



January 2023

# COLUMBIA CLASS SUBMARINE

## Program Lacks Essential Schedule Insight amid Continuing Construction Challenges

ACCESSIBLE VERSION

# GAO Highlights

Highlights of [GAO-23-106292](#), a report to congressional committees

## Why GAO Did This Study

The Navy plans to invest roughly \$132 billion to acquire 12 *Columbia* class nuclear-powered ballistic missile submarines. The shipbuilders are also constructing *Virginia* class attack submarines. Both classes are part of the Navy's plans for deterrence. Challenges delivering *Columbia* class submarines on time could have consequences for the nation's defense.

Congress includes a provision in statute for the Navy to provide updates on the *Columbia* program's design and construction goals, and for GAO to assess this information.

This report examines the extent that (1) the Navy and DOD assessed risks to achieving the lead *Columbia* class submarine's schedule, and (2) the program faced challenges constructing the lead submarine and mitigating construction risks to the class.

GAO compared actions the Navy and DOD took to assess schedule risks to DOD guidance and leading practices, and reviewed Navy and shipbuilder documents to identify construction challenges. GAO interviewed Navy and DOD officials and shipbuilder representatives. This is a public version of a sensitive report that issued in September 2022. Information deemed sensitive has been omitted.

## What GAO Recommends

GAO is making six recommendations, including that the Navy conduct a schedule risk analysis and update long-term plans. DOD concurred with four and partially concurred with two recommendations. GAO maintains that fully implementing all six recommendations is warranted, as discussed in this report.

View [GAO-23-106292](#). For more information, contact Shelby S. Oakley at (202) 512-4841 or [OakleyS@gao.gov](mailto:OakleyS@gao.gov).

January 2023

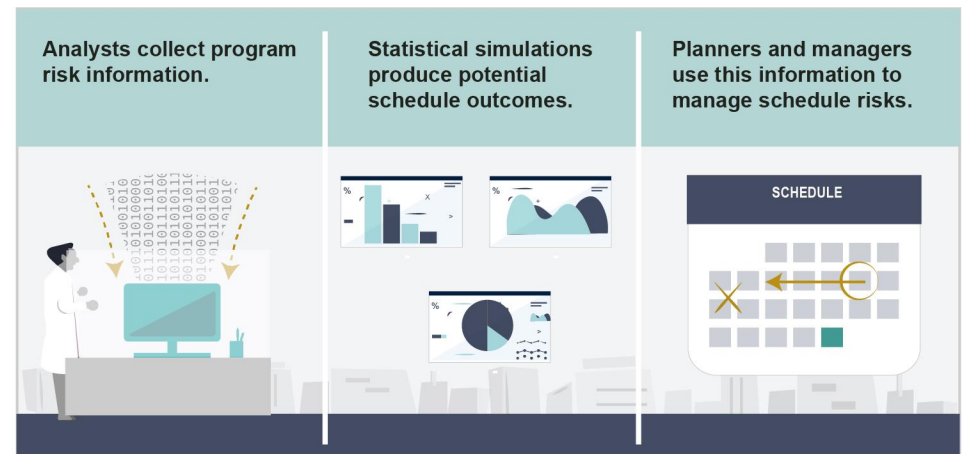
## COLUMBIA CLASS SUBMARINE

### Program Lacks Essential Schedule Insight amid Continuing Construction Challenges

## What GAO Found

The Navy plans to deliver the first, or lead, *Columbia* class submarine—the largest and most complex submarine in its history—more quickly than it did for the lead submarines of prior classes, such as the *Virginia* class program. But the shipbuilder has not conducted a schedule risk analysis of the lead submarine's construction schedule. Both GAO leading practices and Department of Defense (DOD) guidance identify schedule risk analysis as a critical tool for understanding and managing program risks that could impact the schedule.

#### Notional Representation of a Schedule Risk Analysis



Source: Representation of GAO *Schedule Assessment Guide* information. | GAO-23-106292

#### Text for Illustration of Notional Representation of a Schedule Risk Analysis

- Analysts collect program risk information.
- Statistical simulations produce potential schedule outcomes.
- Planners and managers use this information to manage schedule risks.

Source: Representation of GAO *Schedule Assessment Guide* information. | GAO-23-106292

Without a statistical schedule risk analysis, programs have limited insight into how schedule risks could affect the likelihood of achieving key program milestones, including delivery, and the amount of margin—or a reserve of extra time—needed to manage critical risks and avoid delays.

After more than a year of full-scale construction on the lead *Columbia* submarine, the shipbuilders are facing delays because of challenges with design, materials, and quality. The shipbuilders are working to mitigate delays using additional shipyard resources, such as more staff to complete work more quickly. Because of the *Columbia* class program's essential role in strategic deterrence, it has priority status over most national defense related programs, including the *Virginia* class program. The shipbuilder added staff to the *Columbia* class program who were originally planned for the *Virginia* class program, contributing to delays for that program. However, long-term planning does not account for shared risks

between these programs that are likely to present production challenges and could result in additional costs. Without updated long-term planning, the Navy cannot be certain that the fiscal year 2024 budget request will be sufficient to meet the production schedule it has planned for these submarine classes.

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**Abbreviations**

DOD	Department of Defense
Electric Boat	General Dynamics Electric Boat
ITRA	Independent Technical Risk Assessment

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MDA	milestone decision authority
Newport News	Huntington Ingalls Industries Newport News Shipbuilding
OUSD(R&E)	Office of the Under Secretary of Defense for Research and Engineering
PDF	portable document format
SUPSHIP	Supervisor of Shipbuilding, Conversion, and Repair

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January 24, 2023

Congressional Committees

The Navy plans to accomplish delivery of the lead (or first) *Columbia* class nuclear-powered ballistic missile submarine—the largest and most complex submarine acquisition in its history—faster than the delivery of the most recent lead submarines. For example, it took the Navy 88 months to deliver the first *Ohio* class nuclear-powered submarine, and the Navy plans for *Columbia* to be delivered 10 months faster. The 14 current *Ohio* class nuclear-powered submarines are now nearing the end of their service lives, with retirement planned to begin in fiscal year 2027. To prevent a gap in a Department of Defense (DOD) requirement, the lead *Columbia* class submarine needs to be ready for its first patrol before October 2030. Every follow-on submarine in the class will have a similar pressure to achieve on-time delivery so that they can replace retiring *Ohio* class submarines. Since the *Columbia* class program has a critical deterrence mission, challenges to delivering the submarines on time could have far-reaching consequences for the nation’s defense.<sup>1</sup>

The *Columbia* class program will be the nation’s sea-based nuclear deterrent, but it is not the Navy’s only ongoing acquisition in support of its overall deterrence mission. The Navy is also planning to construct two *Virginia* class nuclear powered attack submarines per year. Within the next 20 years, the nation’s two nuclear shipbuilders have to construct and deliver *Columbia* and *Virginia* class submarines at a pace not matched since the end of the Cold War.

The National Defense Authorization Act for Fiscal Year 2018 included a requirement for the Navy to prepare and submit information on the *Columbia* class program’s design and construction goals and progress, and also included a provision that we assess this information.<sup>2</sup> This report

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<sup>1</sup>Department of Defense, *Nuclear Posture Review* (Washington, D.C.: October 2022).

<sup>2</sup>We provided an initial assessment of information included in the Navy’s February 2021 report in response to the National Defense Authorization Act for Fiscal Year 2018 through a briefing, and include additional information in this report. Pub. L. No. 115-91, § 231 (2017).

examines the extent that (1) the Navy and DOD have assessed risks to achieving the lead *Columbia* class submarine's construction schedule;<sup>3</sup> and (2) the program faced any challenges constructing the lead *Columbia* class submarine and mitigating construction risks to the class.

This report is a public version of a sensitive report that we issued in September 2022. DOD deemed some of the information in our September report to be sensitive, which must be protected from public disclosure. Therefore, this report omits sensitive information about the Navy and DOD's efforts to assess schedule risk, sources of construction delays, and shared risks at the shipyards. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

To address these objectives, we reviewed Navy and shipbuilder documents including program briefings, management reports, contract documents, and long-term plans for constructing the *Columbia* class. We compared actions the Navy and DOD took to assess risks to relevant guidance and GAO leading practices for program schedules.<sup>4</sup> We also compared plans for design and construction completion against actual progress. Finally, we interviewed Navy, DOD, and shipbuilder representatives to understand steps they took to review the program schedule and develop mitigations for any challenges. See appendix I for a detailed description of our objectives, scope, and methodology.

We conducted this performance audit from January 2021 to September 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. We subsequently worked with DOD from September 2022 to January 2023 to prepare this unclassified version of the original sensitive report for public release. This public version was also prepared in accordance with these standards.

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<sup>3</sup>We also have ongoing work assessing the reliability of the construction schedule for the lead *Columbia* class submarine.

<sup>4</sup>GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, [GAO-16-89G](#), (Washington, D.C.: December 2015).

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## Background

The Navy plans to invest approximately \$132 billion to research, develop, and purchase 12 *Columbia* class submarines—a \$3.9 billion increase compared to its prior estimate from 2019.<sup>5</sup>

Two U.S. shipbuilders—General Dynamics Electric Boat (Electric Boat) and Huntington Ingalls Industries Newport News Shipbuilding (Newport News)—design and build nuclear submarines. Electric Boat is the prime contractor for design and construction of the *Columbia* class, with Newport News serving as its major subcontractor. Newport News also builds *Ford* class aircraft carriers.

Electric Boat and Newport News are preparing for the most significant increase in ship construction in over 30 years. Construction for the *Columbia* and *Virginia* classes is taking place concurrently at Electric Boat—which has facilities located in Groton, Connecticut and Quonset Point, Rhode Island—and at Newport News, which has a facility in Newport News, *Virginia*. The shipyards are constructing both submarine programs while also completing various activities necessary to sustain existing submarines, and in the case of Newport News, building *Ford* class aircraft carriers. The shipyards are basing their plans for shipbuilding on the Navy’s plans to procure two *Virginia* class submarines per year through 2033 and one *Columbia* class submarine per year starting in 2026.

