant risk of substantial design problems in the lead ship, that is not an argument against including the lead ship in a block buy contract—it is an argument against beginning construction of the ship under any form of contract.

Risk of Delayed Delivery of Lead Ship

GAO has identified a risk of the first PSC being delivered late.²³ I agree with that assessment. The Navy's experience in building lead ships suggests that there is a substantial risk of the lead PSC being delivered late—perhaps as much as a year or more later than scheduled. A late delivery could equate to an increase in the cost of building the ship, because it could reflect having to use more labor hours to build the ship than had been estimated, and because the ship will absorb more of the shipyard's overhead costs by remaining in the shipyard for a longer period of time. The government can insulate itself against the risk of such cost growth by using a fixed-price contract to build the ship (which the Coast Guard and Navy plan to do).

The possibility of a late delivery is something the Coast Guard and Congress may consider preparing for in terms of investments for maintaining *Polar Star* as an operational ship and/or seeking a short-term bridging charter of a foreign polar icebreaker. To the extent that a delay in delivering the lead ship would extend a gap in time between the retirement of *Polar Star* and the entry into service of the first PSC, that could become an argument for starting construction of the lead PSC as soon as its design is brought to a high level of completion and the ship is otherwise ready to begin construction.

Option for Using a Common Design for Heavy and Medium PSCs

The Coast Guard envisages procuring up to three new medium icebreakers after it procures three new heavy polar icebreakers—a plan known as 3+3. The July 2017 NASEM report 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. (That is not particularly surprising—the Coast Guard's current medium polar icebreaker, *Healy*, is actually somewhat larger than the Coast Guard's heavy polar icebreaker, *Polar Star*. *Healy* has less icebreaking capability than *Polar Star*, but more capacity for supporting onboard science operations.) Given this probable similarity in size, the NASEM report recommended building a single medium polar icebreaker to the same common design as the three new heavy polar icebreakers (i.e., 4+0), and operating these four new ships in conjunction with *Healy* to produce a five-ship polar icebreaker fleet. The 4+0 production strategy, the report concluded, would reduce the cost of the medium icebreaker by avoiding the cost of developing a second icebreaker design and 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. An abstract from the NASEM report on this proposal is shown in **Appendix E** to this statement.

If policymakers decide to procure a second or third new medium polar icebreaker, the same general approach recommended by the NASEM report could be followed, leading to a 5+0 or 6+0 acquisition. The potential percentage savings under a five- or six-ship block buy contract with EOQ authority could be greater than the figure of upwards of 7% mentioned earlier for a three-ship block buy—they could be

²³ See GAO's spoken testimony during the question-and-answer portion of a July 24, 2018, hearing on Coast Guard acquisition programs and mission balance and effectiveness before the Coast Guard and Maritime Transportation subcommittee of the House Transportation Committee, as reflected in the transcript of the hearing.

closer to 10%. Building a single common icebreaker design rather than two designs to meet needs for heavy and medium polar icebreakers might also reduce life-cycle operation and support costs.

An April 12, 2018, press report states:

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 "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.²⁴

WCC Program

The WCC program—the program to replace the Coast Guard's current 35-ship inland waterways fleet—is a smaller program than those discussed above. With a notional procurement cost of roughly \$25 million per cutter, a 35-ship replacement program might have a total acquisition cost of roughly \$900 million.²⁵ Although the scale of the program is more modest than that of the NSC, OPC, and FRC programs, the WCC program is of importance in terms of its economic benefit to the nation (by supporting waterborne commerce) and the bidding opportunity it will provide to U.S. shipyards that are not capable of building larger Coast Guard cutters.

As the Coast Guard begins to develop the details of this program, potential oversight issues for the subcommittee could include, among other things, the planned number of replacement cutters (which has not yet been determined and could turn out to be something other than 35), planned annual procurement quantities and the resulting schedule for replacing the existing ships, whether to develop a new design or instead use a parent design, the number of shipyards to be used to build the ships, and the contracting strategy, including whether to use multiyear contracting.

²⁴ Calvin Biesecker, "Coast Guard Leaving Options Open For Future Polar Icebreaker Fleet Type," *Defense Daily*, April 12, 2018. Ellipsis as in original.

