OMAO Must Define and Implement a Disciplined Requirements Management Process to Ensure Future Acquisitions Meet User Needs

FINAL REPORT NO. OIG-21-027-I

MAY 25, 2021

U.S. Department of Commerce
Office of Inspector General
Office of Audit and Evaluation

UNITED STATES DEPARTMENT OF COMMERCE
Office of Inspector General
Washington, D.C. 20230

May 25, 2021

MEMORANDUM FOR: Benjamin Friedman
Deputy Under Secretary for Operations
Performing the duties of the Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator
National Oceanic and Atmospheric Administration

FROM: Frederick J. Meny, Jr.
Assistant Inspector General for Audit and Evaluation

SUBJECT: *OMAO Must Define and Implement a Disciplined Requirements Management Process to Ensure Future Acquisitions Meet User Needs*
Final Report No. OIG-21-027-I

Attached for your review is the final report on the evaluation of the National Oceanic and Atmospheric Administration (NOAA) Office of Marine and Aviation Operations' (OMAO's) Ship Fleet Recapitalization Program. The overall objective for this evaluation was to determine the extent to which NOAA OMAO's acquisition fleet lifecycle processes were followed throughout the development, operation, maintenance, and sustainment of the program to meet mission requirements, with a focus on OMAO's requirements management processes.

We contracted with The MITRE Corporation (MITRE)—an independent firm—to perform this evaluation of NOAA. Our office oversaw the progress of this evaluation to ensure that MITRE performed the evaluation in accordance with the Council of the Inspectors General on Integrity and Efficiency's *Quality Standards for Inspection and Evaluation* (January 2012) and contract terms. However, MITRE is solely responsible for the attached report and conclusions expressed in it. As discussed in the attached report, MITRE found that

1. NOAA and OMAO lack current long-range strategies and well-defined standards and processes for managing ship fleet requirements,
2. requirements allocation is not well defined or organized and there is no formal process for requirements traceability, and
3. OMAO's current requirements validation process is not adequate for new, changing, and emerging requirements.

MITRE recommended that NOAA's Deputy Under Secretary for Operations ensure OMAO does the following:

1. Benchmark, build, and elevate an overarching OMAO strategic plan, acquisition plan, systems engineering management plan, and program management practices.

2. Develop OMAO-specific guidance for managing requirements, including requirements analysis, traceability, and allocation.
3. Document and implement a disciplined approach to validating requirements through increased line office communication.

On April 9, 2021, we received NOAA's response to MITRE's draft report. NOAA concurred with all of the recommendations and described actions it has taken, or will take, to address them. NOAA's formal response is included within the final report as appendix I.

Pursuant to Department Administrative Order 213-5, please submit to us an action plan that addresses the recommendations in this report within 60 calendar days. This final report will be posted on OIG's website pursuant to sections 4 and 8M of the Inspector General Act of 1978, as amended (5 U.S.C. App., §§ 4 & 8M).

We appreciate the cooperation and courtesies extended to MITRE by your staff during this evaluation. If you have any questions or concerns about this report, please contact me at (202) 482-1931 or Amni Samson, Director for Audit and Evaluation, at (571) 272-5561.

Attachment

cc: Tanisha Bynum-Frazier, Director, Audit and Information Management Office, NOAA
Brian Doss, Alternate Audit Liaison, NOAA
Lisa Lim, Alternate Audit Liaison, NOAA
MaryAnn Mausser, Audit Liaison, Office of the Secretary

MITRE

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MITRE TECHNICAL REPORT

Evaluation of the National Oceanic and Atmospheric Administration's Office of Marine and Aviation Operations (OMAO) Ship Fleet Recapitalization Program

for:

Department of Commerce

Office of the Inspector General

For further information, please contact The MITRE Corporation, Contracts Management Office, 7515 Colshire Drive, McLean, VA 22102-7539, (703) 983-6000.

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May 2021

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Executive Summary

The National Oceanographic and Atmospheric Administration's (NOAA) Office of Marine and Aviation Operations (OMAO) operates an aging fleet of 16 hydrographic, oceanographic, atmospheric, and fisheries research vessels. By fiscal year 2028, OMAO expects to decommission at least half of its ships as they reach the end of their useful service life. The substandard state of the NOAA ship fleet is well established and understood by NOAA, the Department of Commerce, the Office of Management and Budget, and Congress. During the eight-year period between 2008 and 2016, OMAO:

- Prepared and updated recapitalization plans at the behest of Congress;
- Developed a fleet composition report;
- Engaged a senior-level independent review team to address the urgency of the anticipated capability gap and the concerns of Congress and the Office of Management and Budget; and
- Established a partnership with the U.S. Navy for assistance in acquiring a new class of ships.

OMAO was also able to satisfy congressional mandates to provide a clear and realistic recapitalization strategy, and Congress released funding in late 2016 for NOAA and OMAO to resume efforts to recapitalize its fleet of research vessels.

Why MITRE Did This Review

Federal programs often fail to assess, capture, and convey their requirements properly.[1] This can lead to program challenges and failures stemming from unmitigated cost, schedule, and performance risks.[2] The lack of a formalized requirements management process may result in requirements that are not testable, prioritized, supportable, or defendable, or are vague.[3]

OMAO's partnership with the Navy was unable to mitigate all risks associated with the ship recapitalization program's requirements management process.[4] Given the importance of this program, the Office of the Inspector General tasked MITRE with conducting a detailed evaluation of OMAO's requirements management processes.

What MITRE Found

OMAO's current, multi-layer governance process, emphasizing collaboration between NOAA Line Offices, is effective when a program's requirements are well understood, relatively mature, and static. However, the ship recapitalization program is a more complex capability

[1] U.S. Federal Acquisition Institute, *Project Managers Guidebook*, November 24, 2015.

[2] U.S. Government Accountability Office, *GAO-17-77*, *Detailed Systems Engineering Prior to Product Development Positions Programs for Success*, November 2016, Washington, DC: Government Accountability Office (GAO).

[3] U.S. Government Accountability Office, *GAO-18-550*, *DHS Acquisitions: Additional Practices Could Help Components Better Develop Operational Requirements*, August 8, 2018, Washington, DC: Government Accountability Office (GAO).

[4] U.S. Department of Commerce Office of Inspector General, Office of Audit and Evaluation, November 2019, *OIG-20-006-A*, *NOAA's Office of Marine and Aviation Operations Needs to Improve the Planning and Governing of Its Ship Fleet Recapitalization Effort*, Washington, DC: Department of Commerce.

development that must satisfy new and emerging requirements. In such cases, collaboration alone will not suffice to mitigate requirement risks.

MITRE found that OMAO lacks well-documented strategies, plans, and institutionalized processes for requirements management, which may impede its ability to respond quickly and efficiently to changing circumstances in a complex acquisition with numerous competing demands and recurring trade-space decisions.

MITRE identified three key findings:

1. NOAA and OMAO Lack Current Long-Range Strategies and Well-Defined Standards and Processes for Managing Ship Fleet Requirements (See Section 2.1)
2. Requirements Allocation Is Not Well Defined or Organized and There Is No Formal Process for Requirements Traceability (See Section 2.2)
3. OMAO's Current Requirements Validation Process Is Not Adequate for New, Changing, and Emerging Requirements (See Section 2.3)

MITRE recommends OMAO take the following actions in coordination with the Department of Commerce and NOAA's Deputy Under Secretary for Operations (DUS-O).

ID	Recommendation	Section
R1	Benchmark, build, and elevate an overarching OMAO strategic plan, acquisition plan, systems engineering management plan, and program management practices.	2.1.5
R2	Develop OMAO-specific guidance for managing requirements, including requirements analysis, traceability, and allocation.	2.2.5
R3	Document and implement a disciplined approach to validating requirements through increased Line Office communication.	2.3.3

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1 Introduction

The Department of Commerce ("the Department") Office of Inspector General (OIG) seeks to improve the efficiency and effectiveness of the Department's programs and operations, and prevent and detect fraud, waste, and abuse. To support achievement of this goal, OIG's Office of Audit and Evaluation (OAE) conducts periodic audits and evaluations of the Department's programs and operations. In September 2019, OAE engaged The MITRE Corporation[5] to conduct an evaluation of the National Oceanic and Atmospheric Administration's (NOAA's) ship fleet acquisition efforts to determine the adequacy of NOAA's ship fleet requirements management processes.

Federal programs often fail to assess, capture, and convey their requirements properly.[6] This can lead to program challenges and failures stemming from unmitigated cost, schedule, and performance risks.[7] The lack of a formalized requirements management process may result in requirements that are not testable, prioritized, supportable, defendable, or are vague.[8]

NOAA's Office of Marine and Aviation Operations' (OMAO's) partnership with the Navy was unable to mitigate all of the risks associated with the ship recapitalization program's requirements management process.[9] Given the importance of this program, OIG tasked MITRE with conducting a detailed evaluation of OMAO's requirements management processes.

1.1 Background

NOAA's fleet of ships traces its origins to the federal fleet NOAA inherited in 1970 when the organization was established. NOAA also acquired vessels by leveraging existing Navy contracts, as well as through a host of interagency transfers and conversions of former U.S. Navy ships. NOAA constructed only two individual, purpose-built ships on its own in its first 30 years.[10]

NOAA's first true venture into building a class of ships began in 2001 when it was awarded a contract to design and construct a Fisheries Survey Vessel (FSV), with options for three additional FSVs. In all, five FSVs were built, delivered, and commissioned between 2005 and 2014. NOAA also built a Small Waterplane Area Twin Hull (SWATH) ship[11] in 2009 to test emerging technologies. While the processes NOAA used to build the SWATH predate the Department's major efforts to revamp its acquisition policies and procedures between 2010 and 2015, challenges with this acquisition program were a key driver behind the need for the Department to develop a better requirements management process.

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[5] The MITRE Corporation operates six federally funded research and development centers for the U.S. Government.

[6] U.S. Federal Acquisition Institute, *Project Managers Guidebook*, November 24, 2015.

[7] U.S. Government Accountability Office, *GAO-17-77, Detailed Systems Engineering Prior to Product Development Positions Programs for Success*, November 2016, Washington, DC: Government Accountability Office (GAO).

[8] U.S. Government Accountability Office, *GAO-18-550, DHS Acquisitions: Additional Practices Could Help Components Better Develop Operational Requirements*, August 8, 2018, Washington, DC: Government Accountability Office (GAO).

[9] U.S. Department of Commerce Office of Inspector General, Office of Audit and Evaluation, November 2019, *OIG-20-006-A, NOAA's Office of Marine and* Aviation *Operations Needs to Improve the Planning and Governing of Its Ship Fleet Recapitalization Effort*, Washington, DC: Department of Commerce.

[10] NOAA Ship (NOAAS) Chapman (R446) in 1980 and NOAAS Ronald H. Brown (R104) in 1997.

[11] NOAAS Ferdinand R. Hassler (S250).

OMAO currently operates a fleet of 16 ships to conduct hydrographic, oceanographic, atmospheric, and fisheries research. These ships were launched and commissioned between 1967 and 2014, and have an average ship age of 25 years. More than half are currently operating beyond their originally designed service lives. To address the imperative of upgrading this aging fleet, NOAA developed three different recapitalization plans between 2008 and 2016:

- *NOAA Ship Recapitalization Plan FY 2010 to FY 2024* (dated 2008): recommended construction of nine ships
- *NOAA Fleet Composition Report: 2012–2027* (dated 2012): recommended construction of 11 ships
- *The NOAA Fleet Plan: Building NOAA's 21st Century Fleet* (dated 2016): recommended construction of four new classes of ships[12] including two vessels (NOAA Vessel Class A Ships) based on existing U.S. Navy design specifications to minimize long lead times

Since the completion of the 2016 NOAA Fleet Plan, NOAA has identified additional strategies to improve fleet readiness and the integration of the fleet with the recapitalization plan including human capital management initiatives and enhanced maintenance practices. NOAA is currently executing these strategies, secured an annual appropriation of $75 million for ship acquisition starting in Fiscal Year (FY) 2016, and plans to award a detailed design and construction contract for two Class A vessels. Requirements analysis for Class B and C is underway, with Class D requirements analysis scheduled to start in FY 2022. A brief description of each ship class can be found in Appendix A.

[12] Eight total - two Class A, three Class B, two Class C, and one Class D.

2 Objectives, Findings, and Recommendations

The overall objective for this evaluation was to determine the extent to which NOAA OMAO's acquisition fleet lifecycle processes are followed throughout the development, operation, maintenance, and sustainment of the program to meet mission requirements. To accomplish this, OIG tasked MITRE with the following six evaluation objectives:

1. Describe OMAO processes to manage ship fleet requirements from requirement identification through validation and delivery of capabilities (Report Section 2.1).
2. Determine whether OMAO processes are responsive to changing circumstances such as schedule delays, funding shortages, and emerging technologies (Section 2.1).
3. Determine the extent to which OMAO requirements are documented in accordance with Department of Commerce policy and guidance for major system acquisitions (Section 2.1).
4. Determine whether OMAO processes adequately allocate high-level requirements down to mission and system-level requirements (Sections 2.2).
5. Determine whether OMAO processes provide traceability among different hierarchies of requirements to identify gaps or orphan requirements (Section 2.2).
6. Determine whether OMAO processes adequately validate ship requirements (Section 2.3).

The following sub-sections detail MITRE's key observations, findings, and recommendations.

2.1 NOAA and OMAO Lack Current Long-Range Strategies and Well-Defined Standards and Processes for Managing Ship Fleet Requirements

MITRE used the Department's own requirements management standards[13] and industry standards[14] to evaluate OMAO's requirements management process. MITRE reviewed Department, NOAA, and OMAO administrative orders, processes, and procedures related to acquisition and program or project management.