The shipbuilders are designing and constructing *Columbia* class submarines in six large hull segments, referred to as super modules. During construction, the shipbuilders outfit the super modules with

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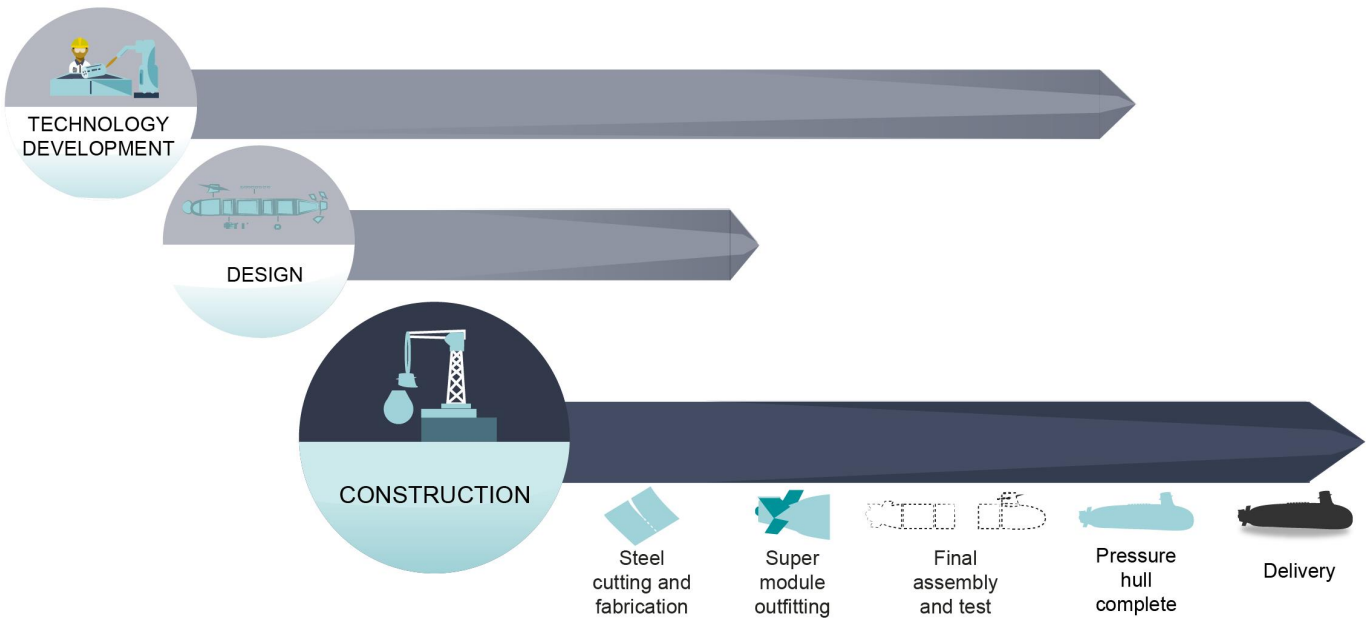
<sup>5</sup>This \$132 billion represents the program’s total acquisition cost, including test and evaluation, and military construction costs. The updated total acquisition cost reflects an independent cost estimate for the class and includes increases due to poor contractor performance during design, costly re-work on missile tubes, expenditures on the supplier base, and increased costs for construction, among other things. The Navy also updated the estimated costs to operate and sustain the class of submarines to \$157 billion, which is an increase of roughly \$17.7 billion between its 2019 and 2021 estimates. Taking both updated estimates into account, the total lifecycle cost for the class increased by approximately \$21.6 billion—an 8.1 percent increase—since 2019. The estimated total acquisition and operation and sustainment costs are presented in then-year dollars, which reflect the effects of inflation, including escalation up to and during the year of the appropriation, and throughout the period during which dollars are expended from the Treasury.



systems and connections prior to attaching them together during final assembly, as seen in figure 1.

Figure 1: Notional Depiction of Key Submarine Construction Events

Phases



Source: Representation of GAO, Navy, and shipbuilder information. | GAO-23-106292

Text for Figure 1: Notional Depiction of Key Submarine Construction Events

- Phases
- Technology development
- Design
- Construction: Steel cutting and fabrication; Super module outfitting; Final assembly and test; Pressure hull complete; Delivery

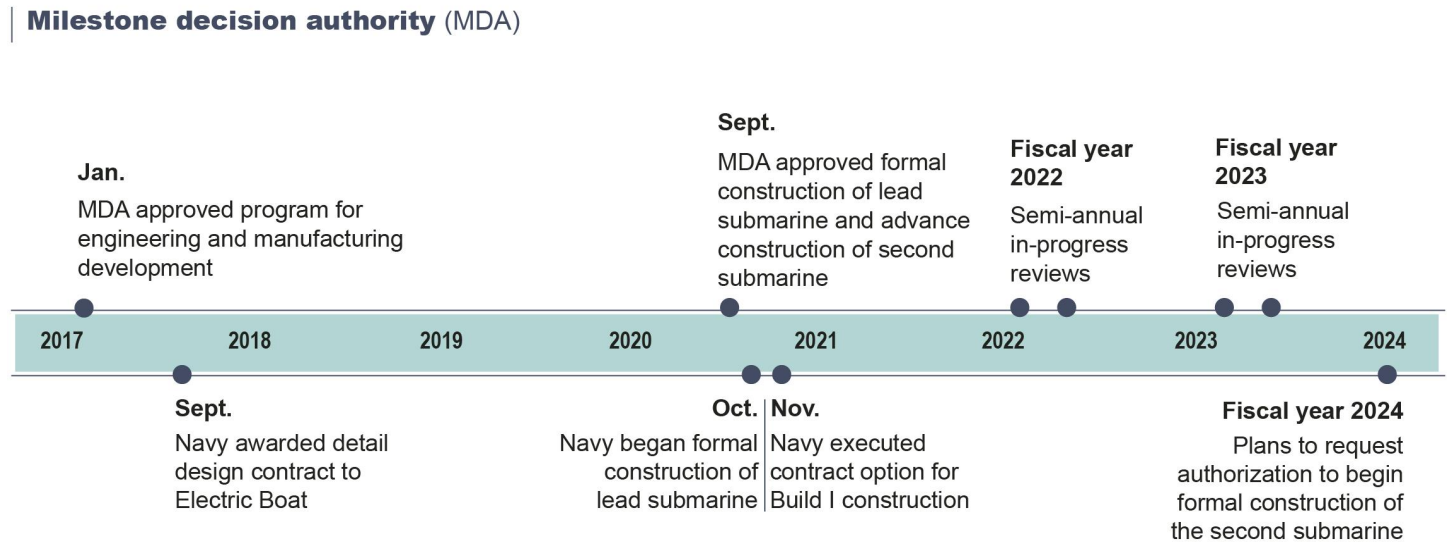
Source: Representation of GAO, Navy, and shipbuilder information | GAO-23-106292

Each shipbuilder will construct segments of the submarines. For example, Newport News will build the stern, bow, and other major components of the *Columbia* class submarine. In its role as the prime contractor, Electric Boat will complete final outfitting and delivery of the submarines to the Navy. The shipbuilders are similarly dividing work for the *Virginia* class submarines, though they alternate final outfitting and delivery for that program.

## Major Events in *Columbia* Class Submarine Design and Construction

In September 2020, the milestone decision authority (MDA) approved the *Columbia* class program to begin formal construction of the lead submarine and advance construction on the second submarine (see fig. 2).<sup>6</sup>

**Figure 2: Key Dates for *Columbia* Class Build I Design and Construction**



**Navy**

Source: GAO representation of Navy and Department of Defense information. | GAO-23-106292

<sup>6</sup>The MDA for this program is the Under Secretary of Defense for Acquisition and Sustainment. The Navy started production of part of the lead submarine before the MDA's lead submarine authorization decision in 2020. This practice, called advance construction, is allowable under the expanded acquisition authorities provided by Congress under the National Sea Based Deterrence Fund. The MDA also authorized the Navy to conduct advance construction on the second submarine, and limited advance construction and procurement for subsequent submarines, in advance of the authorization to complete construction. As such, for the purposes of this report we refer to construction activities that occur after the program was authorized to begin construction in earnest as formal construction.

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**Text for Figure 2: Key Dates for Columbia Class Build I Design and Construction**

**Milestone decision authority (MDA)**

**2017 Jan. MDA approved program for engineering and manufacturing development.**

**2017 Sept. Navy awarded detail design contract to Electric Boat**

**2020 Sept. MDA approved formal construction of lead submarine and advance construction of second submarine**

**2020 Oct. Navy began formal construction of lead submarine**

**2020 Nov. Navy executed contract option for Build I construction**

**2022 Fiscal year 2022 Semi-annual in-progress reviews**

**2023 Fiscal year 2023 Semi-annual in-progress reviews**

**2024 Fiscal year 2024 Plans to request authorization to begin formal construction of the second submarine**

Source: Representation of GAO, Navy, and shipbuilder information | GAO-23-106292

Once approved, the Navy executed a contract option for Electric Boat to begin construction activities for the first two submarines—referred to collectively as Build I. The MDA tasked the Navy with returning for an in-progress review to seek approval to begin formal construction of the second submarine. In-progress reviews for the *Columbia* class program are scheduled to occur semi-annually through fiscal year 2023, and allow program officials and the MDA to evaluate the program’s status and make recommendations.

