



September 2017

NAVY UNMANNED AERIAL REFUELING SYSTEM

Acquisition Addresses
Validated
Requirements and
Reflects a Knowledge-
Based Approach

GAO Highlights

Highlights of [GAO-17-647](#), a report to congressional committees

Why GAO Did This Study

The Navy expects to invest almost \$2.5 billion through fiscal year 2022 in the development of an unmanned aerial refueling system referred to as the MQ-25. The MQ-25 is the result of a restructure of the former Unmanned Carrier-Launched Airborne Surveillance and Strike system. The program is expected to deliver an unmanned aircraft system that operates from aircraft carriers and provides aerial refueling to other Navy aircraft and intelligence, surveillance, and reconnaissance capabilities. The Navy plans to release a request for proposals for air system development by October 2017 and award a development contract one year later.

A House Armed Services Committee report on a bill for the National Defense Authorization Act for Fiscal Year 2017 contained a provision for GAO to review the status of the MQ-25 program. This report assesses the extent to which the MQ-25's acquisition strategy is (1) rooted in validated requirements and (2) structured to follow a knowledge-based acquisition process.

To do this work, GAO reviewed the Navy's requirements documentation, acquisition strategy, and other relevant documents and compared them with acquisition statutes, Department of Defense acquisition policy, and previous GAO reports and best practices. GAO also discussed the MQ-25 requirements and acquisition strategy with the Navy program office and other cognizant officials.

What GAO Recommends

GAO is not making recommendations. DOD's technical comments are incorporated in this report.

View [GAO-17-647](#). For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

September 2017

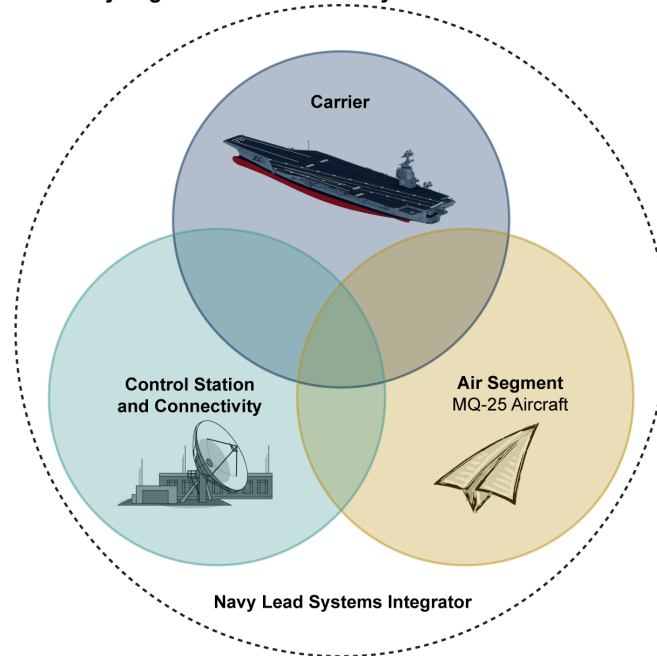
NAVY UNMANNED AERIAL REFUELING SYSTEM

Acquisition Addresses Validated Requirements and Reflects a Knowledge-Based Approach

What GAO Found

The MQ-25 requirements have been validated by DOD's Joint Requirements Oversight Council. The Navy has identified two primary requirements: carrier suitability, which means the ability to operate on and from the Navy's aircraft carriers; and air refueling, which is the ability to provide fuel to other carrier-based assets while in flight. While the MQ-25 system is also expected to possess intelligence, surveillance and reconnaissance capabilities; those capabilities are not considered primary requirements. According to the program's acquisition strategy, the MQ-25 system will consist of three segments: the Air segment; a control and connectivity segment, which will interface with existing command and control systems; and an aircraft carrier segment, which will make modifications to upgrade existing carrier infrastructure. These three segments will be managed and integrated by the Navy's Unmanned Carrier Aviation program office, acting as a Lead Systems Integrator (see figure below).

Three Key Segments of the MQ-25 System



Source: GAO analysis of Navy data (data and images). | GAO-17-647

The Navy has established a knowledge-based approach for acquiring the MQ-25 aircraft. For example, the Navy plans to take an incremental approach to develop and evolve the MQ-25 over time. Further, the Navy expects to use knowledge-based criteria to assess progress at key decision points during development, and to use only technologies with high levels of maturity. With the Milestone B review scheduled in the summer of 2018—signaling the beginning of development—the ultimate success of the MQ-25 program depends heavily on the Navy's ability to present an executable business case and then effectively implement its planned approach.