The Department codifies its processes through Department Administrative Orders (DAOs). The following represents the latest and most relevant Department guidance, which was used to evaluate OMAO:

- DAO 208-16, Acquisition Project Management, dated May 26, 2015; provides the most recent Department guidance on acquisition project management[15]

[13] Department of Commerce, *DAO 208-16 Acquisition Project Management*, effective May 26, 2015, Washington, DC: Department of Commerce.; Department of Commerce, *DOC Scalable Acquisition Project Management Guidebook, version 1.2*, August 31, 2015, Washington, DC: Department of Commerce.; Outlined in DAO 208-16 and the Scalable Acquisition Project Management Guidebook.

[14] INCOSE - International Council on Systems Engineering, *INCOSE Systems Engineering Handbook,* San Diego, CA.

[15] Establishes the policy, procedures, and responsibilities for implementing the Acquisition Program and Project Management Framework ("the Framework") on all acquisition programs and projects with emphasis on high-profile programs and projects.

- The Scalable Acquisition Project Management Guidebook (SAPMG) Version 1.2, dated August 31, 2015; implements the Scalable Acquisition Project management Framework contained in DAO 208-16[16]
- DAO 216-20, Enterprise Risk Management, dated March 13, 2014; provides the most recent Department guidance on enterprise risk management[17]

DAO 208-16 and its companion SAPMG describe the minimum standards for processes used in managing an acquisition project and developing the documentation required for Department of Commerce milestone reviews.[18] For each acquisition milestone in the framework, the SAPMG breaks down the Department's mandated activities into tasks to be accomplished and offers specific guidance on documentation (deliverables) with milestone timing. For example, for Milestone 1, the SAPMG specifies the requirement for a Mission Needs Statement (MNS) and describes the information that it should contain along with assigning a responsible preparer. Table B-1 in Appendix B summarizes the requirements documentation the SAPMG mandates for each milestone, while Appendix C provides a comprehensive discussion on the evolution of Department policy and guidance for major systems acquisition.

NOAA Administrative Orders (NAOs) cover substantive program matters and administrative management policies, procedures, and responsibilities applicable to two or more organizations.[19] NAOs often provide NOAA-specific guidance supplementing the administrative policies issued in the DAO series. Each NOAA Line Office may further tailor policies and procedures to align with its unique mission responsibilities.[20] MITRE reviewed the following NAOs that represent the latest and most relevant NOAA guidance, which was used evaluate OMAO:

- NAO 216-108, Requirements Management, dated October 31, 2005 – provides NOAA policy for managing mission requirements
- NAO 216-111, Strategy Execution and Evaluation (SEE), dated May 25, 2012[21] [22] – provides policy for strategy-based performance management

[16] Department of Commerce, DOC Scalable Acquisition Project Management Guidebook. Companion guidebook to DAO 208-16. The guidebook describes the framework and provides Department and Bureau-level project managers specific "how to" guidance on how to implement principles and processes enumerated in the Framework.

[17] Department of Commerce Chief Financial Officer and Assistant Secretary for Administration, *DAO 216-20, Enterprise Risk Management*, Washington, DC: Department of Commerce, 1. Provides a framework for proactively identifying, managing, and mitigating risk in achieving the Department's strategic objectives and mission, and seeks to integrate risk management into operations to improve organizational effectiveness.

[18] Department of Commerce, DOC Scalable Acquisition Project Management Guidebook, 9.

[19] National Oceanic and Atmospheric Administration, *NOAA Administrative Issuances* [online]. www.noaa.gov/organization/administration/administrative-issuances (accessed September 16, 2020).

[20] National Oceanic and Atmospheric Administration, *NOAA Administrative Issuances* [online].

[21] National Oceanic and Atmospheric Administration, Undersecretary of Commerce for Oceans and Atmosphere, *NAO 216-111, May 25, 2012. Strategy Execution and Evaluation: NOAA's Performance Management System*, 1.; NOAA's Performance Management System codifies a process for making well-reasoned, collaborative, transparent decisions that enable NOAA to achieve corporate strategic objectives and annual priorities effectively within estimated funding levels. The purpose of SEE is to manage NOAA's performance toward meeting the goals of its Strategic Plan.

[22] National Oceanic and Atmospheric Administration, *NOAA Administrative Orders: Chapter 216 – Program Management* [online]. (accessed September 16, 2020).

2.1.1 NOAA and OMAO Strategic Plans Are Not Up to Date and Lack Relevance to Current Fleet Priorities and Capability Needs

MITRE reviewed the most recent NOAA Strategic Plan (last updated in December 2010)[23] and the 2012–2016 OMAO Strategic Plan (released in March 2012)[24] to identify the goals and objectives that pertain to ship fleet requirements; MITRE found both organizations lack up-to-date strategic plans. The lack of an up-to-date NOAA strategic plan made it difficult to evaluate where the NOAA fleet stands in terms of priorities, funding, sustainment concepts, risks, staffing resources, and training. MITRE was also unable to discern a strategy for incorporating priority at-sea data collection requirements, extending the service lives of vessels, reducing ship manning, or incorporating new technology. OMAO does not have a strategy governing where resources would be allocated or what trades would be made if budgets were cut.

Appendix D highlights and focuses on the importance of baselining how an organization manages its requirements from identification through validation and delivery of capabilities. Given the importance of these factors, MITRE concluded that OMAO's lack of strategic guidance could significantly impede its ability to make trade space decisions to respond quickly and efficiently to emerging and evolving conditions.

The 2012–2016 OMAO Strategic Plan, eight years old, centers heavily on OMAO's mission-ready assets, including the fleet. By contrast, each of the other NOAA Line Offices[25] has developed a strategic plan in the last four years (two in 2016, two in 2019, and one in 2020, respectively).

2.1.2 NOAA and OMAO Lack Internal Policies and Procedures to Augment Department Policy and Guide Its Ship Acquisition Processes

The 2016 NOAA Fleet Plan to build four new classes of vessels[26] coincided with the new, mandatory Department of Commerce acquisition approach. Given the recency of these events, MITRE did not expect to find thoroughly developed, detailed, and codified internal processes. The Interagency Agreements (IAAs) with the U.S. Navy were acknowledged and approved by the Acting Deputy Secretary of Commerce in the December 4, 2013, Milestone Decision Memorandum (MDM) that established OMAO would adhere to the U.S. Navy management processes, including how requirements should be documented. As defined in the IAAs, OMAO alone is held responsible for developing several requirements documents (see Guiding Requirements Documentation in Appendix C, C.1). The Class A Project Manager reported that OMAO is following both NOAA/Department and Navy processes in parallel and is required by the SAPMG to periodically brief multiple review boards. While the IAA states that OMAO will use Navy processes, OMAO re-delivers Navy-developed documents to satisfy SAPMG guidance. These documents, however, do not meet all of the criteria of the SAPMG.

Shipbuilding programs rarely start from a "clean sheet of paper," particularly when they involve recapitalizing a fleet or building a class of special mission vessels. Instead, programs begin with

[23] NOAA's Next-Generation Strategic Plan, December 2010

[24] National Oceanic and Atmospheric Administration (NOAA), Office of Marine and Aviation Operations (OMAO), 2012–2016 OMAO Strategic Plan, March 23, 2012.

[25] The National Marine Fisheries Service (NMFS), National Ocean Service, Office of Oceanic and Atmospheric Research (OAR), National Weather Service (NWS), and National Environmental Satellite, Data, and Information Service (NESDIS)

[26] See Appendix A of this report for a definition of the four classes of vessels.

the predecessor class documentation, such as the MNS and Top-Level Requirements (TLR) documents, and tailor them to align with current mission scope normally captured in a concept of operations, technology needs assessment, or regulatory changes. This approach often saves significant time and money by building on a proven baseline and iterating toward a new and improved set of required documentation. This tailoring approach must be well-defined and precise to prevent undesirable issues and concerns with requirements traceability, unmatched or outdated requirement dependencies, and requirements validation.

When asked during a MITRE interview to describe the end-to-end requirements process, OMAO's Platform Acquisition Division (PAD) explained, "PAD has a unique system for capturing ship system and sub-system characteristics, adjudicating and adjusting to requirements, and tracking requirements across the project. It is efficient and has proven to be effective during the Fisheries Survey Vessel (FSV) and NOAA Auxiliary General Oceanographic Research (AGOR) Variant (NAV) acquisition projects." However, PAD did not provide any documentation or guidance regarding implementation of NAO-216-108, nor could MITRE find a validated ship mission requirements baseline under configuration control that is reviewed annually per NAO-216-108. Managing a requirements baseline under strict configuration control is a fundamental pillar of project management and helps to establish and maintain the consistency of a system or product throughout its lifetime.[27]

Given PAD's staff of less than 10 personnel, and the pressure to deliver multiple classes of ships, execution of the work related to planning, designing, and soliciting for ship acquisitions took priority over documenting how the acquisition will be (or was) accomplished.

Based on its reviews, MITRE observed that:

- NOAA and OMAO lack internal written processes that augment and expand in detail on the minimum processes described in DAO 208-16 and the SAPMG, particularly as they relate to acquiring ships.
- DAO 208-16 and the SAPMG are both silent on the use of IAAs as well as guidance for reconciling disparate interagency documentation requirements.
- OMAO lacks documentation or guidance regarding implementation of NAO 216-108.
- OMAO lacks a validated mission requirements baseline as required by NAO 216-108.

2.1.3 OMAO Has Not Baselined Its At-Sea Data Collection Requirements Since 2012, and Lacks System Engineering Policies and Procedures

Baselining why and how an organization conducts its day-to-day business is vital for many reasons including operational efficiency, uniformity, governance, process improvement, staff training and certification, compliance auditing, risk management, and internal control. To be complete, OMAO's requirements processes would include decomposition and translation of strategy-driven mandates, statutes, and regulations at the highest level into detailed ship system and shipbuilding specifications.[28]

[27] AcqNotes, http://acqnotes.com/acqnote/careerfields/configuration-management

[28] Naval Sea Systems Command, Naval Sea Systems Command Technical Publication S9800-AC-MAN-010, Ship Design Manager (SDM) and Systems Integration Manager (SIM) Manual, February 13, 2012.

The 2008 NOAA Ship Recapitalization Plan provides a view of the top-level process OMAO used for decomposing its legislated obligations into required Days at Sea (DAS). DAS serves as NOAA's defined measure of the fleet composition (types and numbers of vessels) needed to discharge its obligations.

The NOAA Office of Technology, Planning, and Integration for Observation (TPIO) assisted OMAO in reevaluating NOAA's at-sea data collection requirements in 2012. TPIO validated and documented a revised list of mission critical (Priority-1) and mission optimal (Priority-2) requirements for vessels larger than 40 meters, with 321 Priority-1 data collection requirements linked to NOAA at-sea missions. The TPIO report emphasized that NOAA must review all requirements "on a regular basis" to ensure early identification of emergent needs. Despite this emphasis, MITRE concluded that:

- NOAA and its Line Offices lack a written process for translating at-sea data requirements into ship TLRs.
- NOAA has not performed a comprehensive review or revalidation of at-sea data collection requirements since its efforts with TPIO in 2012.[29]
- Requirements management in the context of a formal systems engineering practice is widely recognized as a key contributor to successful systems acquisition.[30] [31] [32] [33]

MITRE expected that NOAA and the Line Offices would use a structured approach for decomposing and defining operational requirements in addition to their implementation and verification once satisfied with fielded systems.

However, MITRE found that NOAA and OMAO lack policies and procedures regarding the application of systems engineering. While the policies and processes described in DAO 208-16 and the SAPMG are clearly aligned to the tenets of systems engineering, the term is conspicuously absent. By contrast, both NESDIS[34] and NWS[35] line offices within NOAA have systems engineering policy and process documents that are the standard in mature, large-scale acquisition programs. Figure 2-1 shows the traditional systems engineering "V" diagram. The

[29] A key finding in the 2012 NOAA Fleet Composition: 2012-2027 report was for NOAA to review all requirements "on a regular basis" to ensure early identification of emergent needs, although how often is not specified. Given the pace of regulatory changes and advancements in technology, eight years since the last revalidation is likely too long.

[30] From the INCOSE SE Handbook, v4, p. 52: "Successful projects depend on meeting the needs and requirements of the stakeholders throughout the life cycle."

[31] From the Association for Project Management, webpage, end of 6th para: "Requirements management helps suppliers and customers understand and agree what is needed and to avoid wasting time, resources, and effort. Requirements management helps ensure project success by avoiding the top reasons for project failure: poor requirements capture, scope creep, disagreements about acceptance. Not having an agreed requirement sets you up for project failure."

[32] From the Project Management Institute, webpage, first sentence in abstract: "Poor requirements management processes (or lack of thereof) have been identified as a leading cause of project failure."