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## Lead Submarine Construction Durations

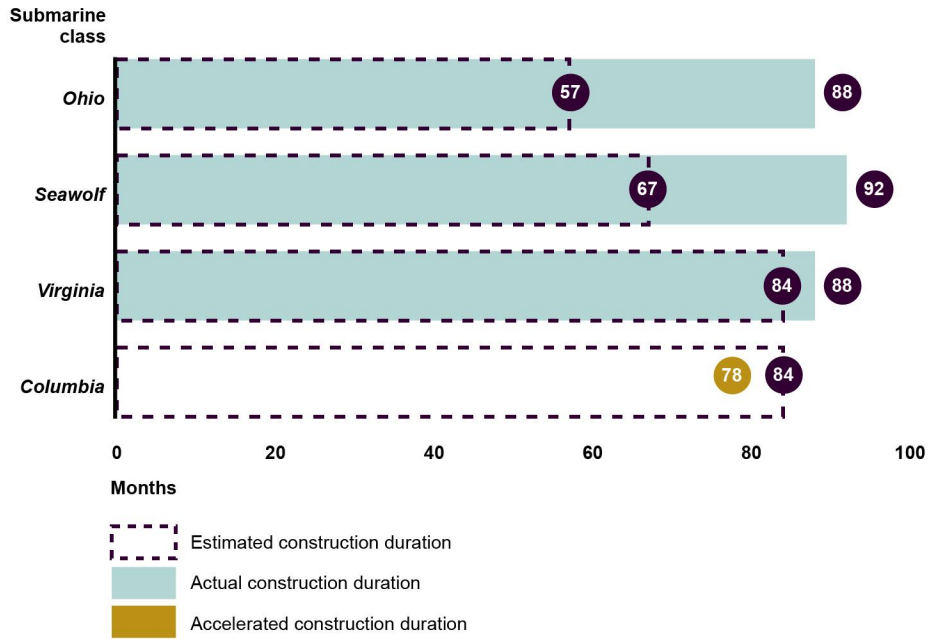
In 2017, we reported that the Navy planned to achieve delivery of the lead *Columbia* class submarine in a shorter construction duration than has been achieved for its most recent lead submarines, with 84 months planned for construction.<sup>7</sup> Navy program officials told us, however, that the shipbuilders updated the program’s construction schedule during the summer of 2020, and now seek to deliver the lead submarine within 78 months after the start of formal construction, as seen in figure 3.<sup>8</sup>

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<sup>7</sup>GAO, *Columbia Class Submarine: Immature Technologies Present Risks to Achieving Cost, Schedule, and Performance Goals*, [GAO-18-158](#) (Washington, D.C.: Dec. 21, 2017).

<sup>8</sup>The shipbuilders’ updated schedule is aligned with the objective delivery date (which is the program’s desired delivery date) in the program’s Acquisition Program Baseline. The previous 84-month schedule was in line with the threshold delivery date in the Acquisition Program Baseline, which is the program’s minimum acceptable date.

**Figure 3: Estimated and Actual Construction Duration for Most Recent U.S. Navy Lead Submarines Delivered by General Dynamics Electric Boat**



Source: GAO analysis of Navy data. | GAO-23-106292

Note: The Navy provided an updated construction duration for the *Virginia* class submarine, but we identified discrepancies in the documentation provided. As such, we elected to rely on evidence provided in support of our prior work that was previously validated by the Navy. Construction duration for the *Columbia* lead submarine is measured from the time formal construction began to the time the submarine is delivered.

**Data for Figure 3: Estimated and Actual Construction Duration for Most Recent U.S. Navy Lead Submarines Delivered by General Dynamics Electric Boat**

Submarine class	Estimated construction duration	Actual construction duration	Accelerated construction duration
Ohio	57	88	
Seawolf	67	92	
Virginia	84	88	
Columbia	84		78

Source: GAO analysis of Navy data | GAO-23-106292

The Navy expects that the lead *Columbia* class submarine will be built in less time than was planned for the lead *Virginia* class submarine—a submarine that is two-and-a-half times smaller and has fewer estimated construction labor hours than the *Columbia* class. To enable its aggressive schedule, the Navy requested and received unique statutory

authorities for the *Columbia* class program from Congress.<sup>9</sup> According to Electric Boat documentation, these authorities enabled the Navy to complete about 7 percent of construction on the lead submarine in advance of congressional authorization to begin formal construction. This period of advance construction is not included in the construction duration.

By reducing the construction duration by 6 months, the shipbuilders plan to deliver the lead submarine in April 2027, rather than October 2027 as originally planned. The shipbuilders plan to complete construction of most of the submarine's super modules in less time than under the previous schedule, and reduce the time spent between when the hull becomes watertight and when the submarine is delivered. In addition, the shipbuilders also plan to complete key contract and government equipment deliveries earlier than planned, among other efforts. According to Navy officials, by accelerating the schedule, the program reduces the risk to its delivery date because the shipbuilder has 6 months of margin to ensure on-time delivery.<sup>10</sup>

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### Integrated Master Schedule for the Lead Submarine

The *Columbia* class program uses an integrated master schedule for the lead submarine to track its progress against plans. An integrated master schedule is a program schedule that includes the entire required scope of effort, including the effort necessary from all government, contractor, and other key parties for a program's successful execution from start to finish.<sup>11</sup> An integrated master schedule connects all the scheduled work of the government and the contractors in a network, or collection of logically linked sequences of activities. These sequences should clearly show dependencies that exist among tasks that make up the schedule, including the relationships between the government's and contractors' tasks. An integrated and reliable schedule provides program management with insight into the program's progress and its planned and forecasted duration.

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<sup>9</sup>Current authorities available for the *Columbia* class program are found at section 2218a of title 10, U.S. Code.

<sup>10</sup>Margin, or a reserve of extra time also referred to as contingency, accounts for known and unknown risks and uncertainty in the schedule. See [GAO-16-89G](#).

<sup>11</sup>[GAO-16-89G](#).

DOD implementation guidance notes that an integrated master schedule is mandatory in all cases where earned value management, which is a tool for program managers to gain insight into contractor cost and schedule performance, is mandatory. Further, the Federal Acquisition Regulation requires the use of an earned value management system for major acquisitions for development. DOD applies this requirement to cost or incentive contracts valued at \$20 million or more.<sup>12</sup> Earned value management processes include the integration of information about the integrated master schedule and resources so that programs are able to establish a dollarized and time-phased plan, called a Performance Management Baseline, against which progress can be assessed. As work is accomplished and measured against the Performance Management Baseline, a corresponding budget value is earned. Programs can examine how value has been earned to identify variances in cost or schedule compared to plans, and to forecast future cost and schedule performance based on trends.

According to GAO's *Schedule Assessment Guide*, programs can help ensure that their baseline schedules are executable by conducting a schedule risk analysis.<sup>13</sup> A schedule risk analysis can be conducted by the program office in coordination with the contractor, or by these parties separately. It gives decision makers confidence that schedule estimates are credible based on known risks and that the schedule can be relied upon to track progress. It is a leading practice that uses statistical analysis to determine:

- A level of confidence, or probability, of achieving key dates,

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<sup>12</sup>Defense Federal Acquisition Regulation Supplement Subpart 234.2, Earned Value Management System. Work for *Columbia* Build I construction is being conducted under a cost contract. Under a cost contract, the government pays allowable costs incurred by the contractor, to the extent prescribed by the contract, such as certain compensation costs for work performed. Incentive arrangements included in the contract can allow the contractor to earn fees tied to performance, such as for performing at lower costs. Under these types of contracts, the government generally assumes the risk of a cost overrun because, although the contractor is to make a good-faith effort to meet contract requirements within the estimated cost, the government is not promised a completed item or service within that cost.

<sup>13</sup>[GAO-16-89G](#). A schedule risk analysis is performed on the schedule before a baseline is set and periodically as the schedule is updated to reflect actual progress on activity durations and sequences. After a baseline is set, a schedule risk analysis can provide information about the amount of schedule margin needed, and support independent assessments when major changes to the schedule are made, among other things.

- How much schedule margin is needed to ensure completion by a certain date,
- The risks and activities most likely to delay the program, and
- The cumulative effect of multiple risks on the schedule.

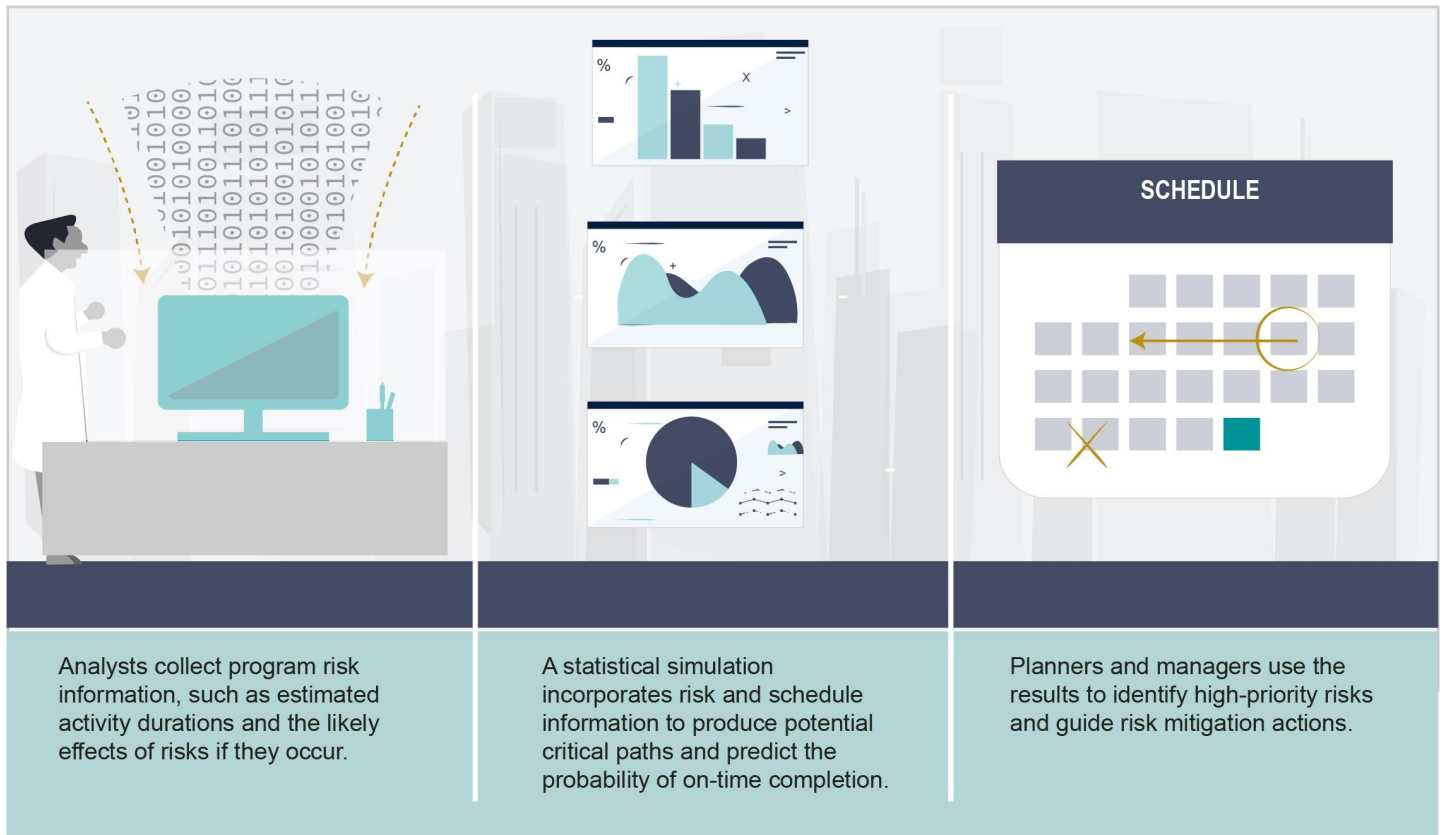
A schedule risk analysis incorporates schedule data and risks into a statistical simulation, such as a three-point estimate or Monte Carlo simulation.<sup>14</sup> The simulations predict a range of possible critical paths based on information about the program—such as resource availability and productivity, uncertainty, and risk.<sup>15</sup> The range of outcomes provides program management with information it can use to manage the program schedule based on acceptable risk tolerances. For a notional representation of how programs can use a Monte Carlo simulation in a schedule risk analysis, see figure 4.