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Abbreviations

CS&C	Control System and Connectivity
DOD	Department of Defense
ICD	Initial Capability Document
ISR	Intelligence, Surveillance, and Reconnaissance
JROC	Joint Requirements Oversight Council
MQ-25	Unmanned Aircraft System
OSD	Office of the Secretary of Defense
UCLASS	Unmanned Carrier-Launched Airborne Surveillance and Strike

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September 6, 2017

Congressional Committees

The Navy expects to invest almost \$2.5 billion through fiscal year 2022 in the development of a Carrier Based Aerial Refueling System, currently designated the MQ-25 Unmanned Air System.¹ This program is the outcome of a restructuring of the former Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) system, which was halted in January 2016. The MQ-25 will be a catapult-launched unmanned aircraft system that operates from aircraft carriers and provides a robust refueling capability while also providing intelligence, surveillance, and reconnaissance (ISR) capabilities needed to search, detect, track, classify, identify, and report on surface targets.

Acquisition statutes, Department of Defense (DOD) acquisition policy, and product-development best practices all illustrate the need for valid, clear, and achievable requirements before committing to make significant investments to develop a new product. Further, our body of work on best practices for weapons system acquisitions has established that successful product developers ensure a high level of knowledge is achieved at key junctures during the acquisition process. A House Armed Services Committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2017 contained a provision for us to review the status of the MQ-25 program.² This report assesses the extent to which the Navy has an MQ-25 aircraft acquisition strategy that is (1) rooted in validated requirements and (2) structured to follow a knowledge-based acquisition process.

To assess the extent to which the Navy's MQ-25 system acquisition strategy is rooted in validated requirements, we reviewed the content of underlying requirements documents and analyses and assessed the extent to which they addressed the need for future carrier based airborne refueling capabilities. We discussed the MQ-25 requirements and our

¹ While no official cost estimate has been completed, the Navy does not expect total development cost to exceed \$5 billion.

² In addition, a House Permanent Select Committee on Intelligence report accompanying a bill for the Intelligence Authorization Act for Fiscal Year 2017 contained a similar provision for our review of the same matter. This report addresses both committee report provisions.

assessment with knowledgeable officials from the MQ-25 program office, the Naval Air Systems Command, and the Cost Assessment and Program Evaluation office within the Office of the Secretary of Defense (OSD). We also assessed whether the requirements had been reviewed and validated within the Navy and by DOD's Joint Requirements Oversight Council (JROC).

To assess the extent to which the Navy's acquisition strategy is structured to follow a knowledge-based process, we reviewed the Navy's Acquisition Strategy for the MQ-25 Unmanned Carrier-Based Capability as well as other related program documents and analyses. We compared the content of those documents and analyses to the knowledge-based aspects of relevant weapon system acquisition statutes, DOD requirements and acquisition policies, and our previous work examining weapon system acquisitions and best practices for product development. To gain additional clarification and insights, we also discussed the acquisition strategy with knowledgeable Navy and OSD officials.

We conducted this performance audit from October 2016 to September 2017 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.

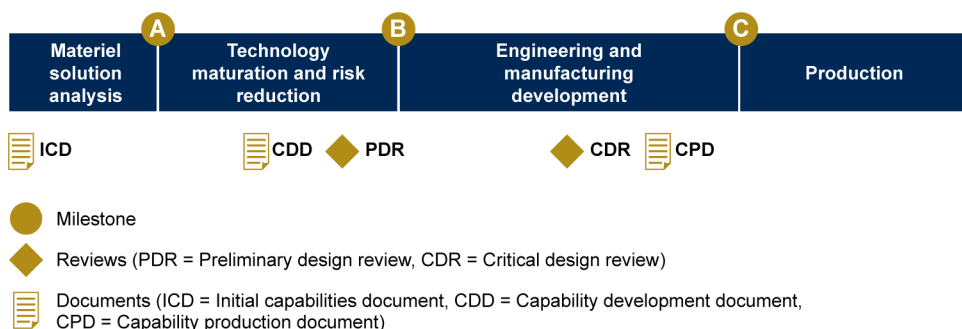
Background

Within DOD, the commitment to make significant investments in developing a new product typically takes place at a decision review known as Milestone B, which authorizes military service officials to enter the engineering and manufacturing development phase of the DOD acquisition process, select a development contractor, and sign a development contract. The process of identifying and understanding requirements typically begins when a sponsor, usually a military service, submits an Initial Capabilities Document that identifies the existence of a capability gap, the operational risks associated with the gap, and a recommended solution or preferred set of solutions for filling the gap. Potential solutions are then assessed in an Analysis of Alternatives prior to the start of the technology maturation and risk reduction phase of DOD's acquisition process. According to DOD guidance, an Analysis of Alternatives assesses the costs and benefits of potential materiel solutions that could fill the capability gaps documented in an Initial

Capabilities Document and supports a decision on the most cost effective solution.