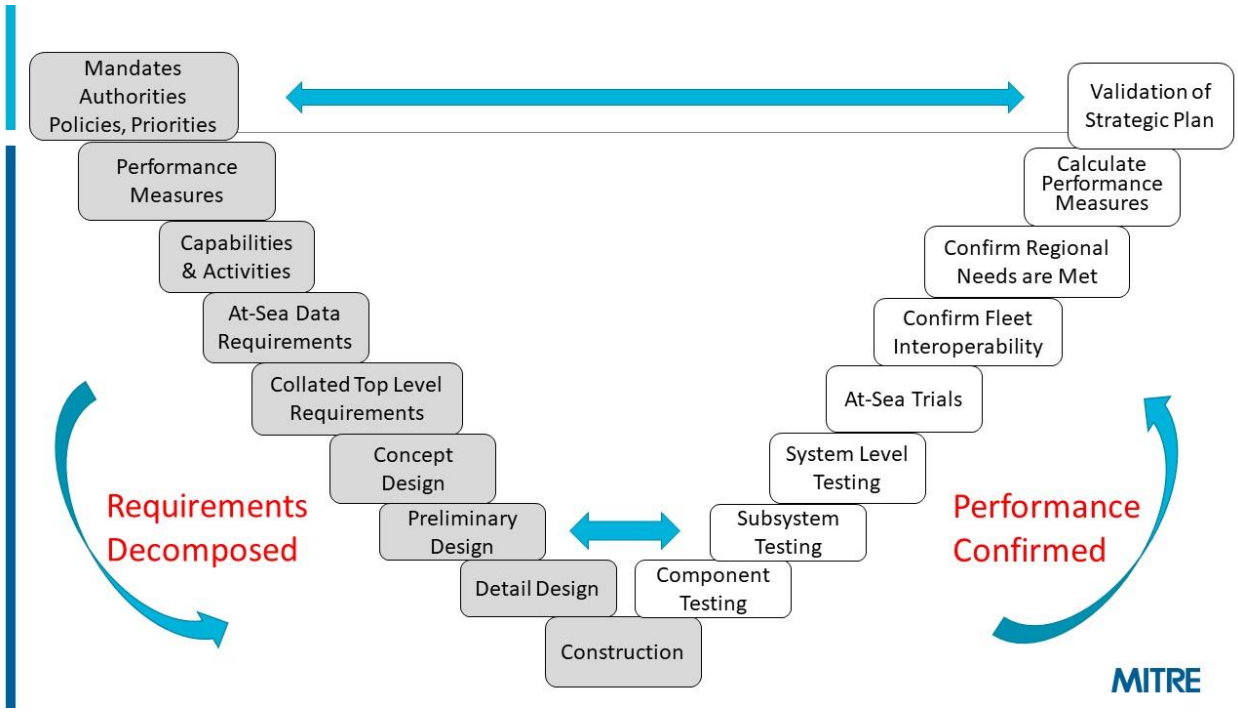
[33] Also, from the INCOSE SE Handbook, v4, Section 2.8, p. 13-16 discusses SE Effectiveness and ROI with a couple of charts from empirical studies.

[34] Mulholland, Mark, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, *NESDIS-PD-1110: NESDIS Systems Engineering and Program Management Policy*, July 2017, Silver Spring, MD: National Environmental Satellite, Data, and Information Service.

[35] National Oceanic and Atmospheric Administration, National Weather Service, *National Weather Service Instruction 80-301: Systems Engineering Process and Lifecycle*, November 11, 2019, Silver Spring, MD: National Weather Service.; National Oceanic and Atmospheric Administration, National Weather Service, *National Weather Service Instruction 80-303: Systems Engineering for New System Development*, January 17, 2020, Silver Spring, MD: National Weather Service.

"V" is an industry standard approach for defining and decomposing requirements together with performing implementation and verification once the requirements are realized as a system.

Figure 2-1. Requirements Decomposition and Allocation.



Source: INCOSE Systems Engineering Handbook[36]

MITRE's finding reinforces the NOAA Independent Review Team's finding in 2016 that a structured process to identify requirements for "days at sea" is in place, but that NOAA lacks the methodology to define the needed fleet capabilities and composition.

In the absence of such codified policies and procedures, organizations such as OMAO are less likely to establish the institutional base of knowledge necessary for generating and managing requirements. This could have a negative impact on OMAO's ability to properly mitigate program risks, close capability gaps, and adequately test and verify processes, and ultimately lead to failure in meeting mission and end user needs.

2.1.4 While a Lack of Institutionalized Processes Hinders OMAO's Ability to Respond to Change, OMAO Does Benefit from the Navy's Disciplined Risk Management Process

MITRE reviewed Department-level governing documents to identify criteria for identifying, managing, and controlling risk (see Appendix E, E.1). MITRE also reviewed NOAA AGOR Variant (NAV) and NOAA deliverables to evaluate NOAA's treatment of risk and risk management (see Appendix E, E.2).

[36] INCOSE - International Council on Systems Engineering, *INCOSE Systems Engineering Handbook*; MITRE adaptation of the International Council on Systems Engineering (INCOSE) V-Model.

MITRE found that in its IAA with the Navy, NOAA agreed to use the Navy-approved Risk Management Plan (RMP) to support Department of Commerce milestone reviews. The Navy Program Management Office, PMS 325, is responsible for the NAV RMP and for implementing a structured risk management approach consisting of four elements: planning, assessment, handling, and monitoring.

OMAO leveraged the NAV RMP to satisfy the Department's requirement to conduct an initial risk assessment for Milestone 1 (Project Initiation/Approval). Risk areas identified in the NAV Milestone 1 review included continuity of funding, mission requirements, base-funded staffing, regulatory changes, delayed IAA, and budget reductions. The risks identified during this initial risk assessment served as the NAV program's risk item baseline. MITRE concluded that the Class A NAV acquisition program is compliant with the Department and Navy risk management directives.

MITRE could not assess the adequacy or robustness of risk management for Class B and Class C since these programs have not yet achieved Milestone 0 (Concept Initiation). Further, neither of these programs are currently partnered with the Navy.

2.1.5 Recommendations

MITRE recommends that the NOAA Deputy Under Secretary for Operations ensure OMAO does the following:

R1: Benchmark, build, and elevate an overarching OMAO strategic plan, acquisition plan, systems engineering management plan, and program management practice.

R1.1: Develop and regularly update a long-range vessel acquisition plan that lays out the dependencies between fleet objectives, funding, inventory, technology, and sustainment costs, among others, and supports program milestone requirements.

R1.2: Establish a requirements management and change control process to ensure guidance is consistent, repeatable, regularly updated, and baselined. Ideally, this would be developed at the NOAA level and disseminated to NOAA program managers and appropriate Line Office representatives.[37]

R1.3: Develop and implement a systems engineering policy that integrates systems engineering principles into program management processes across the entire acquisition lifecycle.

R1.4: Incorporate guidance on the use of IAAs in acquisition policies, with an emphasis on tailoring documentation to minimize duplication while meeting agency requirements.

[37] MITRE recommends NOAA use an industry standard such as the Capability Maturity Model Integration assessment to establish responsibility and authority by having documentation that communicates the "who, what, when, where, and why" of achieving its missions.

2.2 Requirements Allocation Is Not Well Defined or Organized and There Is No Formal Process for Requirements Traceability

MITRE assessed aspects of requirements management by evaluating requirements analysis, traceability, allocation (as well as hierarchy), and quality in OMAO-provided documentation and independently measured requirements allocation and traceability.

MITRE used the following standards and definitions, provided in the International Council on Systems Engineering (INCOSE) Systems Engineering Handbook[38] and the MITRE Systems Engineering Guide,[39] in its evaluation:

- **Requirements Analysis**: "is the process for identifying and refining requirements throughout the project lifecycle, resulting in a requirements baseline and informing requirements allocation and traceability."
- **Traceability**: "is achieved when all requirements at a particular level of the hierarchy have been placed in the database and traced up and down," ensuring there are no gaps or orphaned requirements.
- **Hierarchy**: "is an organizational representation of the system in which each entity is decomposed into more manageable entities (subordinate system elements)."
- **Requirements Allocation**: "is the further decomposition of system-level requirements until a level is reached at which a specific hardware item or software routine can fulfill the needed functional/performance requirements."
- **Requirements Quality**: "maintains engineering rigor, content, and value of the engineering analysis;" the *characteristics of good requirements* contribute to quality requirements.

2.2.1 OMAO Lacks a Formal Requirements Analysis Process

An objective of requirements analysis is to provide an understanding of the interactions between the various functions and to obtain a balanced set of requirements based on user objectives.[40] MITRE evaluated OMAO's ship capability source data[41] (requirements input for the 2016 NOAA Fleet plan, and used to develop tables and figures),[42] conducted a comparison of the NAV OSV Management Plan with the Class A TLR, and analyzed the impact of undefined primary and secondary requirements. In addition to finding the scope of the requirements analysis was limited, MITRE research revealed:

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[38] INCOSE - International Council on Systems Engineering, *INCOSE Systems Engineering Handbook*, San Diego, CA.

[39] *Analyzing and Defining Requirements* | The MITRE Corporation. (n.d.). Retrieved November 6, 2020, from https://www.mitre.org/publications/systems-engineering-guide/se-lifecycle-building-blocks/requirements-engineering/analyzing-and-defining-requirements

[40] INCOSE - International Council on Systems Engineering, *INCOSE Systems Engineering Handbook, Fourth Edition*, p. 60.

[41] OMAO provided MITRE with the following documents that were used to populate the 2016 and 2020 Fleet Plans: 2.b Ship Capabilities Matrix, mission Specific, 2 b. Ship Capabilities Matrix_ ship specific, 2 e. Capabilities Impacts, Existing Capabilities and Missions, Lost Capacity, Stoplight Chart Fleet Plan update 2019

[42] Figures examined in the 2016 plan were Table 3-1 Days-at-Sea required and allocated, Figure 4-1: Estimated service life of NOAA ships, Table 4-2 Loss of NOAA At Sea Capacity Days-at-Sea 2017-2028, Tables 4-3 Lost At-Sea Capability by 2028 and from the 2020 Fleet Plan Table 3.1- Lost Capabilities by 2028: Existing Fleet with Service Life Extensions (% Lost from 2017 Capabilities), Table 3.2: Lost Capabilities by 2028: Existing Fleet with New Ships (% lost from 2017 Capabilities)

- Only the eight ships expected to reach their end of life in 2028 were included in the Ship Capability Matrix Data (there are 16 ships in the NOAA fleet), as indicated by the categorization of "Eight EOL Ship Capabilities."[43]
- The requirements analysis only accounted for Class A capabilities (16 of the 22 ship capability requirements) and did not include Class B and C capabilities.[44]

MITRE also reviewed the Class A TLR and found it contains requirements that meet criteria defined in the Ocean Survey Vessel (OSV) Management Plan (see Table 2-1),[45] except for evidence of a requirements baseline. A requirements baseline is a key component of requirements analysis as it informs requirements activities such as traceability, decomposition, and allocation.

Table 2-1. Comparison of OSV Management Plan and Class A TLR.

OSV Management Plan Criteria	Class A TLR
Mission requirements	Yes
Operational requirements	Yes
Major configuration constraints	Yes
Planned usage and maintenance	Yes
Supply support concepts	Yes
Requirement baseline	Unable to determine[46]

Source: MITRE Analysis

In the 2016 NOAA Fleet Plan, each vessel class has a primary and secondary mission area. The primary mission area numbers were originally defined in the 2016 NOAA Fleet Plan and represent the at-sea activity requirements (see Table 2-2 below). Each vessel must fulfill all the ship capability requirements associated with the primary mission, and at least some of the requirements associated with the secondary mission area. The plan does not define the number and specific ship capability requirements for the secondary mission area. This indicates a lack of requirements analysis and prevents planning for and mitigating functionality gaps, as well as understanding requirements utilization.

[43] The "Eight EOL" Ships are Oregon II, Oscar Elton Sette, Rainier, Fairweather, Hi'ialakai, Okenanos Explorer, Thomas Jefferson, and Gordon Gunter.

[44] The missing ship capability requirements that align with the Class B vessel are bottom mapping, single beam, side scan sonar, moving vessel profiler, survey launches, and flexible deck.

[45] The Ocean Survey Vessel (OSV) Management Plan defines the roles and responsibilities, and the interactions between NOAA and the Department of the Navy. This document indicates that NOAA is responsible for the development of the TLR containing the sections in Table 2-1.

[46] There is no evidence of a requirements baseline in the Class A TLR document.

Table 2-2. Primary Mission Areas.

Fleet Plan Ref. #	Aligned Vessel Class	Primary Mission Area
1.0	Class C	Assessment and Management of Living Marine Resources
1.1		Protected Resources, Science, and Management
1.2		Fisheries Science and Management
1.3		Habitat Conservation and Restoration
2.0	Class B	Charting and Surveying
2.1		Navigation, Observation, and Positioning
2.2		Coastal Science and Assessment
3.0	Class A	Oceanographic Monitoring, Research, and Modeling
3.1		Climate Research
3.2		Weather and Air Chemistry Research
3.3		Ocean, Coastal, and Great Lakes Research

Source: 2016 NOAA Fleet Plan

MITRE found that OMAO is not conducting a formal, iterative requirements analysis process. OMAO does not collect the data necessary to analyze the requirements proactively. This could impact future planning, the incorporation of emergent requirements, and mitigation for any loss in functionality due to routine maintenance.

2.2.2 OMAO Lacks a Formal Requirements Traceability Process

Maintaining requirements traceability is an ongoing process throughout the system lifecycle of a vessel. Traceability provides the foundation for the change management process, requirements analysis, and development of measures of success; thus, traceability is needed to ensure that the product meets the operational need.

MITRE concluded that OMAO's lack of complete requirements traceability increases the risk that OMAO will not meet its operational requirements and, along with the incomplete requirements definition, makes performance analysis, trade studies, and cost benefit analysis difficult.

These shortcomings can lead to downstream gaps in functionality and have an impact on fleet planning. OMAO does not collect the data necessary to analyze the requirements proactively, which would allow OMAO to plan for and mitigate any loss in functionality due to routine maintenance. Additionally, analysis of requirements traceability can ensure that gaps are identified and addressed early in the processes.

OMAO does not maintain a Requirement Traceability Matrix (RTM) or follow a defined traceability process. Therefore, MITRE constructed an RTM by extending mission and at-sea activity requirements in the 2016 NOAA Fleet Plan to capability requirements allocated to each vessel. MITRE evaluated the Fleet Plan and the TLR document for each vessel class separately against the ship capability requirements.

MITRE then analyzed its RTM to determine the completeness of requirements allocation and traceability. The expected outcome was that all requirements can be traced bi-directionally

with no gaps[47] or orphan requirements.[48] The measure of allocation and traceability for each vessel class should be 100 percent.

Table 2-3, Table 2-4., and Table 2-5. provide the results of MITRE's traceability and allocation analysis for Classes A, B, and C, respectively. The most important results in each table are the number of requirements traceable to a lower level (top-down traceability) and the number of requirements traceable to a higher level (bottom-up traceability), with a goal of achieving 100 percent traceability.