²⁵ Source for \$25 million figure: Spoken testimony of Coast Guard Commandant Karl Schultz during the question-and-answer portion of a September 16, 2018, hearing on Coast Guard modernization and recapitalization before the Coast Guard and Maritime Transportation subcommittee of the House transportation and Infrastructure Committee, as reflected in the transcript of the hearing. The Commandant stated: "I'm loathed to put a number out, but I think you're talking a \$25 million, plus or minus, [cost per] ship." The planned number of new replacement WCCs has not yet been determined and could turn out to be something other than 35. GAO states that "according to Coast Guard officials, the preliminary rough order of magnitude estimate for total acquisition cost is \$1.1 billion." Government Accountability Office, *Coast Guard Acquisitions[:] Actions Needed to Address Longstanding Portfolio Management Challenges*, GAO-18-454, July 2018, p. 19.

NOAA Fleet Recapitalization

NOAA is now in the opening stages of its effort to procure eight new ships to replace eight aged ships within its 16-ship research fleet. Current plans call for the eight-ship recapitalization effort to be level-funded at \$75 million per year. Building these ships could provide work to shipyards that are not capable of building larger Navy or Coast Guard ships. They could also help a shipyard involved in building larger Navy or Coast Guard ships to fill in temporary dips in their Navy or Coast Guard workloads, which might permit the Navy or Coast Guard ships in question to be built at lower cost. With procurement of the eight new NOAA ships now beginning, the effort presents some potential oversight issues for the subcommittee.

Unit Procurement Cost and Total Program Procurement Cost

One of these concerns the visibility of the estimated unit procurement costs of the new ships and the estimated total procurement cost of the eight-ship effort. These figures—which are basic points of information for Congress for supporting potential consideration of budget tradeoffs and for use as baselines in monitoring program execution—are not clearly visible in NOAA’s FY2019 budget justification book. It is difficult, moreover, to calculate what the unit procurement cost might be using the information in the budget justification book, since the program is level-funded at \$75 million per year, there is a different combination of activities to be funded each year under that funding figure, and the individual costs of these activities are not broken out. One option the subcommittee may wish to consider would be to request or direct NOAA to include the ships’ estimated unit procurement costs and the program’s estimated total procurement cost in its annual budget justification book.

Number of New Designs

A second potential oversight issue for the subcommittee concerns the number of new designs that NOAA is planning to use for building for the eight new ships. NOAA is currently planning to build the new ships to four designs, meaning an average of two ships per design. Compared to a strategy of building the eight ships to fewer than four designs, NOAA’s planned approach could increase total design costs, reduce opportunities for achieving shipyard production learning curve benefits, and reduce economies of scale in life-cycle operation and support costs.

In a telephone consultation with CRS, NOAA officials stated that the option of building the eight ships to a smaller number of designs was considered for exactly these reasons, but that the decision was to instead plan for four different designs because of the differing operational requirements of the eight ships. Building a common design capable of handling these differing requirements, NOAA stated, would result in a design that would be bigger—and thus more expensive both to procure and to operate and support—than would be needed for some of the eight ships, and these additional procurement and life-cycle operation and support costs were greater than the potential savings of building the ships to a smaller number of designs.²⁶ That explanation is quite plausible. One option the subcommittee may wish to consider would be to request or direct NOAA to provide the details of its analysis on the comparative design, procurement, and life-cycle operation and support costs of building four designs vs. a smaller number of designs, so that the subcommittee, as a matter of due diligence, can examine the Coast Guard’s analysis of this issue.

²⁶ Source: Telephone conversation between CRS and NOAA September 28, 2018.

Multiple-Ship Buys or Block Buy Contracting

NOAA's current plan is to use a series of contracts with options to procure the eight new ships.²⁷ There could, for example, be four contracts (one for each design), with each contract being for the design and construction of one ship, with an option for building a second. This approach would preserve more government flexibility in deciding whether to procure a second ship to a given design, provide multiple bidding opportunities for shipyards interested in building the ships, and create a potential for building the ships in multiple shipyards, all of which policymakers may view as benefits. On the other hand, this approach would forego the potential savings that might be realized through multiple-ship buys (e.g., procuring two ships of a given design in a single year) or block buy contracting. One option the subcommittee may wish to consider would be to request or direct NOAA to devise and share with the subcommittee options (including estimates of potential savings) for making use of multiple-ship buys and block buy contracting while staying, as much as possible, within the level funding profile of \$75 million per year.

Life-Cycle Support

NOAA has not yet begun to scope out in detail the life-cycle support plan for the eight new ships—that work, NOAA officials stated, may start a couple of years from now.²⁸ One option the subcommittee may wish to consider would be to request that NOAA keep the subcommittee apprised of its efforts to develop a life-cycle support plan for the ships.