Operational requirements for that preferred solution are then defined in a draft Capability Development Document that goes through several stages of military service- and DOD-level review and validation. Our work on product-development best practices has found that clearly understood and stable program requirements are critical to establishing a sound, executable business case for any product development program. Figure 1 shows the phases of DOD’s acquisition process.

Figure 1: DOD’s Acquisition Process



Source: GAO analysis of Department of Defense policy. | GAO-17-647

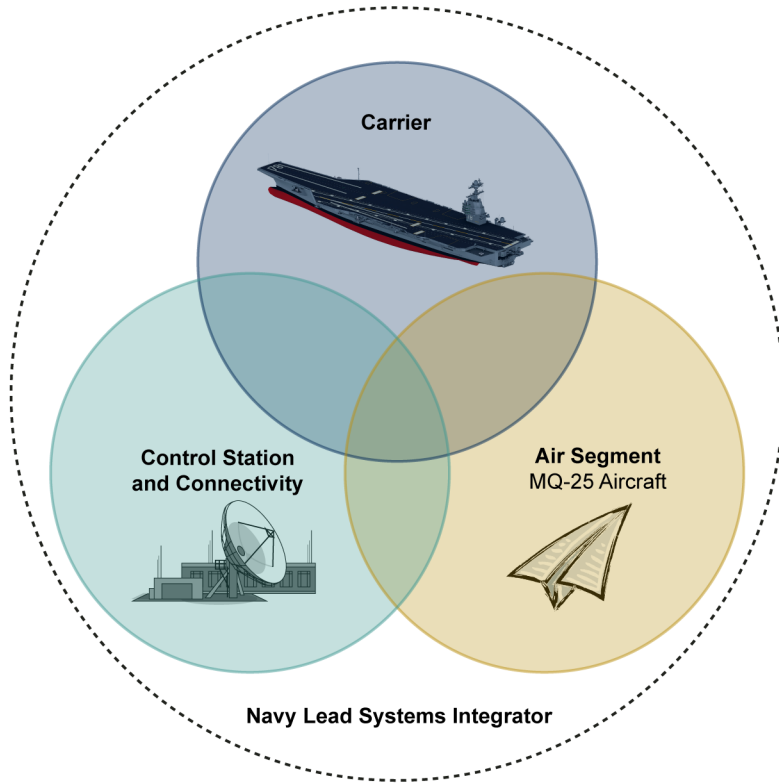
In a March 2016 report, we found that after completing a review of its airborne intelligence, surveillance, and reconnaissance (ISR) portfolio, OSD directed the Navy in January 2016 to focus on developing and fielding an unmanned Carrier Based Aerial Refueling System, which represented a significant shift in requirements.³ The program was subsequently designated the MQ-25. Previously the Navy had been largely focused on developing and fielding a system that could provide ISR and air-to ground strike capabilities, with the potential to add aerial refueling capability in the future. That system, referred to as the Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) system was to have the potential to operate in highly contested environments.

³ GAO, *Unmanned Carrier-Based Aircraft System: Debate over Systems Role Led to Focus on Aerial Refueling*, GAO-16-389R (Washington, D.C.: March 24, 2016).

Under the MQ-25 program, the Navy is now focused on developing and fielding an unmanned tanker capable of operating from the carrier, in a permissive environment, to refuel other naval aircraft and provide only limited ISR capability. The overall system is expected to extend the range of the carrier air wing's mission effectiveness and increase the number of F/A-18E/Fs available for strike fighter missions, among other things.

The MQ-25 system will consist of three segments: an aircraft segment; a control system and connectivity segment (CS&C); and an aircraft carrier segment (see figure 2). The aircraft segment is to develop a carrier-suitable unmanned vehicle and associated support systems. The CS&C segment is to interface with existing command and control systems, and the tasking, processing, exploitation, and dissemination system. The aircraft carrier segment is to make modifications to upgrade the existing carrier infrastructure to support unmanned aircraft systems. These three segments will be managed and integrated by the Navy's Unmanned Carrier Aviation program office, acting as a Lead Systems Integrator.