Table 2-3. Class A Vessel Requirements Traceability.

Class A Traceability Measurement			
Traceability to 2016 Fleet Plan	**Primary Mission Area**		
Primary mission area – Oceanographic Monitoring, Research, and Modeling	**3.1**	**3.2**	**3.3**
Count of required ship capabilities for primary mission area	8	3	9
Count of requirements satisfied for primary mission area	8	3	9
Percent coverage of primary mission area	100%	100%	100%
Traceability to TLR	**Primary Mission Area**		
Primary mission area – Oceanographic Monitoring, Research, and Modeling	**3.1**	**3.2**	**3.3**
Count of required ship capabilities for primary mission area	8	3	9
Count of primary mission requirements satisfied in TLR	4	1	6
Percent of primary mission requirements satisfied in TLR	50%	33%	67%
Class A Traceability Assessment (includes primary and secondary mission areas)	**#**	**%**	
Number of ship capability requirements	22	N/A	
Number of undefined requirements	0	0%	
Number of requirements traceable to a lower level	**11**	**50%**	
Number of requirements traceable to a higher level	**12**	**55%**	
Requirements not decomposed in TLR	0	N/A	
Gaps	2	N/A	

Source: MITRE Analysis

[47] Gaps are requirements identified in a higher-level document that cannot be traced to a lower level in the hierarchy.

[48] Orphan requirements are lower-tier requirements that cannot be traced upward to a higher level in the hierarchy.

Table 2-4. Class B Vessel Requirements Traceability.

Class B Traceability Measurement		
Traceability to 2016 Fleet Plan	**Primary Mission Area**	
Primary mission area – Charting and Surveying	**2.1**	**2.2**
Count of required ship capabilities for primary mission area	13	13
Count of requirements satisfied for primary mission area	12	12
Percent coverage of primary mission area	92%	92%
Traceability to TLR	**Primary Mission Area**	
Primary mission area – Charting and Surveying	**2.1**	**2.2**
Count of required ship capabilities for primary mission area	13	13
Count of primary mission requirements satisfied in TLR	9	9
Percent of primary mission requirements satisfied in TLR	69%	69%
Class B Traceability Assessment (includes primary and secondary mission areas)	**#**	**%**
Number of ship capability requirements	22	N/A
Number of undefined requirements	1	5%
Number of requirements traceable to a lower level	**12**	**55%**
Number of requirements traceable to a higher level	**12**	**55%**
Requirements not decomposed in TLR	2	N/A
Gaps	6	N/A

Source: MITRE Analysis

Table 2-5. Class C Vessel Requirements Traceability.

Class C Traceability Measurement			
Traceability to 2016 Fleet Plan	**Primary Mission Area**		
Primary mission area – Assessment and Management of Living Marine Resources	**1.1**	**1.2**	**1.3**
Count of required ship capabilities for primary mission area	10	7	6
Count of requirements satisfied for primary mission area	10	7	6
Percent coverage of primary mission area	100%	100%	100%
Traceability to TLR	**Primary Mission Area**		
Primary mission area – Assessment and Management of Living Marine Resources	**1.1**	**1.2**	**1.3**
Count of required ship capabilities for primary mission area	10	7	6
Count of primary mission requirements satisfied in TLR	5	5	3
Percent of primary mission requirements satisfied in TLR	50%	71%	50%

Class C Traceability Assessment (includes primary and secondary mission areas)	#	%	
Number of ship capability requirements	22	N/A	
Number of undefined requirements	1	5%	
Number of requirements traceable to a lower level	**11**	**50%**	
Number of requirements traceable to a higher level	**11**	**50%**	
Requirements not decomposed in TLR	1	N/A	
Gaps	2	N/A	

Source: MITRE Analysis

As shown in the tables above, MITRE found that:

- Top-down traceability was 50 percent complete for Class A, 55 percent complete for Class B, and 50 percent complete for Class C.
- Bottom-up traceability was 55 percent complete for Class A, 55 percent complete for Class B, and 50 percent complete for Class C.

MITRE identified the following gaps mentioned as a requirement in the Fleet Plan but absent from lower-level TLR and CDD documents: side scan sonar, moving vessel profiling, dive/extensive dive, unmanned aircraft system, autonomous underwater vehicle, ice strengthening, mooring handling, and longline (the ship capability with the greatest impact, since it is required for assessment and management of living marine resources, a Fisheries Science and Management at-sea activity that is not present in the Class C TLR [NOAA Class C TLR]). MITRE also found orphaned requirements such as flexible deck configuration identified as a requirement in every TLR document but not listed as a ship capability in the NOAA Fleet Plan.

2.2.3 OMAO Does Not Maintain Formal Documentation of Its Requirements Allocation

OMAO did not provide any formal requirements allocation guidance documents or a single-source document that explicitly allocates ship capability requirements successively decomposed down to the corresponding vessel class. MITRE, therefore, developed a requirements hierarchy by extracting information from the 2016 NOAA Fleet Plan, aligning mission requirements to the legal mandates, and allocating the ship capability requirements to the corresponding vessel classes. Extracting requirements from existing documentation to complete a requirements hierarchy enabled analysis of allocation and traceability necessary for this assessment. The MITRE-created hierarchy does not extend to lower levels due to the current level of progress in the overall acquisition process. The expected outcome was that all requirements were appropriately allocated and written according to best practices.

The MITRE-created requirements hierarchy enabled MITRE to conclude:

- All Class A ship capability requirements were decomposed and allocated in the Class A TLR, though allocation is incomplete for Class B and Class C requirements.
- Three of the 22 Class B requirements and two of the 22 Class C requirements must be further decomposed in the TLR to complete allocation.
- OMAO's process for allocating and decomposing requirements from the highest-level legal mandates to mission requirements, at-sea activity requirements, and ship capabilities is not well-defined.

2.2.4 Requirements Are Not Written Clearly and Not Described Consistently

MITRE examined the ship capability requirements to ensure they exhibit good requirement characteristics (i.e., quality).[49] Overall, MITRE concluded:

- Ship capability requirements are not always written in a clear and concise manner. For example, the terms *extensive dive* and *dive* are used interchangeably, although the two are defined differently, making it difficult to determine if a vessel with *dive* capabilities will satisfy *extensive dive* capabilities.
- Requirements are not traceable or are inconsistent within a document. For example, Side Scan Sonar is not listed in Appendix A (Ship Capabilities) of the 2016 NOAA Fleet Plan but is listed as a required capability in an earlier section of the plan. Additionally, flexible deck configuration is listed as a required Class A capability but is not listed in the corresponding mission capability requirements in Table 3-2 of the 2016 NOAA Fleet Plan.

Ship capability requirement descriptions are inconsistent across the draft TLR documents and the 2016 Fleet Plan and include "placeholder" text and copy/paste errors. For example, the Class C TLR incorrectly lists Oceanographic Monitoring, Research, and Modeling as a secondary mission and incorrectly omits trawl as a ship capability. This omission prevents complete traceability and may result in the exclusion of trawl as a ship capability requirement for the vessel.

2.2.5 Recommendations

MITRE recommends that the NOAA Deputy Under Secretary for Operations ensure OMAO does the following:

R2: Develop OMAO-specific guidance for managing requirements, including requirements analysis, traceability, and allocation.

R2.1: Develop a requirements management guide and traceability process that follows the SAPMG and system engineering standards (e.g., INCOSE).

R2.2: Leverage mission requirements and at-sea data collection requirements to provide OMAO with a verifiable means of capturing the annual mission performance.

1. Provide the ship designers with the mission requirements that can be allocated and traced throughout the design and construction process and provide proof of mission capability.
2. Revalidate and update the at-sea data collection requirements and develop a process to conduct this update cycle on a regular basis.

[49] The characteristics of good requirements are: necessary, implementation independent, unambiguous, complete, singular, achievable, verifiable, and conforming; INCOSE - International Council on Systems Engineering, *INCOSE Systems Engineering Handbook v4* (p60-61), San Diego, CA.

2.3 OMAO's Current Requirements Validation Process Is Not Adequate for New, Changing, and Emerging Requirements

Requirements validation is a component of overall program readiness and risk assessment that must occur at each major milestone in the program lifecycle. *The Engineering Design of Systems* textbook defines validation as follows: "Validation is the process of determining that the systems engineering process has produced the right system, based on the needs expressed by the stakeholder."[50] Validation can occur at any stage in the system lifecycle, and early validation through active stakeholder involvement will support conceptual validity, requirements validity, and design validity. The SAPMG also emphasizes a focus on stakeholder engagement and "doing the right thing," consistent with textbook definition of validation. The overall goal is to ensure stakeholder satisfaction.

The first formal validation of requirements occurs with the approval of the MNS. However, the absence of formal systems engineering processes (see Section 2.1.3 of this report) can lead to an informal requirements validation process such as the one OMAO currently uses. Throughout a program's lifecycle, OMAO's requirements validation activities occur through governance processes and organizations that include Fleet Council meetings, ship class Integrated Product Teams (IPTs), direct collaboration between OMAO/PAD and the NOAA Line Offices, and frequent collaboration with the Marine Operations Centers.

2.3.1 OMAO's Baseline Validation Practices Do Not Anticipate and Plan for Future Change

The NMFS Director of Scientific Programs and Chief Science Advisor expressed concerns over not having enough collaboration with OMAO to plan for future needs. NMFS (and other Line Offices) have evolving observational needs due to changes in the natural environment, emerging technologies, changing data needs (by type and amount of data), as well as the impact of artificial intelligence and machine learning that provides new ways to analyze data. For example, the Director predicted the requirements for the Class C vessel may change 25 percent in the next few years based on evolving science and changing environmental conditions, which could ultimately result in a disparity between a Line Office's evolving scientific needs and the abilities of the current ship fleet to meet those future requirements.

MITRE agrees with the Director's assessment that better collaboration between the NOAA Line Offices and OMAO is required to ensure ship capabilities keep pace with evolving requirements. MITRE concluded:

- OMAO's current validation processes are not disciplined or structured enough to maintain full custody of new, changing, and emerging requirements, particularly during the later phases of a platform acquisition program.
- Without standardized methods, documentation, and a record of validation decisions, there is a high likelihood of capability development and acquisition that does not accurately reflect NOAA's evolving operational capability needs.

[50] Buede, Dennis M., and William D. Miller. *The engineering design of systems: models and methods*. John Wiley & Sons, 2016.

Given that the overall objective of validation is to ensure the planned system will meet the operational need, and that requirements engineering is the first activity during which major mistakes can be made, a lack of discipline and structure around early validation activities is likely to negatively impact downstream activities such as design, implementation, and testing for more complex future requirements.

2.3.2 Stakeholder Involvement Is Adequate for Early Validation of Mature Requirements

The approved Class A Vessel MNS indicates formal approval (or validation) of the requirements and is consistent with the definition of validation through stakeholder involvement laid out in the Department's SAPMG.

OMAO chartered an IPT for each of the ship classes, led by the responsible PAD Project Leader, with representation from OMAO leadership, OMAO Marine Operations, and each of the NOAA Line Offices. The IPTs are composed of senior leaders and scientists representing the Line Office's science and observing system needs, uniformed NOAA Corps officers and former ship captains, and project and technical leadership from PAD. The primary responsibility of each IPT is to "qualify, quantify, and clarify the science and mission related requirements."[51] The first section of each IPT charter clearly states guidance pertaining to requirements validation activities, which evidence indicates regularly occur.

MITRE found that each Line Office has different needs that drive ship capability requirements, and the IPT representatives have a good understanding of their own Line Office's ship capability needs and the maturity of their requirements. The mechanisms for transmitting, reviewing, and documenting those activities and decisions vary depending on how much each Line Office's mission needs impact ship design. For example, the OAR Line Office IPT representative stated that PAD provides the IPT with a draft document, such as a TLR, and solicits feedback. In contrast, Line Offices such as NESDIS, whose needs minimally impact ship design, participate in the IPT meetings and provide only minor critiques and feedback on the documentation. MITRE found that the ship class IPTs are well rounded with continuity among representatives from the NOAA Line Offices and OMAO.

[51] Silah, Michael, RADM, *Integrated Product Team (IPT) Charter for the NOAA AGOR Variant (NAV),* June 28, 2019, Silver Spring, MD: Office of Marine and Aviation Operations; Silah, Michael, RADM, *Integrated Product Team (IPT) Charter for Class B,* October 2, 2019, Silver Spring, MD: Office of Marine and Aviation Operations; Silah, Michael, RADM, *Integrated Product Team (IPT) Charter for Class C,* October 2, 2019, Silver Spring, MD: Office of Marine and Aviation Operations. See Section 2, Scope of Responsibilities for Class A, B, and C IPT Charters.

The evolving organizational culture and the static nature of historic ship capability needs (as evidenced by the 2008 and 2016 NOAA Fleet Plans) support such a collaboration-centric validation process. MITRE concluded that this is an adequate approach for early validation of mature requirements in the current phase in the acquisition lifecycle of the Class A vessels.

2.3.3 Recommendations

MITRE recommends that the NOAA Deputy Under Secretary for Operations ensure OMAO does the following:

R3: Document and implement a disciplined approach to validating requirements through increased Line Office communication.

3 Conclusion

OMAO is at a critical juncture as it moves closer to finalizing the Class A vessel design and prepares for the Class B acquisition. If OMAO decides to use in-house resources to acquire future classes of ships, as opposed to relying on outside expertise such as the Navy Program Management Office, then having a well-documented and understood requirements management process will be even more critical to the Ship Fleet Recapitalization Program.

This evaluation report presents MITRE's complete findings and recommendations to capitalize on successful program attributes and to counter areas of risk in OMAO's requirements management processes. Addressing the risks identified in this evaluation will help position OMAO to recapitalize its fleet with vessels that meet NOAA's current, emerging, and evolving needs.