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<sup>14</sup>A three-point estimate captures uncertainty in a schedule's activities by generating estimates—generally through interviews with experts and reviews of actual program performance—of minimum, most likely, and maximum remaining durations. A Monte Carlo conducts thousands of random selections of activity durations and calculates a new critical path and completion date for each.

<sup>15</sup>The critical path is the longest continuous sequence of activities in a schedule. It defines the program's earliest completion date or minimum duration. [GAO-16-89G](#).

**Figure 4: Notional Representation of a Schedule Risk Analysis**



Source: Representation of GAO *Schedule Assessment Guide* information. | GAO-23-106292

**Text for Figure 4: Notional Representation of a Schedule Risk Analysis**

- Analysts collect program risk information, such as estimated activity durations and the likely effects of risks if they occur.
- A statistical simulation incorporates risk and schedule information to produce potential critical paths and predict the probability of on-time completion.
- Planners and managers use the results to identify high-priority risks and guide risk mitigation actions.

Source: Representation of GAO *Schedule Assessment Guide* information | GAO-23-106292

The following parties have roles in the development, oversight, and assessment of the *Columbia* class program’s integrated master schedule:



- **Electric Boat** must conduct management oversight of the program using an integrated master schedule, and manage the program effort to ensure the on-schedule completion of the submarines. The lead submarine construction option negotiated in 2020 specifies a delivery date of October 2027, after an 84-month construction duration. According to the contract, Electric Boat is also required to implement a risk management plan that, among other things, identifies and seeks to mitigate schedule risks.
- **Program Executive Office, Strategic Submarines, and Columbia Class Program Office** are to manage all aspects of life-cycle management of the *Columbia* class program, including program initiation, ship design, construction, testing, delivery, fleet introduction, and maintenance activities. According to DOD guidance, program managers must establish a risk management program to ensure that schedule, cost, and performance objectives are achieved.<sup>16</sup>
- **Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E))** conducts an Independent Technical Risk Assessment (ITRA) of program technical risks before the MDA approves the program for entry into production for a subset of major defense acquisition programs, including the *Columbia* class program.<sup>17</sup> Technical risks may stem from areas such as requirements, technology, software, and quality issues, among other things. According to DOD guidance, an ITRA should describe how technical risks and issues could jeopardize the program's achievement of cost, schedule, and performance objectives using established baselines.<sup>18</sup>
- **Supervisors of Shipbuilding, Conversion, and Repair (SUPSHIP)** serve as the Navy's primary on-site representative at the private shipyards—in the case of the *Columbia* class program, at Electric Boat and Newport News—that build Navy ships and submarines. The

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<sup>16</sup>Department of Defense Instruction 5000.02, *Operation of the Adaptive Acquisition Framework* (Jan. 23, 2020).

<sup>17</sup>The Secretary of Defense must conduct or approve ITRAs before milestone A or B approval may be granted pursuant to sections 4251 and 4252, respectively, of title 10, U.S. Code. 10 U.S.C. § 4272. The Secretary of Defense delegated this responsibility to OUSD(R&E) per Department of Defense Instruction 5000.88, *Engineering of Defense Systems* (Nov. 18, 2020).

<sup>18</sup>Office of the Under Secretary of Defense for Research and Engineering, *Department of Defense Independent Technical Risk Assessment Framework for Risk Categorization* (Washington, D.C.: June 2018).

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SUPSHIPs' services include contract administration, project management, quality assurance, logistics, and financial administration.<sup>19</sup> For the Navy's shipbuilding programs, the SUPSHIPs' earned value management and ship construction experts monitor the compliance of the contractor's business systems with relevant standards and conduct analysis that relies on the program's integrated master schedule.

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## Navy and DOD Lack Essential Schedule Insight

The Navy and DOD lack essential schedule insight because the shipbuilder has not 1) conducted a schedule risk analysis of the lead submarine's construction schedule or 2) provided schedule data in a format that the Navy can easily use to validate the schedule's quality.

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### Shipbuilder Has Not Conducted a Schedule Risk Analysis

Electric Boat has not conducted a schedule risk analysis of the lead submarine's accelerated construction schedule. Both GAO-identified leading practices and DOD guidance identify schedule risk analysis as a critical tool for understanding program risks and managing risks that could impact the schedule. According to our *Schedule Assessment Guide*, a schedule risk analysis can predict the probability that a program can achieve its completion—in the lead *Columbia* submarine's case, delivery—on time.<sup>20</sup>

DOD's guidance for preparing and using an integrated master schedule states that schedule risk analysis allows programs to more fully account for the potential impact of risks—should they be realized during program execution—and better prioritize which risks they should mitigate.<sup>21</sup> Such analysis can also help identify and manage high-priority risks and

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<sup>19</sup>For additional information on the SUPSHIP's roles in shipbuilding quality and challenges that limit their ability to improve shipbuilding outcomes, see: GAO, *Navy Shipbuilding: Increasing Supervisors of Shipbuilding Responsibility Could Help Improve Program Outcomes*, [GAO-22-104655](#), (Washington, D.C.: Apr. 12, 2022). See also Naval Sea Systems Command, *Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP) Operations Manual (SOM)*, S0300-B2-MAN-010, (Mar. 23, 2022).

<sup>20</sup>[GAO-16-89G](#).

<sup>21</sup>Department of Defense, *Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide*, Version 0.9 (Oct. 21, 2005).

determine if there is sufficient schedule margin. Programs can use schedule margin to accommodate unexpected construction events, such as delayed delivery of materials. By statistically analyzing the effects of potential program changes, schedule risk analysis is critical to successfully meeting program commitments.

DOD earned value management guidance emphasizes that the risk inherent in the program should be the prime consideration for tailoring the required contract reporting, which includes whether to require a schedule risk analysis.<sup>22</sup> The *Columbia* class is a schedule driven program, and GAO, the shipbuilders, and the Navy identified significant program risks and issues over the last few years. For example, we found in 2017 that the program's schedule for achieving the lead submarine's first patrol was aggressive and that the program was at risk of schedule delays.<sup>23</sup>

DOD earned value management guidance states that the contract specification requiring a schedule risk analysis is tailorable. Program officials stated that they do not manage the program according to probabilities, such as probabilities of completion that would be calculated by a schedule risk analysis. Instead, program officials stated that they manage the schedule and schedule risk using margin. As such, program officials stated that planners insert buffer periods ahead of contractual events and milestones to accommodate unforeseen problems. Electric Boat representatives added that a margin's length is frequently based on internal best practices and lessons learned from the *Virginia* class. However, a schedule risk analysis could enhance how the shipbuilders apply this professional judgment by quantifying the overall amount of schedule margin needed to achieve completion and whether that margin sufficiently accounts for critical risks.

Electric Boat representatives stated that the *Columbia* class program is too complex for a Monte Carlo simulation-based schedule risk analysis and that it would not correctly assess risks to achieving the lead submarine's delivery date. For example, program officials and shipbuilder representatives explained that there are multiple work-arounds the shipbuilder can employ to accomplish work on time even when all necessary resources, such as components and design products, are not available as planned. According to Electric Boat representatives, because

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<sup>22</sup>Office of the Under Secretary of Defense for Acquisition and Sustainment, *Department of Defense Earned Value Management Implementation Guide* (Jan. 18, 2019).

<sup>23</sup>[GAO-18-158](#).

these work-arounds typically involve resequencing work, they may not be executing work in the most optimal way.

While Electric Boat has flexibility in how it constructs the lead submarine, government programs of similar and in some cases even greater production duration, cost, and complexity routinely conduct schedule risk analysis to better inform program efforts. For example, the National Aeronautics and Space Administration requires that certain projects conduct a joint cost and schedule risk assessment.<sup>24</sup> Among other things, this joint assessment evaluates the likelihood that a project plan, reflected in the integrated master schedule, is achievable within the planned date constraints. GAO previously reported in May 2021 that the James Webb Space Telescope project completed a joint cost and schedule risk analysis and used the schedule results to plan for a more realistic launch date.<sup>25</sup> Moreover, some space systems, like the first Navy ships and submarines of a new class, take years to develop and construct, cost billions of dollars, and typically cannot be fully tested before delivery or launch. Without a schedule risk analysis for the *Columbia* class lead submarine, the Navy lacks key information about how schedule risks could affect the likelihood of achieving key program milestones, including delivery, and the amount of margin needed to manage critical risks and avoid delays.