Chairman Sullivan, this concludes my statement. Thank you again for the opportunity to testify, and I will be pleased to respond to any questions the subcommittee may have.

²⁷ Source: Telephone conversation between CRS and NOAA September 28, 2018.

²⁸ Source: Telephone conversation between CRS and NOAA September 28, 2018.

Appendix A. Biography—Ronald O’Rourke

Mr. O’Rourke is a Phi Beta Kappa graduate of the Johns Hopkins University, from which he received his B.A. in international studies, and a valedictorian graduate of the University's Paul Nitze School of Advanced International Studies, where he received his M.A. in the same field.

Since 1984, Mr. O’Rourke has worked as a naval analyst for CRS. He has written many reports for Congress on various issues relating to the Navy, the Coast Guard, defense acquisition, China’s naval forces and maritime territorial disputes, the Arctic, the international security environment, and the U.S. role in the world. He regularly briefs Members of Congress and Congressional staffers, and has testified before Congressional committees on many occasions.

In 1996, he received a Distinguished Service Award from the Library of Congress for his service to Congress on naval issues.

In 2010, he was honored under the Great Federal Employees Initiative for his work on naval, strategic, and budgetary issues.

In 2012, he received the CRS Director’s Award for his outstanding contributions in support of the Congress and the mission of CRS.

In 2017, he received the Superior Public Service Award from the Navy for service in a variety of roles at CRS while providing invaluable analysis of tremendous benefit to the Navy for a period spanning decades.

Mr. O’Rourke is the author of several journal articles on naval issues, and is a past winner of the U.S. Naval Institute's Arleigh Burke essay contest. He has given presentations on naval, Coast Guard, and strategy issues to a variety of U.S. and international audiences in government, industry, and academia.

Appendix B. A Summary of Some Acquisition Lessons Learned for Government Shipbuilding

This appendix presents a general summary of lessons learned in government shipbuilding, reflecting comments made repeatedly by various sources over the years.²⁹ These lessons learned include the following:

- **At the outset, get the operational requirements for the program right.** Properly identify the program's operational requirements at the outset. Manage risk by not trying to do too much in terms of the program's operational requirements, and perhaps seek a so-called 70%-to-80% solution (i.e., a design that is intended to provide 70%-80% of desired or ideal capabilities). Achieve a realistic balance up front between operational requirements, risks, and estimated costs.
- **Impose cost discipline up front.** Use realistic price estimates, and consider not only development and procurement costs, but life-cycle operation and support (O&S) costs.
- **Employ competition** where possible in the awarding of design and construction contracts.
- **Use a contract type that is appropriate for the amount of risk involved,** and structure its terms to align incentives with desired outcomes.
- **Minimize design/construction concurrency** by developing the design to a high level of completion before starting construction and by resisting changes in requirements (and consequent design changes) during construction.
- **Properly supervise construction work.** Maintain an adequate number of properly trained Supervisor of Shipbuilding (SUPSHIP) personnel.
- **Provide stability for industry,** in part by using, where possible, multiyear procurement (MYP) or block buy contracting.
- **Maintain a capable government acquisition workforce** that understands what it is buying, as well as the above points.

Identifying these lessons is arguably not the hard part—most if not all these points have been cited for years. The hard part, arguably, is living up to them without letting circumstances lead program-execution efforts away from these guidelines.

²⁹ This appendix is adapted from Appendix J of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke. See also Government Accountability Office, *Navy Shipbuilding[:] Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP, June 2018, 36 pp.

Appendix C. Some Considerations Relating to Warranties in Government Shipbuilding and Other Government Acquisition

This appendix presents some considerations relating to warranties in shipbuilding and other defense acquisition.³⁰

In discussions of government shipbuilding, one question that sometimes arises is whether including a warranty in a shipbuilding contract is preferable to not including one. The question can arise, for example, in connection with a GAO finding that “the Navy structures shipbuilding contracts so that it pays shipbuilders to build ships as part of the construction process and then pays the same shipbuilders a second time to repair the ship when construction defects are discovered.”³¹

Including a warranty in a shipbuilding contract (or a contract for building some other kind of end item), while potentially valuable, might not always be preferable to not including one—it depends on the circumstances of the acquisition, and it is not necessarily a valid criticism of an acquisition program to state that it is using a contract that does not include a warranty (or a weaker form of a warranty rather than a stronger one).