4 Summary of Recommendations

Table 4-1 summarizes MITRE's recommendations, as presented in Section 2.

Table 4-1. Recommendations.

Evaluation Tasks: Describe OMAO processes to manage ship fleet requirements from requirement identification through validation and delivery of capabilities. Determine the extent to which OMAO requirements are documented in accordance with Department of Commerce policy and guidance for major system acquisitions.
Key Recommendation:
R1 **Benchmark, build, and elevate an overarching OMAO strategic plan, acquisition plan, systems engineering management plan, and program management practice.**
Sub-Recommendations:
R1.1 Develop and regularly update a long-range vessel acquisition plan that lays out the dependencies between fleet objectives, funding, inventory, technology, and sustainment costs, among others, and supports program milestone requirements.
R1.2 Establish a requirements management and change control process to ensure guidance is consistent, repeatable, regularly updated, and baselined. Ideally, this would be developed at the NOAA level and disseminated to NOAA program managers and appropriate Line Office representatives.
R1.3 Develop and implement a systems engineering policy that integrates systems engineering principles into program management processes across the entire acquisition lifecycle.
R1.4 Incorporate guidance on the use of IAAs in acquisition policies, with an emphasis on tailoring documentation to minimize duplication while meeting agency requirements.

Evaluation Tasks:

Determine whether OMAO processes adequately allocate high-level requirements down to mission- and system-level requirements.

Determine whether OMAO processes provide traceability among different hierarchies of requirements to identify gaps or orphan requirements.

Key Recommendation:

R2

Develop OMAO-specific guidance for managing requirements, including requirements analysis, traceability, and allocation.

Sub-Recommendations:

R2.1

Develop a requirements management guide and traceability process that follows the SAPMG and system engineering standards (e.g., INCOSE).

R2.2

Leverage mission requirements and at-sea data collection requirements to provide OMAO with a verifiable means of capturing the annual mission performance.

Evaluation Task: Determine whether OMAO processes adequately validate ship requirements.

Key Recommendation:

R3

Document and implement a disciplined approach to validating requirements through increased Line Office communication.

Evaluation Task: Determine whether OMAO processes are responsive to changing circumstances such as schedule delays, funding shortages, and emerging technologies.

Key Recommendation: N/A

(N/A)

The recommendations surrounding requirements management processes in prior sections of this report will underpin the program office's ability to respond to changing circumstances.

5 Summary of Response

In response to the draft report, NOAA concurred with the recommendations, described actions taken or planned for each, provided a comment regarding its Fleet Council and ship allocation process, and made several recommended changes for factual/technical information. The response is included within this report as Appendix I.

MITRE is pleased that NOAA concurs with the recommendations and agrees with the actions NOAA described in response. Regarding NOAA's comment on the Fleet Council and the Ship Allocation process, which OMAO has found to be a crucial indicator of high-priority requirements and missions, Section 2.3 of the draft report does in fact refer to the OMAO requirements governance processes and organizations including Fleet Council meetings. Finally, MITRE reviewed NOAA's recommended factual changes to the report and made such changes that were both material to the report's findings and recommendations and factually supported by sufficient, appropriate evidence.

Appendix A Office of Marine and Aviation Operations Ship Classes

The NOAA Vessel Class A ships are based on the U.S. Navy Auxiliary General Purpose Oceanographic Research Vessel (AGOR) specifications. The AGOR is a multipurpose vessel that is capable of oceanographic science and data collection in both coastal regions and the deep ocean. The primary capabilities of the Class A vessels are oceanographic monitoring, research, and modeling activities with secondary capabilities for assessment and management of living marine resources, charting, and surveying.

The NOAA Vessel Class B ships' primary capabilities are to perform all charting and surveying activities. The secondary capabilities for the Class B vessels include assessment and management of living marine resources and oceanographic monitoring, research, and modeling activities.

The NOAA Vessel Class C ships are low-endurance, multipurpose, shallow-draft, trawl-capable stock assessment vessels.[52] The Class C vessels are intended to meet the needs for assessment and management of living marine resource requirements along the coasts and in the Gulf of Mexico.

The NOAA Vessel Class D is intended to supplement the Class A, Class B, or Class C vessels. Class D ships' primary mission is performing assessment and management of living marine resources and having trawl capability. Class D ships have secondary capabilities for charting and surveying; and oceanographic monitoring, research, and modeling.

Table A-1 below provides additional detail on the planned NOAA vessel classes:

Table A-1. OMAO Planned Ship Classes.

Ship Class	Number of Ships to Be Built	Primary Mission	Secondary Mission(s)
Class A	2	Oceanographic Monitoring, Research, and Modeling	• Assessment and Management of Living Marine Resources (no trawl) • Charting and Surveying
Class B	3	Charting and Surveying	• Assessment and Management of Living Marine Resources (no trawl) • Oceanographic Monitoring, Research, and Modeling
Class C	2	Assessment and Management of Living Marine Resources (trawl-capable, shallow-draft)	• Charting and Surveying
Class D	1	Assessment and Management of Living Marine Resources (trawl-capable, near-shore and deep ocean, longer endurance)	• Charting and Surveying • Oceanographic Monitoring, Research, and Modeling

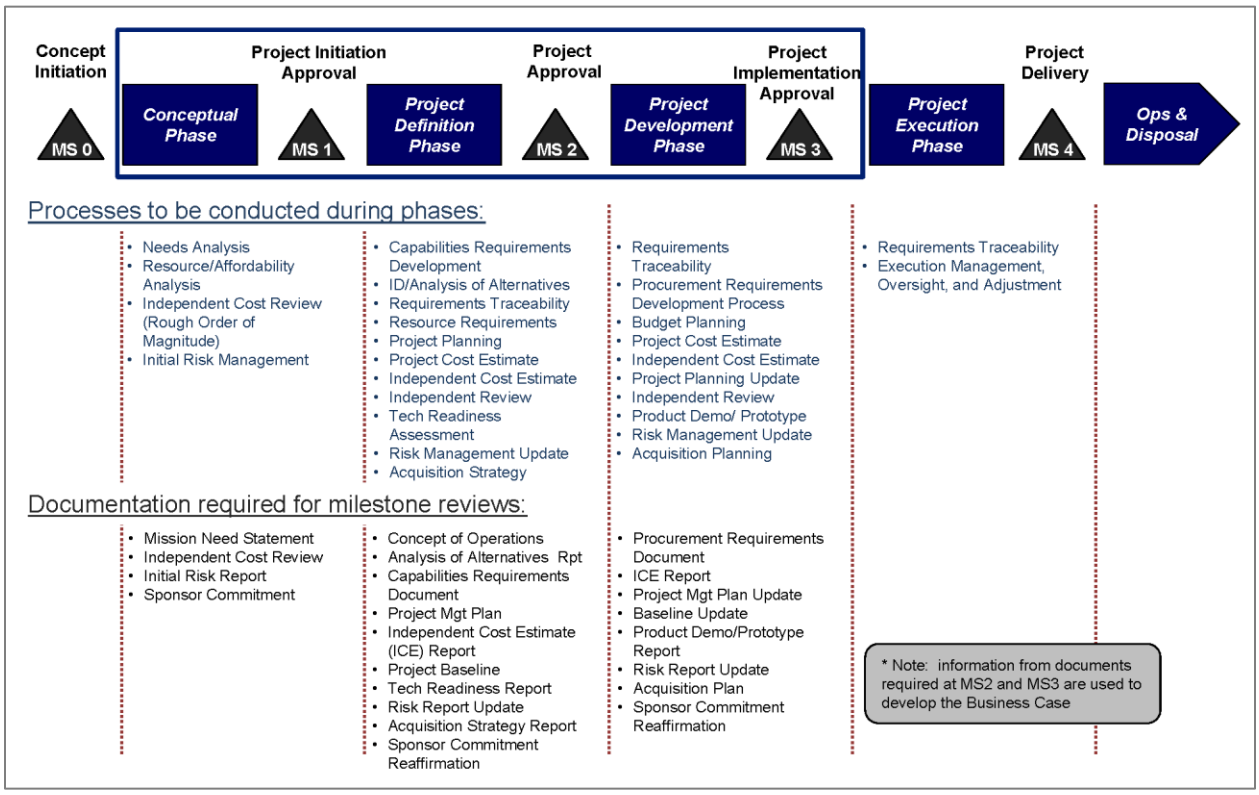
[52] Trawls are commercial size bottom and pelagic trawl nets, gear, and sampling systems to meet fisheries survey requirements.

Appendix B Excerpts from the Department of Commerce Scalable Acquisition Program Management Guidebook

B.1 Framework Chart

The details of the Scalable Acquisition Project Management Framework include specific processes conducted during each of the key phases as well as the corresponding documentation required for milestone reviews. Figure B-1 provides lists of minimum processes and documentation required for high-profile projects and recommended for all other projects.

Figure B-1. Department of Commerce SAPMG Framework Details.



The framework more fully describes these processes and documentation requirements for the first three phases. Each subsection of the descriptions for conceptual through project development phases is organized as follows:

- Phase objectives
- Summary of phase processes
- Listing and description of required milestone documentation.

Note that the described processes are only the minimum activities needed to prepare for a milestone review. Depending on the project and any functional Department or Bureau

guidance, there may be additional processes and required documentation not included in this guidebook.

Additionally, framework concepts and requirements may have to be adjusted to fit the specific lifecycle of certain projects; for example, satellites, facilities, and IT. Often those projects require early design reviews, interim approvals, and so on, which require changes to the timing of the framework elements. Each project should be individually mapped to the framework to determine if the framework needs to be tailored to meet unique characteristics of the project. Regardless of how the framework is tailored, however, a high-profile project must still complete each of the required processes and documentation, and other projects must still adhere to the basic concepts.

Templates for completing the required documentation for presentation at a milestone review, including descriptions of what is expected in each document, are provided in Appendix B of the Scalable Acquisition Project Management Guidebook (SAPMG). The templates are provided to assist project managers by describing the minimum information required for a Milestone Review Board. If a Bureau is already using its own templates to provide this same information, then the Guidebook templates do not need to be used. However, it is requested that when a Bureau uses its own templates, the Bureau correlate information requirements of the guidebook templates to its own templates and appropriately annotate sections of the Bureau template with its corollary section in the Guidebook template.

Table B-1. Summary of SAPMG Requirements Documentation by Milestone.

Milestone 1		
Document	**Description**	**Preparer**
Mission Need Statement (MNS)	The MNS contains a high-level synopsis of specific functional capabilities needed to accomplish a mission or objective(s). It includes descriptions of the mission need, deficiencies in existing capabilities, and potential strategies to meet the mission need, and a required timeframe for initial operations.	Sponsor Designee
Milestone 2		
Document	**Description**	**Preparer**
Requirements Document	The requirements document sets the context of the gaps to be addressed to guide the development and evaluation of alternative design concepts. It is derived from the MNS, concept of operations, and early sponsor analysis. It describes the missions, operational capabilities, operating environment, and system constraints that competing system concepts must satisfy.	Project Manager
Milestone 3		
Document	**Description**	**Preparer**
Requirements Document Update	The requirements document update becomes the formal statement of the operational performance and related parameters for the proposed concept or system. It describes a system in terms of a range of acceptable and desirable standards of performance. Because it consolidates these performance measures and requirements for the support and maintenance of the system in one document, the updated requirements document serves as the source document for a host of systems engineering activities, ongoing requirements analysis, and cost estimation to ensure the success of the project.	Project Manager

Appendix C Evolution of Department Policy and Guidance for Major Systems Acquisition

C.1 Guiding Requirements Documentation

To evaluate the extent to which Office of Marine and Aviation Operations (OMAO) is documenting requirements in accordance with the Department's policy and guidance, MITRE reviewed and evaluated OMAO's against the following guiding documents (which represent the latest relevant requirements and acquisition guidance from the Department of Commerce, National Oceanographic and Atmospheric Administration [NOAA], and OMAO):

- Department Administrative Order (DAO) 208-16 and its companion Scalable Acquisition Program Management Guidebook
- Interim Policy on Commerce Acquisition Project Management (November 6, 2012)
- 2014 Interagency Agreement[53], 2017 Interagency Agreement,[54] [55] NOAA Auxiliary General Oceanographic Research (AGOR) Variant (NAV) Mission Needs Statement (MNS) (August 4, 2017)
- NOAA Ocean Survey Vessels 1 and 2 Milestone Decision Memorandum (December 4, 2013)

C.2 Overview of Evolving Policy and Guidance

In June 2010, the Secretary of Commerce mandated an immediate and comprehensive review of the acquisition processes across the Department. The catalyst behind the resulting Acquisition Improvement Study (AIS) was provided by challenges encountered in four high-profile acquisitions, three of which are managed by NOAA:

- Small Water Plane Area Twin Hull, also known as NOAA's Ferdinand R. Hassler (S-250)
- Joint Polar Satellite System
- Marine Operations Center – Pacific

The AIS identified the need for a more comprehensive and corporate approach for overseeing and managing acquisitions, including definition of a formal requirements development and management process, better program planning, and departmental oversight and insight. A

[53] United States Government Interagency Agreement (IAA) – Agreement Between Federal Agencies, Order Requirements and Funding Information (Order Section), OMAO-PAD-00001, May 2014, 6, 8.; IAA states that OMAO shall provide Top-Level Requirements (TLRs), including any scheduling parameters, to Naval Sea Systems Command (NAVSEA)/Program Executive Office Ships (PEO Ships) for its use in developing the statement of work and/or specifications for each acquisition. The IAA also states that OMAO was solely responsible for the MNS deliverable.

[54] United States Government Interagency Agreement (IAA) – Agreement Between Federal Agencies, Order Requirements and Funding Information (Order Section), OMAO-PAD-00002-001, 2.; OMAO signed a second IAA in 2017 for the Phase II Detail Design and Construction portion of the rebranded NOAA Auxiliary General Oceanographic Research (AGOR) Variant (NAV).