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### Navy's Insight into the Quality of the Construction Schedule Is Limited by the Schedule Data's Format

The Navy did not require Electric Boat to provide it with schedule data in their native format, which limits the Navy's ability to easily validate the quality of the schedule. Native format data have the same structure or the same file type as the data in the contractor's scheduling software.<sup>26</sup> DOD guidance states that programs should assess the quality of a schedule by checking its underlying assumptions and ensuring it is free of errors that

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<sup>24</sup>National Aeronautics and Space Administration Procedural Requirement 7120.5F, *NASA Space Flight Program and Project Management Requirements* (Aug. 3, 2021).

<sup>25</sup>GAO, *James Webb Space Telescope: Project Nearing Completion, but Work to Resolve Challenges Continues*, [GAO-21-406](#) (Washington, D.C.: May 13, 2021).

<sup>26</sup>Department of Defense Data Item Description documentation describes contractor data requirements, such as content, format, and use. See Office of the Under Secretary of Defense for Acquisition and Sustainment, *Integrated Program Management Data and Analysis Report*, DI-MGMT-81861C (Aug. 30, 2021).

would affect schedule analysis.<sup>27</sup> Valid schedule data ensure that the results of additional assessments, such as schedule risk analysis, are accurate. Moreover, a quality integrated master schedule clearly and correctly communicates the work to be accomplished and when it is to be completed so that programs can accurately track progress through earned value management.

According to GAO leading practices and Defense Contract Management Agency schedule assessment experts, to conduct schedule assessments, the government generally needs native file format data that are compatible with its scheduling analysis software.<sup>28</sup> Electric Boat uses a scheduling software called Artemis.<sup>29</sup> Instead of a direct output from the Artemis system, Electric Boat provides the Navy with schedule data in PDF and Microsoft Excel—the shipbuilder’s preferred formats.

Officials from the program office and SUPSHIP Groton stated that PDF and Excel schedule information is sufficient for their oversight needs. According to program and SUPSHIP officials, they monitor changes to the schedule by reviewing static timelines, lists of milestone dates, and the shipbuilder’s monthly program management briefings. They then discuss with shipbuilder representatives whether changes to the schedule are justified. Program officials stated that over the last 30 years of submarine building, the Navy has not required submarine builders to submit native file schedule data. Further, officials stated that such data are not necessary to assess the quality of the contractor’s schedule or to ensure the shipbuilders are meeting schedule best practices. However, the last three lead submarines of a new class constructed by Electric Boat were delivered an average of 20 months late.

Officials at SUPSHIP Groton stated that they may request to view limited Artemis schedule data from shipbuilder representatives if they have specific questions about or find discrepancies in their analysis of earned value management data. However, SUPSHIP officials at other shipyards

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<sup>27</sup>Department of Defense, *Risk, Issue, and Opportunity Management Guide for Defense Acquisitions Programs* (Washington, D.C.: January 2017); and DOD, *Earned Value Management Implementation Guide*.

<sup>28</sup>The Defense Contract Management Agency evaluates the quality of schedule contract deliverables and assesses program schedule performance information for DOD’s non-shipbuilding programs.

<sup>29</sup>Artemis project management software is a relational database that Electric Boat uses to construct individual design and construction schedules for each of the submarines it builds and delivers.

responsible for constructing Navy surface ships—including Expeditionary Sea Base ships, Littoral Combat Ships, and *Arleigh Burke* Destroyers—stated that they receive and assess schedule data in their native file format. These SUPSHIP officials stated that the native data allow them to ask shipbuilder representatives detailed questions, monitor schedule changes, and predict milestone achievements.

Earned value management and schedule experts at the Defense Contract Management Agency also stated that static schedule format data, such as data contained in PDF and Excel, do not allow for independently adjusting or testing changes to the schedule in statistical software to account for potential schedule risks or opportunities. Defense Contract Management Agency officials also told us that schedule data translated from a contractor's schedule software to other formats may contain unknown modifications. As a result, a program's use of PDF and Excel format data could result in management making decisions that are based on incorrect information and limit the usefulness of schedule data analysis.

Insight into the quality of the construction schedule could be limited by not receiving the schedule data in native format. Further, the use of static data can inhibit independent checks for errors, accurate tracking of the program's progress, and efficient allocation of resources to mitigate critical schedule risks.

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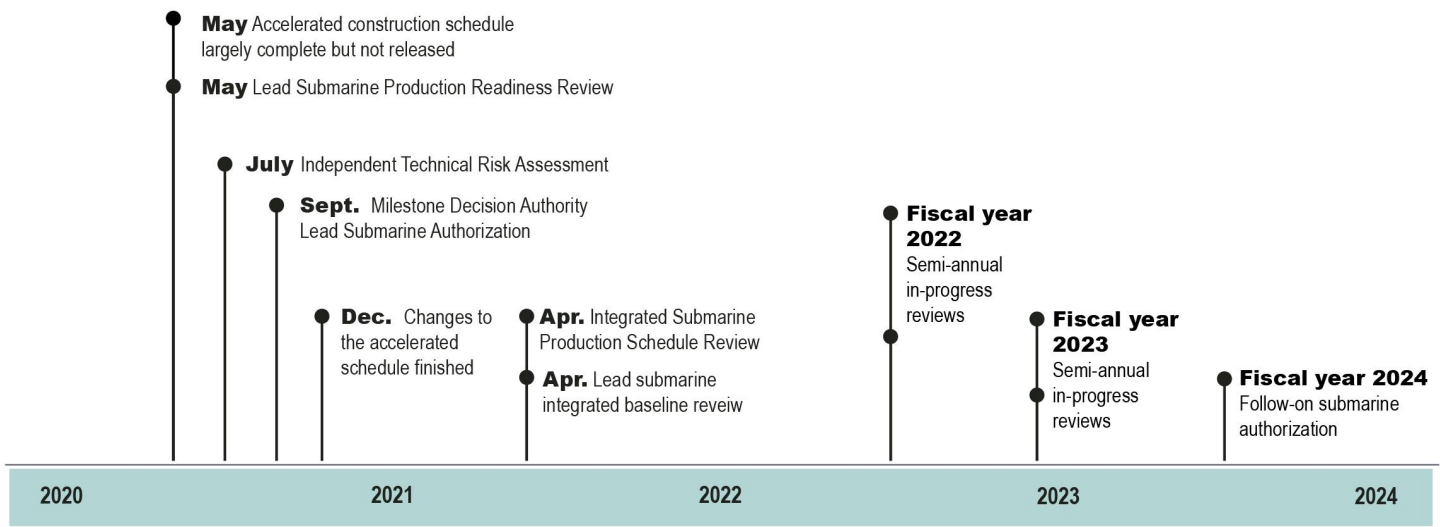
## DOD Decision Makers Were Not Provided with Detailed Information to Assess the Construction Schedule

The Under Secretary of Defense for Acquisition and Sustainment, who serves as the MDA for the *Columbia* class program, has not been provided detailed information needed to assess the feasibility of achieving the lead submarine's construction schedule and identify critical risks. Our work found that a schedule risk analysis provides important information on the probability that programs will be completed on time and how programs can take action to minimize schedule risks.

In September 2020, the MDA approved the lead submarine to begin formal construction, in part based on the *Columbia* program's readiness to construct the lead submarine in 84 months. To help inform the MDA's decision, OUSD(R&E) officials attempted to conduct a schedule risk analysis as part of the program's July 2020 ITRA. However, OUSD(R&E) was not able to conduct the analysis because the Navy does not have

and therefore could not provide the native format schedule data needed to conduct statistical simulations. See figure 5 for the timing of OUSD(R&E)'s ITRA, the MDA's lead submarine authorization decision, program reviews, and the accelerated schedule.

**Figure 5: Timeline of Columbia Class Program Reviews and Changes to the Lead Submarine Construction Schedule**



Source: GAO representation of Navy, Department of Defense, and shipbuilder information. | GAO-23-106292

**Text for Figure 5: Timeline of Columbia Class Program Reviews and Changes to the Lead Submarine Construction Schedule**

**2020**

- **May** Accelerated construction schedule largely complete but not released
- **May** Lead Submarine Production Readiness Review
- **July** Independent Technical Risk Assessment
- **Sept.** Milestone Decision Authority Lead Submarine Authorization
- **Dec.** Changes to the accelerated schedule finished

**2021**

- **Apr.** Integrated Submarine Production Schedule Review
- **Apr.** Lead submarine integrated baseline review

**2022**

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- **Fiscal year 2022** Semi-annual in-progress reviews
  - **Fiscal year 2022** Semi-annual in-progress reviews
- 2023**

- **Fiscal year 2024** Follow-on submarine authorization

Source: GAO representation of Navy, Department of Defense, and shipbuilder information. | GAO-23-106292

OUSD(R&E) recommended that the Navy subject the lead *Columbia* class submarine's accelerated construction schedule to a schedule risk analysis as soon as possible to determine whether it is feasible and to identify critical schedule risks. Officials who conducted OUSD(R&E)'s ITRA stated that a full analysis of the schedule would be useful to identify schedule gaps, dependencies, concurrencies, and time allotted for tasks.

In response to OUSD(R&E)'s recommendation, Navy officials told us that they conducted a joint *Columbia* and *Virginia* class schedule review—entitled the Integrated Submarine Production Schedule Review—to assess joint schedule risks in April 2021, as seen in the previous figure. The Navy conducted this review to inform the *Columbia* class program's integrated baseline review.<sup>30</sup> Navy officials described their approach for the joint program schedule review as leveraging experience from previous submarine programs to judge whether the *Columbia* class lead submarine schedule is executable. Specifically, Navy officials evaluated schedule health metrics and proposed production schedules for the *Columbia* class lead submarine and future *Virginia* class submarines in PDF—as static timelines and lists of activities and milestones—to assess their achievability. Program officials stated that they reviewed schedule risks that OUSD(R&E) officials indicated were important for understanding the feasibility of the accelerated schedule—schedule gaps, dependencies, concurrencies, and time allotted for tasks. However, program officials also stated that they did not document the results of this assessment or conduct a statistical schedule risk analysis. In addition to conducting the joint schedule review, program officials said that they included schedule as a main risk consideration in their risk management program and tracked actions to mitigate schedule risk.