Including a warranty generally shifts to the contractor the risk of having to pay for fixing problems with earlier work. Although that in itself could be deemed desirable from the government’s standpoint, a contractor negotiating a contract that will have a warranty will incorporate that risk into its price, and depending on how much the contractor might charge for doing that, it is possible that the government could wind up paying more in total for acquiring the item (including fixing problems with earlier work on that item) than it would have under a contract without a warranty.

When a warranty is not included in the contract and the government pays later on to fix problems with earlier work, those payments can be very visible, which can invite critical comments from observers. But that does not mean that including a warranty in the contract somehow frees the government from paying to fix problems with earlier work. In a contract that includes a warranty, the government will indeed pay something to fix problems with earlier work—but it will make the payment in the less-visible (but still very real) form of the up-front charge for including the warranty, and that charge might be more than what it would have cost the government, under a contract without a warranty, to pay later on for fixing those problems.

From a cost standpoint, including a warranty in the contract might or might not be preferable, depending on the risk that there will be problems with earlier work that need fixing, the potential cost of fixing such problems, and the cost of including the warranty in the contract. The point is that the goal of avoiding highly visible payments for fixing problems with earlier work and the goal of minimizing the cost to the government of fixing problems with earlier work are separate and different goals, and that pursuing the first goal can sometimes work against achieving the second goal.³²

³⁰ This appendix is adapted from Appendix K of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O’Rourke.

³¹ See Government Accountability Office, *Navy Shipbuilding[:] Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP, June 2018, p. 21. A graphic on page 21 shows a GAO finding that the government was financially responsible for shipbuilder deficiencies in 96% of the cases examined by GAO, and that the shipbuilder was financially responsible for shipbuilder deficiencies in 4% of the cases.

³² It can also be noted that the country’s two largest builders of Navy ships—General Dynamics (GD) and Huntington Ingalls Industries (HII)—derive about 60% and 96%, respectively, of their revenues from U.S. government work. (See General

The Department of Defense's guide on the use of warranties states the following:

Federal Acquisition Regulation (FAR) 46.7 states that "the use of warranties is not mandatory." However, if the benefits to be derived from the warranty are commensurate with the cost of the warranty, the CO [contracting officer] should consider placing it in the contract. In determining whether a warranty is appropriate for a specific acquisition, FAR Subpart 46.703 requires the CO to consider the nature and use of the supplies and services, the cost, the administration and enforcement, trade practices, and reduced requirements. The rationale for using a warranty should be documented in the contract file....

In determining the value of a warranty, a CBA [cost-benefit analysis] is used to measure the life cycle costs of the system with and without the warranty. A CBA is required to determine if the warranty will be cost beneficial. CBA is an economic analysis, which basically compares the Life Cycle Costs (LCC) of the system with and without the warranty to determine if warranty coverage will improve the LCCs. In general, five key factors will drive the results of the CBA: cost of the warranty + cost of warranty administration + compatibility with total program efforts + cost of overlap with Contractor support + intangible savings. Effective warranties integrate reliability, maintainability, supportability, availability, and life-cycle costs. Decision factors that must be evaluated include the state of the weapon system technology, the size of the warranted population, the likelihood that field performance requirements can be achieved, and the warranty period of performance.³³

Dynamics, *2016 Annual Report*, page 9 of Form 10-K [PDF page 15 of 88]) and Huntington Ingalls Industries, *2016 Annual Report*, page 5 of Form 10-K [PDF page 19 of 134]). Thus, even if a warranty in a shipbuilding contract with one of these firms were to somehow mean that the government did not have pay under the terms of that contract—either up front or later on—for fixing problems with earlier work done under that contract, there would still be a question as to whether the government would nevertheless wind up eventually paying much of that cost as part of the price of one or more future contracts the government may have that firm.

³³ Department of Defense, *Department of Defense Warranty Guide*, Version 1.0, September 2009, accessed July 13, 2017, at [https://www.acq.osd.mil/dpap/pdi/uid/docs/departmentofdefensewarrantyguide\[1\].doc](https://www.acq.osd.mil/dpap/pdi/uid/docs/departmentofdefensewarrantyguide[1].doc).