[55] United States Government Interagency Agreement (IAA) – Agreement Between Federal Agencies, Order Requirements and Funding Information (Order Section), OMAO-PAD-00001, May 2014, 6, 8.; IAA states that OMAO shall provide Top-Level Requirements (TLRs), including any scheduling parameters, to Naval Sea Systems Command (NAVSEA)/Program Executive Office Ships (PEO Ships) for its use in developing the statement of work and/or specifications for each acquisition. The IAA also states that OMAO was solely responsible for the MNS deliverable.

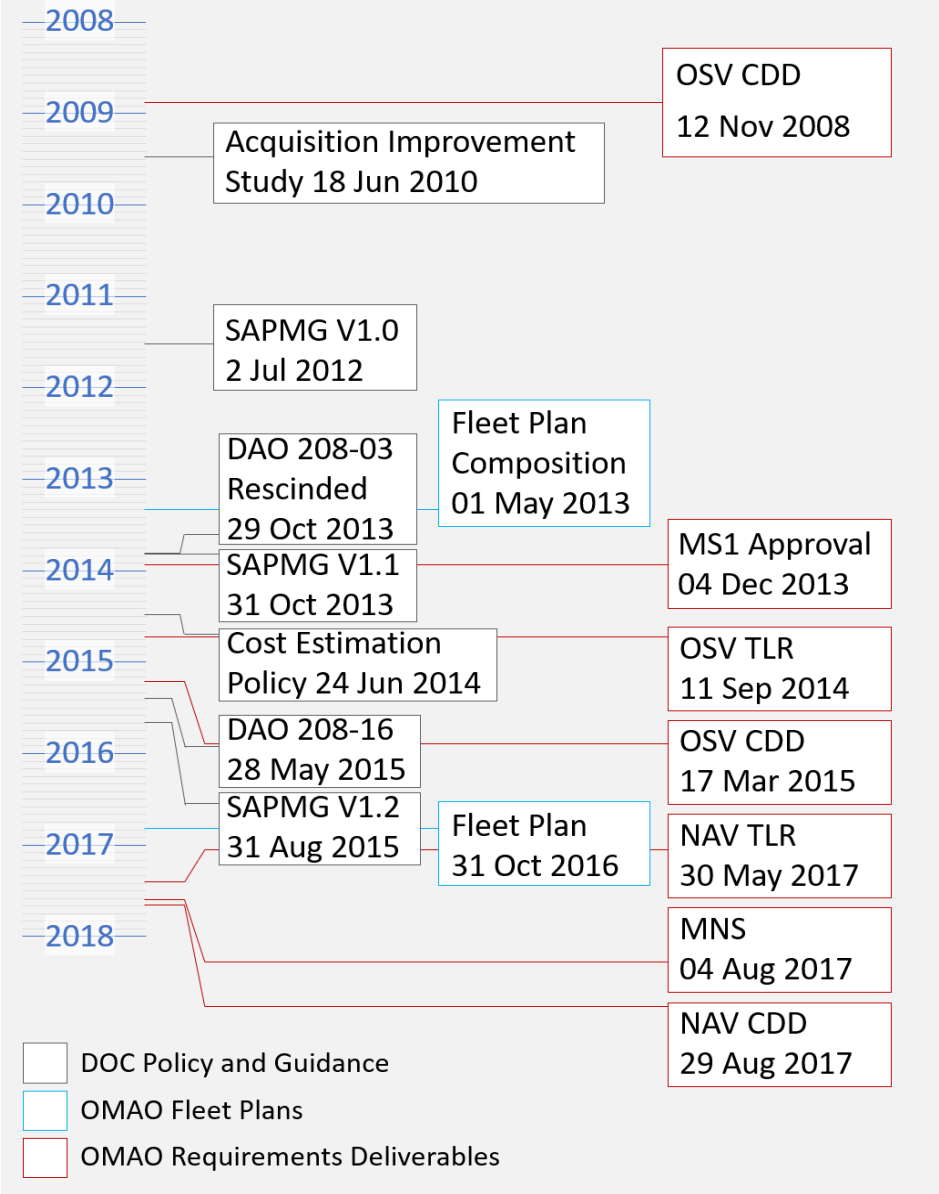
follow-on Acquisition Improvement Program led to the development of the Scalable Acquisition Project Management Guidebook (SAPMG) and the Policy on Commerce Acquisition Project Management that addressed a variety of "tipping point" requirements-related issues identified in the four high-profile acquisition programs. These issues included (1) the need for a robust requirements development process; (2) better refinement and articulation of requirements; (3) systemic validation of requirements; and (4) development of requirements in a joint sponsorship environment. The SAPMG laid out the "how-to" guidance specific to Department- and Bureau-level project managers for implementing the enumerated principles and processes. Four months later, the Acting Secretary of Commerce signed an interim Policy on Commerce Acquisition Project Management memorandum, implementing the SAPMG as policy However, the memo was noticeably silent on the need for a robust requirements development process.

This interim policy memo superseded both DAO 201-45, Departmental Oversight of Major Systems, and DAO 208-3, Major System Acquisitions for the Department of Commerce, and was effective until replaced by a new DAO. However, DAO 208-3 was not officially revoked until October 29, 2013, approximately one year later.

On October 31, 2013, the Department issued Version 1.1 of the SAPMG. The following year, the Deputy Secretary of Commerce released a companion policy memorandum on Commerce Cost Estimation and Independent Cost Estimates for High-Priority Programs and Projects. Another year later, on May 26, 2015, both policy memoranda were combined and issued as DAO 208-16, Acquisition Project Management. The DAO prescribes the policy, procedures, and responsibilities of implementing the framework on all acquisition programs and projects, with emphasis on high-profile programs and projects. MITRE did not find an order rescinding the November 2012 interim policy, though it is implied by the issuance of the DAO. Figure C-1 provides a visual timeline representation of the compilation of the Department's policy and guidance, requirements deliverables, and a succession of the various fleet plans. The gray outline boxes represent the Department's governing requirements policy and guidance, the blue outline boxes pertain to fleet plans, and the red outline boxes outline the requirements deliverables.

On August 31, 2015, the Department of Commerce released the current version of the SAPMG, Version 1.2. The guidebook describes the minimum mandated processes and reviews for high-profile projects with a focus on the early aspects of project planning and preparation necessary for acquisition and project success. Later phases and milestones for completing the project management lifecycle (i.e., project execution including management, oversight, operation, and disposal) are not covered in any depth in the current version of the SAPMG. Subsequent updates are projected once the framework becomes part of the Department's normal practices and culture. Neither DAO 208-16 nor the SAPMG were updated in the past five years.

Figure C-1. Department of Commerce Requirements Policy and Guidance Timeline.[56]



In addition to the MNS, MITRE reviewed related requirements documents including a November 12, 2008, Capability Development Document (CDD) for the Ocean Class AGOR. The Department of Commerce provided this first version of the CDD to guide the acquisition community in making tradeoff decisions between the threshold and objective levels of the stated attributes in expectation of a combined Milestone B/C, the Department of Defense equivalent to the Department's Milestone 2/3. The CDD was later reissued on March 17, 2015, as an Ocean Survey Vessel (OSV) CDD, and then once more on August 29, 2017, as the rebranded NAV CDD. Three Top-Level Requirements (TLRs) were also developed for the OSV

[56] MITRE analysis of DOC Policy and Guidance, OMAO Fleet Plans, and OMAO Requirements Deliverables.

and NAV. The original OSV TLR was published on September 11, 2014, updated to Revision 1 on September 4, 2015, as the rebranded to the NAV TLR.

Appendix D Why Evaluate Requirements Management

Requirements management is a cornerstone of program and project management and is one of three formal decision domains that must be balanced in federal acquisition (the other two being budgeting and execution, and acquisition governance). At its core, requirements management is the process of documenting, analyzing, tracing, prioritizing, and controlling changes to requirements. It is a continuous process, conducted throughout a system's lifecycle and confirmed at each technical review, serving as the single authoritative definition of the requirements. Its purpose is to ensure that the documented requirements continue to meet the needs and expectations of an organization's users and stakeholders.

The Department of Commerce Office of the Inspector General (OIG), other federal OIGs, and the Government Accountability Office (GAO) have consistently reported that federal programs often fail to assess, capture, and convey their requirements properly. This leads to program challenges and failures resulting from unmitigated cost, schedule, and performance risks. For example, a 2018 GAO study[57] examined the practices used by Department of Homeland Security components (agencies) for developing requirements and found several components did not have established policies and independent organizations for developing requirements. The study concluded that organizational components that did not develop requirements policies aligned with Department standards suffered in several ways. Components focused requirements on functionality instead of meeting a capability, and sub-components and organizations developed their own guidance and policies for requirements management that risked not meeting mission needs. It also found the lack of an overarching, formalized policy at the Department level resulted in requirements that were vague, not testable, not prioritized, and not supportable or defendable.

Similarly, the Department of Commerce directed an Acquisition Improvement Study in 2010 to investigate problems in several high-profile acquisitions, including the NOAA Small Water Plane Area Twin Hull vessel. The study identified significant shortcomings in requirements development and management, among other areas.

[57] U.S. Government Accountability Office, *GAO-18-550, DHS Acquisitions: Additional Practices Could Help Components Better Develop Operational Requirements*, August 8, 2018, Washington, DC: Government Accountability Office (GAO).

Appendix E Risk Management Review

E.1 Guiding Department Risk Management Documentation

MITRE reviewed the following Department-level governing documents to identify criteria for identifying, managing, and controlling risk:

- Department Administrative Order (DAO) 216-20: Department of Commerce Enterprise Risk Management administrative order[58]
- The Department's Scalable Acquisition Project Management Framework[59]
- Secretary of the Navy Instruction 5000.2[60]

E.2 Guiding Bureau Risk Management Documentation

MITRE reviewed the following National Oceanographic and Atmospheric Administration (NOAA) Auxiliary General Oceanographic Research (AGOR) Variant (NAV) and NOAA deliverables to evaluate NOAA's treatment of risk and risk management:

- NAV Acquisition Strategy – Risk Management[61]
- NOAA Ocean Survey Vessel (OSV) Program Systems Engineering Plan – Risk Management[62]
- NAV Management Plan[63]
- NOAA Fleet Recapitalization Program and Ocean Survey Vessels (OSV 1 and 2) Initial Risk Assessment Report[64]

[58] Provides a framework for identifying, managing, and mitigating risk to achieve the Department's strategic objectives and mission. The DAO directs that risk management practices at all levels be integrated into informed decision making and priority setting, and that consistent and disciplined consideration and treatment of risk be part of each organization's day-to-day processes.

[59] Requires that organizations employ risk management processes during the Conceptual, Definition, and Development phases of any high-profile project, such as acquiring a class of NOAA ships. Required risk documentation includes an Initial Risk Assessment Report at Milestone 1 and updated risk reports at Milestones 2 and 3.

[60] For assisted acquisitions such as the Class A NAV program, which is managed by the U.S. Navy, requires that a risk assessment identifying all technical, cost, schedule, and performance risks be conducted prior to each milestone decision.

[61] Describes a structured and systematic risk management process to support decision making and to keep the program on track to meet schedule, budget, and technical constraints.

[62] Describes the use of a structured risk management approach consisting of four elements: planning, assessment, handling (including mitigation), and monitoring.

[63] Gallagher, Patrick D., *NOAA Ocean Survey Vessels 1 and 2*, December 4, 2013.; notes that a Milestone 1 review included an Initial Risk Assessment presentation. The Department of Commerce Deputy Undersecretary approved Milestone 1 on December 4, 2013.

[64] Hubbard, Joseph, *NOAA Fleet Recapitalization Program and Ocean Survey Vessels (OSV 1&2) Initial Risk Report*, November 4, 2013.; Supporting Milestone 1, dated 11/04/2013, notes that a Risk Management Board was established to identify and review potential risk areas, and potential issues within each risk area, at a level appropriate for Milestone 1.

Appendix F Evaluation Objective, Scope, Standards, and Approach

F.1 Objective

In September 2019, the Department of Commerce Office of the Inspector General (OIG) engaged The MITRE Corporation to provide evaluation services to fulfill the OIG, Office of Audit and Evaluation's mission to improve the programs and operations of the Department through independent and objective oversight. This evaluation provides timely, actionable, and relevant recommendations to improve Office of Marine and Aviation Operations' (OMAO) ship fleet requirements management processes. The result of this evaluation will also inform and help OIG strengthen its oversight of OMAO recapitalization needs.

F.2 Scope

The evaluation scope was to assess the adequacy of NOAA's ship fleet requirements management processes. MITRE coordinated continuously with OIG leadership throughout the evaluation process to ensure the evaluation meets OIG's needs. To satisfy the evaluation objective, MITRE was tasked to:

1. Describe OMAO processes to manage ship fleet requirements from requirement identification through validation and delivery of capabilities
2. Determine the extent to which OMAO requirements are documented in accordance with Department of Commerce policy and guidance for major system acquisitions
3. Determine whether OMAO processes adequately allocate high-level requirements down to mission- and system-level requirements
4. Determine whether OMAO processes provide traceability among different hierarchies of requirements to identify gaps or orphan requirements
5. Determine whether OMAO processes adequately validate ship requirements
6. Determine whether OMAO processes are responsive to changing circumstances such as schedule delays, funding shortages, and emerging technologies

F.3 Standards

MITRE conducted this evaluation according to MITRE standards for the conduct of evaluations, which are well aligned and consistent with the Council of the Inspectors General on Integrity and Efficiency, *Quality Standards for Inspection and Evaluation* (Blue Book). Appendix G describes this alignment of MITRE and Blue Book standards. Standards that are unique to each evaluation task are described separately in the standards and relevant factors subsections of Sections 2.1 through 2.3.