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<sup>30</sup>At the integrated baseline review the government and contractor assess the contractor's baseline to be used for performance measurement to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks. Programs that utilize earned value management must conduct an integrated baseline review within 180 days of contract award. See Defense Federal Acquisition Regulation Supplement 252-234.7002 Earned Value Management System.



The Navy's review did not statistically analyze the feasibility of achieving on-time delivery—a key element of a schedule risk analysis according to our *Schedule Assessment Guide* and multiple DOD guidance documents. Our leading practices and DOD guidance define a schedule risk analysis as a statistical assessment. Although program officials stated that their joint program schedule review satisfied OUSD(R&E)'s recommendation to subject the lead *Columbia* submarine's accelerated schedule to a schedule risk analysis, the Navy's efforts did not meet our or DOD's definition of a schedule risk analysis.

The MDA plans to hold in-progress reviews of the *Columbia* program twice per year through at least fiscal year 2023. At these reviews, the MDA can further evaluate the program's readiness to make sound investment decisions and whether the program has or will have the funding to achieve its objectives. The MDA can also make recommendations based on new information, such as the results of a schedule risk analysis. Per DOD acquisition guidance, at the request of leadership in the Office of the Secretary of Defense or the Navy, OUSD(R&E) can undertake focused technical reviews, including schedule risk analysis.<sup>31</sup> This detailed and independent analysis could provide the MDA with key information at its next review about the likelihood of achieving the program's schedule and whether critical schedule risks were correctly identified. It would also enable more informed resource decisions in advance of the Navy's budget submissions. The analysis could better inform DOD about whether the schedule has sufficient margin to manage any critical risks if realized and whether the program's efforts to allocate resources to achieve on-time delivery are targeted correctly. Moreover, if the Navy determines an approach for conducting schedule risk analysis for the rest of the class, the MDA's reviews to authorize construction for follow-on submarines could also be better informed by this information.

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## Lead Submarine Is behind the Accelerated Construction Schedule and Navy Needs Additional Long-Term Planning

After more than a year of full construction for the lead submarine, overall construction progress was behind where Electric Boat planned to be

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<sup>31</sup>DOD Instruction 5000.88, *Engineering of Defense Systems*.

under its accelerated schedule. In response, the shipbuilders prioritized *Columbia* class construction over *Virginia* class construction. The Navy needs additional long-term planning to identify risks that are shared between both submarine programs.

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## Construction Schedule Delays

### Lagging Design Performance

Construction delays on the lead submarine have been caused, in part, by lagging shipbuilder performance on design products, in particular, work instructions—detailed instructions used by workers to execute construction tasks. We reported in January 2021 that the shipbuilders were behind on planned rates for completing design products during advance construction.<sup>32</sup> The shipbuilders continued to remain behind on producing work instructions for most super modules throughout 2021, and, as of February 2022, continued to miss these targets. However, program officials told us that there is some margin in the schedule for work instructions before design delays will affect the construction schedule.

According to a program briefing, the shipbuilders recognize delayed work instructions—that have implications for construction—are a top overall program issue. This briefing stated that in December 2021, Electric Boat stopped work for some full-time equivalents because, in part, design products were not ready in time to support planned construction tasks. Further, Navy officials stated that the shipbuilders cannot overcome schedule delays unless the shipbuilders improve work instruction issuance. If the shipbuilders are unable to improve the work instruction completion rate, delays in the lead submarine’s construction schedule are likely to continue.

### Late materials

Electric Boat’s planning documents highlight that having material available when needed is key to meeting the construction schedule and avoiding cost increases. Total material availability for the lead submarine continued to lag as of December 2021. Program officials told us that the shipbuilders generally had the materials ready when needed to support

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<sup>32</sup>GAO, *Columbia Class Submarine: Delivery Hinges on Timely and Quality Materials from an Atrophied Supplier Base*, [GAO-21-257](#) (Washington, D.C.: Jan. 14, 2021).

construction. However, they stated that in some cases, construction delays occurred when key materials arrived late. For example, in the first half of 2021, late deliveries of missile tubes were a primary driver of schedule delays.

### First-time quality challenges

The shipbuilders and their suppliers also experienced problems producing quality materials for the lead submarine during first-time production, which has resulted in delays. A Navy official stated that some of these problems occurred because inadequate supervision at the shipyard led to work instructions not being followed properly. Navy and shipbuilder representatives also stated that because of challenges hiring supervisors, less experienced engineering staff—often recent graduates—are supervising complex work. Program officials told us that less experienced engineering staff are assisting operations supervision to manage this work. A representative from Electric Boat also told us that the shipbuilder is implementing improvements to supervision practices, such as assigning supervisors dedicated to work solely on the *Columbia* class program, in order to promote knowledge building and consistency.

Electric Boat's problems with the first-time quality from critical suppliers caused delays during advance construction, as we previously reported. We recommended that the Navy assess when additional inspections at supplier facilities are necessary to reduce quality issues from suppliers.<sup>33</sup> In response, the Navy noted that it instituted an ongoing effort to determine how to provide oversight at supplier facilities.<sup>34</sup>

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## Shipbuilder Prioritization of *Columbia* Class Construction

Because of the *Columbia* class program's essential role in strategic deterrence, it has priority status over most national-defense-related

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<sup>33</sup>[GAO-21-257](#).

<sup>34</sup>[GAO-22-104655](#). We reported that the Navy assessed the current approach to oversight of the supply chain and concluded that the SUPSHIPs need to provide increased oversight of the shipbuilder's management of suppliers with dedicated quality oversight staff for nuclear-powered shipbuilding programs. SUPSHIP Management officials noted, however, that the Navy has yet to fully determine the funding approach and total staffing needed to support targeted quality assurance efforts for critical systems constructed away from the shipyards.

programs, including the *Virginia* class program.<sup>35</sup> To mitigate growing schedule delays, the shipbuilder is adding staff to the *Columbia* class program by using workers that were originally planned for the *Virginia* program. According to the Navy, the shipbuilders plan to add more workers beyond its original staffing plan for *Columbia* class construction work until it recovers from schedule delays. This will likely result in additional delays to the *Virginia* class program. Additionally, the shipbuilder plans to backfill the *Virginia* class program with new hires. Program officials told us that new hires will be paired with experienced staff. Electric Boat is attempting to mitigate additional cost and schedule delays by providing training to new staff.

To fully staff both programs, the shipbuilders will have to overcome challenges to keep pace with their hiring goals. Navy officials attributed these challenges to a competitive environment caused by a high overall employment rate. Navy officials also stated that the COVID-19 pandemic exacerbated existing challenges by forcing a temporary pause in new hire training.

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## Navy Needs Additional Long-Term Planning

The Navy's fiscal year 2022 30-year shipbuilding plan states that *Virginia* class submarines will be produced at a rate of two per year and *Columbia* class submarines at one per year.<sup>36</sup> However, shared risks between the programs are likely to continue to have a more pronounced impact on the

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<sup>35</sup>This priority is established in the Defense Production Act and put into operation through the Defense Priorities and Allocations System. The Defense Production Act of 1950 authorized the president to require preferential treatment of national defense programs. The Department of Commerce administers the system and delegated DOD the authority to place priority ratings on contracts or orders. Programs can be approved for one of two types of priority: programs with the highest national priority, like *Columbia* class, may be approved to use a DX rating, while a DO rating may be used by programs of a second-tier priority, like the *Virginia* class. Contractors must give DX-rated orders priority over DO-rated orders in instances when a production or delivery schedule conflict arises. Part 700 of title 15, Code of Federal Regulations, provides rules for the Defense Priorities Allocation System program. DOD 4400.1-M provides guidance for DOD activities. Per DOD 4400.1-M, an Under Secretary approves DO rated orders and nominates them to the Secretary of Defense for approval of DX rated orders.

<sup>36</sup>Section 231 of title 10, U.S. Code, requires the Secretary of the Navy to submit an annual report on a 30-year plan for the construction of naval vessels with the Navy's budget submission to Congress. The Navy submitted a plan in conjunction with the fiscal year 2022 budget that outlines the mixture of ships and submarines it identified as necessary for a modernized naval force that can compete effectively against rival nations, deter aggression, and, if required, win decisively in combat.

*Virginia* class program because the *Columbia* class program is the Navy's top priority. The shipbuilders and Navy have not yet updated long-term planning documents to reflect how shared program risks could affect submarine production goals for either program.

In 2016, the Navy requested that the shipbuilders develop a plan that would provide the Navy with details it needed to plan for construction across the nuclear shipbuilding enterprise. In response, the shipbuilders engaged in a multiyear planning effort—called the Integrated Enterprise Plan—that identifies a plan for using facilities and resources, like staff, across programs to meet the Navy's production goals. Program officials stated that they expected the shipbuilders to conduct this planning as part of their regular business practices.

After the shipbuilders produced the initial plan in 2016, they made six successive updates intended to optimize construction at the shipyards, with the last update occurring in December 2019. The program office reviewed the Integrated Enterprise Plan and requested funding for initiatives outlined in the plan. It used this plan as the basis for informing construction plans for the *Columbia* class submarine program, including for developing estimated durations for submarine construction. In addition, the Navy used the Integrated Enterprise Plan to help develop the schedule for concurrent construction of the *Columbia*, *Virginia*, and *Ford* classes and to inform its shipbuilding plan and budget requests.

However, although the Integrated Enterprise Plan was intended to provide a basis for planning construction across the programs at the shipyards, the Navy and shipbuilders recently began to examine and understand the effects that joint risks could have. The Navy recommended that the shipbuilders develop a mechanism to assess and mitigate joint risks. The Integrated Enterprise Plan states that document revisions will occur to maintain alignment with budget and funding decisions as well as updated program execution plans.