Appendix D. Some Considerations Relating to Avoiding Procurement Cost Growth vs. Minimizing Procurement Costs

This appendix presents some considerations relating to avoiding procurement cost growth vs. minimizing procurement costs in shipbuilding and other government acquisition.³⁴

The affordability challenge posed by the Navy's shipbuilding plans can reinforce the strong oversight focus on preventing or minimizing procurement cost growth in Navy shipbuilding programs, which is one expression of a strong oversight focus on preventing or minimizing cost growth in DOD acquisition programs in general. This oversight focus may reflect in part an assumption that avoiding or minimizing procurement cost growth is always synonymous with minimizing procurement cost. It is important to note, however, that as paradoxical as it may seem, avoiding or minimizing procurement cost growth is not always synonymous with minimizing procurement cost, and that a sustained, singular focus on avoiding or minimizing procurement cost growth might sometimes lead to higher procurement costs for the government.

How could this be? Consider the example of a design for the lead ship of a new class of Navy ships. The construction cost of this new design is uncertain, but is estimated to be likely somewhere between Point A (a minimum possible figure) and Point D (a maximum possible figure). (Point D, in other words, would represent a cost estimate with a 100% confidence factor, meaning there is a 100% chance that the cost would come in at or below that level.) If the Navy wanted to avoid cost growth on this ship, it could simply set the ship's procurement cost at Point D. Industry would likely be happy with this arrangement, and there likely would be no cost growth on the ship.

The alternative strategy open to the Navy is to set the ship's target procurement cost at some figure between Points A and D—call it Point B—and then use that more challenging target cost to place pressure on industry to sharpen its pencils so as to find ways to produce the ship at that lower cost. (Navy officials sometimes refer to this as “pressurizing” industry.) In this example, it might turn out that industry efforts to reduce production costs are not successful enough to build the ship at the Point B cost. As a result, the ship experiences one or more rounds of procurement cost growth, and the ship's procurement cost rises over time from Point B to some higher figure—call it Point C.

Here is the rub: Point C, in spite of incorporating one or more rounds of cost growth, might nevertheless turn out to be lower than Point D, because Point C reflected efforts by the shipbuilder to find ways to reduce production costs that the shipbuilder might have put less energy into pursuing if the Navy had simply set the ship's procurement cost initially at Point D.

Setting the ship's cost at Point D, in other words, may eliminate the risk of cost growth on the ship, but does so at the expense of creating a risk of the government paying more for the ship than was actually necessary. DOD could avoid cost growth on new procurement programs starting tomorrow by simply setting costs for those programs at each program's equivalent of Point D. But as a result of this strategy, DOD could well wind up leaving money on the table in some instances—of not, in other words, minimizing procurement costs.

DOD does not have to set a cost precisely at Point D to create a potential risk in this regard. A risk of leaving money on the table, for example, is a possible downside of requiring DOD to budget for its

³⁴ This appendix is adapted from Appendix L of CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

acquisition programs at something like an 80% confidence factor—an approach that some observers have recommended—because a cost at the 80% confidence factor is a cost that is likely fairly close to Point D.

Procurement cost growth is often embarrassing for DOD and industry, and can damage their credibility in connection with future procurement efforts. Procurement cost growth can also disrupt congressional budgeting by requiring additional appropriations to pay for something Congress thought it had fully funded in a prior year. For this reason, there is a legitimate public policy value to pursuing a goal of having less rather than more procurement cost growth.

Procurement cost growth, however, can sometimes be in part the result of DOD efforts to use lower initial cost targets as a means of pressuring industry to reduce production costs—efforts that, notwithstanding the cost growth, might be partially successful. A sustained, singular focus on avoiding or minimizing cost growth, and of punishing DOD for all instances of cost growth, could discourage DOD from using lower initial cost targets as a means of pressurizing industry, which could deprive DOD of a tool for controlling procurement costs.

The point here is not to excuse away cost growth, because cost growth can occur in a program for reasons other than DOD's attempt to pressurize industry. Nor is the point to abandon the goal of seeking lower rather than higher procurement cost growth, because, as noted above, there is a legitimate public policy value in pursuing this goal. The point, rather, is to recognize that this goal is not always synonymous with minimizing procurement cost, and that a possibility of some amount of cost growth might be expected as part of an optimal government strategy for minimizing procurement cost. Recognizing that the goals of seeking lower rather than higher cost growth and of minimizing procurement cost can sometimes be in tension with one another can lead to an approach that takes both goals into consideration. In contrast, an approach that is instead characterized by a sustained, singular focus on avoiding and minimizing cost growth may appear virtuous, but in the end may wind up costing the government more.

Appendix E. NASEM Report Recommendation for Building Heavy and Medium Polar Icebreakers to a Common Design

Regarding its proposal to build heavy and medium polar icebreakers to a common design, the July 2017 NASEM report stated (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.³⁵

³⁵ 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.