The evaluation described in this report provides timely, actionable, and relevant recommendations to improve OMAO's ship fleet requirements management processes.

F.4 Approach

F.4.1 Methodology

As an operator of federally funded research and development centers, MITRE leveraged its 60 years of independent and unbiased systems engineering expertise to provide technical management, program and project management, development engineering, requirements management, ship/vessel/aircraft acquisition expertise, and business process engineering expertise to conduct the evaluation of Office of Marine and Aviation Operations (OMAO) fleet management and replenishment practices. MITRE technical experts in these areas assessed the processes using a comprehensive approach that included document and program artifact reviews, personnel interviews, comparison with similar efforts from a deep resource of corporate experience, identification and review of existing standards within the Department of Commerce and the National Oceanographic and Atmospheric Administration (NOAA), and benchmarking against best practices. MITRE conducted this evaluation in three phases: planning, fieldwork, and reporting.

F.4.1.1 Planning Phase

MITRE obtained an understanding of OMAO's structure, history, risk areas, internal challenges, external challenges, and plans for risk mitigation. MITRE also identified responsible personnel, internal controls relevant to the scope of the evaluation, and potential risk areas (including potential internal control weaknesses). MITRE then conducted preliminary meetings with key personnel.

MITRE extensively reviewed publicly available documentation, which led to the development of preliminary interview topics and questions for the fieldwork phase. This environmental scan of documentation on OMAO's organizational structure and roles provided vital background information for introductory meetings with key NOAA leaders, insight into the acquisition process for the four classes of ships, and background on the NOAA ship fleet recapitalization effort. Additionally, MITRE requested and received nearly 180 documents related to OMAO shipbuilding and OMAO's requirements management processes. The resulting knowledge helped MITRE identify additional important resources for the fieldwork phase of the evaluation.

Overall, the information learned during the planning phase strengthened MITRE's focus on which key areas to examine further. The initial set of interest areas included:

- History of the challenges associated with ship fleet modernization and acquisition planning
- Recapitalization complexity due to specialized ship and research requirements
- Process for requirements trades between the NOAA strategic vision and budget
- Days at sea as a driver for requirements
- Status of the requirements development lifecycle for Class A, B, C, and D ships
- Staffing levels and availability of additional human resources
- Depth of shipbuilding institutional knowledge
- Adequacy and stability of funding for ship procurement and maintenance
- OMAO knowledge repository and lessons learned capability

- Analysis of at sea data collection requirements (as of 2012) as input into the ship fleet requirements analysis in the NOAA 2016 Fleet Plan
- Line Office role in Fleet Recapitalization Program

F.4.1.2 Fieldwork

MITRE conducted this evaluation under the authority of the Inspector General Act of 1978, as amended (5 U.S.C. App.), and Department Organization Orders 10-13, dated April 6, 2013.[65] MITRE performed the fieldwork at Department headquarters in Washington, DC, and at OMAO headquarters in Silver Spring, Maryland. Over a 130-day period, MITRE reviewed 194 source documents and program artifacts, including Department and Administration Policies, Instructions, and Orders; organizational operating procedures; and ship recapitalization program documents and artifacts that pertain to OMAO's requirements management processes for ship fleet recapitalization. MITRE also conducted interviews with 46 key persons involved in OMAO's ship fleet recapitalization efforts who have interest in and/or responsibility for requirements management. MITRE collected additional information from independent sources, including open sources and subject matter experts in major acquisition programs, systems engineering, ship architectural and naval operations, and related requirements management processes. Table F-1 shows the number of persons interviewed in the various organizations.

Table F-1. Organizations and Persons Interviewed.

Organization	# Persons Interviewed
Department of Commerce Office of Acquisition Management	2
NOAA Acquisition and Grants, Eastern Acquisition Division	3
NOAA Assistant Secretary of Commerce for Oceans and Atmosphere	2
NOAA Chief Financial Officer (Budget & Finance, Performance, Risk, and Social Science Office)	3
NOAA National Environmental Satellite, Data, and Information	1
NOAA National Marine Fisheries Service	1
NOAA National Ocean Service	2
NOAA National Weather Service	1
NOAA Office of Marine and Aviation Operations	5
NOAA Office of Oceanic & Atmospheric Research	2
NOAA OMAO Marine Operations Center – Pacific	3
NOAA OMAO Platform Acquisition Division	6
NOAA OMAO Standing Review Board	10
NOAA Technology, Planning, and Integration for Observation	3
US Naval Sea Systems Command, Support Ships, Boats and Craft Programs	2

[65] Department Organization Orders 10-13 was amended on October 21, 2020, after the completion of the fieldwork phase of this assessment.

F.4.1.3 Reporting

The MITRE team synthesized the observations and findings from the prior stages of the evaluation to author this evaluation report.

Appendix G Alignment of MITRE and Blue Book Standards

MITRE conducted this evaluation work according to MITRE standards for the conduct of evaluations and in alignment with the Council of the Inspectors General on Integrity and Efficiency, *Quality Standards for Inspection and Evaluation* (January 2012, Blue Book). Table G-1 describes the alignment between Blue Book standards and MITRE standards.

Table G-1. Alignment of MITRE and Blue Book Standards.

Blue Book Competencies	MITRE Independent Assessment (Evaluation) Standard
Competency The staff assigned to perform inspection work should collectively possess adequate professional competency for the tasks required.	MITRE carefully selects staff who have the knowledge, skills, abilities, and expertise necessary for the task, including assessment (evaluation) methodologies; technical domain; and the ability to quickly develop a working familiarity with the organizations, programs, activities, and/or functions identified for assessment.
Independence In all matters relating to inspection work, the inspection organization and each individual inspector should be free both in fact and appearance from personal, external, and organizational impairments to independence.	*Working in the public interest requires MITRE to render impartial services that are free of conflict of* (MITRE Code of Ethics and Conduct). MITRE maintains strict adherence to the principles of independence—personal, external, and organizational—so that observations, findings, conclusions, and recommendations will be impartial and will be viewed as valid and impartial by knowledgeable third parties.
Professional Judgment Due professional judgment should be used in planning and performing inspections and in reporting the results.	MITRE is committed to exercise reasonable care and diligence and to adhere in all matters to the principles of serving in the public interest. MITRE highly esteems its reputation for maintaining the highest degree of integrity, objectivity, and independence in applying professional judgment to all aspects of its work.
Quality Control Each Office of the Inspector General organization that conducts inspections should have appropriate internal quality controls for that work.	MITRE maintains disciplined internal processes and procedures for ensuring the work performed and the products delivered meet an exceptional quality standard.
Planning Inspections are to be adequately planned.	MITRE follows a disciplined and structured methodology for conducting assessments, beginning with comprehensive planning and preparation that meets well-understood expectations and lays the groundwork for a timely, impactful, and relevant assessment result.
Data Collection and Analysis The collection of information and data will be focused on the organization, program, activity, or function being inspected, consistent with the inspection objectives, and will be sufficient to provide a reasonable basis for reaching conclusions.	MITRE defines key focus areas and points of contention; focuses on answering assessment questions. MITRE considers resources, time, and data available; the need for different expertise; and time to integrate findings and recommendations.
Evidence Evidence supporting inspection findings, conclusions, and recommendations should be	MITRE considers data-supported, evidence-based analysis as one of the hallmarks of its work. MITRE's disciplined quality standards are designed to ensure sufficient

Blue Book Competencies	MITRE Independent Assessment (Evaluation) Standard
sufficient, competent, and relevant and should lead a reasonable person to sustain the findings, conclusions, and recommendations.	evidence is provided such that any reasonably informed person will concur in the findings, conclusions, and recommendations provided.
Records Maintenance All relevant documentation generated, obtained, and used in supporting inspection findings, conclusions, and recommendations should be retained for an appropriate period.	MITRE carefully catalogs and maintains all relevant documentation generated during the conduct of the assessment that is used to support inspection findings, conclusions, and recommendations. All data is carefully controlled and stored in accordance with the sponsor's and MITRE's security policies and sponsoring agreements. There shall be no sharing or release of sponsor sensitive information without express permission by the government, need to know, and appropriate clearance.
Timeliness Inspections should strive to deliver significant information to appropriate management officials and other customers in a timely manner.	MITRE scopes the assessment with consideration of the resources, data availability, time to integrate findings and recommendations, and conducts comprehensive internal and sponsor reviews and delivers an impactful and relevant assessment result.
Fraud, Other Illegal Acts, and Abuse In conducting inspection work, inspectors should be alert to possible fraud, other illegal acts, and abuse and should appropriately follow up on any indicators of such activity and promptly present associated information to their supervisors for review and possible referral to the appropriate investigative office.	MITRE is committed to performing all work activities to the highest achievable standards and will promptly report any findings that may indicate the possibility of fraud or other illegal acts and abuse.
Reporting Inspection reporting shall present factual data accurately, fairly, and objectively and present findings, conclusions, and recommendations in a persuasive manner.	MITRE will assure all reported findings are represented factually and fairly and are verifiable by multiple unbiased sources.
Follow Up Appropriate follow up will be performed to ensure that any inspection recommendations made to Department/Agency officials are adequately considered and appropriately addressed.	MITRE considers follow-up an important phase in the lifecycle of an assessment and recommends the sponsoring agent solicit the services of MITRE or any reputable independent organization to conduct follow-on activities that increase the likelihood of successful implementation of assessment recommendations.
Performance Measurement Mechanisms should be in place to measure the effectiveness of inspection work.	MITRE considers this competency the responsibility of the sponsoring organization and encourages the same.
Working Relationship and Communication Each inspection organization should seek to facilitate positive working relationships and effective communication with those entities being inspected and other interested parties.	MITRE considers the establishment of trust and transparency a critically important first step in the conduct of an assessment. Once these are established, positive working relationships and effective communications with the entity being assessed can thrive.

Appendix H Definitions of Requirements Types

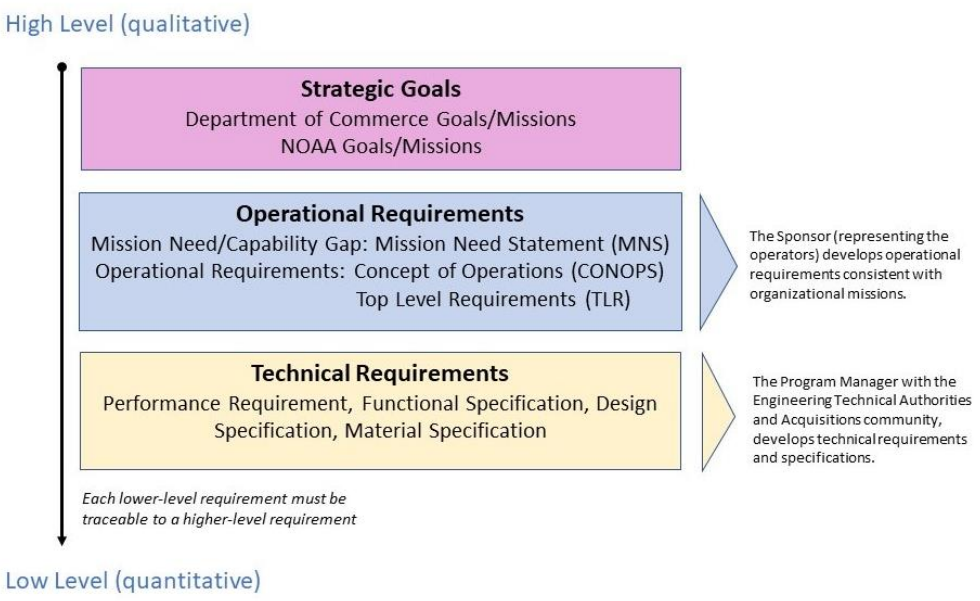
MITRE uses "ship fleet requirements" in this report to describe the hierarchy of requirements that drive the mission need and the technical design, construction, and operation of National Oceanographic and Atmospheric Administration (NOAA) seagoing vessels (i.e., the fleet). This hierarchy is divided into two domains:

- **Operational requirements** – statements that describe the capabilities needed to accomplish NOAA's mission requirements.
- **Technical requirements** – statements that describe the technical attributes (for example, of a system) necessary to provide the capability or the "solution space."

End users in the field (in this case the NOAA Line Offices) are generally responsible for determining operational requirements—from top-level mission requirements to detailed system-level operational requirements. The MITRE Systems Engineering Guide refers to the process of decomposing requirements from the highest to the lowest level of detail as requirements generation, or requirements development. This process begins with strategic planning—a third domain in the requirements hierarchy.

Figure H-1 depicts this hierarchy of requirements—from high-level strategy through detailed technical specifications.[66] As noted, each tier of lower-level requirements must be bi-directionally traceable to a higher-level requirement.

Figure H-1. Requirements Hierarchy.



The term requirement is used variably across the NOAA Line Offices, including the Office of Marine and Aviation Operations (OMAO). For example, in the 2016 NOAA Fleet Plan: Building NOAA's 21st Century Fleet the word "requirement(s)" is applied 47 different ways as part of a

[66] Coast Guard Operational Requirements Generation Manual; adapted from Figure 1-2.

range of terms, including “at-sea capability requirements,” “core mission requirements,” and “shipbuilding requirements.” Baseline documentation contains few definitions for the ways these terms are used, which contributes to ambiguity and confusion. Table H-1 outlines NOAA’s primary definitions for various requirements types.

Table H-1. Definitions of Requirements Types Used in This Report.