Navy officials told us in February 2022 that the shipbuilders began to hold regular meetings to discuss shared risks that could lead to identifying additional resources needed to meet planned production levels. However, the Navy did not identify that these meetings would substitute for the long-term planning typically completed as part of an update to the Integrated Enterprise Plan. Without updating the Integrated Enterprise Plan to reflect how shared risks and updated program plans will affect simultaneous construction of the *Virginia* and *Columbia* class submarines, this plan does not provide complete information about the resources

necessary to meet the Navy's submarine production goals. According to Navy officials, the program office and the shipbuilders started discussions to update the plan in late 2021.

As a consequence of not having a comprehensive update to the shipbuilders' planning that addresses shared risks between programs, the Navy will not have reliable information to serve as a basis for updating its budget requests—or its 30-year shipbuilding plan. In fiscal year 2022, congressional conferees reported that the Navy's budget request included nearly \$250 million in funding for initiatives from the Integrated Enterprise Plan that had not been identified in prior years. They also expressed concern about a similar lack of transparency for additional initiatives requested in future budget submissions. The conferees directed the Assistant Secretary of the Navy for Research, Development and Acquisition to submit a fully funded Integrated Enterprise Plan initiative strategy with the submission of future budget requests that includes funding for such initiatives. A lack of transparency about Integrated Enterprise Plan initiatives could result in budget documents that do not reflect the resources needed across the submarine and aircraft carrier enterprise.

The 30-year shipbuilding plan for fiscal year 2023 was released in April 2022. Since the Integrated Enterprise Plan has yet to be updated, the shipbuilding plan did not reflect updated information that a current Integrated Enterprise Plan could provide. Under U.S. Code, the 30-year shipbuilding plan should include a detailed program for the construction of combatant and support vessels over the next 30 years and a certification by the Secretary of the Navy that the budget submitted is sufficient for procuring vessels according to the plan.<sup>37</sup> However, without complete and reliable information from the shipbuilders about the resources needed to address joint risks, the Navy cannot be certain that the next 30-year shipbuilding plan will reflect the cost of producing submarines on the schedule planned. Further, without this information, the Navy will also not be able to assure that the fiscal year 2024 budget it provides to Congress will be sufficient to allow it to procure submarines and ships on the schedule planned to meet national security and strategic deterrence needs. Program officials told us that the process for updating the Integrated Enterprise Plan is iterative, and that it will be updated in time for the fiscal year 2025 budget process.

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<sup>37</sup>10 U.S.C. § 231.

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## Conclusions

The *Columbia* class submarine is a schedule-driven program with a national security imperative to deliver the lead submarine on time. Adopting a more rigorous process for understanding schedule risks would better position the program to more efficiently and effectively mitigate risks to achieving key dates.

As the Navy's top acquisition priority, the *Columbia* class program is afforded some protection from the consequences of delays through its priority access to resources. Additional information about the costs to mitigate the likely outcome of shared risks would provide the Navy with greater certainty that it requested appropriate resources to meet plans and would enable better long-term planning for future naval forces.

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## Recommendations for Executive Action

We are making a total of six recommendations, five to the Department of the Navy and one to the Department of Defense:

The Secretary of the Navy, in coordination with the program office, should seek to obtain lead and follow-on *Columbia* class construction schedule information in the shipbuilder's native file format or other format that is compatible with government scheduling software. (Recommendation 1)

The Secretary of Defense should ensure that OUSD(R&E) conducts a schedule risk analysis of the lead *Columbia* submarine's construction schedule to inform the first in-progress program review of 2023, and provide the results to the program office. (Recommendation 2)

The Secretary of the Navy should ensure that the program office uses the schedule risk analysis from OUSD(R&E), once provided, to update plans for the lead submarine's delivery, as appropriate, and mitigate any identified risks, as appropriate. (Recommendation 3)

The Secretary of the Navy should ensure that the program determines an approach for conducting schedule risk analysis for future *Columbia* class submarines, to include who is responsible for conducting the analysis and when it will be conducted. (Recommendation 4)

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The Secretary of the Navy should obtain updated information about the shipbuilders' Integrated Enterprise Plan that reflects the updated execution plans and resources needed to address shared risks across the nuclear shipbuilding enterprise. (Recommendation 5)

The Secretary of the Navy should ensure that the Fiscal Year 2024 30-year shipbuilding plan is informed by updated planning that reflects resources needed to address shared risks between the *Columbia* and *Virginia* class programs, in order to certify that the budget the Navy submitted is sufficient to procure submarines on the schedules outlined in the plan. (Recommendation 6)

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## Agency Comments and Our Evaluation

We provided a draft of our report to DOD for comment. DOD's written comments are reprinted in appendix II of this report. DOD concurred with four recommendations and partially concurred with the second and third recommendations. DOD stated that ongoing and thorough schedule reviews are key to the efficient construction of submarines; however, several of the actions that DOD described in its letter will not fully address the issues that we discuss in this report. We maintain that fully implementing all six recommendations is essential to bolstering the Navy's ability to achieve its cost and schedule goals.

In response to the first recommendation, DOD concurred and agreed that assessing scheduling information in a format compatible with government-owned scheduling software is key to the efficient construction of submarines. DOD also stated in its letter that the information the Navy and program office currently receive from the contractor is sufficient for assessing and monitoring the lead submarine schedule and identifying risk areas for mitigation. However, as we state in the report, since the Navy does not receive schedule data in its native file format it cannot independently adjust or test schedule changes, which is essential to the Navy's oversight of the schedule. Receiving this information would better position the Navy to accurately track the program's progress or correctly identify and mitigate critical schedule risks.

In response to the second recommendation, DOD partially concurred. DOD stated that it agreed to identify the appropriate organization and timeline to conduct additional schedule evaluations. To be consistent with the intent of this recommendation, additional schedule evaluations would need to include a statistical schedule risk analysis. As we state in the



report, a schedule risk analysis is a critical tool for understanding and managing risks that could impact the schedule. Further, we recommended that OUSD(R&E) conduct this analysis to inform the first fiscal year 2023 in-progress review as a near term opportunity to provide the milestone decision authority with information in support of its recommendations and investment decisions. As we noted in the report, OUSD (R&E) previously attempted to conduct a schedule risk analysis for the lead submarine in 2020. We acknowledge that other organizations within DOD or the Navy may be similarly well-positioned to conduct a statistical schedule risk analysis. Doing so would better position the program to take additional necessary actions to deliver the lead submarine on time.

In response to the third recommendation, DOD partially concurred. DOD stated it agreed to incorporate additional schedule evaluations into its existing risk management approach. DOD noted in its letter that the program already has a risk management process that has included assessments of the program schedule and associated risks. However, this existing risk management framework does not include the use of statistical schedule risk analysis, which would improve program's understanding of its ability to construct and deliver the submarine as planned. Implementation of the first two recommendations is necessary for the program to be able mitigate risks and update its plans for delivery. Without a statistical schedule risk analysis, the program will continue to lack information about the likelihood of achieving its delivery date, and the steps it can take to manage critical risks.

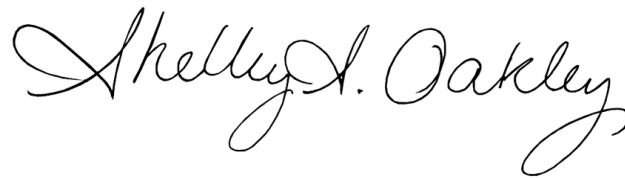
In response to the fourth recommendation, DOD concurred and stated that the milestone decision authority would determine the appropriate organization and timing to conduct additional schedule evaluations for the follow-on submarines in the class. However, as with the lead submarine, to fully implement the recommendation, additional schedule evaluations for follow-on submarines must include a statistical schedule risk analysis.

DOD also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretary of the Navy, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

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If you or your staff have any questions about this report, please contact me at (202) 512-4841 or [OakleyS@gao.gov](mailto:OakleyS@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

A handwritten signature in black ink that reads "Shelby S. Oakley". The signature is written in a cursive, flowing style.

Shelby S. Oakley  
Director, Contracting and National Security Acquisitions

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*List of Committees*

Chair  
Ranking Member  
Committee on Armed Services  
United States Senate  
Chair  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
United States Senate  
The Honorable Mike Rogers  
Chairman  
The Honorable Adam Smith  
Ranking Member  
Committee on Armed Services  
House of Representatives  
The Honorable Ken Calvert  
Chair  
Ranking Member  
Subcommittee on Defense  
Committee on Appropriations  
House of Representatives

## Appendix I: Objectives, Scope, and Methodology

This report assesses the Navy's *Columbia* class submarine program. Specifically, we assessed the extent to which (1) the Navy and the Department of Defense (DOD) have assessed risks to achieving the lead *Columbia* submarine's construction schedule, and (2) the program faced challenges constructing the lead *Columbia* class submarine and mitigating construction risks to the class.

This report is a public version of a sensitive report that we issued in September 2022. DOD deemed some of the information in our September report to be sensitive, which must be protected from public disclosure. Therefore, this report omits sensitive information about the Navy and DOD's efforts to assess schedule risk, sources of construction delays, and shared risks at the shipyards. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

To assess the extent to which the Navy and DOD assessed risks to achieving the lead *Columbia* submarine's construction schedule, we reviewed Navy and shipbuilder documents, including program briefings, schedules, contract documents, and management reports. The reports we reviewed included outputs from the integrated baseline review for the lead submarine, Independent Technical Risk Assessment, and the Integrated Submarine Production Schedule Review. We compared actions the Navy and DOD took to assess schedule risks to leading practices identified in our *Schedule Assessment Guide* as well as a relevant guidance, including the DOD Earned Value Management Implementation Guide, the DOD Risk, Issue, and Opportunity Management Guide, and the Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP) Operations Manual.<sup>1</sup> We also examined relevant

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<sup>1</sup> GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, [GAO-16-89G](#), (Washington, D.C.: December 2015); Office of the Under Secretary of Defense for Acquisition and Sustainment, *Department of Defense Earned Value Management Implementation Guide* (Jan. 18, 2019); Department of Defense, *Risk, Issue, and Opportunity Management Guide for Defense Acquisitions Programs* (Washington, D.C.: January 2017); and Naval Sea Systems Command, *Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP) Operations Manual (SOM)*, S0300-B2-MAN-010, (Mar. 23, 2022).

provisions in the Defense Federal Acquisition Regulation Supplement to identify guidance for contract data requirements related to earned value management. Further, we compared actions the Navy and DOD took for the *Columbia* class program to those used for other programs to assess schedule risk. We also compared DOD's guidance for schedule risk assessments to guidance used by other departments.