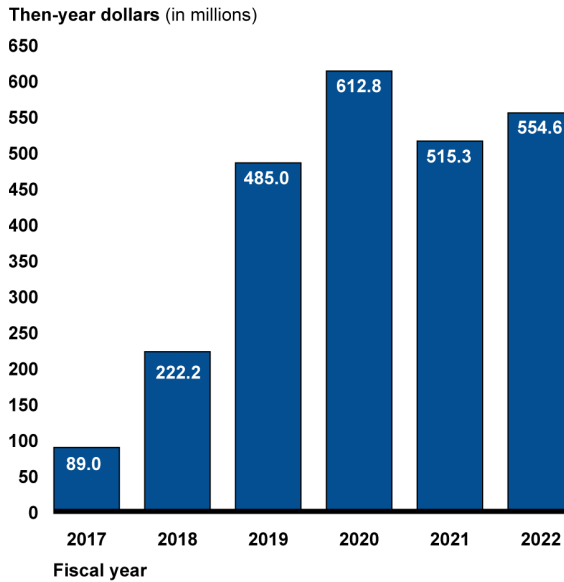
Figure 2: Three Key Segments of the MQ-25 System



Source: GAO analysis of Navy data (data and images). | GAO-17-647

Between fiscal years 2017 and 2022, the Navy has budgeted almost \$2.5 billion to continue development of the MQ-25 carrier and control segments and to begin development of the aircraft segment. Over that period, the annual funding requirements for the overall MQ-25 system will increase from \$89.0 million in 2017 to \$554.6 million in 2022 (see figure 3).

Figure 3: Navy's MQ-25 Investment Plan (FY 2017-2022)



Source: GAO analysis of Department of Defense data. | GAO-17-647

Note: Then Year dollars include the effects of inflation and escalation.

In the first quarter of fiscal year 2018, the Navy plans to request MQ-25 aircraft proposals from four competing contractors.⁴ Then, in the summer of 2018, the Navy expects to hold a Milestone B review to assess whether the Navy is ready to enter the engineering and manufacturing development phase of the acquisition process for the aircraft segment and downselect to one of the four contractors.

⁴ The four contractors are The Boeing Company, General Atomics Aeronautical Systems Inc., Lockheed Martin Corporation, and Northrop Grumman Systems Corporation.

MQ-25 Requirements Have Been Validated

In July 2017, the Joint Requirements Oversight Council (JROC) validated system requirements for the MQ-25. The Navy has two primary requirements, known as key performance parameters. Those requirements are: (1) carrier suitability and (2) air refueling. Carrier suitability is defined by the Navy as the ability of the aircraft to effectively operate on and from all current and planned aircraft carriers and to integrate into carrier air wing operations. Air refueling indicates the ability of the aircraft to be equipped as a sea-based tanker to refuel other carrier-based aircraft—a mission currently performed by Navy's F/A-18E/F Super Hornets.

The MQ-25 requirements have evolved intermittently over the past 16 years instead of following the more sequential processes described in DOD requirements and acquisition guidance. The MQ-25 requirements are not traced back to a single, standalone Initial Capabilities Document (ICD). Instead they address capability gaps identified in two different such documents that were developed more than 4 years apart.⁵ Over time, the Navy conducted various analyses, each focused on different aspects of those capability gaps.

Our assessment of the content of the Navy's underlying documentation and analyses, when taken together, is that they provide a basis for the current set of MQ-25 requirements. Figure 4 illustrates the iterative evolution of the MQ-25 requirements.

⁵ The UCLASS ICD is classified and dated June 9, 2011 and the Next-Generation Air Dominance Family of Systems ICD is also classified and dated August 18, 2015.

Figure 4: Evolution of MQ-25 Requirements



Source: GAO analysis of DOD documentation. | GAO-17-647

As noted in the figure, after receiving direction from OSD in January 2016 to pursue a carrier based airborne tanking system, the Navy began the process of defining more specific MQ-25 aircraft requirements and reducing technology and design risks. In September and October 2016, the Navy awarded cost-plus-fixed-fee contracts to each of the four competing contractors to conduct risk reduction activities, including concept refinement and requirements trade analysis. The total combined value of the contracts, including options, is approximately \$250 million. The Navy expects the contractors to provide concepts for an unmanned aircraft that could meet the tanking requirements of the F/A-18E/F in the mid-2020s, while also providing some ISR capabilities.