Requirement	Description	Example
Mission Requirements	A validated NOAA responsibility resulting from one or more requirements drivers.	Charting and surveying – NOAA’s mission includes support of safe navigation; management of coastal and ocean resources; and restoration, response, and technical assistance for coastal zone management. Data collected by the NOAA fleet in support of these activities has significant economic and societal benefits. Without recapitalization, the accuracy of nautical charts will be reduced, thus placing ships at greater risk of running aground, and harming the economy and ecology. Additionally, decreased fleet capacity will reduce the surveying of habitat, which will result in less accurate and more conservative fishery quotas and stagnate the mapping of the Exclusive Economic Zone so it no longer reflects current data.
User Observation Requirements (also referred to as At-Sea Data Collection requirements)	Documented and validated user needs for environmental parameters, with their associated attributes. These needs are required to produce specific products and services to meet mission objectives.	Requirement – Bering Sea Pacific cod and other groundfish trawl survey.
At-Sea Activities	The activities at sea that support the NOAA mission requirements	Navigation, observations, and positioning – NOAA observes, monitors, and collects data about the ocean and coasts to deliver tools and information that help mariners safely navigate the nation’s ports and harbors. Nautical charts, or maps, are the tools used by all sectors of the maritime industry (commercial, military, and recreational) for safe navigation in waterways and coastal areas.
Ship Capability Requirements	The instrumentation, mission support equipment, and design and configuration factors that provide the ability for ships to meet at-sea data collection requirements	Trawl – Commercial-size bottom and pelagic trawl nets, gear, and sampling system to meet fisheries survey requirements.

Appendix I NOAA's Response

UNITED STATES DEPARTMENT OF COMMERCE
Deputy Under Secretary for Operations
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

APR 07 2021

MEMORANDUM FOR: Frederick J. Meny, Jr.
Assistant Inspector General for Audit and Evaluation

FROM: Benjamin P. Friedman
Deputy Under Secretary for Operations
Performing the duties of the Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

SUBJECT: *OMAO Must Define and Implement a Disciplined Requirements Management Process to Ensure Future Acquisitions Meet User Needs*
Draft Report

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) is pleased to submit the attached response to the draft report on NOAA's Ship Fleet Recapitalization Program. We reviewed the report and concurred with the recommendations.

We appreciate the opportunity to review and respond to your draft report. If you have any questions please contact Tanisha Bynum-Frazier, Director, Audit and Information Management Office at 301-467-0832.

Department of Commerce
National Oceanic and Atmospheric Administration
Comments to the OIG Draft Report Titled
"OMAO Must Define and Implement a Disciplined Requirements Management Process to Ensure Future Acquisitions Meet User Needs"
March 2021

General Comments

The National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to review and comment on the MITRE Corporation Draft Report entitled "OMAO Must Define and Implement a Disciplined Requirements Management Process to Ensure Future Acquisitions Meet User Needs," for the Department of Commerce, Office of Inspector General (OIG). NOAA reviewed the draft report and concurs with the recommendations. The response to each recommendation, general comments, and recommended changes to the draft report, are provided below.

We would like to highlight that it appears MITRE did not talk to one important organization within NOAA that manages and tracks at-sea observing requirements. Specifically, the draft report does not mention the Fleet Council or its Ship Allocation process, which the Office of Marine and Aviation Operations (OMAO) has found to be a crucial indicator of the requirements and missions NOAA has determined are a high priority for the organization.

Recommended Changes for Factual/Technical Information

Why MITRE did this review, page iii, second paragraph and Introduction, page 1-1, third paragraph:

The report explains that OMAO's partnership with the Navy was unable to mitigate all risks associated with the ship recapitalization program's requirements management process. We request that the following be included in the final OIG report:
The partnership with the Navy was not intended to mitigate all risks associated with NOAA's ship recapitalization program requirements management process. The NOAA Auxiliary General Oceanographic Research (AGOR) Variant (NAV) project was a directed effort initially funded through reprogrammed funds. It was not until fiscal year (FY) 2016 that Congress appropriated funds, which could not be released until the NOAA Fleet Plan was made public, on October 31, 2016. The program was initiated to leverage an existing Navy contract and design that was deemed suitable for meeting NOAA's mission.

What MITRE found, page iii/iv:

The report states, "OMAO's current, multi-layer governance process, emphasizing collaboration between NOAA Line Offices, is effective when a program's requirements are well understood, relatively mature, and static. However, the ship recapitalization

program is a more complex capability development that must satisfy new and emerging requirements. In such cases, collaboration alone will not suffice to mitigate requirement risks."

We request that the following be included in the final OIG report:
OMAO is following the NOAA prioritized at-sea requirements outlined in the 2016 NOAA Fleet Plan, and using Line Office collaboration to determine the core capability requirements for new ships. NOAA's processes are also based on the Federal Fleet Capacity/Capability gaps identified in the 2016 Federal Oceanographic Fleet Status Report. The NOAA Fleet Plan and Fleet Status Report highlighted the need for new assets to be constructed to fill capability gaps between the required Days at Sea and the capacity of the NOAA Fleet. The 2016 NOAA Fleet Plan provides a long-term strategy for NOAA's Fleet Recapitalization Program to construct Classes A, B, C, and D. OMAO's Platform and Acquisition Division (PAD) led the development of initial requirements and overall engineering, design, procurement, and construction efforts of the new ship platforms.

Page 2-5, first sentence of Section 2.1.2:
The report states, "The 2016 NOAA Fleet Plan to build four new classes of vessels coincided with the new, mandatory Department of Commerce acquisition approach and the creation of OMAO's Platform Acquisition Division (PAD)."

We request that the OIG change this statement to reflect that the Platform Acquisition Division (PAD) was established a decade earlier on October 15, 2006 by NOAA Circular 06-03 to manage the acquisitions of NOAA's planned ships.

Page 2-6, Paragraph 2:
The report states that, "When asked to describe the end to end requirements process, OMAO's PAD explained, 'PAD has a unique system for capturing ship system and sub-system characteristics, adjudicating and adjusting to requirements, and tracking requirements across the project. It is efficient and has proven to be effective during the Fisheries Survey Vessel (FSV) and NOAA Auxiliary General Oceanographic Research (AGOR) Variant (NAV) acquisition projects.'"

MITRE paraphrased PAD's full response, which should state as follows:

"Through a myriad of technical and data collection meetings, architectural and engineering research, analytics, model tests, IPT working groups, and close coordination with NOAA Line Offices, requirements were developed into performance criteria, Key Performance Parameters, detailed ship and science mission specifications, a statement of work, and a data requirements list to enable shipyard vendors to price, develop preliminary and detailed designs to construct the new vessels. PAD has a unique system for capturing ship system and sub-system characteristics, adjudicating/adjusting to requirements, and tracking requirements across the project. It is efficient and has proven to be effective during the FSV and NAV acquisition projects."

NOAA Responses to OIG Recommendations

Recommendation 1: That the NOAA Deputy Under Secretary for Operations ensure that OMAO benchmark, build, and elevate an overarching OMAO strategic plan, acquisition plan, systems engineering management plan, and program management practice.

NOAA Response: NOAA concurs. OMAO recently released a five-year strategic plan that serves as a roadmap for OMAO through 2025. Additionally, OMAO recently established a Strategic Management Division (SMD), which will oversee management of the OMAO Strategic Plan, as well as centralize OMAO's policies to ensure consistency in business practices across the organization, including acquisitions, systems engineering, and program management plans.
PAD and SMD will work together to include the Fleet Force Architecture into these documents.

Recommendation 1.1: That the NOAA Deputy Under Secretary for Operations ensure that OMAO develop and regularly update a long-range vessel acquisition plan that lays out the dependencies between fleet objectives, funding, inventory, technology, and sustainment costs, among others and supports program milestone requirements.

NOAA Response: NOAA Concurs. The NOAA Fleet Plan will be updated regularly to provide an internal long-range vessel acquisition plan that lays out the dependencies between fleet objectives, funding, inventory, and technology. NOAA will work towards completion of this plan for use with the Class B acquisition.

Recommendation 1.2: That the NOAA Deputy Under Secretary for Operations ensure that OMAO establish a requirements management and change control process to ensure guidance is consistent, repeatable, regularly updated, and baselined. Ideally, this would be developed at the NOAA level and disseminated to NOAA program managers and appropriate Line Office representatives.

NOAA Response: NOAA concurs. NOAA has tasked the NOAA Observing Systems Council (NOSC), in coordination with the NOAA Technology, Planning and Integration for Observation division (TPIO), to establish a requirements management and change control policy and to update the NOAA Program Observation Requirements Documents (PORDs). Included in the policy will be annual updates on ship requirements to inform the process. OMAO has used an internal requirements traceability matrix tool for the fisheries survey vessel (FSV) acquisitions. We acknowledge the need to document and establish formal requirements management and change control processes to ensure consistent guidance and practice across the organization.

Recommendation 1.3: That the NOAA Deputy Under Secretary for Operations ensure that OMAO develop and implement a systems engineering policy that integrates systems engineering principles into program management processes across the entire acquisition lifecycle.

NOAA Response: NOAA concurs. OMAO is currently engaged with National Environmental Satellite, Data, and Information Service (NESDIS) personnel to review

their systems engineering policy and, where applicable, modify the policy for OMAO's implementation across the entire acquisition lifecycle.

Recommendation 1.4: That the NOAA Deputy Under Secretary for Operations ensure that OMAO incorporate guidance on the use of IAAs in acquisition policies, with an emphasis on tailoring documentation to minimize duplication while meeting agency requirements.

NOAA Response: NOAA concurs. OMAO will review guidance such as the Department of Commerce Acquisition Manual (CAM) Chapter 1317.570 on IIAs and will work to tailor its internal documentation to minimize duplication while meeting agency requirements.

Recommendation 2: That the NOAA Deputy Under Secretary for Operations ensure that OMAO develop OMAO-specific guidance for managing requirements, including requirements analysis, traceability, and allocation.

NOAA Response: NOAA concurs. OMAO is currently engaged with NESDIS personnel to review their requirements management plan and, where applicable, modify the documents for OMAO's implementation across the organization. Additionally, OMAO is working to hire additional staff for policy and standardization efforts. OMAO will develop a requirements traceability and implementation plan to ensure fleet requirements are properly recorded, understood, and tracked in technical and programmatic documentation.

It is important to note that OMAO has hired and augmented personnel (i.e., hiring a Director of PAD, a Class B Project Manager, and over 10 support personnel) in the past 2 years, and also has augmented resources (e.g., new CAD programs, Business Management with Workflow and Life Cycle software, Engineering computers, and Online technical subscriptions with augmenting options). PAD has evaluated commercial-off-the-shelf (COTS) software systems to better manage requirements analysis, traceability, and allocation, and NOAA currently is using the Navy Program Management Office Program Manager, Ships (NAVSEA's PMS), Google Drive, and ImageSite in support of the NAV. NOAA will continue using Google Drive with other supporting software (e.g., spreadsheets and Word documents) for analyzing, tracking, and allocating requirements for Class B until they are transferred to ImageSite.

Recommendation 2.1: That the NOAA Deputy Under Secretary for Operations ensure that OMAO develop a requirements management guide and traceability process that follows the SAPMG and system engineering standards (e.g., INCOSE).

NOAA Response: NOAA concurs. OMAO is currently engaged with NESDIS personnel to review their requirements management plan and systems engineering policy and, where applicable, modify the process for OMAO's implementation across the organization.

Additionally, OMAO is working to hire additional staff for policy and standardization efforts. OMAO will develop a requirements traceability and implementation plan to ensure fleet requirements are properly recorded, understood, and tracked in technical and programmatic documentation.

PAD has evaluated some COTS software systems to better manage requirements analysis, traceability, and allocation, and NOAA currently is using the NAVSEA's

PMS, Google Drive, and ImageSite in support of the NAV. NOAA will continue using Google Drive with other supporting software (e.g., spreadsheets and Word documents) for analyzing, tracking, and allocating requirements for Class B until they are transferred to ImageSite.

Recommendation 2.2: That the NOAA Deputy Under Secretary for Operations ensure that OMAO leverage mission requirements and at-sea data collection requirements to provide OMAO with a verifiable means of capturing the annual mission performance.

NOAA Response: NOAA concurs. NOAA has tasked the NOSC, in coordination with TPIO, to establish a requirements management and change control policy and to update the NOAA PORDs that address NOAA mission requirements and at-sea data collection requirements. OMAO will manage the technical and ship specification requirements to meet these mission needs.

Recommendation 3: That the NOAA Deputy Under Secretary for Operations ensure that OMAO document and implement a disciplined approach to validating requirements through increased Line Office communication.

NOAA Response: NOAA concurs. A disciplined approach to validating requirements will be achieved through the NOSC, in coordination with TPIO, to coordinate, update, and maintain the PORDs. OMAO will manage technical and ship specification requirements to meet mission needs.

Appendix J Abbreviations and Acronyms

AGOR	Auxiliary General Oceanographic Research
AIS	Acquisition Improvement Study
CDD	Capability Development Document
DAO	Department Administrative Orders
DAS	Days at Sea
FSV	Fisheries Survey Vessel
FY	Fiscal Year
GAO	Government Accountability Office
IAA	Interagency Agreement
INCOSE	International Council on Systems Engineering
IPT	Integrated Product Team
MDM	Milestone Decision Memorandum
MNS	Mission Needs Statement
MRB	Milestone Review Board
NAO	NOAA Administrative Order
NAV	NOAA AGOR Variant
NAVSEA/PEO	Naval Sea Systems Command/Program Executive Office
NESDIS	National Environmental Satellite, Data, and Information Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NWS	National Weather Service
OAE	Office of Audit and Evaluation
OAR	Office of Oceanic and Atmospheric Research
OIG	Office of the Inspector General
OMAO	Office of Marine and Aviation Operations
OSV	Ocean Survey Vessel
PAD	Platform Acquisition Division
RMP	Risk Management Plan
RTM	Requirements Traceability Matrix
SAPMG	Scalable Acquisition Project Management Guidebook
SEE	Strategy Execution and Evaluation
SWATH	Small Water Plane Area Twin Hull
TLR	Top Level Requirements
TPIO	Technology, Planning, and Integration for Observation