To evaluate the extent to which the program faces challenges constructing the lead *Columbia* class submarine and mitigating construction risks to the class, we compared plans for design and construction completion against actual progress and identified the source of any delays. We also reviewed the matrices submitted by the Navy to Congress in February 2021, to determine the status of the program and identify any changes to the Navy's design and construction goals for the program since our last report in January 2021.<sup>2</sup> We analyzed information reported in Navy and shipbuilder documents, briefing slides, and other documentation on construction challenges and construction risks to the class. Additionally, we discussed mitigation plans for delays with Navy and shipbuilder representatives and compared them with Navy plans outlined in construction readiness reviews, budget briefings, shipbuilder long-term planning, and the Navy's 30-year shipbuilding plans from fiscal years 2022 and 2023 in order to examine the potential effects of mitigations. Further, to gain context about the status of the construction effort and any associated challenges we visited General Dynamics Electric Boat's (Electric Boat) Groton, Connecticut and Quonset Point, Rhode Island facilities and observed construction efforts.

We met with officials from the Navy's *Columbia* class submarine program office; *Virginia* class submarine program office; Navy Strategic Systems Programs; Naval Sea Systems Command SUPSHIP Management, SUPSHIP Groton, and SUPSHIP Newport News. We met with Department of Defense officials from the Office of the Under Secretary of Defense for Acquisition and Sustainment; the Office of the Under Secretary of Defense for Research and Engineering; and the Defense Contract Management Agency. We also met with shipbuilding representatives from Electric Boat—the prime contractor—as well as its main subcontractor, Huntington Ingalls Industries Newport News

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<sup>2</sup>GAO, *Columbia Class Submarine: Delivery Hinges on Timely and Quality Materials from an Atrophied Supplier Base*, [GAO-21-257](#) (Washington, D.C.: Jan. 14, 2021).

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Shipbuilding, to understand their role in *Columbia* class scheduling, design, and construction.

We conducted this performance audit from January 2021 to September 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We subsequently worked with DOD from September 2022 to January 2023 to prepare this unclassified version of the original sensitive report for public release. This public version was also prepared in accordance with these standards.

## Appendix II: Comments from the Department of Defense



OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE  
3600 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3600

ACQUISITION

Ms. Shelby Oakley  
Director, Contracting and National Security  
U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548

Dear Ms. Oakley:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GA0-22-104758SU, "COLUMBIA CLASS SUBMARINE: Program Lacks Essential Schedule Insight Amid Continuing Construction Challenges," dated May 2022 (GAO Code 104758). Over the past 15 months the Navy and the Columbia class submarine shipbuilders have supported this GAO engagement, including providing over 100 documents, organizing 17 meetings, and responding to approximately 700 questions. The Department's detailed responses to the recommendations in this draft report and technical comments are enclosed.

The Department agrees that ongoing and thorough schedule reviews are key to the efficient construction of submarines. Consistent with all previous successful submarine contracts, the Navy COLUMBIA (CLB) Program Office receives the lead submarine (SSBN 826) schedule in multiple formats on a routine basis; which are deemed sufficient for assessing and monitoring SSBN 826 schedule and identifying risk areas for mitigation.

The Department agrees that risk reduction is imperative to meet the scheduled delivery date. The CLB integrated risk management program executes risk management approaches and processes across multiple stakeholders, including the shipbuilders and subcontractors involved in submarine design, construction, and sustainment. Individual risks are categorized by potential severity and likelihood in accordance with DoD policy and best practices. The CLB Program leverages a variety of tools and processes to ensure seamless communication and foster participation across the various stakeholders for an integrated risk management approach.

The Department agrees that a thorough understanding and analysis of schedule risk is important for the SSBN 826, as well as all follow-on submarines of the class. The Navy includes schedule analysis as one of its main areas of consideration in the CLB Program's risk management program. To ensure delivery of SSBN 826 by the contract delivery date of October 2027, the shipbuilders developed an Integrated Master Schedule (IMS). The Navy conducted a detailed review of this IMS utilizing subject matter experts to assess planned production sequence and duration and determined it was executable. Additionally, the Navy obtains schedule data from the shipbuilders required for continuous detailed Government evaluation of the SSBN 826 schedule.

**Appendix II: Comments from the Department  
of Defense**

The Department agrees with the GAO that improvements to staffing are necessary for schedule recovery and maintenance. The shipbuilders continue to focus significant effort on hiring and recruitment; they are making even greater investments in workforce development programs while modernizing their business systems and training/continuing education programs to help retain existing staff. The shipbuilders also continue to leverage leased labor to off-set differences between hiring demand and actual achieved hiring as appropriate to maintain program health.

The Department agrees that the Submarine Industrial Base remains a top program risk. Continued risk mitigation measures are required to ensure the Submarine Industrial Base can support submarine program schedules. For this reason, the Navy has taken unprecedented proactive steps to develop the Integrated Enterprise Plan (IEP) to coordinate comprehensive, holistic, and actionable nuclear shipbuilding industrial base efforts that align submarine construction requirements with resources, capability, and capacity. The IEP continues to guide cross-program industrial base preparation efforts for the ramp-up to support both CLB and VIRGINIA class serial production.

The CLB Program continues to execute key risk mitigation activities to promote success in meeting cost, schedule, and performance requirements. The CLB Program's goal continues to be to maintain stable operational and technical requirements, achieve high design maturity at construction start, ensure manufacturing and construction readiness, and take proactive, aggressive action to reduce costs and maintain schedule.

The Department appreciates the opportunity to comment on the draft report. For further questions concerning this matter, please contact Ms. Sorahi Azarbarzin at 703-614-6485 or via email at [sorahi.a.azarbarzin.civ@mail.mil](mailto:sorahi.a.azarbarzin.civ@mail.mil).



Tanya M. Skeen  
Acting Assistant Secretary of Defense  
for Acquisition

Enclosures:  
As stated



**GAO DRAFT REPORT DATED MAY 2022  
GAO-22-104758SU (GAO CODE 104758)**

**“COLUMBIA CLASS SUBMARINE: PROGRAM LACKS ESSENTIAL SCHEDULE  
INSIGHT AMID CONTINUING CONSTRUCTION CHALLENGES”**

**DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS**

**RECOMMENDATION 1:** The GAO recommends that the Secretary of the Navy, in coordination with the program office, should seek to obtain lead and follow-on COLUMBIA class construction schedule information in the shipbuilder’s native file format or other format that is compatible with government scheduling software.

**DoD RESPONSE:** Concur. The Department agrees that detailed evaluation of the COLUMBIA Program schedule is critical to support its on-time delivery including having access to scheduling information in a format compatible with Government-owned scheduling software.

**RECOMMENDATION 2:** The GAO recommends that the Secretary of the Defense should ensure that OUSD(R&E) conduct a schedule risk analysis of the lead COLUMBIA submarine’s construction schedule to inform the first in-progress program review of 2023, and provide the results to the program office.

**DoD RESPONSE:** Partially Concur. The Milestone Decision Authority (MDA), independent of the COLUMBIA Program Office, will identify the appropriate organization and timeline to perform additional schedule evaluations and will provide the results to the COLUMBIA Program Office.

**RECOMMENDATION 3:** The GAO recommends that the Secretary of the Navy should ensure that the program office use the schedule risk analysis from OUSD(R&E), once provided, to update plans for the lead submarine’s delivery, as appropriate, and mitigate any identified risks, as appropriate.

**DoD RESPONSE:** Partially Concur. The Navy will use established risk management processes and mitigation strategies to evaluate schedule risk of the lead submarine delivery. These will include current and newly identified mitigations from historical and additional schedule evaluations.

**RECOMMENDATION 4:** The GAO recommends that the Secretary of the Navy should determine an approach for conducting schedule risk analysis for future COLUMBIA class submarines, to include who is responsible for conducting the analysis and when it will be conducted.

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**Appendix II: Comments from the Department  
of Defense**

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**DoD RESPONSE:** Concur. The MDA will determine the appropriate organization and timeline to perform additional schedule evaluations required for future COLUMBIA construction schedules.

**RECOMMENDATION 5:** The GAO recommends that the Secretary of the Navy should obtain updated information about the shipbuilders' Integrated Enterprise Plan that reflects the updated execution plans and resources needed to address shared risks across the nuclear shipbuilding enterprise.

**DoD RESPONSE:** Concur. Since Fall 2021, the Navy has been working with the shipbuilders on developing an update to the applicable portions of the Integrated Enterprise Plan, consistent with the update of five prior versions over the last six years.

**RECOMMENDATION 6:** The GAO recommends that the Secretary of the Navy should ensure that the Fiscal Year 2024 30-year shipbuilding plan is informed by updated planning that reflects resources needed to address shared risks between the COLUMBIA and VIRGINIA class programs in order to certify that the budget the Navy has submitted is sufficient to procure submarines on schedules outlined in the plan.

**DoD RESPONSE:** Concur.

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## Text of Appendix II: Comments from the Department of Defense

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WASHINGTON, DC 20301-3600

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Tanya M. Skeen

Acting Assistant Secretary of Defense for Acquisition

Enclosures: As stated

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**DoD RESPONSE:** Concur

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## Appendix III: GAO Contact and Staff Acknowledgments

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### GAO Contact

Shelby S. Oakley, (202) 512-4841 or [oakleys@gao.gov](mailto:oakleys@gao.gov).

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### Staff Acknowledgments

In addition to the contact named above, the following staff members made key contributions to this report: Diana Moldafsky, Assistant Director; Lindsey Cross, Analyst-in-Charge; Sierra Hicks; Nicole Mackowski; Brendan K. Orino; and Daniel R. Singleton. Other contributions were made by Brian Bothwell, Kurt Gurka, Stephanie Gustafson, Yvette Gutierrez, and Robin Wilson.

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