Our comparison of the Navy's final requirements document—the Carrier Based Unmanned Aircraft System Capability Development Document—with earlier draft versions found that the Navy reduced the total number of key performance parameters from seven to two—carrier suitability and air refueling—and made adjustments to both. The Navy refined the carrier suitability requirement to focus more clearly on the MQ-25's basic ability to operate on and from the aircraft carrier. For air refueling, the Navy adjusted the mission focus and the required refueling capacity at a specific distance from the ship.⁶ Our work in product-development best practices has found that as detailed requirements are identified, decision makers can make informed trades between the requirements and available resources, potentially achieving a match and establishing a sound basis for a program business case before entering the product development phase of the defense acquisition system.⁷

⁶ The number of key performance parameters was limited by the Secretary of Defense pursuant to the National Defense Authorization Act for Fiscal Year 2017, Pub. L. No. 114-328, § 854. According to the Act, the Secretary of Defense may carry out a pilot program under which the Secretary may identify at least one acquisition program in each military department for reduction of the total number of key performance parameters established for the program, for purposes of determining whether operational and programmatic outcomes of the program are improved.

⁷ A business case should provide demonstrated evidence that the warfighter's needs are real and necessary and can be met with the chosen concept and be developed and produced within existing resources—including technologies, design knowledge, funding, and the time to deliver the product when it is needed.

Navy's Proposed Acquisition Strategy Largely Reflects a Knowledge-Based Approach

The Navy's MQ-25 acquisition strategy, approved by Navy leadership in April 2017, reflects key aspects of an evolutionary, knowledge-based acquisition approach. While the Navy is still developing, refining, and finalizing most of the acquisition documentation that will make up its program business case, our review of its acquisition strategy and other available documentation showed that they reflect key aspects of a knowledge-based approach and generally align with what we have found to be product-development best practices:

- **Using open systems standards and an evolutionary approach:** The Navy is planning to use open systems standards and an evolutionary development approach to develop, fly, and deploy the MQ-25 over time. The Navy expects to provide primarily aerial refueling and ISR capabilities first, while using open systems standards to support incremental capability upgrades in the future like adding the capability to receive fuel, weapons and improving radars. In July 2013, we concluded that the adoption of open systems standards in defense acquisitions can provide significant cost and schedule savings. In addition, we have previously reported that adopting a more evolutionary, incremental approach can enable the capture of design and manufacturing knowledge and increase the likelihood of success in providing timely and affordable capabilities.⁸
- **Using knowledge-based criteria to assess progress and inform key decisions:** The Navy has established knowledge-based criteria for seven key points during MQ-25 aircraft development. Those points include the development contract award, the system design review, the low-rate production contract award, and the start of initial operational testing. At each point, the Navy plans to assess program progress against the established criteria and provide briefings to key leadership stakeholders before moving into the next phase of development. If implemented, this knowledge-based approach would align with best practices that we identified in our body of work related to product-development. Specifically, we have found that achieving positive program outcomes requires the use of a knowledge-based

⁸ For example, see GAO, *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, [GAO-01-288](#) (Washington, D.C.: Mar. 8, 2001); and *Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time*, [GAO-10-382](#) (Washington, D.C.: Mar. 19, 2010).

approach to product development that demonstrates high levels of knowledge attained at key junctures.⁹

- **Constraining development schedule:** According to the Navy's acquisition strategy, the MQ-25 aircraft is expected to take 6 to 8 years from the start of product development (i.e., Milestone B) to the fielding of an initial operational capability. Based on our work in product development best practices, constraining the development phase of a program to 5 or 6 years is preferred because, among other things, it aligns with DOD's budget planning process and fosters the negotiation of trade-offs in requirements and technologies.
- **Limiting technology risk:** The Navy expects to significantly reduce technology risk during development by mandating that technologies, or subsystems, for the MQ-25 aircraft must be demonstrated in a relevant environment to be included in the design. If a technology is identified that does not meet this criteria, the Navy plans to push that technology into the future and include it only when it reaches the specified level of maturity. Federal statute and product development best practices illustrate the critical importance of demonstrating high levels of technology maturity prior to entering the product development phase of the defense acquisition system.¹⁰ As we reported in March 2017, failure to fully mature technologies prior to developing the system design can lead to redesign and cost and schedule growth if later discoveries during development lead to revisions.¹¹

⁹ GAO, *Best Practices: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed*, [GAO-10-439](#) (Washington, D.C.: Apr. 22, 2010); *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, [GAO-09-322](#) (Washington, D.C.: May 13, 2009); *Defense Acquisitions: A Knowledge-Based Funding Approach Could Improve Major Weapon System Program Outcomes*, [GAO-08-619](#) (Washington, D.C.: July 2, 2008); *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, [GAO-02-701](#) (Washington, D.C.: July 15, 2002); *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, [GAO-01-288](#) (Washington, D.C.: Mar. 8, 2001); and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, [GAO/NSIAD-99-162](#) (Washington, D.C.: July 30, 1999).

¹⁰ A major defense acquisition program generally may not receive approval for development start until the milestone decision authority certifies that the technology in the program has been demonstrated in a relevant environment. 10 U.S.C. § 2366b(a)(2). Under certain circumstances, this requirement may be waived.

¹¹ [GAO-17-333SP](#)

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- **Limiting design risk:** While the Navy does not plan to hold a MQ-25 system level preliminary design review prior to the start of development, as best practices recommend, it is tailoring its previous UCLASS aircraft requirements which may allow the contractors to leverage the preliminary design knowledge gained under that program. In addition, the Navy is leveraging knowledge gained under the four recent risk reduction contracts, as well as various levels of prototyping done by each of the contractors and the Navy. Our work in product-development best practices emphasizes the importance of gaining early design knowledge to reduce design risk before beginning a product development.¹² In June 2017, we reported that prototyping helped programs better understand design requirements, the feasibility of proposed solutions, and cost—key elements of a program business case.¹³
 - **Developing an independent cost estimate:** Cost analysts within the Cost Analysis and Program Evaluation office of the Office of the Secretary of Defense are in the process of developing an independent cost estimate for the MQ-25 aircraft. Federal statute, DOD acquisition guidance, and product-development best practices illustrate the importance of having an independent cost estimate to inform the business case for a new product development program.¹⁴ Cost Analysis and Program Evaluation officials explained that they had not yet completed their estimate, but they plan to have it done in time to support the Navy's MQ-25 Milestone B review in the summer 2018.

Given the early focus on defining requirements and reducing risk prior to the start of product development, the Navy plans to award a fixed-price incentive, firm target contract for MQ-25 aircraft development. This type of contract is designed to provide a profit incentive for the contractor to control costs. It specifies target cost, target profit, and ceiling price amounts, with the latter being the maximum amount that may be paid to the contractor.¹⁵ The Navy plans to issue a request for proposals to the four competing contractors in October 2017 and award the contract to

¹² [GAO-06-368](#), [GAO-02-701](#), [GAO-01-288](#).

¹³ GAO, *Weapon Systems: Prototyping Has Benefited Acquisition Programs, but More Can be Done to Support Innovation Initiatives*, [GAO-17-309](#) (Washington, D.C.: June 27, 2017).

¹⁴ A major defense acquisition program may not receive approval for development start until the milestone decision authority considers an independent cost estimate for the program. 10 U.S.C. § 2334(b)(1)(B).

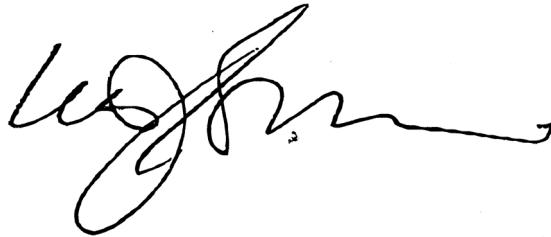
¹⁵ Federal Acquisition Regulation § 16.403-1.

one of those four contractors the following year. With the Milestone B review scheduled in the summer of 2018, the ultimate success of the MQ-25 program largely depends on the Navy's ability to present an executable business case and then effectively implement its planned approach.

Agency Comments

We are not making recommendations in this report. We provided DOD with a copy of this report and they returned technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense and the Secretary of the Navy. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. If you or your staff have any questions about this report, please contact me at (202) 512-4841 or sullivanm@gao.gov. GAO staff who made key contributions to this report are listed in the appendix.



Michael J. Sullivan

Director
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Appendix I: GAO Contact and Staff Acknowledgments

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In addition to the contact named above, key contributors to this report were Travis Masters, Assistant Director; Marvin E. Bonner; Laura Greifner; Kristine Hassinger; and Roxanna Sun.

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